ADB SAFEGATE

LED-based AFL- Live Long and Prosper!

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October 27th, 2016

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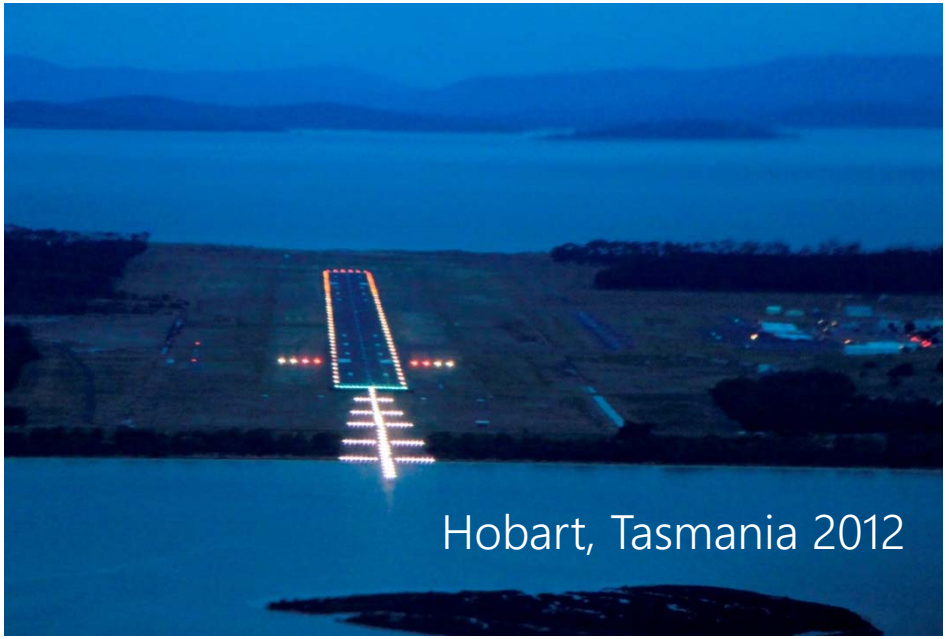
LED-based AFL

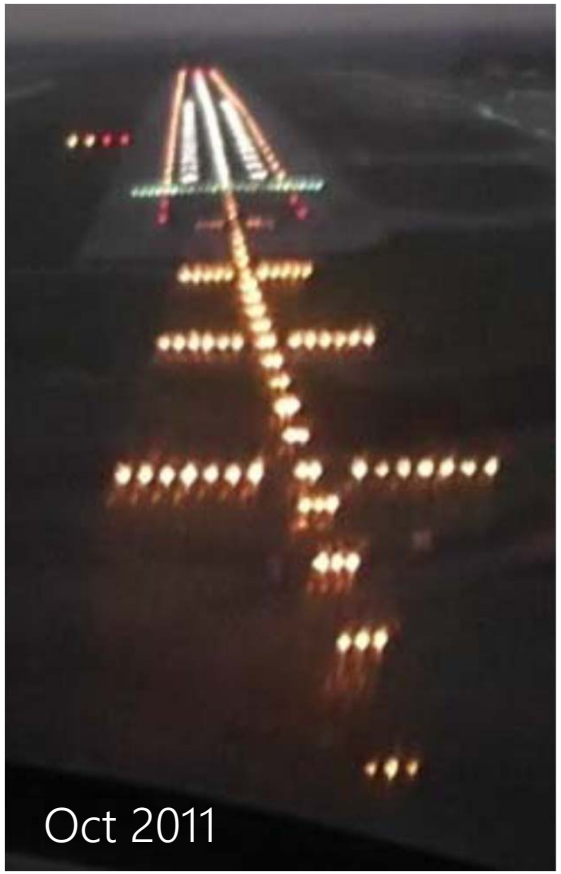
From Taxiway Edge
to
Approach



Red obstruction, ETL cert 1999
Taxiway Edge, ETL cert 2001
Taxiway edge first installation, 2002

