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Road Lighting & Safety

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Contents

1 General findings

In urban areas there is general agreement among Member States about common treatments for Traffic Route Lighting. Roads in urban areas are usually lit. Recent thinking seems to suggest that 'white light' is much better from a road safety/crime prevention point of view than traditional sodium lights.

There is also a move towards LED street lights. They can save a great deal of money, are very good for a country's carbon footprint, to say nothing of reducing night glare.

An article from the Netherlands on dynamic public lighting investigated the possibility of reducing lighting to 20% of normal levels during off-peak periods. A survey of motorists revealed a high level of support for the concept of the dynamic illumination of motorways. Some pilot studies in South Dublin in Ireland have shown that appreciable energy savings (up to 10%) can be achieved by dimming public lighting in urban areas at off-peak times.

There is also some interesting ongoing work on alternatives like solar powered 'cat's eye' studs. The studs can also be installed on approaches to roundabouts, road side barriers, traffic cones, signs, and anywhere where advance warning is necessary, e.g. on the approach to traffic islands, road works etc. The system automatically lights up at dusk and switches off at dawn.

Apart from motorways and dual carriageways, there is generally no traffic route lighting (TRL) on rural roads, with the exception of signal controlled intersections, roundabouts, and junctions that have a specific night-time collision history. Some countries illuminate major rural at-grade junctions where the mainline and sideline flows are above certain values.

The UK recently changed its standards regarding the places where lighting should be used on rural motorways and dual carriageways. This change in standard seems to be based on a recent analysis of night-time accidents on lit and unlit strategic roads. It has shown that the accident-saving benefits previously assumed by lighting have not been achieved in practice on links between junctions. The UK concluded that the safety benefit of lighting was a reduction in accidents of less than 10%, rather than the 30% plus that had previously been assumed. Further details on this study are included in the chapter 3 and in the appendix 2.

For details on the standards/guidelines in the various countries surveyed, see Appendix 1. Appendix 2 is a summary of the latest UK TD 49/07 Appraisal of Lighting on road network. Appendix 3 has information on the European standard EN 13201- 2 -2003 Standard on Road lighting. Appendix 4 contains the Spreadsheet Summary of CEDR Country Comments, updated from March 08.

Generally, the issues that seem to be driving this change in policy direction are:

- cost benefit/economic appraisal including maintenance and operation costs
- environmental issues like light pollution, light trespass, influence on the life cycle and behaviour of animals, and energy savings
- road safety issues relating to the transition from dark to light (dark adaptation)
- forgiving roadsides, where less traffic route lighting means less objects in the clear zone to be hit by drivers
- health & safety issues regarding actual maintenance operations

2 Rural motorways and dual carriageways

Recent research in both France and the UK indicates that the safety benefit of road lighting on rural motorways and dual carriageways is limited.

In June 1990, Setra (France) published a document on ‘lighting in interurban areas’, which deals with the link between lighting and safety. This document (in French) can be found on the Setra website at:
http://portail.documentation.equipement.gouv.fr/documents/Dtrf/0000/Dtrf-0000957/DT957.pdf

This document states that according to the studies available at this time, there is nothing to support the view that lighting improves road safety on interurban motorways. The high costs of lighting including capital and running costs are highlighted. This document concludes that the 1974 (French) guideline must be applied with caution.

The UK recently changed their standards regarding where lighting should be used on rural motorways and dual carriageways. Paragraph 5.35 of the standard UK TD 22/ 06 now reads:

‘It is normal practice to light grade separated junctions (i.e. the roundabout, the T-junction etc). The lighting of the grade separated junction would normally extend 60m along each entry or exit slip road without lighting the mainline carriageway.’

This change in the standard seems to be based on recent analysis of night-time accidents on lit and unlit strategic roads that has shown that the accident saving benefits previously assumed by lighting have not been achieved in practice on links between junctions.

This was the basis of the revised lighting standard, following on from the conclusion that the safety benefits of lighting were a reduction in accidents of less than 10%, rather than the 30% plus that had previously been assumed.

This is reflected in the new UK lighting investment appraisal Standard TA49/07 published in August 2007, which follows the extensive and critical review of the previous twenty year old standard. It states that there is no presumption to light any new road, and lighting will now only normally be provided where the requirements of TA49/07 are met by way of a positive benefit.

It further states that, as a stand-alone improvement, lighting should not be used to mitigate a high darkness personal injury accidents (PIA) rate unless a road safety engineer has carried out a full accident analysis and evaluation and concluded that road lighting would be the best solution.

It is also interesting to note the results of a review that was carried out on the following highway arrangements:

- slip road and link road merges and diverges on motorways and all-purpose dual carriageways;
- other elements of grade-separated interchanges on motorways and all-purpose dual carriageways;
- roundabouts on all-purpose single and dual carriageways;
- T-junctions and staggered junctions on all-purpose single and dual carriageways; and v. cross-roads on all-purpose single carriageways.

The results state that, with the exception of slip road merges and diverges, the available statistics do not give a clear indication of the PIA savings likely to be realized in any of the above circumstances.

