

MATERIAL TESTS FOR OUTDOOR AREAS

BARTHELME ENCAPSULATED LED LUMINAIRES
FLEXIBLE AND ROBUST IN ALL ELEMENTS

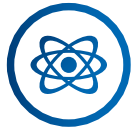
Bartheime
LED Solutions



QUALITY.



KNOWLEDGE.



INNOVATION.



FLEXIBILITY.



DEDICATION.

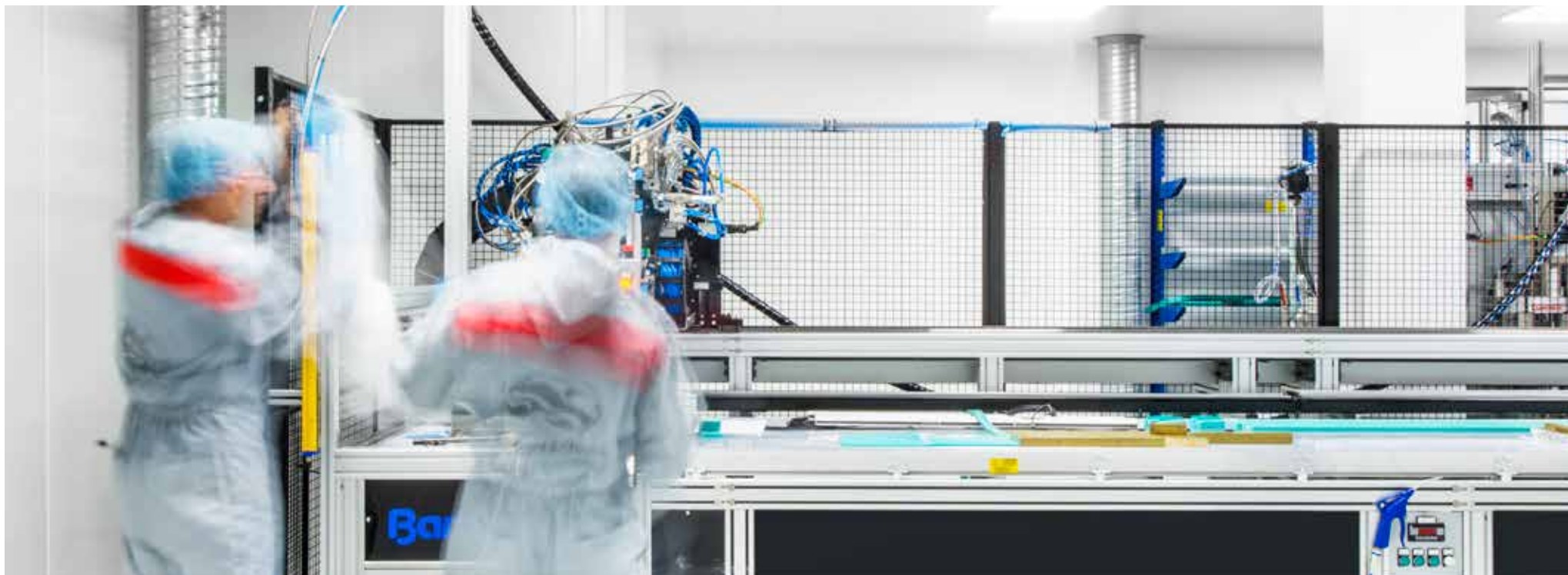


Barthelme
LED Solutions

Further information can be found at www.barthelme.de

CONTENTS

| | |
|--|----|
| Overview outdoor luminaires | 6 |
| Types of encapsulation Structure of encapsulation materials..... | 8 |
| WEATHER RESISTANCE | |
| Florida test..... | 12 |
| Arizona test..... | 13 |
| Xenon Wom test..... | 14 |
| Acid rain test..... | 15 |
| UV-radiation test..... | 16 |
| WATER AND CHEMICAL STABILITY | |
| Material stability with chlorine..... | 18 |
| Steam and warm water tests | 19 |
| Tests with disinfectants | 20 |
| Household material tests..... | 21 |
| IP68 protection class test | 22 |
| Salt spray resistance..... | 23 |
| Moisture resistance..... | 24 |
| TEMPERATURE STABILITY | |
| Temperature shock test | 25 |
| ABRASION AND WEAR RESISTANCE | |
| Abrasion test | 26 |
| Stone chip impact resistance..... | 27 |
| Test with high pressure cleaner..... | 28 |
| FLAME RESISTANCE AND ELECTRICAL PROPERTIES | |
| Flammability resistance..... | 29 |
| Test of specific electrical resistivity | 29 |
| REGULATORY COMPLIANCE | |
| Overview of the regulatory norms..... | 30 |
| Contacts..... | 31 |



INNOVATIVE DEDICATION.