All LED airports

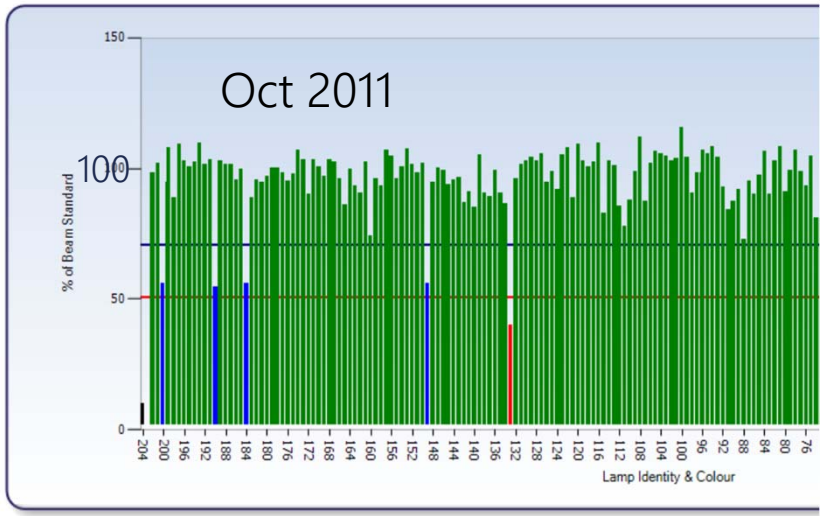
Runway trial in Manchester

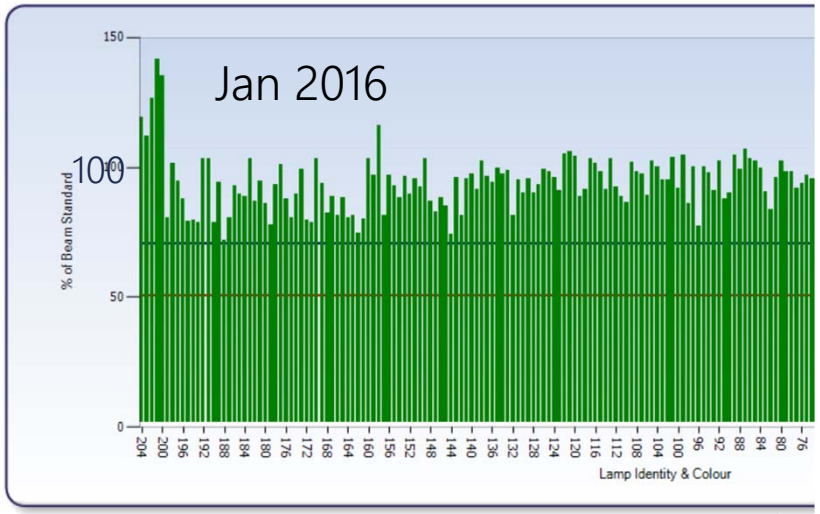


- Trial 2010, 26 weeks with prototype fixtures
- New RCL and TDZ fixtures installed Oct 2011
- During 5 years, 4 fixtures have been replaced

Runway trial in Manchester

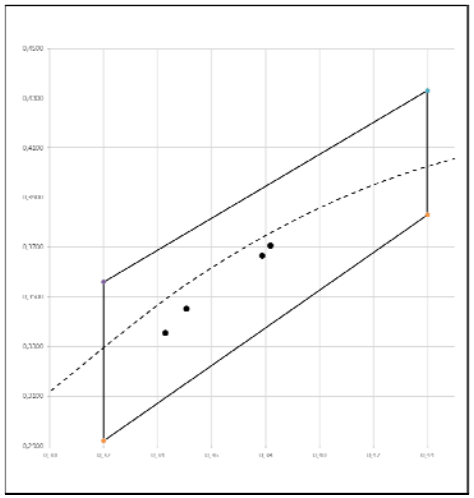
- 23 000 hours operation
- 10 000 hours at 6.6A
- Monthly cleaning of prisms
- Photometric measures regulary
- Invested in LED RWY Edge, Thr, End and PAPI

