DALMAS® in use at Cologne Bonn Airport, Germany
Operational Influences

As a consequence of normal airport operation, lighting systems along runways become damaged from rubber abrasion, deicers and material aging.

Somewhere along the way the lighting systems falls below the ICAO specifications.

DeWiTec offers the mobile DALMAS monitoring system - an innovative and user-friendly all-in-one solution for monitoring your airport lighting system.

Regardless of the manufacturer, DALMAS can be used to measure any type of elevated and inset lights along runways and airfields. Runway Centerline lighting is measured as efficiently as PAPI lighting during maintenance work or when commissioning new installations.

With elevated lights, the entire lightbeam is measured.

1. Airplane Touchdown
   Leaves approx. 2 kg on runway and lights
2. DALMAS
   Daylight measurement during rain
3. General Report
   Sample report for RWE system
4. PAPI Measurement
   The entire lightbeam is measured
Operational Influences

**New RCL Light**
- New light or light after service in workshop
- New and clean prism

**Used RCL Light (6 months in service)**
- Blackening of prisms in lower area transverse to light direction Rubber deposits across entire light.
- Prism surfaces have been dulled by rubber deposits and exposure to glycol. Both prism photos were taken under identical lighting conditions!

**Insetlights**

- The insetlights shall be measured most frequently in accordance to ICAO Annex 14 due to its heavy load under normal operation conditions.

**Elevated Lights**
- It is important to measure the complete light beam - also the sector below the light's center. This is applicable for REH, THR, RWE, APH and PAPI lights.

**Photometric test certificates:**

**Measurement anytime**
- At daytime
- At twilight
- In the night

DALMAS® can be used under all lighting conditions. Even if it is morning, afternoon or night: Due to the patented measurement system it is also possible to use the system at daylight.

DALMAS® is a long-term investment - if the conditions for access to the runway are changed at your airport some times DALMAS® can be used yet.

Stay independent with DALMAS® - always.
Advantages of DALMAS®

- Mobile and dynamic measurement
- Measuring with any car with trailer hitch
- It only takes one person to handle DALMAS®
- Software management: Easy
- Functional in all lighting conditions
- Measurement of the complete lighting system including PAPI
- Also working as workshoptester
- Results immediately after measurement available
- Options: DALMAS® Lightfinder
  - DALMAS® Workshoptester
  - Customized versions
I Preparation

- Attach trailer
- Mount the notebook, the data cables and front module in the car
- Switch on system and notebook
- Checklist for all steps
- Easy selection of the desired system components
- Software navigates to the starting position

II Measurement

- Start of measurement
- The measurement is performed driving with a speed of approx 25 - 35 km / h
- The front module supports the driver:
  - The horizontal direction is indicated by coloured arrows
  - The display is connected with two cameras
  - Feedback for the driver in front of him and additionally on the PC-screen
  - A laser line supports direction guiding in darkness
- The operation is performed via a graphical user interface
- The interface is customized for each airport
- Measurement anytime
III Protocols: Data analysis

- The results are available immediately after the measurement
- General and individual reports
- Trustworthy certification
- Export function
- Clearly structured
- High resolution (HD) reports
- Trustworthy Documentation
- All parameters documented
- Easy light identification
- General report: Summary at the top
- Well arranged layout
- Limits clearly illustrated

1. Single Report
   Light in accordance to ICAO
2. Single Report
   Light not in accordance to ICAO
3. General Report
   Lighting System OK
4. General Report
   Lighting System below Limits
5. General Report
   Printed after measurement for analysis with customer
Lightfinder and Workshoptester

- **Faster and easier service on site**
  - **DALMAS®** creates a list with all lights that need service: Amount and type of light
  - The Lightfinder application navigates the driver automatically to the lights position on the airfield
  - Valuable time on the runway and taxiway is used more effective

**Workshoptester**

- **DALMAS®** can also be used in your workshop
- Verification of reconditioned lights
- **DALMAS®** pays for itself quickly
- Easy to use graphical interface
- Automatic measurement

**Individual Versions**

- Customized versions possible with illuminated roof to meet the airports safety rules.
- Also other individual versions possible: We can advise you!
Complete Maintenance Cycle

Visual landing guidances are the most important aid during the approach of an airplane once the DH has been reached – especially during low visibility procedures.

