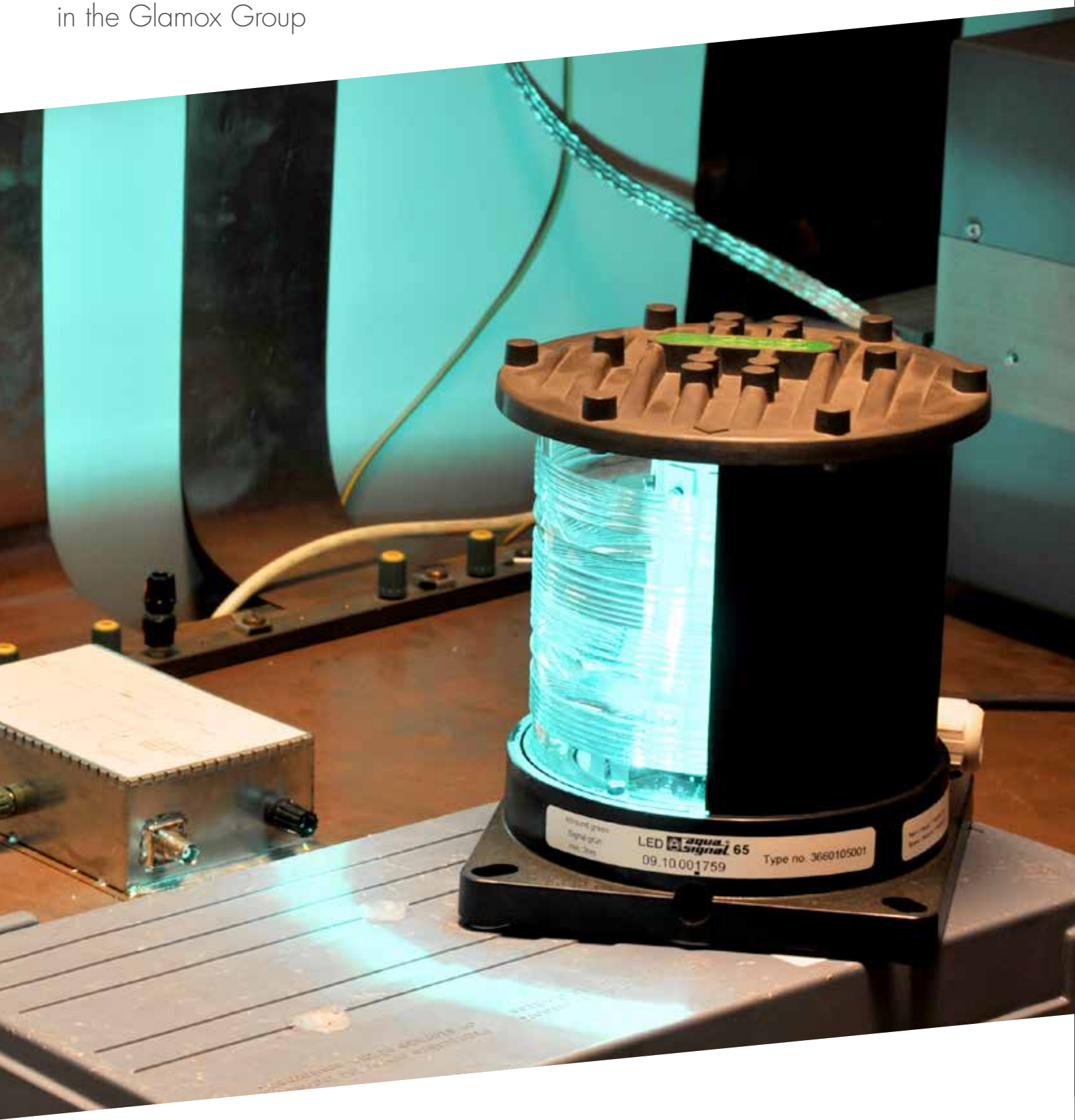
GLAMOX aqua signal

GLOBAL MARINE & OFFSHORE
LIGHTING SOLUTIONS

Dedicated to quality

About quality assurance, test procedures and product certification in the Glamox Group



The Glamox Group is dedicated to quality

Glamox is the leading supplier of lighting solutions to the world's marine and offshore markets. We take pride in providing products of superior technical quality that work reliably even under the most extreme conditions.

Technology and expertise
Our products and solutions are developed and tested by our engineers at our own research and testing facilities, and manufactured and certified in accordance with all relevant quality and environmental standards. They are based on the latest technology and expertise – and generations of experience.

Our quality systems
The Glamox Group's quality policy is laid down in the primary control documents of the Glamox Control System, in compliance with the ISO 9001 quality standard. Most of our production units and testing facilities have certified quality systems according to ISO 9001. Our quality policy encompasses all of the following important aspects of our activities:

- Quality in product development and construction
- Quality in the selection of suppliers and components
- Quality in manufacturing
- Quality in testing and certification
- Quality in logistics and product shipment
- Quality in customer care and complaints handling

Environmental policy
The Glamox Group also has an environmental policy, and several of our production units hold the ISO 14001 environmental approval.

Product marking and certification
Official approvals provide security for our customers, and prove that our lighting systems are first class.

They are also recognition of the fact that we are never satisfied with what we have achieved so far, but seek perfection in the performance of our products.

Special lighting leads to enhanced durability and stability of the materials and electronic gears in use which leads to special demands and requirements. Standards and rules issued by international authorities cover these extended requirements in design and functionality, they outline the most sophisticated design process that often results in a complex type approval procedure.

CE and ENEC marks
Each luminaire that leaves our production includes the CE mark. The CE mark indicates that the manufacturer guarantees that the relevant requirements for health and safety expected of the product are fulfilled. Further, all major luminaire series from Glamox have ENEC certification. ENEC certification is a common certification agreement for lighting equipment, which is accepted in the whole CEN area.

The CE mark is a mandatory conformity marking for products sold in the European Economic Area (EEA). It is the manufacturer's declaration that the product meets the requirements of the applicable EC directives.