The excellent standard of quality which Barthelme achieves can only be generated by dedicated dialogue between lighting designer, production and user. This is why we decided to concentrate the product design and development as well as a major portion of production at our headquarters in Nuremberg, Germany.

In this way we ensure high flexibility, excellent reliability and constant quality controls. This is the hub from where our multi-lingual experts develop new customer-specific solutions for our partners and customers around the world

ENDLESS VARIETY: CUSTOMER SPECIFIC LINEAR LUMINAIRES

The Barthelme customised linear LED luminaires for indoor and outdoor use are manufactured according to customer specification. With our broad range of LED strips in different colour temperatures and brightness, extensive aluminium profile and cover options, numerous protection classes and connection types, Barthelme manufactures customized LED luminaires for a wide spectrum of requirements.

Whether as an absolutely homogenous luminaire, extremely flat with 180° or 30° optic cover; partially or fully enclosed; from 10 to 290 cm in length; equipped with simple cable outlet or PG connectors – the Barthelme individual system provides endless combinations for your lighting visions.

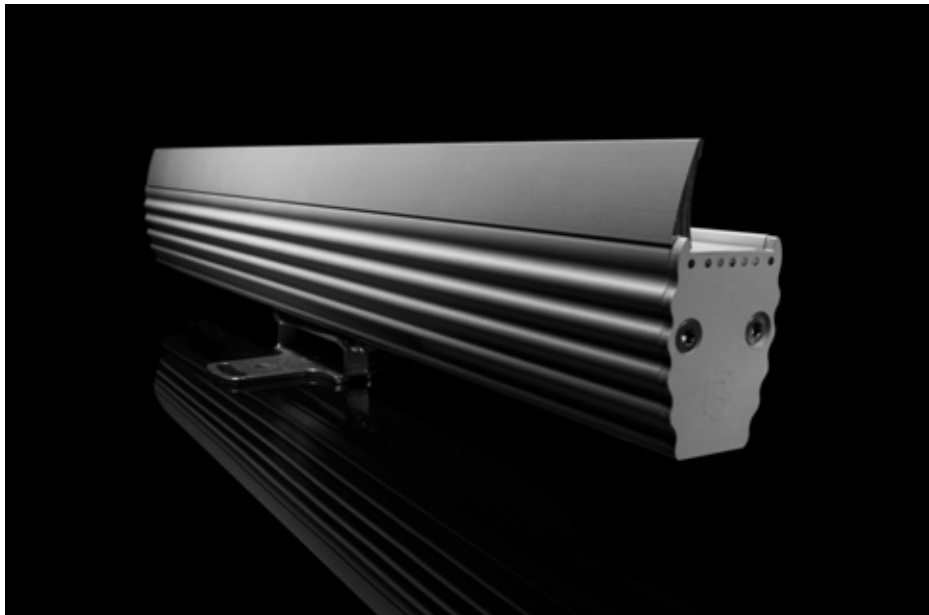
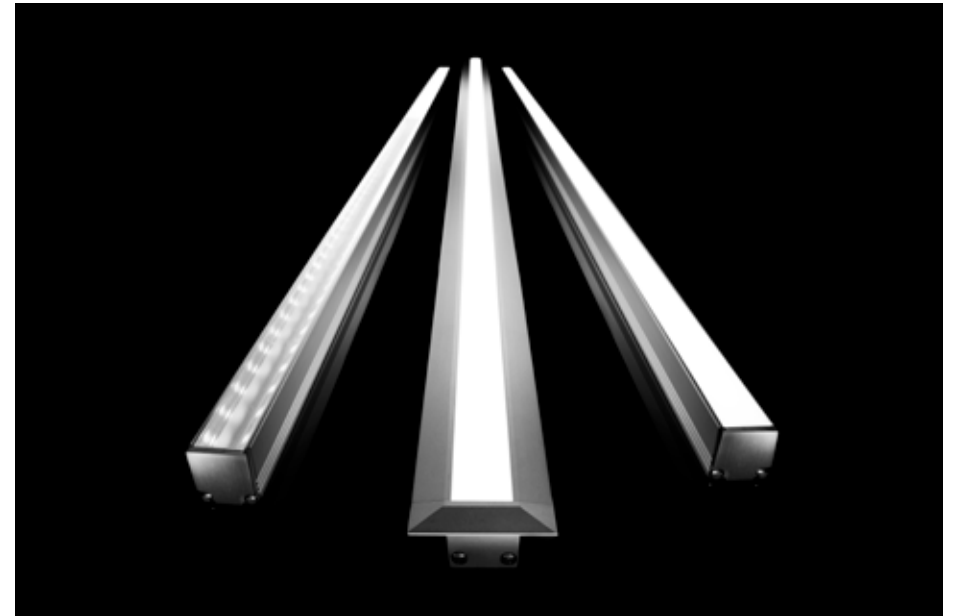
ELEMENTAL DURABILITY: AQUALUC LIGHT LINES

The AQUALUC series is extremely durable and weather-resistant and due to its high protection class IP 67/68 is ideal for a broad range of outdoor and indoor applications. AQUALUC has been extensively tested for resistance to UV radiation, abrasion, salt, water, dust, and chemicals*. It is therefore perfectly suitable for shipbuilding, general outdoor lighting, pool and wellness areas as well as for garden and landscape architecture.