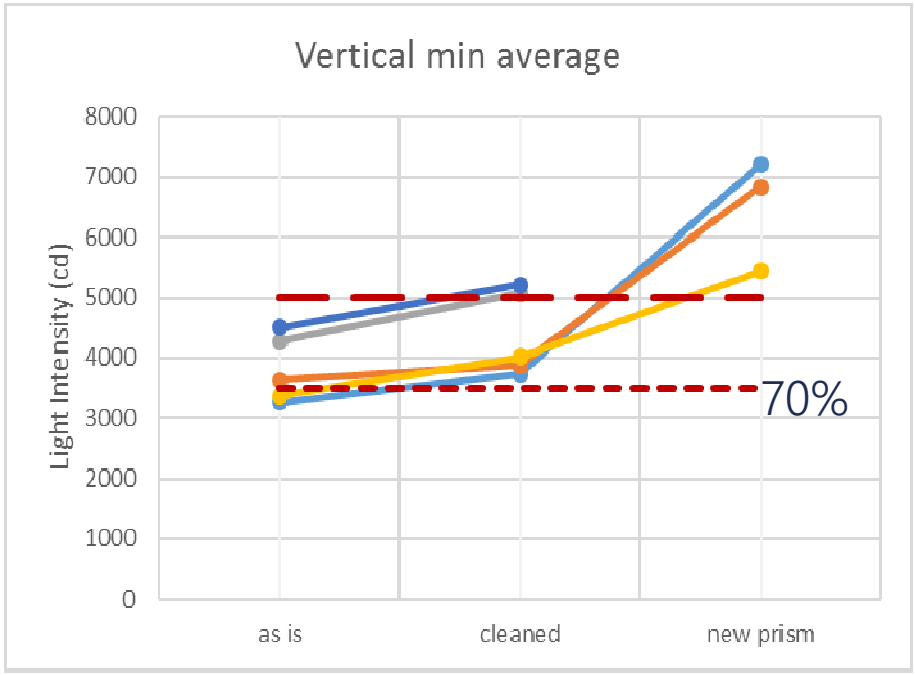




Raleigh Durham LED fixture evaluation

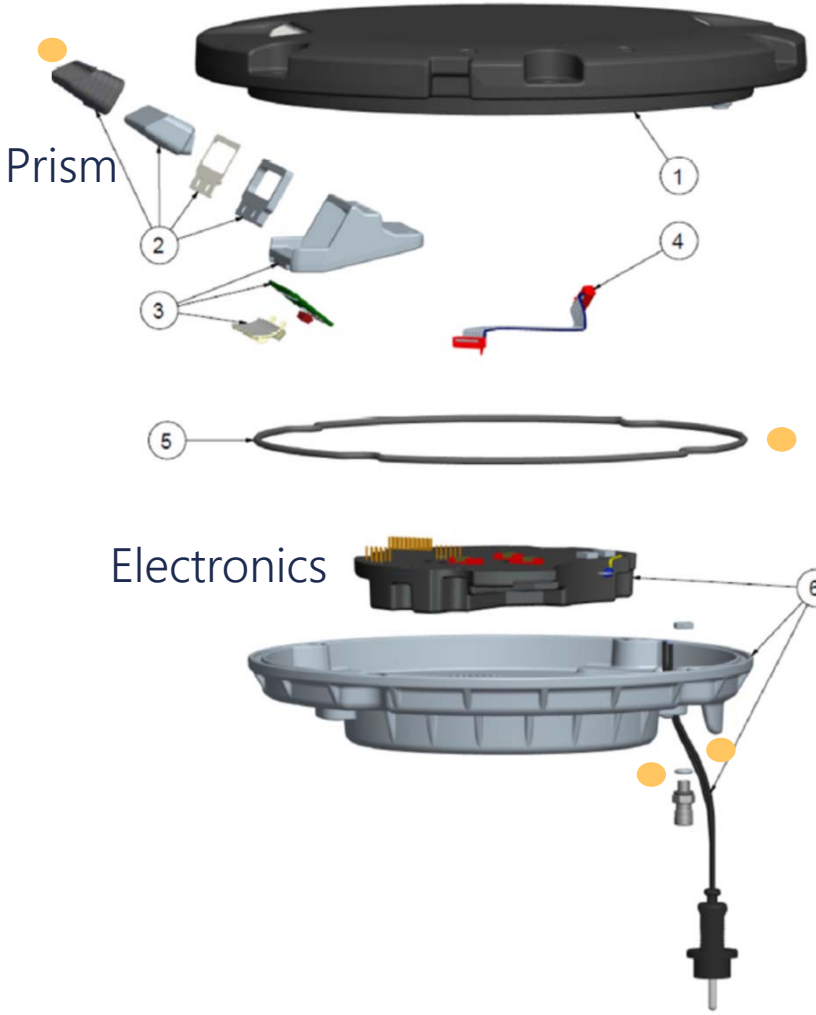
- 4 fixtures
- 3 TDZs and one RCL
- Installed during 2009
- Removed November 2015





By changing prisms, the fixtures are as good as new!

Lifetime definitions



Light engine
- LEDs
- Optics

Mechanics
- Top cover
- Bottom cover

Electronics

● Gaskets

Technical lifetime

Servicable lifetime

Economical lifetime

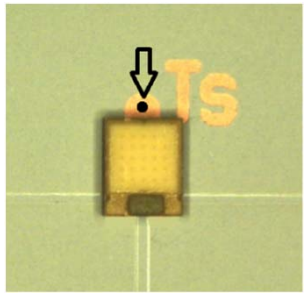
Lifetime of LEDs in fixtures

- IES LM-80-15: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules
  - LED current regulated
  - Measure LED case temperature T_s
  - Measure for at least 6 000 hours, test every 1000 hours
  - Preferably measure 10 000 hours

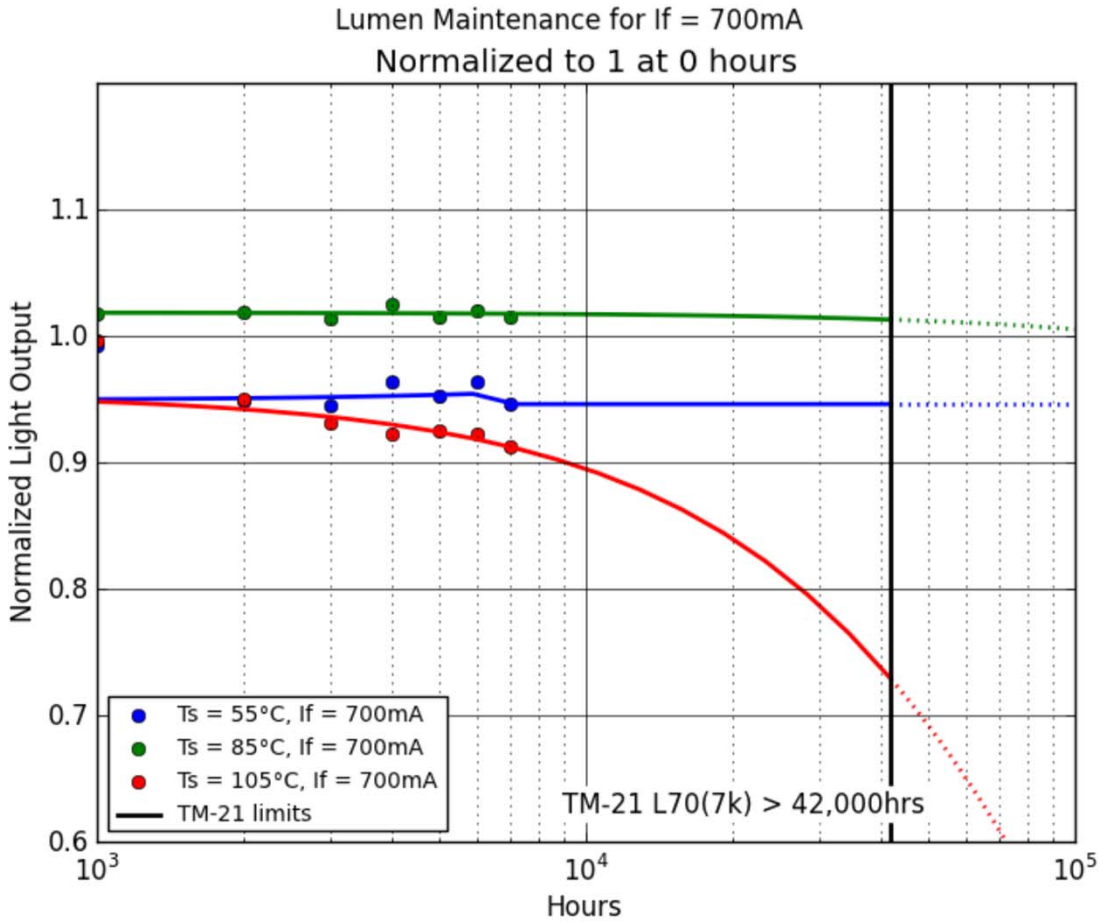
- IES TM-21-11: Projecting Long Term Lumen Maintenance of LED Light Sources
  - Describes exponential fit to the data from the test results
  - Presented as L70B50 lifetime values
  - Lifetime value is limited to maximum 6x test duration