ENEC is the high quality European mark for electrical products that demonstrates compliance with European safety standards. The two-digit number indicates which certification body has issued the ENEC certification.

Contents

The laboratories in Bremen and Molde have been certified in accordance to the requirements of ISO 9001, ATEX and IECEx.

Modern testing facilities

As a result of the high demands placed on the quality and durability of its products, the Glamox Group operates modern assessment and testing laboratories in Norway and Germany for the simulation of a wide variety of environmental conditions.

Environmental test centers in Bremen and Molde
These institutes have earned an excellent reputation in the lighting industry, and possess licenses from institutions such as the European Norms Electrical Certification (ENEC), the BSH Bundesamt für Seeschifffahrt und Hydrographie (the German Federal Maritime and Hydrographic Agency) and Germanischer Lloyd (GL).

Third party testing
On account of their significance and their reliable simulation and testing methods, the laboratories are also used by external firms and organizations. The test reports of our laboratories are accepted e.g. by Germanischer Lloyd (GL), Lloyd's Register (LR), Det Norske Veritas (DNV), Bureau Veritas (BV), Physikalisch-Technische Bundesanstalt (PTB) and many more.

The importance of testing and simulations
The simulations performed in our laboratories aim to test our products in the most realistic conditions possible.

For instance, on their perpetual voyage across the world's oceans our luminaires have to resist lowest and highest temperatures, as these might travel in the Arctic seas as well as in equatorial regions. The luminaires have to withstand rough seas as well as high temperatures exposed to direct sunlight. In any circumstance, our luminiares must operate flawlessly and reach their ranges of visibility and light colours specified. To meet these very highest quality standards, all our products leave our laboratories not until they have passed the most stringent tests and examinations.

In the following pages we are presenting some of the wide range of tests and simulations carried out at our testing facilities.

Free fall shock tests

Mechanical shock has the potential for damaging a product. For this reason there are shock resistance requirements based on a number of international standards, depending on a luminaire's intended application and purpose. We test our luminaires in accordance with these requirements for type approval purposes.

Sometimes a shock may result in only minor damage which may not be critical for use. However, cumulative minor damage from several shocks could eventually result in the product becoming unusable, or cause the service life of the product to be shortened. Therefore it is important that we should know the effects of mechanical shocks on our products. Shock testing is an important element in many type approval processes.

Free fall shock test stand (half-sine)
In the fall-shock facility, the objects are tested with a maximum weight of 70 kg. Each shock pulse is recorded in an oscillogram. Depending on the height of drop, a maximum of 300G can be achieved.

Our free fall shock test stand is designed to perform high-G/ short duration shock impulses. This free fall shock test system will accomplish half-sine wave impact results.

Oscillographed
The shape and duration of each shock pulse is oscillographed.

Free fall shock test
In these images we are testing a small LED navigation light for recreational boats.

Vibration testing

Marine luminaires and luminaires with Ex approvals have to be vibration tested. We have equipment to do pre-qualifying tests for vibration. Within the scope of vibration testing, three different types of tests are performed: Sinusodial vibration, various shock tests and random testing.

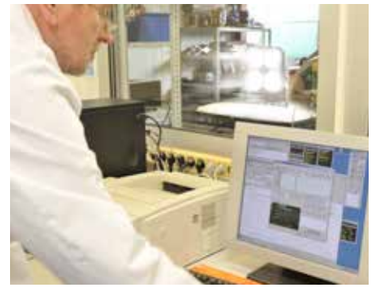
A slip table with an oil film is used to test products from impact with sinus, random and shock impulses. Acceleration sensors are used to investigate the behaviour of the test subject under the influence of vibration loading. Using the slip table, acceleration values of up to 15 G can be achieved. Without the slip table, values of up to 50 G can be reached.

Vibration testing with a stroboscope
As each specimen has to be tested in three axes (X, Y, Z) very specific resonance frequencies have to be determined. In each of these, long-term testing has to be performed, and the behaviour of the specimen has to be observed using a stroboscope.

With the aid of a stroboscope it is possible to observe the specific movements of the specimen in its resonance.

Vibration testing
Our equipment is designed for vertical, horizontal and lateral vibration testing.

Analyses
The test results are carefully recorded and analyzed by our scientists.



Impact resistance in sub-zero environments

In mechanics, an impact is a high force or shock applied over a short time period when two or more bodies collide.

Impact tests are used in studying the toughness of material. A material's toughness is a factor of its ability to absorb energy during deformation. Brittle materials have low toughness as a result of the small amount of deformation that they can endure. The impact value of a material can also change with temperature. Generally, at lower temperatures the impact energy of a material is decreased.

Minus 50°C
We test our luminaires with the aid of a pendulum of known mass and length that is dropped from a known height to impact a specimen. The specimen is placed in a specialized chamber with temperatures down to -50°C. The temperature in the chamber should be five degrees lower than the lowest ambient temperature (Ta value) specified by the manufacturer for the luminaire being tested.

Impact tests
Tests are carried out by using a pendulum and basic physics to measure how much energy it will hold when released from a particular height.

Climatic testing

Environmental simulations in climate test chambers allow us to measure the effects of temperature and humidity on our products in a controlled manner.