Despite the use of high-quality materials and a robust design, there are chemical-related limitations in the areas of application. Please refer to the following link:

<https://www.barthelme.de/shared/download/katalog/AQUALUC-Chemische-Mittel-Chemical-Agents.pdf>

OVERVIEW OUTDOOR LUMINAIRES



TYPES OF ENCAPSULATION

The encapsulation process in combination with the composition of the encapsulation mixture make our components highly weather and UV resistant. The materials have been used for many years in the automobile industry in accordance with the stringent quality niveau and have successfully passed a range of diverse tests.

Barthelme offers the right encapsulation for your luminaires designated application:

- » **partly enclosed** offers protection against dew moisture and splashing water
- » **clear fully enclosed (soft/hard)** for higher demands on the luminary; offers excellent lumen output with visible light spots
- » **frosted fully enclosed (soft/hard)** for higher demands on the luminary; offers a homogenous and even lumination area

A hard, full encapsulation is used if mechanical strain is exerted on the luminaire. Depending on the profile selected the luminaire can be walked on.

COMPOSITION OF THE ENCAPSULATION MATERIAL

The distinctive characteristic of the material is its composition. The bonding of polyurethane and ceramic materials enables protection against moisture with excellent heat management and high flexibility of the plastic.

POLYURETHANE

Polyurethane (PU, DIN code: PUR) is a mixture of copolymers, nano technology and polymers and belongs to the family of plastics and synthetic resins. PU is extracted from a polyaddition reaction of polyisocyanates and polyols. It comes to a reaction of the molecules of a isocyanate group ($-N=C=O$) and a hydroxyl group ($-OH$). The result of this chemical bonding is a urethane group ($-NH-CO-O-$), which after hardening, poses no health risks. Depending on the manufacturing process, polyurethanes are brittle and hard or soft and flexible.