Lifetime of LEDs in fixtures

White LED



	T_s If = 700mA
Ts = 105°C	> 42,000
Ts = 85°C	> 42,000
Ts = 55°C	> 42,000



Lifetime value limited by TM-21 rule!

Lifetime test for LEDs in fixtures

- The published LED data is used for evaluating LED lifetime in specific fixtures
- Test condition:
  - 100% intensity at 6.6A
  - inset in base in sand +55C
  - elevated standing in heat chamber +55C
  - stabilized for 4 hours
  - Ts measured

White LEDs	Elevated Runway Edge	Inset Runway Centreline
LED T_s	83 °C	101 °C
Projected L_{70}	246 000 h	100 000 h
Reported L_{70}	> 60 000 h	> 42 000 h

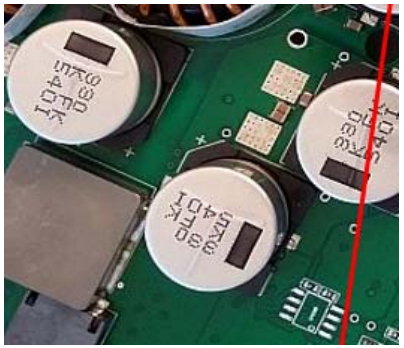
Reported L_{70} lifetime for fixtures is limited by the test duration in the LM-80 test performed by the LED manufactures

Lifetime Electronics

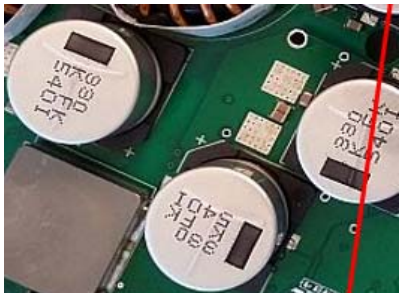
- No observed “end-of-life” electronics parts
- The electrolytic capacitors are the components that most probably will reach its estimated lifetime the first.
- When the capacitors degrade, the current to LEDs will remain as specified
- Life time is dependent on component temperature, which is dependent on
  - Intensity step when used
  - Ambient temperature
  - Fixture power

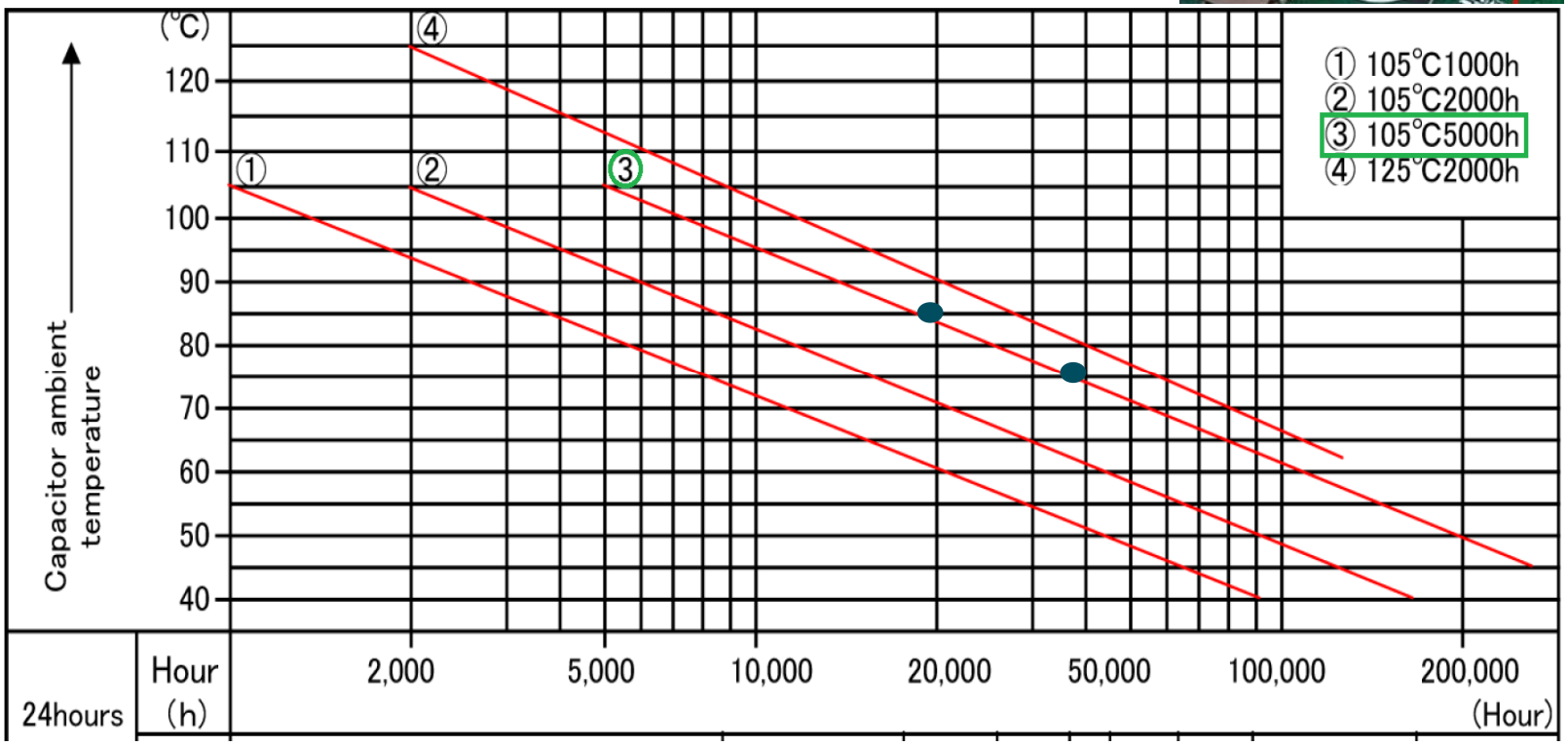
Life time of capacitors is also dependent on