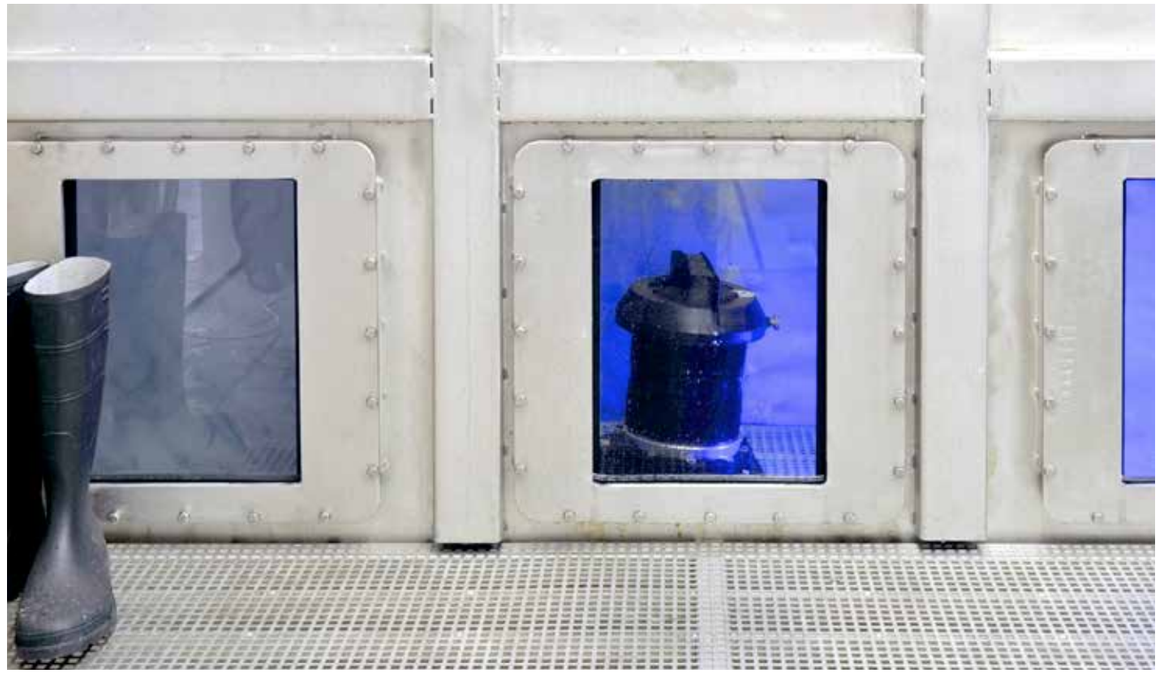
Climatic testing is required to ensure that our luminaires will perform to standard under the climatic conditions they will encounter in service use. Materials can deteriorate over time, ageing prematurely due to either high or low temperature extremes, while humid conditions may lead to condensation which can be damaging to electronic components.

Our climate test chambers have a test space of up to 1,500 litres. They are used to undertake heat tests of up to +180°C, cold tests of down to -75°C and humidity examinations in a range from 15% to 98%.

Here we are able to reproduce the effect on our luminaires of a wide range of temperature and humidity levels, including extreme stress parameters such as rapid temperature change. The accurate simulation of authentic environmental conditions speeds up the research into new materials and improves the quality and reliability of our products.

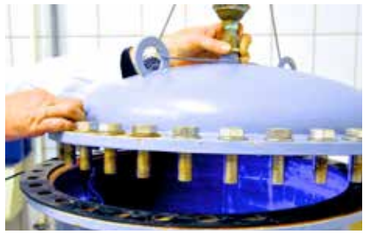
The 5-year test
One of our climatic testing chambers is dedicated to five-year testing of a navigation light.

Rapid temperature change
Rapid temperature changes of up to 5°C per minute are possible in a 180 litre chamber.



Submersion into water
The luminaires are tested against ingress of water in up to 1 meter depth.

Water pressure tank
The luminaires are submerged into a water pressure tank, simulating various depths beyond one meter.



Spray water/splash water
The luminaires are hosed with varying degrees of power, from fine spray to hard water jets.

IP rating (water)

In our wetrooms we assess the protection of our luminaires against ingress of water, varying over differing degrees of protection, depending upon the requirements for the different types of lighting product.

From rain testing through spray water and water jets to permanent submersion in the pressure vessel, all IP degrees of protection for products can be tested. Different test means for simulation are possible:

Rain IP X4
Spray water IP X5
Splash water IP X6
Submersion into water IP X7
Water pressure tank up to 40 meters' depth (IP X8)
Additional with high pressure cleaner for special applications (IP X9)

IP rating (dust)

In our dust chambers we assess the protection of our luminaires against ingress of solid particles, varying over differing degrees of protection, depending upon the requirements for the different types of lighting product.

Solid objects protection
There are six levels of protection against the ingress of solid foreign objects, represented by the first digit in the two-digit IP rating of a product.

> *50mm:* Any large surface of the body, such as the back of a hand, but no protection against deliberate contact with a body part

>*12.5 mm:* Fingers or similar objects

> *2.5 mm:* Tools, thick wires, etc.

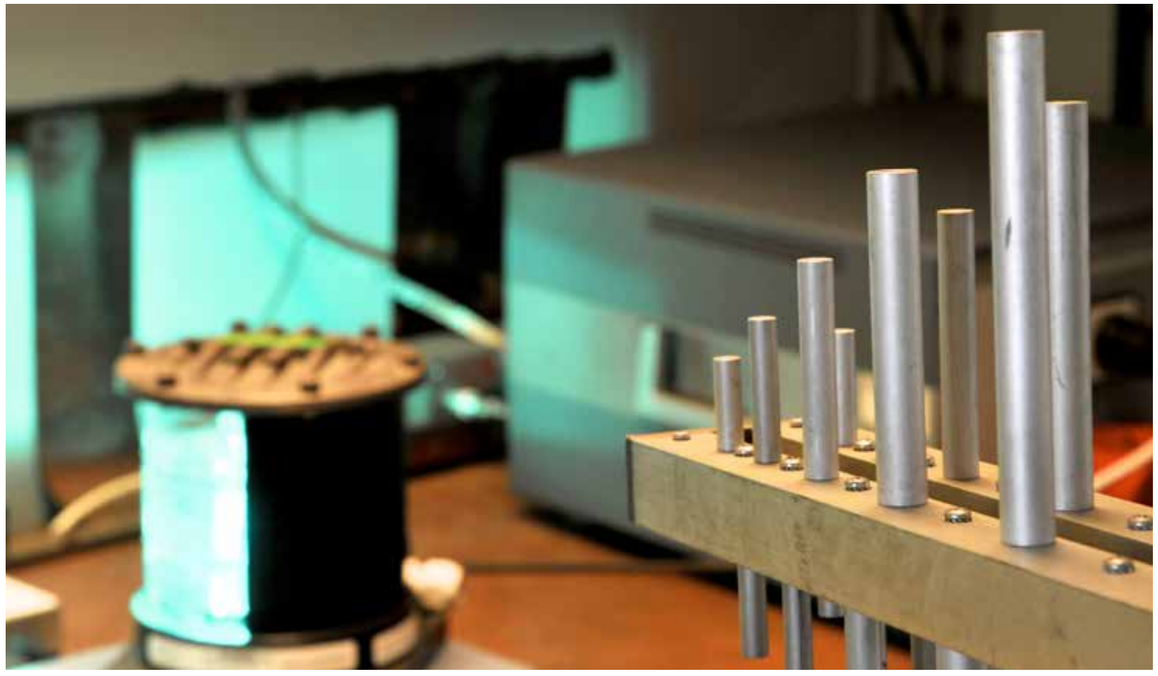
> *1mm:* Most wires, screws, etc.