For slip road merges and diverges the statistics show that they generally have a significantly lower number of darkness PIAs when lit, but other methods of accident reduction should always be considered alongside (for example, lengthening the merge/diverge).

3 Research

A review of research literature has highlighted a number of studies:

- Risk compensation—the case of road lighting
- Accident Analysis & Prevention, Volume 31, Issue 5, September 1999, Pages 545-553 Terje Assum, Torkel Bjørnskau, Stein Fosser, Fridulv Sagberg
- Drivers' response to the installation of road lighting. An economic interpretation on Accident Analysis & Prevention, Volume 34, Issue 5, September 2002, Pages 601-608 Finn Jørgensen, Pål Andreas Pedersen
- Main road and motorway lighting
- Lighting Engineering, 2001, Pages 346-388 R.H. Simons, A.R. Bean

The general theme of these articles is that traffic route lighting (TRL) does lead to a reduction in collisions, but that this reduction is less than might be expected due to the fact that drivers 'compensate' and speed up when they reach a section of motorway that is lit.

However, a very important study was recently carried out in the UK as part of an overhaul of various UK Highways Agency lighting standards. Research was carried out into the role played by road lighting in reducing personal injury accidents after dark.

It was considered impractical to carry out 'before and after' studies because of the difficulty and length of time in obtaining a statistically significant sample size. A large number of sites would need to be monitored for several years in order to draw conclusions that would be relevant to the network in general. Instead, accident rates on lit and unlit parts of the network were compared using two different approaches:

(i) Comparison of lit and unlit links of motorway, all-purpose dual carriageway and all-purpose single carriageway, totalled across the entire Highways Agency strategic road network,

(ii) Comparison of matching lit/unlit pairs of links for motorway, all-purpose dual carriageway and all-purpose single carriageway on the Highways Agency strategic road network.

The new UK Highways Agency's directive TA 49/07 is based on recent work that suggests the assumed 30% accident saving figure is much too high. The figure to be used for economic appraisal is now as follows:

(i) Motorway links: 10%, or as determined by a road safety engineer

(ii) AP dual carriageway links: 10%, or as determined by a road safety engineer

(iii) AP single carriageway links: 12.5%, or as determined by a road safety engineer

(iv) All junctions: as determined by a road safety engineer (no figure specified).

It is important to note that road safety engineering advice is needed. This is for two reasons:

(i) for links, a blanket figure may not always be appropriate

(ii) for junctions, it is not possible to provide a simple overall figure.

Further details on this research can be found in Appendix 2.

An article from the Netherlands on dynamic public lighting investigated the possibility of reducing lighting to 20% of normal levels during off-peak periods. A survey of motorists found that the concept of dynamic lighting of motorways was highly supported. See www.rws-avv.nl/pls/portal30/docs/12956.PDF. Some pilot studies in South Dublin Co. in Ireland have shown that appreciable energy savings (up to 10%) can be achieved by dimming public lighting in urban areas at off-peak times.

There is also some interesting ongoing work on alternatives like solar powered 'cat's eye' studs. The studs can also be installed on approaches to roundabouts, road side barriers, traffic cones, signs, and anywhere where advance warning is necessary, e.g. on the approach to traffic islands, road works etc. The system automatically lights up at dusk and switches off at dawn. Two web references are

http://www.astucia.co.uk/catalog_category.aspx?cat_id=24 and

http://www.made-in-china.com/showroom/sanmoo/product-detailuoqQVNSjrakW/China-Solar-Road-Studs-SRS-.html

There is an FHWA article from 1994 called 'Comparison of the safety of lighting options on urban freeways'. It quoted the finding of the Box study (from the early 1970s) which indicated that the illumination of an unlighted freeway (installation of overhead lighting at the interchanges and between the interchanges) could theoretically reduce night accidents by an average of 40%.

This study found that the illumination of an unlighted urban freeway between interchange areas (installation of overhead lighting between the interchanges only) could theoretically reduce night accidents by 16 percent.

Another conclusion of this study is that the relative benefit of overhead lighting for urban freeways between interchange areas is primarily associated with material damage accidents. http://findarticles.com/p/articles/mi_m3724/is_n2_v58/ai_16340196/pg_8

Generally, the issues that seem to be driving this change in policy direction are:

- cost benefit / economic appraisal,
- environmental issues like light pollution, light trespass, influence on the life cycle and behaviour of animals, and energy savings
- road safety issues relating to the transition from dark to light (dark adaptation)
- forgiving roadsides, where less traffic route lighting means less objects in the clear zone to be hit by drivers

APPENDIX 1: Summary of comments from CEDR Member States

Austria

In Austria street lighting is compulsory on all roads in built-up areas.

In general, in rural areas there is no street lighting except at very dangerous road sections (e.g. junctions or pedestrian crossings) to be identified on a case-by-case basis. Above-average history of night-time accidents at pedestrian crossings due to poor visibility showed that sufficient lighting at pedestrian crossings is strongly recommended and pedestrian crossings are retrofitted accordingly. On motorways in general no street lighting is provided except on urban motorways. Special standards exist for tunnel lighting.