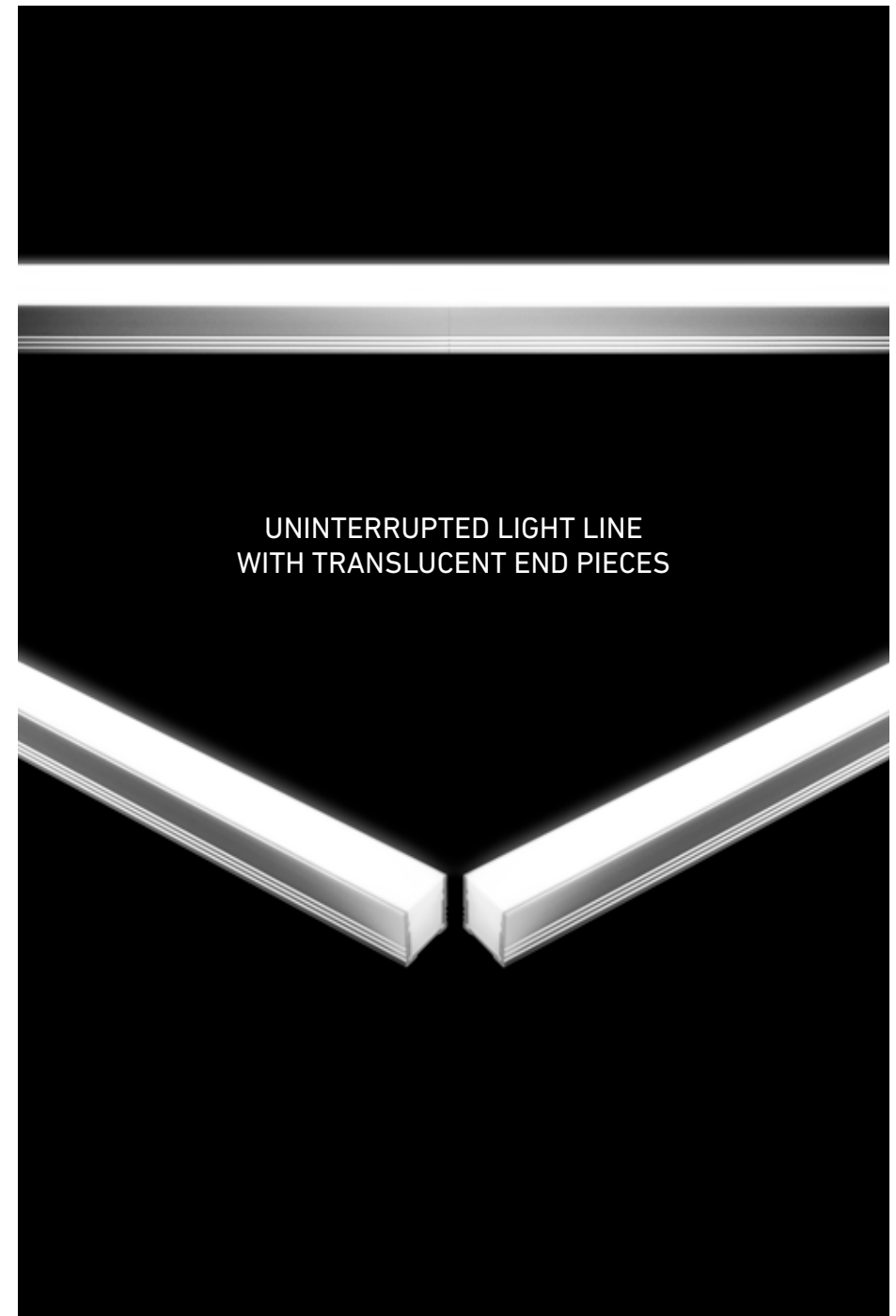




Photo: Wind Tower, Hong Kong, Brighten Lighting Engineering Ltd.,
Photograph: Hans Astrup