The ICAO has defined properties, target values and KO criteria for every type of lighting.

DALMAS is the perfect tool for inspecting the ICAO limit values in an economical manner.

The maintenance department makes their decisions according to the DALMAS data and can make repairs in the shortest possible time.
Prevent of total losses

Regular photometric analysis of airfield lighting increases maintenance effectiveness

- With every touchdown, an airplane leaves something behind:
  For example, a Boeing 747 deposits up to 20 lbs (2 kg) of rubber with each landing. This rubber burns into the hot light prisms of the in-pavement lights of the runway. Everyone is probably familiar with the smell of burned rubber that occurs after touchdown.

- During takeoff, the TDZ, RCL and THR/RWE lights are subjected to jet blasts of up to several hundred km/h.

- In winter, snow removal also places a heavy load on the in-pavement lights:
  The glycol contained in deicing substances attacks the prism surfaces and makes them dull. The high surface temperature of the lights causes the water component to evaporate while the glycol remains.

- There are no lighting systems that are able to retain the same light intensity throughout their entire service life.

- And regardless of airport traffic, atmospheric pollution is the enemy of every light surface.

Detect light damage at an early stage using DALMAS® and increase maintenance efficiency

The photo above shows a light that has been completely filled with water as a result of leakage.

This was not noticed until several months later during the course of regular inspections. The light was completely filled with water but was still shining weakly.

There was no indication that a serious fault was at hand.

DALMAS helps you to avoid total losses of lights and helps to reduce costs by detecting problems at an early stage.

DALMAS helps you to comply with all safety standards.

Economical and objective monitoring of ICAO-ISO-Candela diagram for installed lights.
Reducing Maintenance Costs

Without mobile and dynamic photometric measurement methods, it is only possible to do the following:
- Replace lights once they have completely failed
- Carry out visual inspections with subjective evaluations
- Replace entire groups of lighting (for example, RCL, TDZ, TXC) at definite intervals.

In this case, it is inevitable that you’ll end up exchanging some lights that were still within the acceptable limits.

It is not likely that you can accurately assess the situation by inspecting just a single light of the thousands that exist. The human eye adapts to and compensates by up to 40% to fluctuations in light intensity.

However, the light is already below acceptable limits by this stage. In fact, ICAO studies have shown that the human eye is only really able to detect a loss in intensity once it has decreased to 30% of its original value. Damage to the prism is not usually detected.

Furthermore, the human eye is not able to discern whether the light is incorrectly oriented or not.

Is it reasonable to expect that the pilots can carry out an effective visual inspection of the entire lighting system in such a short period of time?

Besides:
Depending on the altitude of the lowest cloud layer, a pilot has approx. 1 - 2 minutes after coming clear of the clouds to “check” the lights.

A typical airfield lighting system (RCL, TDZ, RCL without TX, and THR/RWE) uses between 400 and 800 lights.

Reducing maintenance costs using DALMAS
DALMAS provides you with the following features:
- Light measurements
- Light monitoring
- Optimization of total light output

DALMAS is more than just a service tool
All of this leads to a reduction of your maintenance costs

- You can export data for use in your overall planning processes.
- You can also generate histograms on your PC for each light.
- Analyzing help you to determine which lighting errors have occurred at which locations so that you can plan your maintenance work.
- By optimizing your storage costs for replacement lights, you reduce your capital investments.

MAINTENANCE AIRFIELD LIGHTING
TARGETED MAINTENANCE
CLEANING
ANALYSIS
MAINTENANCE
RUBBER REMOVAL
PACKAGE LIST
Synchronized
EXCHANGE ON SITE
RECONDITIONING IN WORKSHOP
MATERIAL SAVINGS
GUIDANCE
**Data Analysis: Forms of data**

The data measured in real-time is evaluated following the measurement.
The analyzed data is available as follows:

**Summary**
1. Summary report, lights below the specified limits are shown in red. You can specify your own limit values, for example, 75% of maximum.