Denmark

In rural areas, the main rule is: no street lighting except at signal-controlled intersections and at pedestrian crossings. If there are humps on priority roads, such a road section will normally have street lighting as well. However, there are also many locations in rural areas with street lighting, e.g. at roundabouts, major intersections, and black spots. With the exception of lighting at signal-controlled intersections and pedestrian crossings (where lighting is a must), it is up to the different road authorities to decide.

In urban areas, the main rule is that street lighting must be provided on all roads. But again, with the exception of lighting at signal-controlled intersections and pedestrian crossings (where lighting is a must), it is up to the local road authority to decide.

The level of light depends on the type of street, number of lanes, speed, pedestrians, cyclists, intersection type etc.

Estonia

In Estonia, lighting is provided as follows:

Inside an urban area: on all roads

Motorways: on the entire length of motorway and at ramps and the whole areas around interchanges on minor roads

Dual carriageways: at all interchanges and bus-stop areas

At-grade junctions: on class II and class III roads (single carriageway roads), for 250 m along every arm of the junction (this is not always the case in practice), also on railroad crossings

Rural areas:

- at grade-separated interchanges
- on sections between grade-separated interchanges if the distance between interchanges is less than 2,000 m or the gap between lit sections is less than 1,500 m
- on sections between lit sections where the gap between the sections is less than 500 m
- at pedestrian crossings
- at junctions with traffic signals

- at busy/popular roadside rest areas
- in tunnels
- at ferry boat quays and connecting road sections

Lighting is recommended in the following areas:

- at sections with a high concentration of accidents
- at channelled (separate turning lanes) junctions

Finland

In Finland, lighting is provided as follows:

Urban areas: lighting on all streets and roads

Rural areas: the decision as to whether a road should be lit is defined in the national road lighting policy. The basis for calculating the benefits of road lighting installations that are justified by traffic volume is the average personal injury and fatality for each road class. On motorways and other highways, travel time savings may also be considered.

In general, road lighting may be warranted, feasible, and worthwhile without studies due to location, traffic volume, or accidents.

Typical profitable traffic volumes from a traffic economics point of view are:

- Motorway, central reserve <12 m, ADT ≥1’800 vehicles/day
- Main roads, cars only, junction density 2 pc/km, ADT ≥8’000 vehicles/day
- Main roads, all-purpose, ADT ≥6’000 vehicles/day
- Collector roads, all-purpose, ADT ≥5’000 vehicles/day

Roundabouts are usually lit. Intersections are normally lit as a part of the illuminated road section; individual junctions are given special consideration.

Junctions with raised islands are lit.

Grade-separated junctions are lit.

On motorways between lit interchanges, carriageways are lit if the distance between the nose of the off-ramps is< 1,500 m.

The profitability of road lighting in terms of traffic economy is analyzed by comparing the average annual savings in total costs of road traffic with the combined influence of lighting costs and the cost of column collisions. All necessary factors and coefficients such as the proportion of night-time traffic, reduction in night-time accidents due to road lighting, and the personal injuries and fatality accident rate are found in the national traffic safety statistics.

France

In France, a very old guideline (1974) for national roads only states that:

'For interurban and urban motorways, lighting must be provided according to the daily following traffic volumes:

- *more than 50'000 vehicles/day: general lighting*
- *between 25'000 and 50'000 vehicles/day: general lighting where interchanges are less than 5 km apart, lighting only at interchanges when these are more than 5 km apart.*
- *less than 25'000 vehicles/day: lighting at interchanges only.*

For other national roads: one must ensure homogeneity of lighting. Outside urban areas, lighting must be limited to some junctions, particularly those that are dangerous at night.'

In June 1990, Setra published a document on 'lighting in interurban areas' which deals with the link between lighting and safety. You will find this document (in French) on the Setra website at:

http://portail.documentation.equipement.gouv.fr/documents/Dtrf/0000/Dtrf-0000957/DT957.pdf

This document states that according to the studies available at the time, there is no reason to assume lighting improves road safety on interurban motorways. The high cost of lighting including investment and 'function' are highlighted. This document concludes that on the basis of these results, the 1974 guideline must be applied with great caution.

Germany

Provisions concerning road lighting are part of several specific road design guidelines (e.g. Recommendations for pedestrian facilities (EVA 2002), Guidelines for the design of urban roads (RAST 2007), Guidelines for the design and operation of tunnels (RABT), etc.).

Generally, roads within urban areas are lit if these areas are built up or if the roads connect built up areas. Outside urban areas, lighting is infrequently applied. Decisions as to whether a location will be lit, are taken on the basis of the probability of night-time accidents or dazzle by ambient light, e.g. from adjacent road stretches, crossing or parallel roads or from the roadsides.

On motorways, service-areas are lit to ensure safety and ease of traffic at the entrance and exit ramps, as well at the parking lots and pedestrian facilities.

Greece

Greece does not appear to have national guidelines on where to provide lighting on the road network. However, as far as the national road network is concerned, there are a number of cases where lighting should be provided on particular road sections.