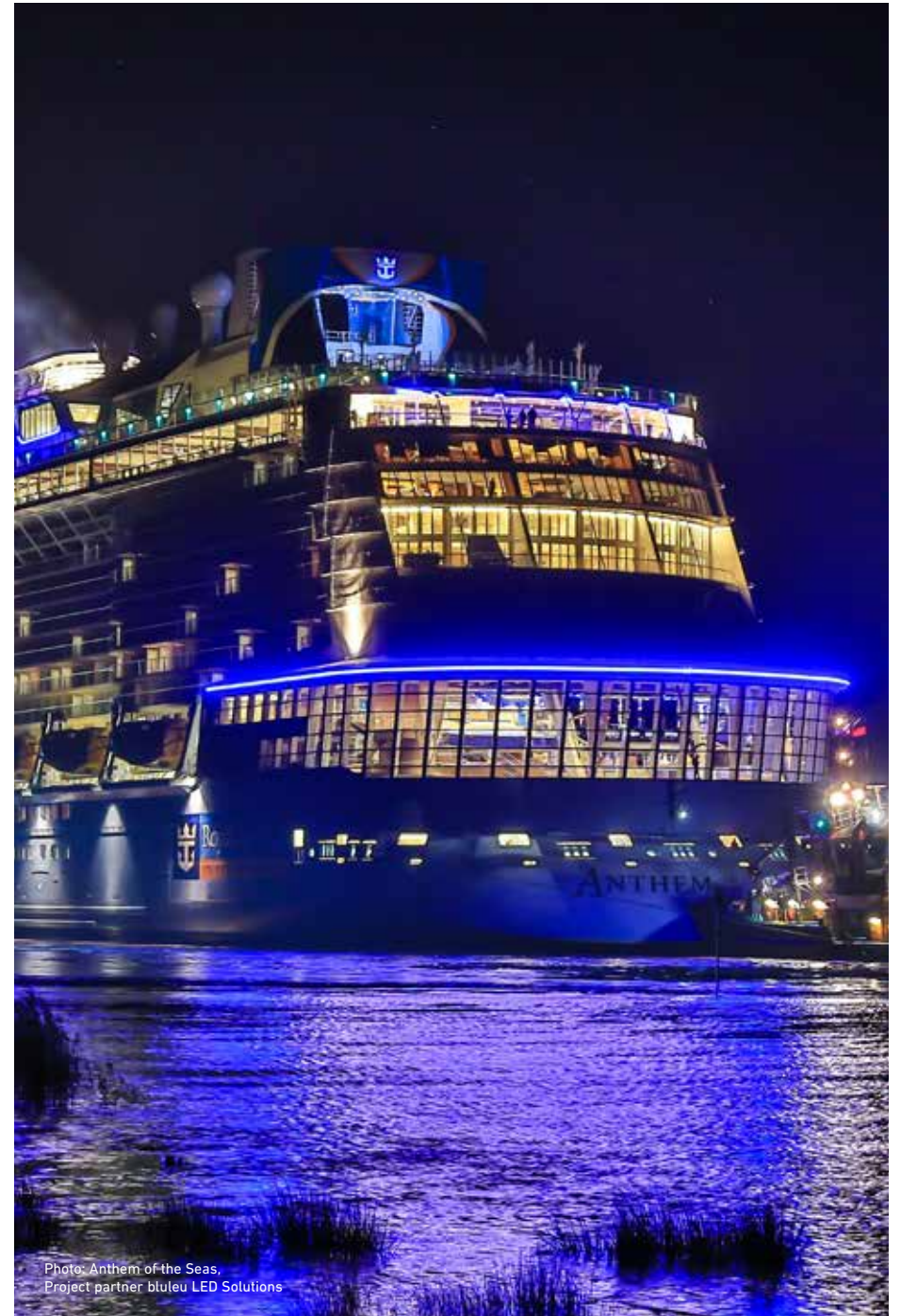


Photo: Anthem of the Seas,
Project partner bluleu LED Solutions



WEATHER RESISTANCE FLORIDA TEST BASED ON SAE J 1976

Florida is the internationally recognised reference location for the weather resistant testing of various materials. The tests are not only realistic but are also time accelerated. The amount of UV-radiation in a year in Florida equals the UV-radiation of multiple years in numerous regions around the world. The alternation between highly intensive sunshine, ample precipitation and very high air humidity creates ideal conditions on the south east coast of the USA to test materials for:

- » colour changes, fading and loss of gloss
- » tearing, flaking, chalking and chipping
- » loss of mechanical stability and physical ageing
- » moisture sensitivity of products such as coatings, building substances and plastics
- » biological degradation, including rot, mold, fungal and algae growth
- » corrosion susceptibility

TEST CONDITIONS: 1 year, direct weather influence inland, 45° south facing, high air humidity, very high temperature, high UV-radiation



TEST RESULT

GOOD



WEATHER RESISTANCE ARIZONA TEST BASED ON SAE J 1976

The climate in Arizona features very intensive sunlight and high temperatures throughout the year. Compared to Florida, the location offers 20 % more UV-radiation, higher annual average temperatures and lower air humidity. This desert and steppe climate is especially suitable for tests on materials which are to be permanently used outdoors. The focus of this test is:

- » loss of mechanical stability and physical ageing of plastics
- » thermal expansion
- » determination of the maximum operating temperature
- » colour changes, fading and loss of gloss
- » cracking, warping and ageing through heating

TEST CONDITIONS: 1 year, direct weather influence, 45° south facing, low air humidity, extremely high temperatures, high UV-radiation



TEST RESULT

GOOD



WEATHER RESISTANCE XENON-WOM-TEST BASED ON SAE J 1960-89

Optical and mechanical changes can be evaluated in much less time with this simulated climatic effect test than would be possible on the basis of field tests. All necessary climate factors such as UV radiation, heat, moisture and precipitation can be simulated in this test.

TEST CONDITIONS: 65 °C (149 °F), 102 minutes UV-radiation and 18 minutes UV and water mist, extremely high temperatures, high UV-radiation

DURATION: 2000 hours (equivalent to 6-8 years in external use)



PASSED

NO COLOUR CHANGE,
LITTLE LOSS OF GLOSS



WEATHER RESISTANCE ACID RAIN TEST FOR PERMANENT EXTERIOR USE

The acid rain test simulates industrial air pollution with sulphur dioxide (SO₂), as it is created by the burning of fossil fuels such as coal and oil products and which is the cause of acid rain. This concentrated rain is not only damaging for the environment but also damages materials which are used in the outdoors.

LEDs are extremely sensitive to sulphur as materials in the LEDs can react with the sulphur.

In the test process, the samples are exposed to an atomised solution of SO₂ (600 ppm) and distilled water at a temperature of 1,7 °C.

The test accelerates the normal impact of SO₂ on the tested material.



PASSED

NO YELLOWING,
NO LOSS OF GLOSS.

WEATHER RESISTANCE

UV-RADIATION TEST QUV-A TEST | QUV-B TEST BASED ON SAE J 2020

This laboratory test provides a perfect simulation of sunshine in the critical shortwave range of 295 nm - 365 nm which is mainly responsible for the damaging of polymers. All important radiation factors can be simulated in this test. The impact of sunshine and condensation on materials and stability can also be accelerated and chronicled.

In the QUV-A test our products were radiated with 340 nm for over 3,000 hours with a UV lamp, which equals an exterior deployment of 10 years. Furthermore, our products were radiated with 313 nm for 1,000 hours in the QUV-B Test which corresponds with an exterior deployment of 3-4 years.

The test intervals are identical in the two tests and alternate between 8 hours at 70 °C and 4 hours at 50 °C with condensation.

The results of the QUV-A test can be clearly seen with the samples on the opposite page. The first product is an LED light line of the AQUALUC series, into which a Barthelme LEDlight flex LED strip was encapsulated. The remaining strips come from other manufacturers.



PASSED

NO YELLOWING,
MINIMAL CHANGE IN GLOSS

OUR PRODUCT AFTER THE QUV-A TEST

BARTHELME LED SOLUTIONS

AQUALUC



OTHER MANUFACTURERS





WATER AND CHEMICAL STABILITY CHLORINE TEST

If luminary systems are to be installed in pools or wellness areas then resistance to chlorine must be ensured. This test is conducted at increased temperatures of 50 °C and with a chlorine concentration of 2 %.