- Capacitor quality
- Temperature rating
- Equivalent series resistance



Lifetime Electronics





- If temperature drops from 85°C to 75°C
  - Lifetime 20 000 hours increase to 40 000 hours

Lifetime of electronics and LEDs

- The lifetime of electronics and LEDs is dependent on
  - Temperature of the compenents
  - Drive current, i.e. operational use of intensity steps

- Temperatures in electronics an LEDs are dependent on
  - Annual averge temperature where the fixture is installed
  - Design of fixture
    - Efficient optical design gives low power usage for LEDs
    - Efficiency in electronics, low idle wattage, LED driver efficiency
    - Heat conduction within fixture
    - Heat conduction from fixture to base and surrounding air

W ?

The power usage of a fixture is a clue to evaluate the optical, electrical and thermal design

Helsinki

Helsinki

General maintenance

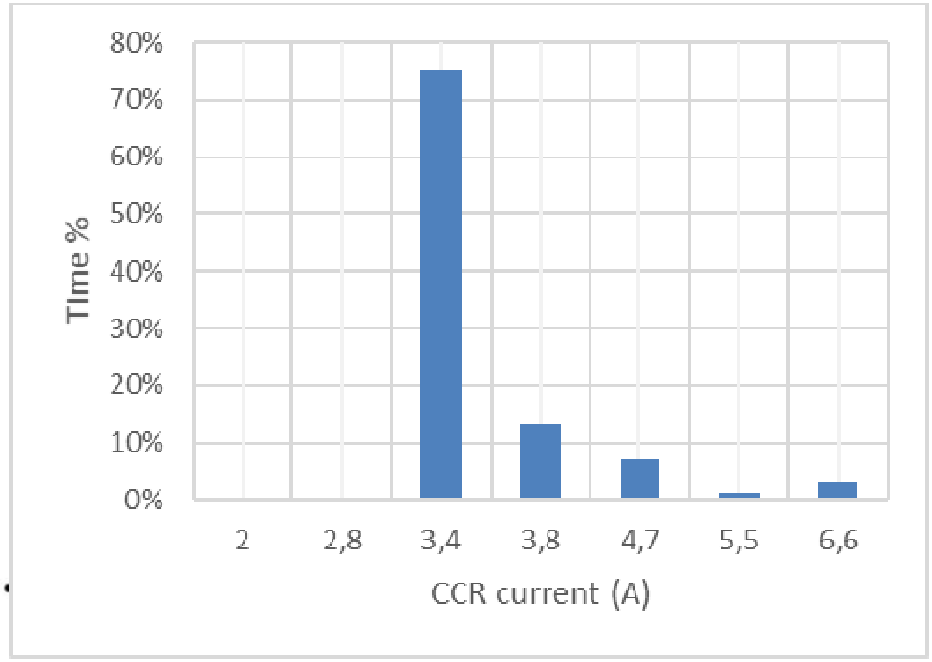
- Visual inspection every day
- Torque check annualy
- CO_2 dry ice to clean prisms
  - 4 times / year

Winter maintenance

- Snowploughs and brushes
- Chemicals for ice removal
  - Formiate Acetate
  - Type I and II propyleneglycol will also end up on the runways

Helsinki

- Test with one RCL and one TDZ
- Installed
  - November 2013 to
  - September 2016, 1 063 days
- Operational time
  - RCL: 14 976 hours, 624 days, 59%
  - TDZ: 3 667 hours, 153 days, 14%