Dust protected: Ingress of dust is not entirely prevented, but it must not enter in sufficient quantity to interfere with the satisfactory operation of the equipment; complete protection against contact

Dust tight: No ingress of dust; complete protection against contact

The dust test chamber
Dust tests are performed to test the functioning of our luminaires under extreme environmental conditions. International standards specify the test duration and the composition of dust used. The formation of dust within the test space is effected by compressed air injection.

The IP code
The IP code (Ingress Protection Rating) classifies and rates the degree of protection provided against the intrusion of solid objects (including body parts like hands and fingers), dust, accidental contact, and water in mechanical casings and with electrical enclosures. The standard aims to provide more precise information than vague marketing terms such as *waterproof* or *dustproof*.



Electromagnetic compatibility testing (EMC)

EU directives set requirements to which norms equipment of any kind have to be satisfied before released for the EU market. Therefore all electric equipment must satisfy the EMC-directive.

This EU directive refers to European product norms EN-55015 (electromagnetic interference from a luminaire) and EN-61547 (immunity of a luminaire against electromagnetic interference from outside).

The importance of EMC control
Electromagnetic compatibility (EMC) is a branch of electrical sciences. Its aim is to ensure that equipment items or systems will not interfere with or prevent each other's correct operation through spurious emission and absorption of electromagnetic interference (EMI).

Testing in a shielded chamber
Inside our shielded chamber we can perform all tests necessary for luminaires. We can test products against radiated and conducted emission, electrostatic discharge ESD, burst and surge on power lines and immunity to high frequency electromagnetic fields.

EMC testing
All electrical products are potential emitters of electromagnetic waves. Our luminaires are tested according to both EN-55015 and EN-61547.

GTEM cell
In a GTEM cell we can measure a product's immunity to HF radiation and radio emissions.

UV radiation testing

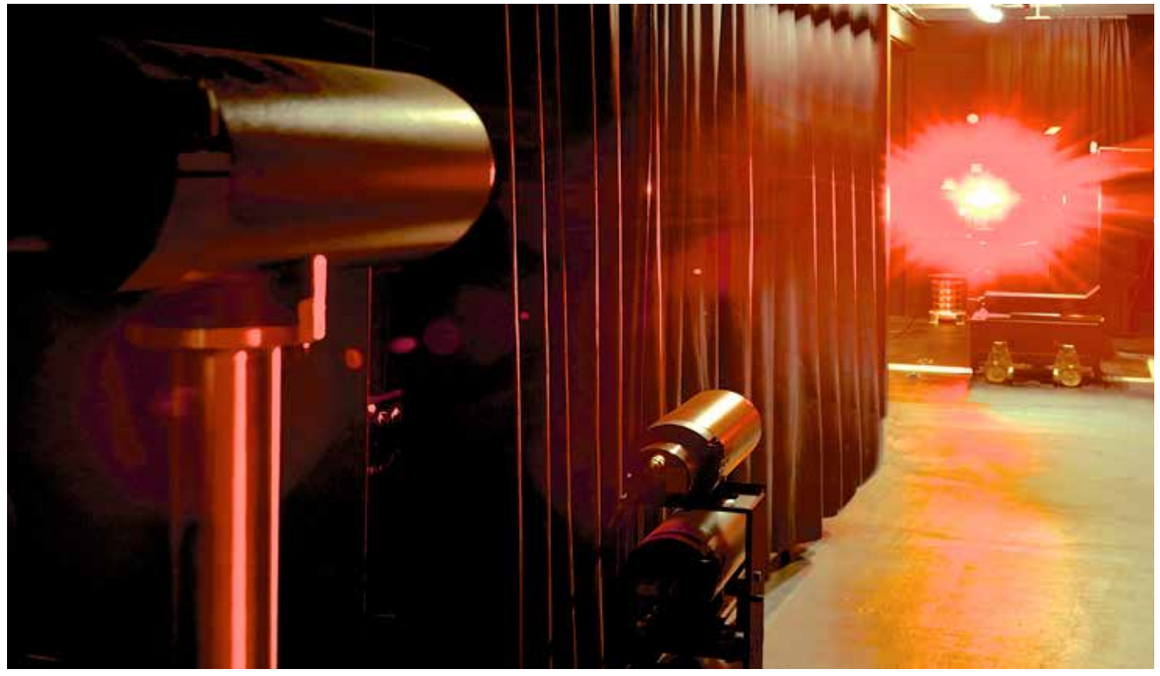
Ultraviolet radiation (UV) is a specific range of light on the electromagnetic spectrum. It is invisible to humans because its wavelength range is beyond the limit of human perception.

UV radiation can impact the performance products and components. Many natural and synthetic polymers are attacked by ultra-violet radiation, and products using these materials may crack or disintegrate if they're not UV-stable. The problem is known as UV degradation, and is a common problem in products exposed to sunlight. Continuous exposure is a more serious problem than intermittent exposure, since attack is dependent on the extent and degree of exposure.