For comparison: in a normal swimming pool the maximum concentration is 0,5 - 1 mg/l which equates to a chlorine concentration of 0.001 %. The test environment therefore has a 2,000 times higher concentration than that which is commonly found in swimming pools.

The testing period was 60 hours.

Applies to hard encapsulation types.



PASSED

NO CHANGE IN
APPEARANCE AND FUNCTION.



WATER AND CHEMICAL STABILITY TEST WITH STEAM AND WARM WATER

As LEDs are increasingly integrated in steambath areas or oven lighting it is necessary to test the reaction of the material to hot steam. For this test the LED stripes were hung above boiling water in intervals of 15 to 60 cm. The duration of the test is 8 hours.

The focus of the test with warm water is the suitability of LEDs in wellness and swimming pool areas. The encapsulated LED stripes were immersed in 45 °C warm water for a duration of 240 hours. This test was conducted on the basis of WSK-M3G178.



PASSED

NO CHANGE IN GLOSS
NO DETERIORATION



WATER AND CHEMICAL STABILITY TEST WITH DESINFECTANTS

In this test the material resistance to disinfectant agents, as found in swimming pools, saunas or wellness centers, is evaluated.

Cleaning agents are tested which are based on the following substances:

- » hydrogen peroxide (H₂O₂)
- » sodium hypochlorite (NaClO)
- » chlorine 2 % (Cl)

In the testing process the material samples were exposed to a direct moist coating for a period of two hours.



PASSED

NO CHANGE IN
APPEARANCE AND FUNCTION..



WATER AND CHEMICAL STABILITY HOUSEHOLD TEST BASED ON SAE J 2020

In this test, the resistance of the products to cleaning and chemical agents, which are typically used in the household. The following cleaning agents were tested:

- » Viss scouring agent
- » Gut & Günstig dishwashing liquid
- » Kiehl Sanpurid Citro
- » Gut & Günstig vinegar-based cleanerr
- » bleaching agent (Hypochlorite NaClO 2 %)
- » Lysol disinfectant

In all variations of the test the material samples were exposed to a moist coating for two hours.



PASSED

NO CHANGE IN
APPEARANCE AND FUNCTION.



WATER AND CHEMICAL STABILITY IP68 PROTECTION CLASS TEST

Luminaires which are installed in pool and wellness areas are often installed under water. To determine the suitability of the luminaires under water they were subjected to a IP68 protection class test. This test ensures full functionality - also with permanent use under water. However, the light line must be completely dried, at the latest within 2 years, in order to again be ready for continuous underwater use.

The test was conducted in the TÜV Rheinland laboratory in Nuremberg.

The product was tested for 5 days in a 5 meter deep water column at a pressure of 1,5 bar. No water is allowed to penetrate the housing in order to pass the test.

A SECOND TEST (BASED ON EN60529:1991+A1:2000+A2:2013) OF THE PRODUCT WAS CONDUCTED OVER A PERIOD OF 6 MONTHS AT AN IMMERSION DEPTH OF 1,2 METERS.

Applies to hard and clear encapsulation for AQUALUC products.



PASSED

**NO PENETRATION OF WATER
IN THE HOUSING**



WATER AND CHEMICAL STABILITY MOISTURE RESISTANCE TEST BASED ON MS-CG121

In this test the material is tested for resistance to moisture. This occurs in a climatic chamber which can simulate numerous climatic scenarios. The material samples are tested for 250 hours at an ambient temperature of 40°C and 100% relative air humidity.



PASSED

**NO CHANGE IN
APPEARANCE AND FUNCTION.**



WATER AND CHEMICAL STABILITY SALT SPRAY TEST BASED ON ASTM B117-95

The goal of the test is to evaluate the resistance to salt water as is found in maritime environments. The test is especially important for products which are used in saline environments such as shipyards, cruise ships, yachts, cargo ships or the navy.

The material samples were sprayed with a 5 % sodium chloride (NaCl) solution for 2,000 hours at a temperature of 38 °C.



PASSED

NO CHANGE IN
APPEARANCE AND FUNCTION.



TEMPERATURE RESISTANCE TEMPERATURE SHOCK TEST

The temperature shock test evaluates the reaction of the material to fast temperature changes. Goal is to emulate northern climates with cold ambient temperatures and heat from thermal springs impacting on the material.

A test cycle consists of 10 runs in which the material is initially cooled for 16 hours at a temperature of -40 °C. Subsequently the temperature is raised to +70 °C with the addition of hot water. Concluding a run, the material is once again cooled to -40 °C within 10 minutes.



PASSED

NO CHANGE IN APPEARANCE
AND NO DISTORTIONS



ABRASION AND WEAR RESISTANCE TEST FOR ABRASION BASED ON ASTM D1044

The material is tested for abrasion as found on steps and stair edges. A disc (wheel) on the test machine simulates abrasion movements with a pressure between 250 to 1000 g.