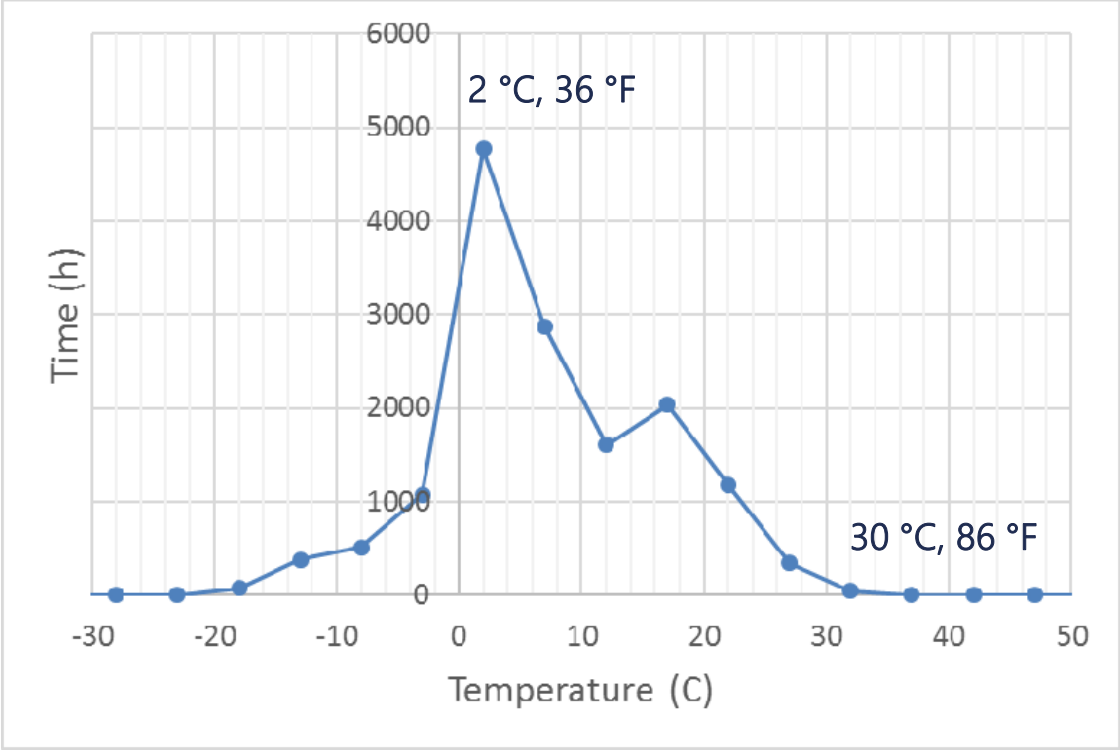


FAA EB67D

CCR (I)	Light Int
2,8	0,4%
3,4	1,6%
4,1	5,6%
4,8	14,8%
5,5	34,0%
6,6	100,0%

Helsinki

- Temperature on LEDboard, RCL White side



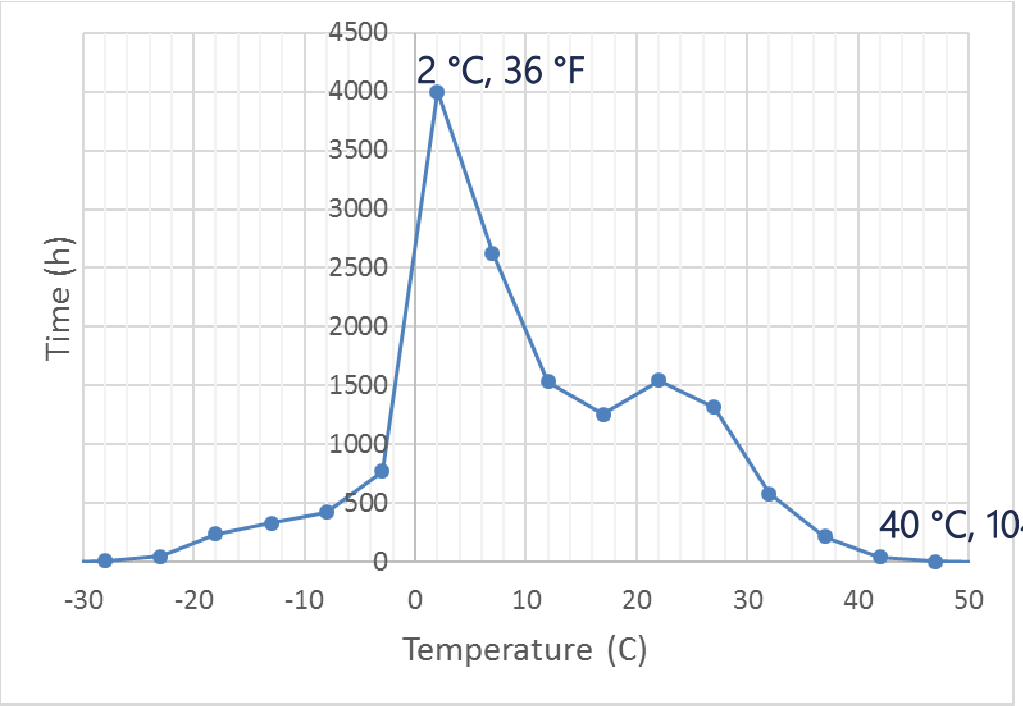
Annual average temperature southern finland: 6,5 °C, 44 ° F