UV degradation in materials testing
UV radiation tests are used to test products and components under solar radiation conditions. In this process, products and components are subjected to ultraviolet exposure in a controlled environment. A solar simulator is used to create ultraviolet radiation and simulate months or years of exposure.

These tests allow us to reproduce the conditions a product is likely to be exposed to during its life time. Testing is done in accordance with EN 61439-1 Resistance to ultra-violet (UV) radiation.

UV degradation
The effects of UV degradation on materials that require a long service life can be measured with accelerated exposure tests. UV light is present in sunlight and can cause chemical reactions in certain materials.



Photometry

Photometry is the science of the measurement of light, in terms of its perceived brightness to the human eye.

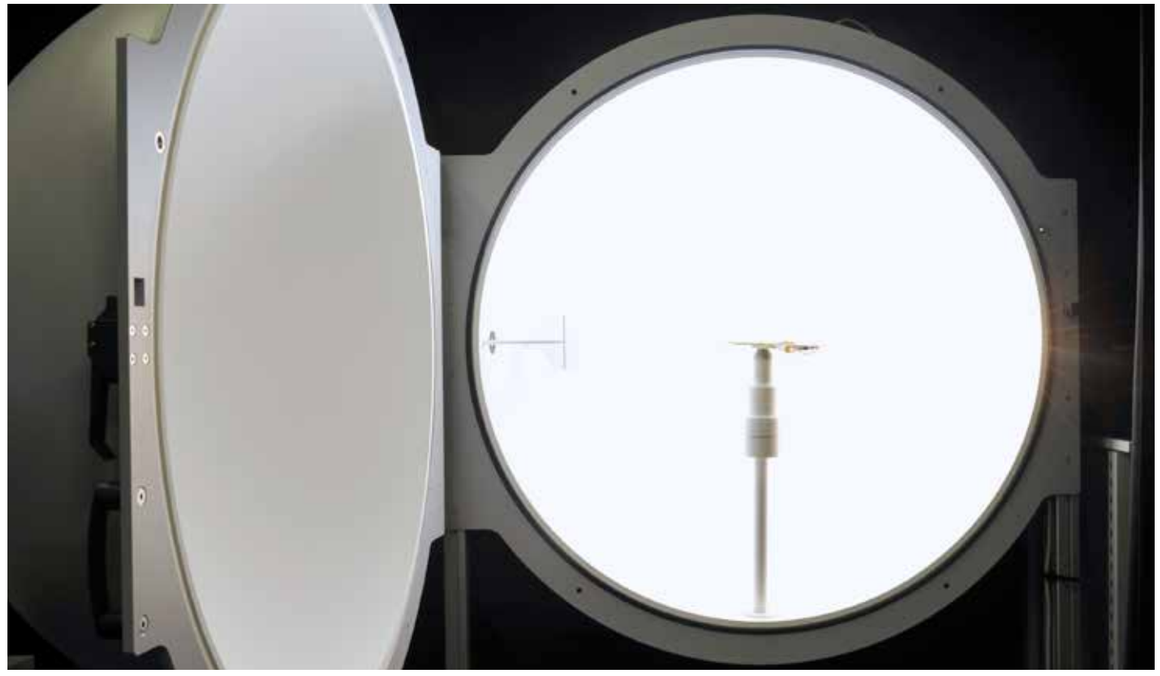
Our luminaires are tested using goniophotometers, which keep the luminaire stationary at a sufficient distance from the photocell that the luminaire can be considered a point source. Goniophotometers use a rotating 2-axis table to change the orientation of the luminaire with respect to the photocell. From the photometric data it is possible to produce light technical data according to utilized standards and applications.

The data serve as basis for lighting calculation programs in which entire rooms, fitted with diverse luminaires, are calculated and evaluated, exact illumination design plans can be produced.

Flash measurements
A flash measurement unit with computer-supported evaluation of the flash pulses and assessment of the effective luminous intensity completes this facility. With our transportable testing units, we are also able to perform measurements of luminous intensity and light density in the field.

Photodetection
Photometric measurement is based on photodetectors that produce an electric signal when exposed to light.

Photometry
All photometry is executed according to the EN13032-1 and CIEs (International Lighting Commission) regulations and guidelines.



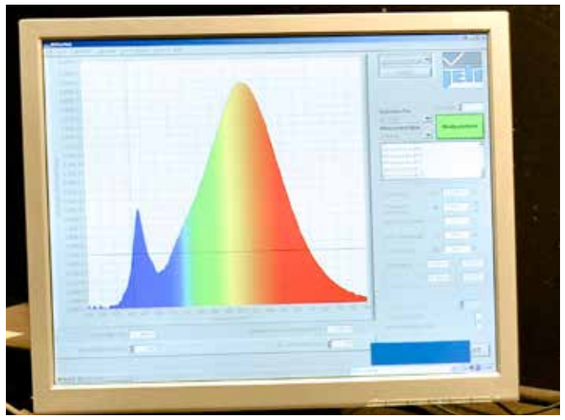
Optical spectrometry

Spectrometry is the study of objects based on the spectrum of colour they emit or reflect.

The visible spectrum is the portion of the electromagnetic spectrum that can be detected by the human eye. At Glamox, we use sophisticated equipment such as spectroradiometers to determine the quality of light sources and luminaires.

For example, in our spectral sphere we can produce precise measurements of total luminous flux and total spectral flux. Standard configurations are optimized for capturing total flux measurements of LEDs, lamps and luminaires.

All measurements are made according to CIE (International Lighting Commission) recommendations and industry standards.



Colour spectrums
The results of our tests are represented by colour spectrums.

Salt mist spray test

The salt mist spray test is a standardized test method used to check corrosion resistance of coated samples. The test produces a corrosive attack to the coated samples in order to predict the coating's suitability in use as a protective finish.

Salt spray testing is very important for assessing the suitability of products intended for outdoor use or for use in cold or wet environments. Unacceptable products corrode within a short time under the influence of the saline air.