The test of the material samples was conducted under medium conditions:
RAD: CS 10 | WEIGHT: 500 G

A test cycle consists of 1,000 runs.



PASSED

MINIMAL ABRASION



ABRASION AND WEAR RESISTANCE TEST FOR STONE CHIP RESISTANCE BASED ON ISO 20567-1

Lighting plays an important role in the outdoors and road traffic. It is important that the luminaires are durable not only with regards to the weather but also regarding the physical stresses. In this test series the impact of stone chips on the material, as can be found in gravel, is evaluated.

In the test process, the material specimen is radiated with 500 g permanent mould grains at a constant pressure of two bar at an angle of 90 °. The ambient temperature fluctuates between 23 °C and -25 °C

A test cycle consists of ten runs.



PASSED

NO VISIBLE
DAMAGE



ABRASION AND WEAR RESISTANCE TEST WITH HIGH-PRESSURE WASHER BASED ON ISO 20567-1

A high pressure washer is often used for the cleaning of facades, walls and pathways. The material must be able to resist this stress. As a result this test was designed to evaluate the resistance of the material under these conditions.

The material samples were subjected to 50 °C water temperature at a water pressure of 70 bar from a distance of 45 cm. This procedure takes 30 seconds.

Applies to hard encapsulation surfaces.



PASSED

**NO VISIBLE DAMAGE SUCH AS WARPING,
PEELING OR FLAKING OF THE MATERIAL**

FLAME RESISTANCE AND ELECTRICAL PROPERTIES TEST FOR MATERIAL FLAMMABILITY BASED ON UL94

Tests the material for flammability and self-extinguishing

TEST CONDITIONS: the test is conducted with the open flame of a Bunsen burner

TEST DURATION: 30 seconds

RESULT: CLASSIFICATION HB

THIS TEST APPLIES TO ALL CURRENTLY USED MATERIALS.

FLAME RESISTANCE AND ELECTRICAL PROPERTIES TEST FOR MATERIAL FLAMMABILITY BASED ON FMVSS 302

Tests the material for flammability, spreading of flames and self-extinguishing

TEST CONDITIONS:

- the test is conducted with the open flame of a Bunsen burner
- material strength as per application
- horizontal position of the flame

REQUIREMENT: maximum spreading of flames: 102 mm/min

DURATION: 15 seconds

RESULT: SE- SELF-EXTINGUISHING

THIS TEST APPLIES TO THE CERAMIC ELEMENT OF AQUALUC PRODUCTS.







FLAME RESISTANCE AND ELECTRICAL PROPERTIES TEST OF SPECIFIC ELECTRICAL RESISTIVITY BASED ON ASIM D257

The goal of the test is to test the material for its dielectric strength. A 2mm thick sample is subjected to a voltage of 500 V DC.

DURATION: brief

RESULT: 1 X 10E15 OHM*CM

OVERVIEW OF THE REGULATORY NORMS

| SYMBOL | DIRECTIVES & REGULATIONS | DESCRIPTION | ISSUED BY | SCOPE |
|---|--|---|---------------------------|---|
|  | REACH Regulation No. 1907/2006-2013 | Registration, evaluation, authorisation for chemical substances | Europe | SVHC list (aromatic amines, phthalates and other carcinogenic substances) |
|  | RoHS II Directive no. 2011/65/EC (Directive no. 2002/95/EC) | Restriction of use of certain hazardous substances in electrical and electronic equipment | Europe | Lead, Cadmium, Hexavalent Chromium, Mercury, PBB, PBDE |
|  | ELV Directive no. 2000/53/EC | Restriction of use of certain substances in old vehicles due to the recycling process | Europe | Heavy metals, organic substances (see GADSL 2009) |
| | WEEE Directive no. 2002/96/EC | Waste Electrical and Electronic Equipment | Europe | |
| | UNI EN 71-3 | Safety of toys | Europe | Restriction of heavy metals |
| | ASTM F963 | Safety of toys | USA | Restriction of heavy metals |
|  | Directive no. 2005/84/EC | Phthalates (softener) in toys | Europe | Phthalates (softener) |
| | CPSIA 2008 Consumer Product Safety Improvement Act | Safety for childrens products | USA | see ASTM F963-07 |
|  | EC-Directive 89/109; 02/72;97/48;82/711;85/572;76/769 Germany §30-§ 31 LMBG Foodstuffs and Commodities Act | Materials in contact with foodstuffs | Europe | Restrictions on substances and testing of changes in flavour |
| | Directive no. 2005/69/EC | Inclusion of PAHs | Europe | PAHs (polycyclic, aromatic hydrocarbons) |
|  | Chemical Substance Control Law 2006 | Benzotriazole - Class I specified chemical substances | Japan | Benzotriazole (UV-stabilisor) |
| | Proposition 65 | Content of chemicals causing cancer, birth defects or reproductive harm | State of California (USA) | See list 11. September 2009 |
| | Directive No. 2006/122/ECOF | Restrictions on the marketing and use of certain dangerous substances and compounds | Europe | PFOS (perfluorooctane sulfonates) |