The cases where lighting is compulsory are:

a) On 'main' junctions on the national road network;

b) On all interchanges on motorways and dual carriageways;

c) On most sections connecting urban areas, although there is no formal directive;
d) On parking areas along motorways;
e) On service areas along motorways;
f) On sections of the secondary road network connecting motorways;
g) On any sections constructed in order to connect private businesses with the national road network.

As for lighting on the provincial road network and in urban areas, the decision on lighting is taken by the local authorities.

Iceland

In general lighting is provided at the following locations:

1 Urban areas:
All national roads (on some of them, the speed limit is as high as 80 km/hr).

2 Rural areas:
In rural areas lighting is, in general, only provided at the following locations:
- at roundabouts
- at junctions with raised islands
- at other junctions only if certain conditions apply, e.g. bad geometry or poor accident records

3 Political pressure:
One major road outside an urban area is lit, i.e. the road to the Keflavik International Airport. The lighting of this road was a political decision. The traffic volume on this road was less than 6'000 cars/day when the lighting was installed. There are also preparations to light another road with less than 1'400 cars/day!

Ireland

In normal circumstances, lighting should be provided at the following locations:

- Inside an urban area: i.e. speed limit 60 km/h or less. This does not include lighting where periodic special speed limits are in place e.g. at schools
- at-grade junctions
- at roundabouts
- at junctions with raised islands
- at-grade junctions on dual carriageways where there is a median break for use by turning traffic
- at junctions where the mainline flow > 12'000 and the sideline flow > 3'500

USA, Canada, Australia

- Walker and Roberts (US), 1976, lighting at intersections results in greatest improvement in night-time accident rate where flow on side road > 3’500 vehicles/day.
- Australia: flow varies between 10’000 and 15’000 vehicles/day on mainline.
- Canada: all junctions with right turn lanes.

Notes:

- Junctions on 2-plus-1 roads should not be treated differently—lighting should depend on junction type and flows as outlined above.
- Where developments on side roads result in the thresholds being exceeded, the cost of providing lighting should be covered by the developer.
- Retrofit of the existing network should be carried out.
- For new schemes, where the traffic flows will not exceed the thresholds at year of opening, but are expected to exceed the thresholds within 10 years, then ducting should be provided during scheme construction.

<u>Motorways/high-quality dual carriageways</u>:

At grade separated interchanges:

- The mainline should be lit from the start of the diverge taper to the end of the merging manoeuvre – approximately 100m past the end of the merge taper. The slips should also be lit, along with the junctions of the slip roads with the side road(s).

Gramza, Hall & Sampson (US), 1980, full lighting of interchanges has a better accident record than partial lighting of interchanges, which has a better accident record than no lighting at all.

Janoff, Freedman & Decina (US), 1982 find the same conclusion as above.

Where there is only an off-slip:

- The mainline should be lit from the start of the diverge taper to 50 m after the end of the diverge nose. The slip should also be lit, along with the junction of the slip with the side road(s).

Where there is only an on-slip:

- The mainline should be lit from 215 m back from the start of the merge nose to 100 m after the end of the merge taper. The slip should also be lit, along with the junction of the slip with the side road(s).
- Light between lit interchanges when the distance between them < 1.5 km

Canada: light if < 1.5 km between interchanges

Australia: light if < 2 km between interchanges

Apart from the above, lighting will not normally be provided, except where there is an above-average history of night-time accidents, and an examination of the crash history at those locations indicates that improved lighting should reduce the possibility of collisions.

Italy

In Italy, there is a new standard for the design of new intersections that requires mandatory lighting for all grade-separated interchanges. There is no formal standard for lighting. The EN standard 13201 has been translated into Italian and is now an UNI standard but this has not been formally adopted by the ministry as a national standard (and is therefore not mandatory).

Italy also has a mandatory guideline for tunnel lighting covering all the technical requirements for designing tunnel lighting.

Luxembourg

In Luxembourg, the 'service électromécanique' uses the standard EN13201 Part 1 to 4, which was transposed to Luxembourgish law in 2005.

Norway

Inside urban areas (i.e. where speed limits of 60 km/h or less apply), lighting should be provided at the following locations:

- pedestrian crossings
- where cycle paths/footpaths cross roads
- junctions with raised islands
- roundabouts
- toll areas
- at ferry connections
- short distances (< 500 m) between lighted areas to ensure continuity

Lighting should also be provided on the following roads:

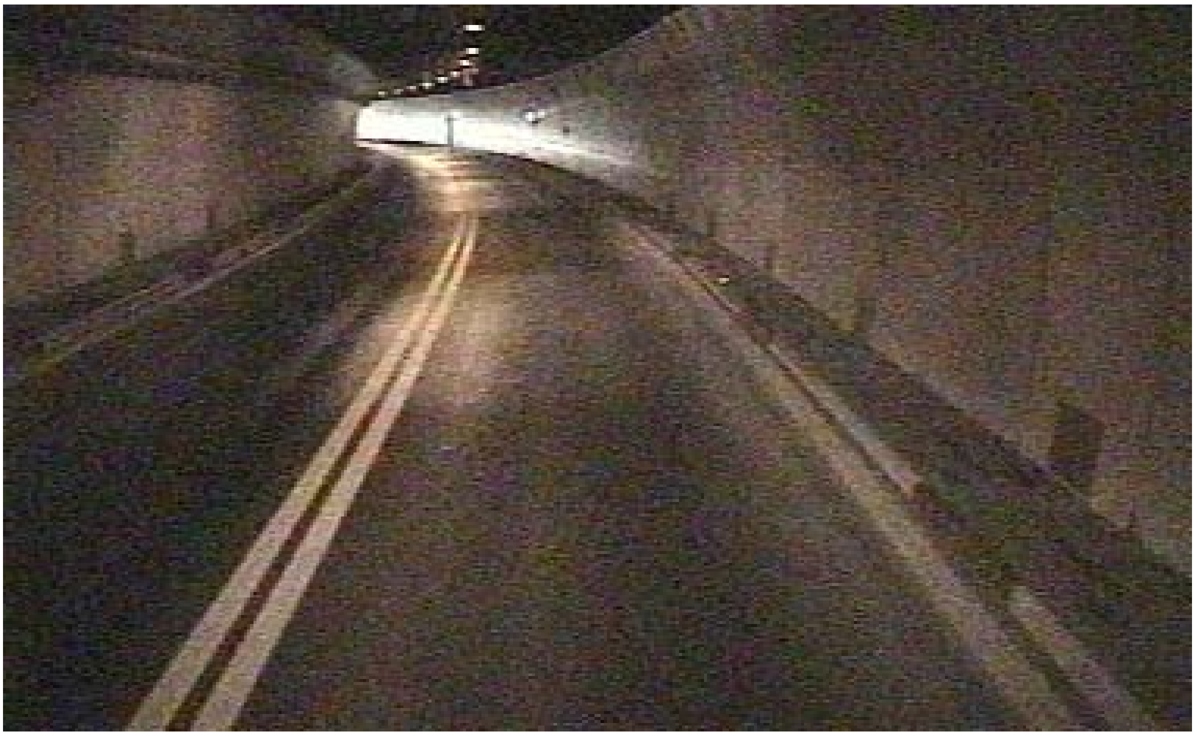
- two-lane roads with a central reserve (annual average daily traffic 8'000–12'000; speed limit of 90 km/h)
- four-lane roads with an annual average daily traffic of over 20'000 and a speed limit of 80 km/h
- motorways with a speed limit of 100 km/h

Switzerland

The situation in Switzerland is somewhat complicated. There is a Swiss standard for lighting public roads (based on the European norm EN 13201). The Swiss Association for Lighting (a PPP association) has published explanations and additional recommendations.

In Switzerland, the application of this standard is the responsibility of the cantons, the cities, or the municipalities. There is no centralized control over the implementation. Some cities or cantons seem to have a sophisticated approach (including the lighting of black spots in rural areas), while others have other priorities.

Most urban areas, however, are well lit.



UK

There is no mandatory requirement to provide lighting, but where it is provided, it must be maintained to established standards. Approximately one third of the network is lit. Recent analysis of night-time accidents on lit and unlit strategic roads has shown that the accident saving benefits previously assumed by lighting have not been achieved in practice on links between junctions.

This is reflected in the new lighting investment appraisal Standard TA49/07 published August 2007, which follows the extensive and critical review of the previous twenty year old standard.

A new lighting design Standard TD34/07, with specific environment requirements, was also published in August 2007, this links to British and EU Standards.

There is no presumption to light any new road, and lighting will now only normally be provided where the requirements of TA49/07 are met by way of a positive benefit. This benefit, which is assessed as an economic saving to the community, is based on the saving through the reduction in night-time personal injury accidents weighed against the 'whole life cycle' capital and operational (maintenance and energy) costs of providing lighting. The overall appraisal requirements within TA49/07 also take account of the environmental impact of road lighting.

The new appraisal standard provides for more consistency of approach, and is linked to the mandatory Project Appraisal Report (PAR) process. This provides greater accountability with decisions required to be placed on a Technical File for audit purposes.

The need for lighting at ‘junctions’ is based on a site-specific analysis and evaluation undertaken by a road safety engineer - and not solely by a contractor’s lighting engineer’s assessment.

These new standards are part of the overall Efficiency Strategy for Road Lighting, which supports the government’s climate change objectives and the need to reduce adverse environmental impacts including, CO_2 emissions, daytime visual impact to landscape, and light pollution to the night-sky and rural landscape. It is also an aim to reduce capital, maintenance, and energy costs, while maintaining and improving road safety, and considering alternative safety measures to road lighting.

Appendix 2: UK research

ROAD LIGHTING AND ACCIDENTS ON THE STRATEGIC ROAD NETWORK
DERIVATION OF SAVINGS FOR ECONOMIC APPRAISAL
Highways Agency - April 2008

SUMMARY

As part of an overhaul of various Highways Agency lighting standards, research was carried out into the role played by road lighting in reducing personal injury accidents after dark. For economic appraisal purposes it had been assumed that road lighting saved 30% of darkness accidents on strategic road network links (not junctions). This was based on research carried out more than thirty years ago when there were relatively few motorways.