**Certificate**
2. Separate test certificates for each light including solarization image

**CSV**
3. Exported data file (CSV standard) stored on a data carrier (CD-R) for archival or import into other programs such as Microsoft Excel or Access.

**PDF**
4. Exported single test certificates (PDF format) on data carriers (CD-R)

**DGPS**
5. Optionally, you can also export the light coordinates in DGPS format.

You decide whether to receive our results on paper, on a data carrier, or both.

> DALMAS utilizes a dense array of linear sensors that scans through many closely packed grid points the luminous intensity distribution.

> DALMAS measurements expand on the ICAO and CENELEC provisions to include additional parameters:

> DALMAS can shield almost all of the surrounding light. The minimal remaining light is saved before the measurement and taken into consideration as an offset value.

> The lights are measured by driving over them at a recommended speed of 25 - 35 km/h.

> The relative horizontal drive-over position is computed.

> DALMAS can also be used during the day, for example, if there is heavy traffic during the night.

> DALMAS also evaluates the light intensity outside of the main beam.

> DALMAS also has an auxiliary sensor array that captures and records the relative position of the main array to the light beam during the measurement. This allows you to detect whether the beam orientation of the installed lights is correct. Any passenger car, bus or offroad vehicle can be used to tow the DALMAS equipment.

> Additional sensors are used to verify the results of the lighting measurements.
One System for all Lights

1. RWE / THR
   Daylight measurement

2. Insetlights
   Daylight measurement in rain

3. Insetlights
   Night measurement

4. REH
   Daylight measurement
Realization

Fast and reliable measurement

- Regular measurements prevent from total black-outs
- Trailer is in configuration for elevated lights:
  Measurement box rotated and embedded by 90° to the left
- Static measurement
- Exact photometric results for each lamp
- It takes only 15 minutes to measure a full PAPI system

DALMAS measures the complete light beam

- Separated results for red and white due to special measurement method
- The laser lines provide guidance to the driver:
  In the front module you can see the projector via the camera installed in the rack
- To obtain the most accurate results, the other two parts of the projector are covered

Illustration:
Photometric requirements (FAA) inserted at projection area
Regulations

FAA Advisory Circular 150/5340-26B

- According to FAA (and ICAO) the light distribution shown at the right side has to be achieved
- In operation, not more than one lamp per unit out of service
- The complete light beam has to be measured

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Standard</th>
<th>Tolerance / Limits: Initial</th>
<th>Tolerance / Limits: Operating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamps burning</td>
<td></td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>a. PAPI</td>
<td>All</td>
<td>All</td>
<td>Not more than one lamp out per unit</td>
</tr>
</tbody>
</table>

4.9 Photometric Tests

a. A photometric test for the color, intensity, and beam pattern requirements of paragraph 5 in this AC must be conducted.
b. All lamps used for photometric testing must be randomly selected from a production lot.
c. The photometric requirements in paragraph 3.9.1 must be tested for one set of lamps.
d. To demonstrate repeatability, the intensity along the horizontal and vertical axes for two additional sets of lamps must be checked.
e. If any retouching is required after lamp replacement, it must be accomplished using the manufacturer’s FAA approved procedure to demonstrate that the required photometrics are reproduced.
f. Any test equipment must be calibrated before testing.
g. All measurements must be taken at a distance that allows full focusing of the beam.

3.9 Light Units

3.9.1 Photometric Requirements

a. Each light unit must have at least two light sources.
b. The light units must produce a beam of light split horizontally, with aviation white light in the top sector and aviation red light in the bottom.
c. When the PAPI is viewed at 1000 feet (300 meters), the transition from red light to white light must be within 3 minutes of arc at the beam center and within 3 minutes of arc at the beam edges.
d. A line drawn through center of the transition band at +10 degrees, 0 degrees, and -10 degrees must be straight within 3 minutes of arc.
e. The transition band must be flat within 5 minutes of arc.
f. The light distribution and intensity for each light unit must be per Figure 1.

FAA AC150/5340-26B:

- PAPI Light Distribution Requirements

ICAO Annex 14:

- PAPI Light Distribution Requirements
In Annex 14, the ICAO guidelines distinguish between “recommendations” and “shall” requirements.