AUSTRALIA

KODA Lighting Pty Ltd.
Unit 21, 198-222 Young Street
Waterloo NSW 2017
T +61 2 9699 6007
E info@kodalighting.com.au

GERMANY (MARKET MARITIME)

bluleu LED Solutions GmbH & Co. KG
Hauptstraße 51b
30982 Pattensen-Schulenburg
T +49 5069 48025-10
F +49 5069 48025-11
E info@bluleu.de

HUNGARY

Rio Lámpastúdió Kft.
Margit u. 114,
1165 Budapest
T +36 1 323 1637
E lampa@t-online.hu

ITALY

(LOMBARDIA, PIEMONTE, VAL D'AOSTA, LIGURIA, MARCHE, ABRUZZO, PUGLIA, SICILIA)
D.A.D.A. SYSTEM S.R.L.
Via Cadorna 40/42
20032 Cormanò (MI)
T +39 02 84269630
E info@lightsolution.it

MEXICO

GTEC ILUMINACIÓN S.A. DE C.V.
Palo Alto 66
Del. Cuajimalpa de Morelos
05110 Mexico City
T +52 5525910363
E naty.cervantes(at)g-tec.com.mx

SAUDI ARABIA

ViaLighting
P.O. Box 4146
Riyadh 12384
T +966 114 57 57 57
E info@vialighting.com

UNITED KINGDOM

Engineered 4 Projects Limited
8a Fanton Hall
Wickford, Essex, SS12 9JF
T + 44 1268 572655
E sales@engineered4projects.com

BELGIUM

HUPPERTZ nv/sa
Golden Hope Straat 35 B
1620 Drogenbos
T +32 2 334 3436
E info@huppertz.be

GREECE

Elektromeleti Audio Design HD LTD
29 Epeirou Street
Chalandri 152 31
Athens
T +330 210 6827305
E info@elektromeleti.com

ICELAND

Jóhann Ólafsson & Co
Krókhálsi 3
IS 110 Reykjavík
T +354 533 1900
F +354 533 1901
E sala@olafsson.is

ITALY

(VENETO, FRIULI VENEZIA GIULIA, TRENTINO ALTO ADIGE, EMILIA ROMAGNA, TOSCANA, LAZIO, CAMPANIA)
S.I.L.E. s.n.c.
Via Luigi Scattolin 5
31055 Quinto di Treviso (TV)
T +39 0422 470614
E info@glip.it

NORWAY

Sale and Distribution
Nortronic AS
Skiveien 6
1400 Kolbotn
T +47 66 81 38 60
E firmapost@nortronic.no

SINGAPORE

Koizumi Lighting Singapore Pte. Ltd
41 Ubi Crescent
408588 Singapore
T +65 6747 7116
E sales@koizumi.sg

FRANCE

(PROVENCE-ALPES-CÔTE D'AZUR)
Elumin Sarl
29 Route de la Wantzenau
67800 Hoenheim
T +33 39020 0645
E elumin@elumin.fr

HONG KONG & MACAO

SPL Lighting (HK) Co. Ltd.
1401 Harbour Centre,
25 Harbour Road
Wanchai Hong Kong
T +852 3529 5132
E info@splighting.com.hk

INDIA

Innovative Lighting Designs Ltd.
D-14/9, 1st Floor,
Okhla Industrial Area Phase-I
110020 New Delhi
T +91 11 41406716
E info@ildlimited.com

LUXEMBOURG

SensLight S.a.r.l.
19, rue Eugène Ruppert
2453 Luxembourg
T +352 266 49494
E office@senslight.lu

NORWAY

Project Design
Concept Design AS
Pilestredet 75C
0354 Oslo
T +47 22 56 13 10
E fredrik@conceptdesign.no

SPAIN

NOON light solutions
Carrer d'En Garriga 215
08912 Badalona
T +34 670 420 420
E info@noonlighting.es

JOSEF BARTHELME GMBH & CO. KG

Oedenberger Straße 149 | 90491 Nürnberg | Germany

T: +49 911 42476 0 F: +49 911 42476 66 E: info@barthelme.de

www.barthelme.de

All information contained in this manual is current as of its creation/publication. Josef Barthelme GmbH & Co. KG reserves the right to change the contents of this manual without notice. The information contained herein is believed to be accurate as of the date of publication; however, Josef Barthelme GmbH & Co. KG makes no warranty, expressed or implied, with regard to the products or documentation contained within this manual. In addition, Josef Barthelme GmbH & Co. KG shall not be liable for any incidental or consequential damages in connection with or arising from the furnishing, performance or use of the product(s) in this documentation.