Standardized salt spray chamber
Equipment for salt mist testing are standardized under national and international regulations. These standards describe the necessary information needed to carry out the tests; determining testing parameters such as the size of the chamber, temperature, air pressure of the sprayed solution, preparation of the spraying solution, concentration, pH, etc.

In our salt spray chamber with a volume of 1000 liters we are able to simulate the effect of saline air on our luminaires, speeded up in time. The appearance of corrosion products (oxides) is evaluated after a period of time. Test duration depends on the corrosion resistance of the coating; the more corrosion resistant the coating is, the longer the period in testing without showing signs of corrosion.

Corrosion control
Different coatings provide different degrees of corrosion resistance to metallic parts.

Programmable
Different spraying periods and temperatures are programmable.

Electrical examinations

In our laboratories a number of electrical tests and examinations are performed on a daily basis.

Testing for power variations
Without the proper power, an electrical device may malfunction, fail prematurely or not operate at all. With our testing equipment we are able to test products and equipment to extreme power supply levels and voltage variations, in order to demonstrate reliability and compliance with the requirements.

ESD simulation and testing
Electro-Static Discharges may be harmful to a luminaire and other equipment. We therefore test our products mechanically at similar values measured for real human body discharges. Our ESD dischargers generate discharge currents that are fully compliant with the standards.

High voltage tests
High voltages may lead to electrical breakdown, and equipment and conductors that carry high voltage warrant particular safety requirements and procedures. We carry out high voltage tests to ensure that we meet the safety standards.

Danger of breakdown
High voltages may lead to electrical breakdown.

Electrical examinations
Our test centers are equipped with a range of specialized tools and measuring devices for electrical examinations.

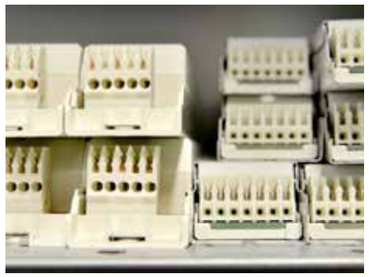
Component testing

Our lighting products consist of a large number of components, manufactured by a wide variety of suppliers from all over the world. Careful component selection and supplier quality control is a key element in our quality system.

At our laboratories much time is dedicated to the testing of alternative components. This requires a great deal of know-how about the nature of different materials. The components in our products are electric and electronic, of glass, metal or polymer materials, and much more. We always use the best quality components for our purposes, from the best manufacturers. This requires a rigid testing and supplier selection policy.

LED: Light source of the future
A good example of this is our policy for the testing and selection of LED light sources. Light Emitting Diodes are in rapid development, and the lighting industry is disadvantaged by the lack of international standards.

At Glamox we aim to produce LED luminaires with single LEDs, LED modules and LED drivers of the best possible quality. For this purpose our test centers are hard at work identifying the components that will provide the most efficient and reliable over time when included in one of our LED luminaires.



Choice of components
There are literally thousands of components in use at our production facilities – and thousands more available on the market.

LED challenge
LED components are a particular challenge. The components in our products are all carefully selected for quality and performance.

Heat testing with infrared camera

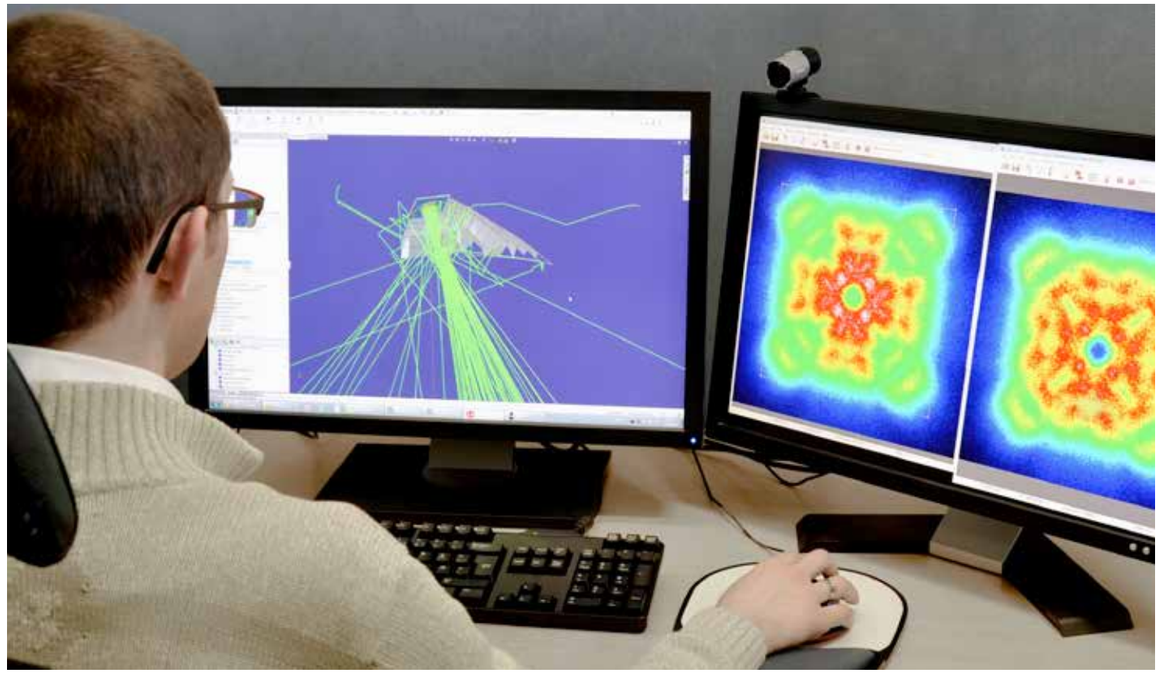
Many printed circuit board assembly defects cannot be identified easily using conventional methods. For this reason we use thermographic cameras when inspecting these components in our luminaires.