At CCR 3.4 A
LEDpower about
RCL W 0.13W

The LEDS are running at very cold temperatures

Helsinki

- Temperature measurements on processor inside fixture, RCL white side



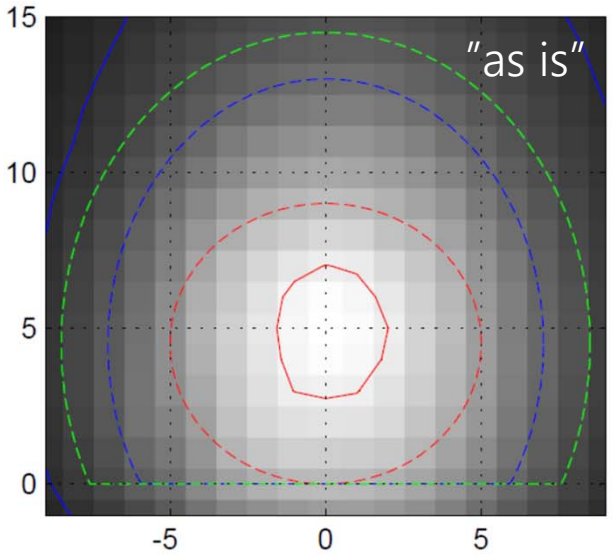
The processor and the electrinics are running at low temperatures

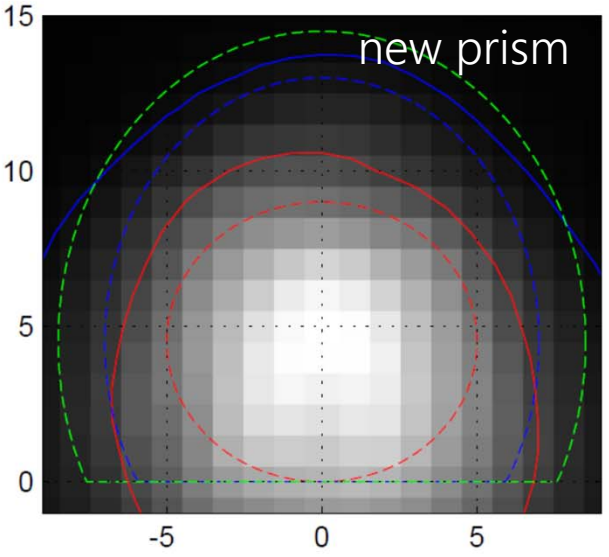
Annual average temperature southern finland: 6,5 °C, 44 ° F

Helsinki

- Prisms were scratched
- Light intensities
  - Measured ”as is”
  - Changed prisms

Runway centreline White, 15m spacing



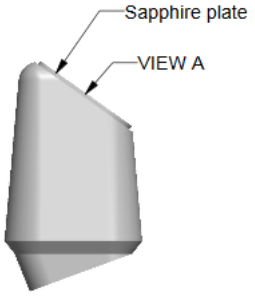


	MBA RCL W	MBA TDZ W	MBA RCL R
Req	5000	5000	750
”as is”	2215	3072	278
new prism	7184	6622	1088

By changing prisms, the fixtures are as good as new

Sapphire coated prisms

- Helsinki experience from inset halogen threshold fixtures, test 2011-2014
  - more durable than regular prisms
  - not economically for incandescent
- Rovaniemi, Finland airport recently installed LED RCL and TDZ with reinforced prisms
  - Evaluation to be done Spring 2017
- Stockholm experience
  - Using reinforced prisms on taxiways since 2010
  - Last much longer



Experience of heaters

Inset fixtures

Helsinki, Canada, Stockholm

- No heaters needed

Oslo

- Heaters needed

Elevated fixtures

Helsinki, Canada

- No heaters needed

Chicago, Columbus

- Heaters needed

The need for heaters is depending on location, type of snow, maintenance equipment and maintenance procedures

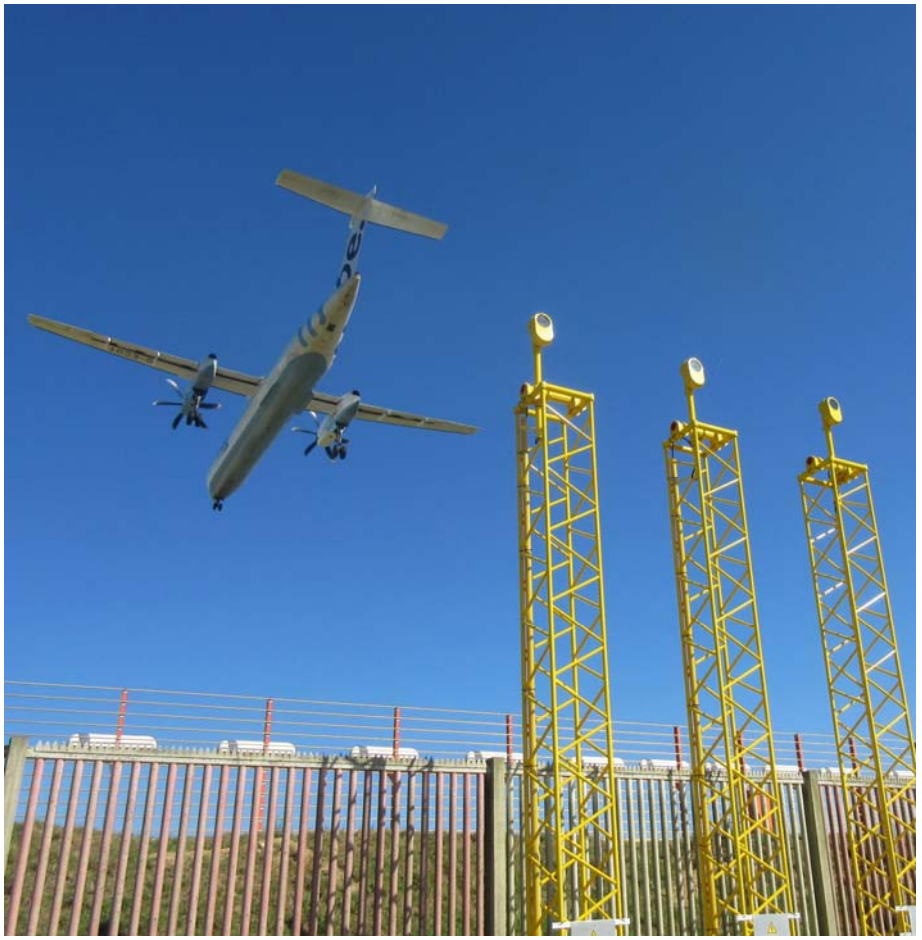
Airfield managers expectations on lifetime