It was considered impractical to carry out 'before and after' studies because of the difficulty and length of time in obtaining a statistically significant sample size. A large number of sites would need to be monitored for several years in order to draw conclusions that would be relevant to the network in general. Instead, accident rates on lit and unlit parts of the network were compared using two different approaches:

- comparison of lit and unlit links of motorway, all-purpose dual carriageway and all-purpose single carriageway, totalled across the entire Highways Agency strategic road network
- comparison of matching lit/unlit pairs of links for motorway, all-purpose dual carriageway and all-purpose single carriageway on the Highways Agency strategic road network.

Both analyses were based on police collision data held by the Transport Research Laboratory (TRL).

<u>Road Motorways in England.</u>

Motorway Link Average National Data (CS methodology)

The first analysis was peer reviewed by TRL; the figures for accident saving were found to be 10% for motorways and dual carriageways and 12.5% for single carriageways.

It was found that, on English motorways, darkness PIAs are 10% less frequent when road lighting is provided. This figure was reached by comparing the number of darkness accidents with the total number of accidents (darkness plus daytime), having split the motorway network into two categories, lit and unlit. It was concluded that lighting a motorway could be expected to reduce the number of darkness PIAs by an average 10%. The same data showed that on the motorway network as a whole, 28.6% of all PIAs occurred at night.

<u>Motorway junctions</u>

No significant darkness PIA saving due to road lighting was found for any motorway junction elements, except slip road merges and diverges, where it was found that a saving of 24% could be expected on average. It was concluded that assessment of the likely PIA savings at a given motorway junction should be carried out by a road safety engineer, who would be able to look at all the circumstances and review any accident history.

Motorway Link Pairs Study (TRL)

TRL has now looked at 30 motorway pairs. These pairs have matching flow rates and are exactly the same length. It was hoped this would give as near a like-for-like comparison as is possible.

TRL found that the average darkness accident reduction taken over all 30 pairs was 3.5%. Individual pairs varied between a reduction of 51% and an increase of 108%. They concluded that the 3.5% saving was not statistically significant because of this very large variation in results. TRL then eliminated certain pairs where the accident rate (PIA/million vehicle km) was unusually high, low, or undetermined. This gave an average darkness accident reduction of 5.5%, although the variation remained unchanged. This was also not statistically significant.

Further detailed study would be necessary to reveal the reasons behind the enormous variations found in the TRL pairs study. Local factors may probably explain such variations, including: weather patterns, driver behaviour (e.g. drink-driving, excessive speeding, lane-changing on approaching/leaving junctions), carriageway maintenance, proximity of junctions.

The work described in the report relates purely to the strategic road network. It does not have any intended relevance to other roads, although local highway authorities may consider that some of the findings are relevant to their inter-urban routes.

RECENT SITUATION

The old standard, TA 49/86, stated that it was to be assumed that road lighting would save 30% of darkness accidents. This then enabled an economic calculation to be carried out to see whether lighting would have a net benefit, based on the average cost of a darkness accident.

The 30% figure had its origins in research carried out in the 1950s, 1960s, and early 1970s, and was presented in two sources, both referenced in TA 49/86.

The first of these was a paper by J C Tanner of the then Road Research Laboratory, published in 1958. It looked at 64 sites that were relit between 1949 and 1955. The conclusion was that lighting reduced night-time accidents by about 30%. Interestingly, it also concluded that much of this accident reduction was among pedestrians. The problems with these findings are obvious:

(i) the study is very old, pre-dating the inception of motorways

(ii) accidents involving pedestrians on the strategic road network are no longer a significant issue.

The second was a paper by Barbara Sabey and H D Johnson of TRRL in1973. They looked at 43 trunk road sites and found a reduction on 70-mph roads ‘of the order of 50%’. The results for other road speeds were not statistically significant, but there was the suggestion of a marked increase in accidents on 50-mph roads. Again, there are two problems with these findings:

(i) even 30 years ago the results were rather inconclusive

(ii) very few motorways were included in this study.

Note that TA 49/86 did not define a saving for junctions, but suggested that road lighting might be considered as a safety measure.

CURRENT SITUATION (Conclusions of this study)

The new TA 49/07 is based on recent work that suggests the 30% accident saving figure is much too high. The figure to be used for economic appraisal is now as follows:

(i) motorway links: 10%, or as determined by a road safety engineer

(ii) AP dual carriageway links: 10%, or as determined by a road safety engineer

(iii) AP single carriageway links: 12.5%, or as determined by a road safety engineer

(iv) all junctions: as determined by a road safety engineer (no figure specified)

It is important to note that road safety engineering advice is needed. This is for two reasons:

(i) for links, a blanket figure may not always be appropriate

(ii) for junctions, it is not possible to provide a simple overall figure

UK Standard TD 49/07 summary

Summary of UK Standard - Traffic Route Lighting

Lighting is used as a safety measure on the strategic road network. However, it should be recognised that previously advised accident savings may no longer be realised and there may be associated adverse impacts. Furthermore, as new technologies become available, other scheme safety measures may provide better value for money, or lower adverse impact, or both.