A thermographic camera or infrared camera is a device that forms an image using infrared radiation, similar to a common camera that forms an image using visible light. Instead of the 450–750 nanometer range of the visible light camera, infrared cameras operate in wavelengths as long as 14,000 nanometers.

Circuit board infrared analysis
All objects emit electromagnetic energy in a broad spectrum of wavelengths and in an amount that is proportional to their temperature. As the temperature of an object increases, the amount of electromagnetic energy it emits increases.

Since thermal behavior is closely related to current flow, the temperature distribution on an operating package, component, or assembly can be a good, repeatable indication of its operational status. Therefore, infrared images of a circuit board can be analyzed to determine a board's operational status.

Infrared analysis
Printed circuit boards are an integral part of many of our modern luminaires.

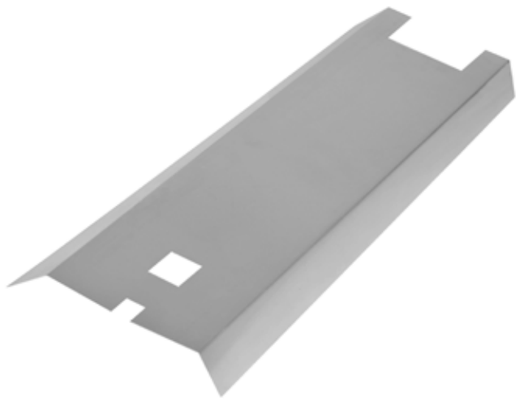


Light data simulation

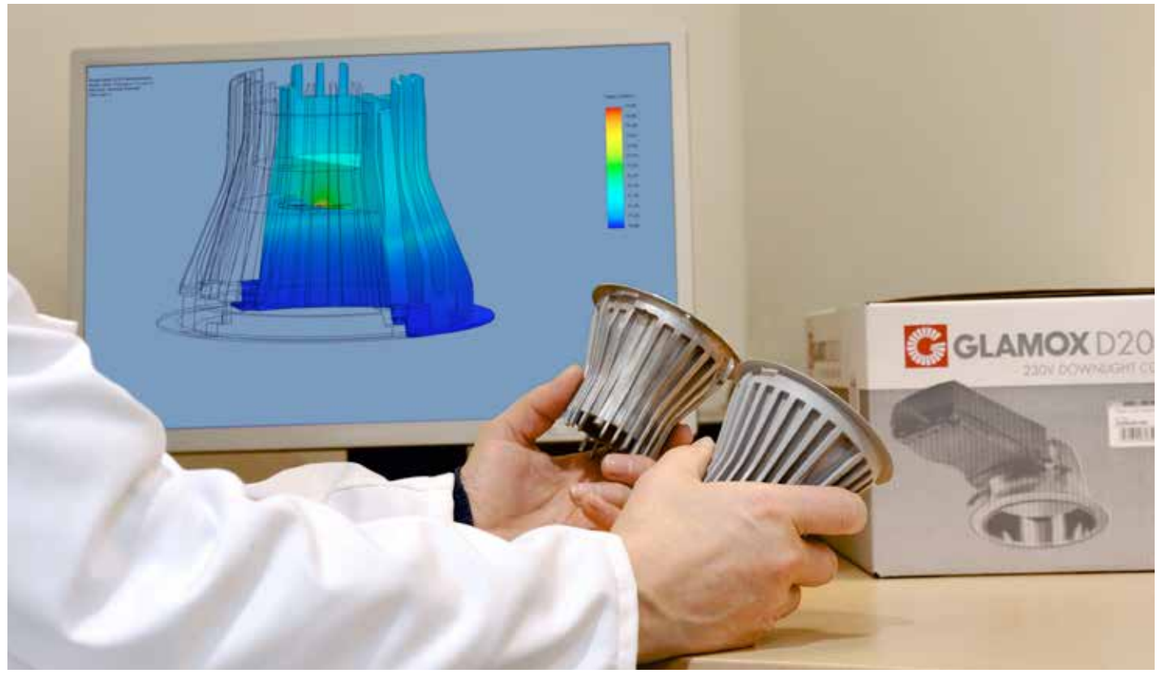
Light data computer simulations help determine the exact shape and positioning of reflectors and other optical components in our luminaires.Computer simulations have become a useful part of mathematical modeling of many natural systems in physics, chemistry, economics and engineering. They are utilized to explore and gain new insights into new technology, and to estimate the performance of the components of a new product while in the early planning stages.

The importance of optics
When developing a new luminaire, the careful calculation of reflectors and diffusers are essential for the product's efficacy, i.e. how much light is coming out of the luminaire in relation to the total power consumption. Light data simulations help us determine the best solutions in developing the most energy-efficient solutions.

A great many of our lighting products are available with a choice of diffusers, for various purposes, made of materials such as opal or microprismatic acrylic, glass or aluminium. Light data computer simulations allow us to predetermine the effect of various diffusers while the luminaire is still on the drawing board.



Reflectors
A reflector is a component inside a luminaire that reflects light from the light source in a controlled manner. It can be made from many different materials. Interestingly, Glamox takes its name from the method for electrochemical surface treatment of aluminium which was used to manufacture efficient aluminium reflectors for powerful luminaires in the company's early years.



Heat simulation

Computer-aided heat simulation is an important part of the creative process in the development of a new product. Laboratory scientists, engineers and designers work closely together to control the heat inside a luminaire – even before the prototypes are made.

Developing a new lighting product is a cooperative effort, involving many of our employees, and often also contributing independent designers. Design and aesthetics mean a lot in this process. Equally important is our experience and know-how about the design of thermal control, so that the products will perform to standard over a long period of time.

This is especially important when developing products with LED light sources. The expected lifetime of a LED luminaire is dependent on how well we manage the heat inside the product. Heat simulation allows us to calculate the dimensions of heat-reducing components such as aluminium heat sinks, minimizing trial-and-error costs and time lapses.

3-D printing of components
3-D printing is a useful part of the process when designing components for a new luminaire. The process allows for accurate simulations well in advance of actual pre-production.