Helsinki
- Will use reinforced prisms
- Use the LEDs to the bitter end

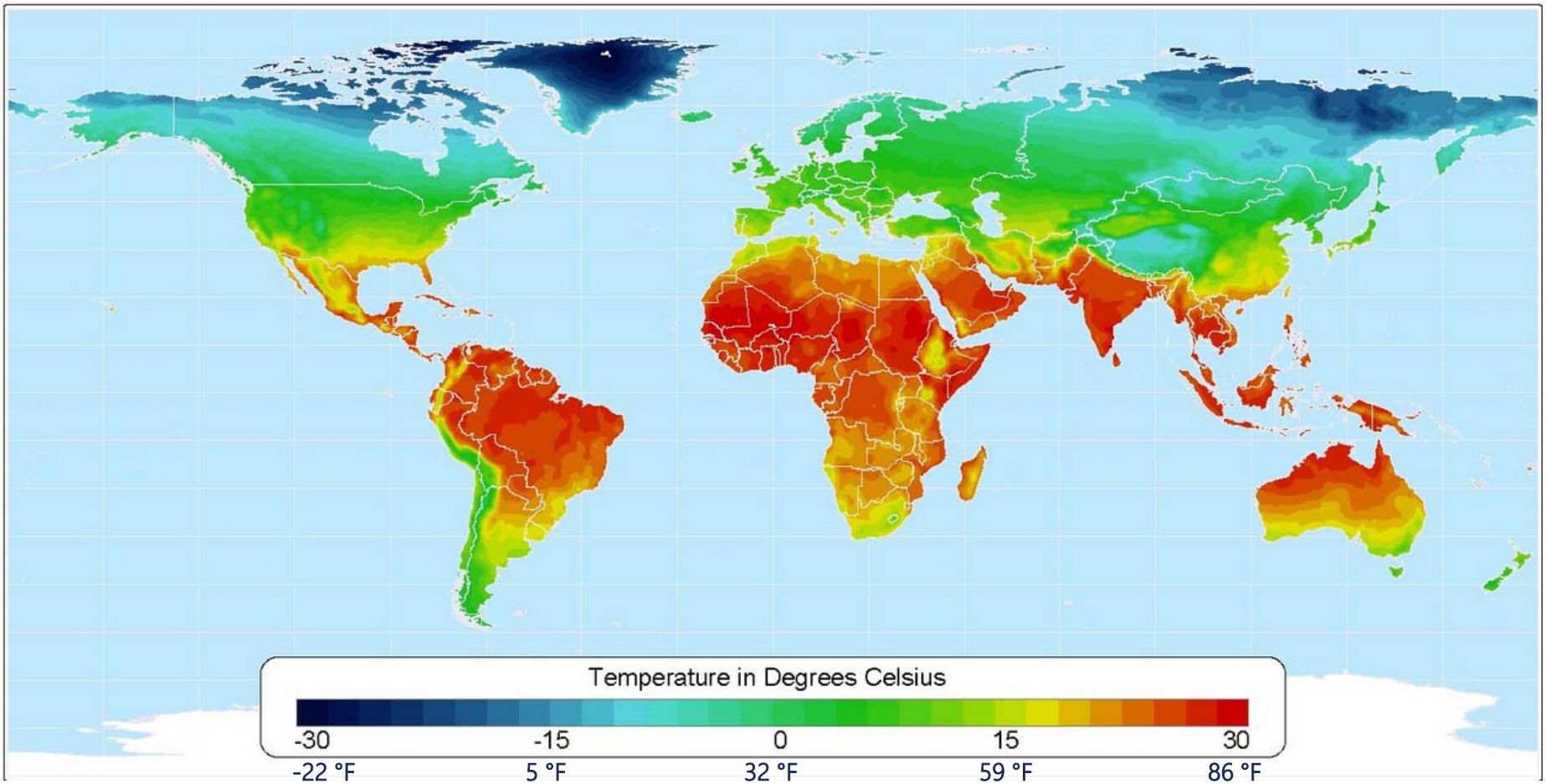
Brussels
- At least 6 years in field

Lyon
- At least 10 years in field

Stockholm
- Using reinforced prisms on taxiway
- Will use reinforced prisms on RWY
- At least 12 years in field



Average Annual Temperature



In low and moderate temperatures locations

- Lifetime of LEDs, optics and electronics will be the same or longer than for the mechanical parts

In hot locations

- Heat Chamber tests show very good lifetime for LEDs
- More long term field data is needed from installed fixtures

Conclusions

- Keep the watertightness intact
- Clean prisms
- Perform photometric tests
  - At least every second year
- Change prisms when needed

KEEP

CALM

AND

LIVE LONG

AND PROSPER