The primary purpose of road lighting on the strategic road network is to reduce personal injury accidents (PIAs). This is a quantifiable benefit. Consequently the most important consideration is the predicted accident cost saving, which should be greater than the lighting scheme cost in order to provide economic justification for road lighting.

The role of road lighting as a safety benefit has limitations, however, as follows: as a stand-alone improvement, it should not be used to mitigate a high darkness PIA rate unless a road safety engineer has carried out a full accident analysis and evaluation and concluded that road lighting would be the best solution.

The proportion of darkness PIAs on all types of strategic road is on average 28% of the total PIAs occurring during daylight and darkness [source: Road Casualties Great Britain 2004, DfT]. Where only the total accident figures are known it can be assumed, therefore, that 28% of them occur during the hours of darkness.

Darkness PIA saving for junctions

Junctions include the following highway arrangements:

- slip road and link road merges and diverges on motorways and all-purpose dual carriageways;
- other elements of grade-separated interchanges on motorways and all-purpose dual carriageways;
- roundabouts on all-purpose single and dual carriageways;
- T-junctions and staggered junctions on all-purpose single and dual carriageways; and v. cross-roads on all-purpose single carriageways.

With the exception of slip road merges and diverges, the available statistics do not give a clear indication of the PIA savings likely to be realized in any of the above circumstances. For slip road merges and diverges, the statistics show that they generally have a significantly lower number of darkness PIAs when lit, but other methods of accident reduction should always be considered alongside (for example, lengthening the merge/diverge).

Whether the junction exists or is proposed, a road safety engineer should carry out an assessment to estimate the likely PIA saving through providing road lighting for use in PAR. If it is not possible to provide such an estimate it should be assumed that there would be no PIA saving.

Government policy

All impacts on government policy should be reported. For example, road lighting would contribute to meeting casualty reduction targets. On the other hand, road lighting would consume energy, thus working against the government's long-term strategy to reduce greenhouse gas emissions. Other policies where road lighting would have a non-neutral impact should also be mentioned. Note that in PAR the adverse impact of greenhouse gas emissions should be reported here, not in the greenhouse gas worksheet, since that is reserved for emissions arising from vehicle use.

Appendix 3: EN 13201- 2 -2003 Standard

nsai
National Standards Authority of Ireland

IRISH STANDARD

I.S. EN 13201-2:2003

ICS 93.080.40

National Standards
Authority of Ireland
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ROAD LIGHTING - PART 2: PERFORMANCE REQUIREMENTS

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EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 13201-2

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ICS 93.080.40

English version

Road lighting - Part 2: Performance requirements

Eclairage public - Partie 2: Exigences de performance

Straßenbeleuchtung - Teil 2: Gütemerkmale

This European Standard was approved by CEN on 1 September 2003.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 13201-2:2003 E

EN 13201-2:2003 (E)

Foreword

This document (EN 13201-2:2003) has been prepared by Technical Committee CEN/TC 169 "Light and lighting", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2004, and conflicting national standards shall be withdrawn at the latest by April 2004.

This document EN 13201-2 has been worked out by the Joint Working Group of CEN/TC 169 "Light and lighting" and CEN/TC 226 "Road Equipment", the secretariat of which is held by AFNOR.

Annexes A and B are informative.

This document includes a Bibliography.

This standard, EN 13201 *Road Lighting*, consists of three parts. This document is;

Part 2: Performance requirements

The other parts of EN 13201 are:

Part 3: Calculation of performance

Part 4: Methods of measuring lighting performance

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

A lighting class is defined by a set of photometric requirements aiming at the visual needs of certain road users in certain types of road areas and environment.

The purpose of introducing lighting classes is to make it easier to develop and use road lighting products and services in CEN member countries. The lighting classes have been defined with consideration of road lighting standards in these countries aiming at harmonization of requirements where possible. However, some lighting classes and subclasses reflect particular situations and national approaches based on traditional, climatic or other conditions.

The ME classes are intended for drivers of motorized vehicles for user on traffic routes, and in some countries also residential roads, allowing medium to high driving speeds.

The CE classes are also intended for drivers of motorized vehicles, but for use on conflict areas such as shopping streets, road intersections of some complexity, roundabouts and queuing areas. These classes have applications also for pedestrians and pedal cyclists.

The S and A classes are intended for pedestrians and pedal cyclists for use on footways and cycleways, emergency lanes and other road areas lying separately or along the carriageway of a traffic route, residential roads, pedestrian streets, parking areas, schoolyards etc.

The ES classes are intended as an additional class in situations where public lighting is necessary for the identification of persons and objects and in road areas with a higher than normal crime risk.

The EV classes are intended as an additional class in situations where vertical surfaces need to be seen in such road areas as toll stations, interchange areas etc.

The requirements of the lighting classes reflect the category of road user in question or the type of road area. Thus the ME classes are based on the road surface luminance, while the CE, S and A classes are based on the illumination of the road area. The S and A classes reflect different priorities to the road lighting. The ES classes are based on semi-cylindrical illuminance, while the EV classes are based on the vertical plane illuminance.