According to section 10.4.1:

“…a light shall be deemed to be unserviceable when the main beam average intensity is less than 50 per cent of the value specified in the appropriate figure in Appendix 2. (Note: Appendix 2 contains the ISO – Candela diagrams for various types of runway lighting). For light units where the designated main beam average intensity is above the value shown in Appendix 2, the 50 per cent value shall be related to that design value.”

Furthermore, section 10.4.2 prescribes:

“A system of preventive maintenance of visual aids shall be employed to ensure lighting and marking system reliability.”

Recommendations are given on how often to carry out the measurements, section 10.4.6:

“…the frequency of measurement of lights for a precision approach runway category II or III should be based on traffic density, the local pollution level, the reliability of the installed lighting equipment and the continuous assessment of the results of the in-field measurements but in any event should not be less than twice a year for in-pavement and not less than once a year for other lights”.

As a result, the question arises whether it is worth purchasing a measurement system or to engage an external service provider. Both are possible.

Note:
All of the regulations are based on measurable physical quantities such as “50% of x candela” [cd]. These guidelines make no mention of relying on visual inspections, pilot remarks, or any other empirical measurements.
Detection of damages in its first phase using DALMAS: TDZ

Does your lighting system currently comply with the ICAO requirements?

As an example, compute this for your TDZ lighting:
Number of lights in the touchdown zone: 180 lights in each landing direction for CAT II and III.

Extract from ICAO Annex 14:

"90 percent of the lights are serviceable in the touchdown zone lights"

Next, subtract 90% of the TDZ lights from 100%:

100% = 180 lights = all lights
-90% = -162 lights = minimum number of available lights

10% = 18 lights = maximum number of lights under 50%

Result: The TDZ lights are only then considered to be fully serviceable when at least 162 lights have a average intensity of 50% along the main beam!

Can you prove this for YOUR airfield’s TDZ lighting system?

Detection of damages in its first phase using DALMAS: RCL

Calculate your airfield’s RCL lighting:

Number of RCL light beams (each RCL light has 2 beams): ............... 

Extract from ICAO Annex 14:

"a) 95 percent of the lights are serviceable in each of the following particular significant elements: 2) runway centerline lights"

Next, calculate 100% minus 95% of the RCL light beams:

100% = ............ light beams
-95% = -......... light beams

5% = ............ light beams

Result: The RCL lights are only then considered to be fully serviceable when at least ........ light beams have an average intensity of 50%! 
What are the FAA requirements for the availability of CAT II/III airfield lighting systems?

Extract from JAA-AOM for CAT II which serves as a minimum requirement for CAT III:

At a decision height (DH) of 100 feet in a CAT II operation, the approach lights are already BEHIND the aircraft at the time when the decision to continue or abort the approach is made. Therefore, the runway lights have a particularly high priority in these cases.

In other words, a safe approach depends on the condition of the runway lights, especially in a CAT II/III operation!

Extract from German air traffic authorization regulations (LuftVZO):

§47 Supervision

(1) The licensing authority is entitled to verify that

1. the physical and operational conditions of the airfield continue to be in accordance with the licensing agreement
2. the imposed conditions are adhered to
3. airfield operations are carried out correctly. The licensing authority may ask for any necessary information and is entitled to perform inspections/checks on the airfield.

(2) The above does not affect the areas of competence and tasks of another authority.

DALMAS provides you with the current status of your airfield lighting system as it pertains to ICAO regulations.

When new lights are installed, DALMAS helps you during the technical approval process. You can check whether the installed lighting actually conforms with the given specifications after the installation!

DALMAS is also appropriate for recording the luminous flux during switchover to emergency power systems (EPS). This way, you can check that required light intensity is still given during the EPS switchover.
The German airports trust in DALMAS®

Germany

- Berlin
- Cologne
- Düsseldorf
- Hannover
- Dortmund
- Niederrhein/Weeze
- Frankfurt
- Nuremberg
- Stuttgart
- Karlsruhe/Baden-Baden
- Munich

Europe

- Bratislava
- Košice
- Linz
- Innsbruck
- Slovakia
- Austria
- Netherlands

Please respect that we cannot name all our customers.

DALMAS is verified by the German TÜV (technical review)!
Call us now, we support you personally!