3-D printing
3-D printing is a process of making a three-dimensional solid object of virtually any shape from a digital model. 3-D printing is achieved using an additive process, where successive layers of material are laid down in different shapes. In these images we see the printed model (right) next to the finished product – an aluminium component in a Glamox downlight.

Functionality testing

Functionality testing is employed to verify whether a product meets the intended specifications and functional requirements laid out in the development documentation.

In marine and offshore lighting it is critical that we can deliver products that are virtually problem-free. Functionality testing helps us deliver products that perform as planned, for increasingly sophisticated applications.

A part of the quality process
Functionality testing is a quality assurance process examining test cases against the specifications of the product being tested. The functionality is tested by feeding the product electronic input and examining the results. The important question is: Does the product do what it is supposed to so? This is what we need to verify before releasing a new luminaire.

Functionality tests
The equipment we use in our functionality tests is purpose-made for the testing of electronic products.

Production testing and quality control

Routine testing consisting of a number of safety and functionality tests are carried out on 100% of our manufactured products in our production facilities.

At the factories, safety and functionality testing is a regular feature of the quality control that takes place in the assembly units. When the luminaires are assembled, each is tested and marked before packaging and labeling takes place.

Functionality testing includes controlling moveable parts, if any. Operators make sure the products provide the right light output, and check for irregularities in the electrical current and cable isolation. For this purpose, calibrated test instruments are in place along the assembly lines.

The importance of calibration
The instruments used for testing at our production and test simulations facilities are carefully calibrated on a regular basis at our laboratories to ensure accuracy.

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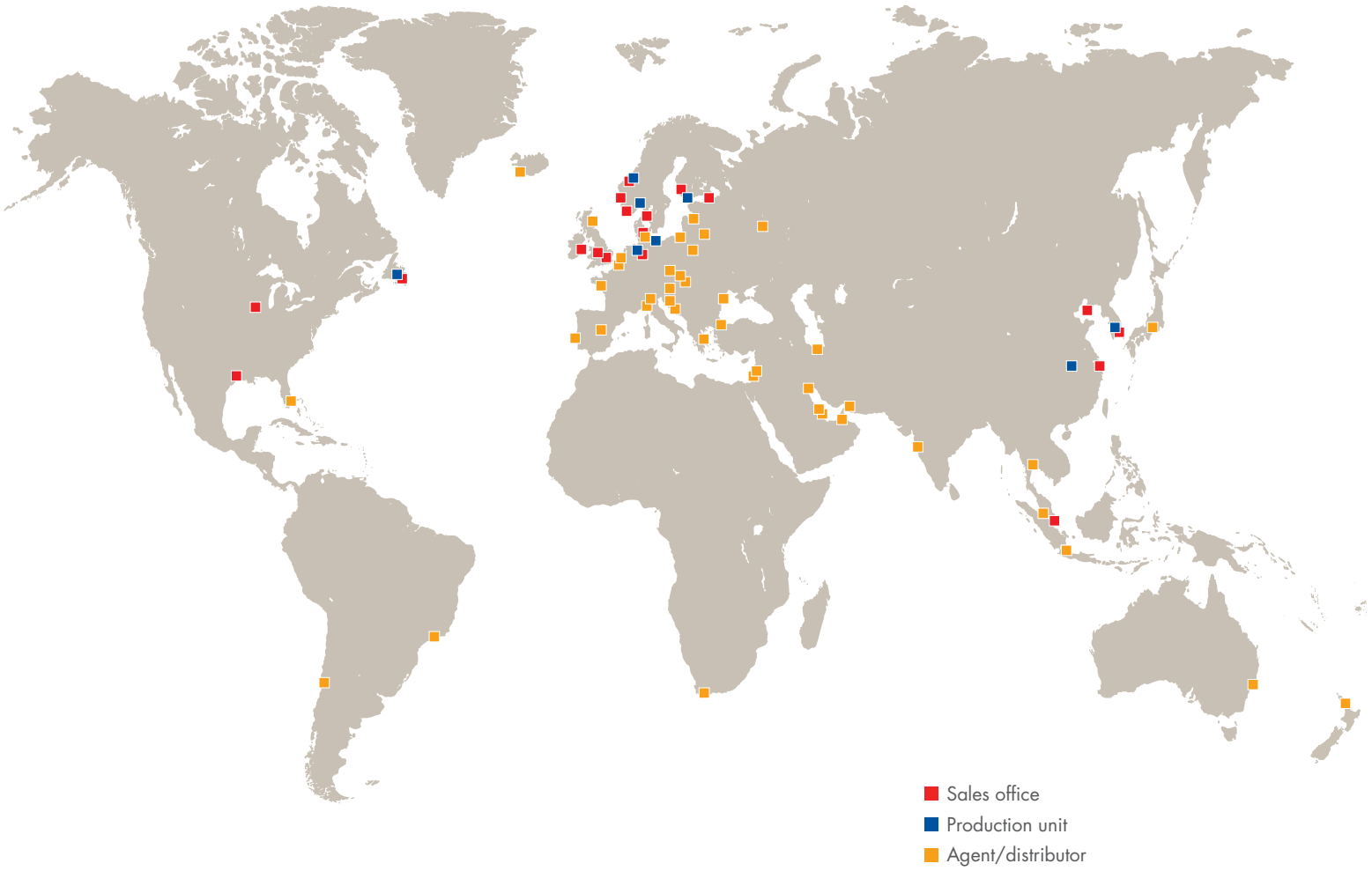

Light influences people

Glamox is an industrial group that develops, manufactures and distributes professional lighting solutions for the global market. The Glamox Group is a leading supplier to the world's marine and offshore markets, and a significant supplier to the professional building market in Europe. We own a range of quality lighting brands including Glamox, Aqua Signal, Luxo, Høvik Lys and Norselight.

Quality and expertise
Our products and solutions are developed and tested by our engineers at our own research and testing facilities, and manufactured and certified in accordance with all relevant quality and environmental standards. They are based on the latest technology and expertise – and generations of experience.

www.glamox.com/gmo