The ME classes present increasingly stronger requirements in the order ME 6, ME 5,...ME 1 forming steps of the lighting level as measured for instance in illuminance. The other classes are arranged in the same way, and so that their steps interlock.

Environmental aspects of road lighting are considered in clause 7 in terms of day time appearance, night time appearance and light emitted in directions, where it is neither necessary nor desirable. The purpose is to point to matters that can be included in tender specifications or similar, when relevant.

Installed intensity classes for the restriction of disability glare and control of obtrusive light G.1, G.2, G.3, G.4, G.5 and G.6 are introduced in the informative annex A. The use of G classes is mentioned in clause 5 for conflict areas and in clause 7 on appearance and environmental aspects.

Installed glare index classes for the restriction of discomfort glare D.0, D.1, D.2, D.3, D.4, D.5 and D.6 are introduced in the informative annex A as well. These classes are intended mainly for road areas lighted for the benefit of pedestrians and pedal cyclists.

Local lighting of pedestrian crossings is considered in the informative annex B. The intention of local lighting is to attract the attention of drivers of motorized vehicles to the presence of the pedestrian crossing and to illuminate pedestrians in or at the crossing area.

APPENDIX 4 - 1

	Urban Area (SL<60km/hr)	Rural Areas	General	At Roundabouts & At-Grade Jns	Junctions with raised islands	Motorways, Duals	Grade separated interchanges	Between lit interchanges	Above-average history of night time accidents, lighting related.
Austria	street lighting on all roads in built-up areas	in general no street lighting except at very dangerous road sections (e.g. junctions or pedestrian crossings) to be identified from case to case; special standards exist for tunnel lighting				In general no street lighting except on urban motorways			above average history of night-time accidents at pedestrian crossings due to bad sight, thus sufficient lighting of pedestrian crossings is strongly recommended
Denmark	street lighting on all roads	No street lighting except at signal controlled intersections and pedestrian crossings	street lighting at roundabouts, major intersections and black spots	Yes					
Estonia	street lighting on all roads	At grade separated interchanges At pedestrian crossing At junction with traffic signals At roadside resting area if it has lot of users In tunnels At ferry boat quay and connecting road section		On II and III class roads (single carriageway roads) 250 m on every arm of the jn, also on railroad crossings		On entire length of motorways (turn off at night time); Dual Carriageways - at all interchanges and at bus-stop areas.	At ramps and whole areas of interchanges on minor road	Between G. S. Interchanges < 2000m apart or Lit gap < 1500 m Between lit sections if gap < 500 m	Recommended to use at accident concentration points and at channelled (separated lanes for turning) junctions
Finland	Lighting on all streets and roads	The decision on whether a road should be lit is defined in the national road lighting policy. The basis for calculating the benefits of road lighting installations that are justified by traffic volume is the average personal injury and fatality for each road class. On motorways and other highways, the savings obtained in travel time may also be considered.	Road lighting may be warranted, feasible and worthwhile without studies due to location, traffic volume or accidents. Typical profitable traffic volumes from traffic economics point of view are; - motorway, central reserve <12 m ADT≥1800 veh/d - main roads, cars only, junction density 2 pc/km 8000 veh/d - main roads, all-purpose 6000 veh/d - collector roads, all-purpose 5000 veh/d	Roundabouts are usually lit. Intersections normally as a part of the lit road section, Individual junctions are to be considered specially.	Yes	Urban motorways are always lit. Rural motorways, see "General"	Yes	Carriageway shall be lit if distance between noses is ≤ 1500 m.	The profitability of road lighting in terms of traffic economy is analyzed by comparing the average annual savings in total costs of road traffic with the combined influence of lighting costs and the cost of column collisions. All necessary factors and coefficients such as proportion of night -time traffic, reduction in night-time accidents due to road lighting and personal injuries and fatality accident rate will be found from the national traffic safety statistics.
France	street lighting on all built-up areas.	For national roads except motorways : one must take care of homogeneity of lighting. Outside urban areas, lighting must be limited to some junctions, particularly dangerous at night.	In June 1990, Setra published "Lighting in interurban area" which deals with the link between lighting and safe This document says, according to the studies at the time, that there's no indication that lighting gives an improvement on road safety for interurban motorways. The high costs of lighting including investment/maintenance are highlighted. This document concludes that, according to these results, the 1974 guideline must be applied with much caution.			More than 50 000 veh/day : general lighting; Between 25 000 and 50 000 veh/day : general lighting where interchanges are less than every 5 km, lighting only at interchanges when these are more than every 5 km; Less than 25 000 veh/day : lighting at interchanges only. (1974)			Outside urban areas, lighting must be limited to some junctions, particularly dangerous at night.
Germany	street lighting on all roads		Road authorities have the legal duty to maintain safety on their roads which partly obligates them to light roads hazardous intersections, sharp curves, pedestrian crossings, work zones, traffic islands, unexpected bottlenec						
Greece	Though there is not a formal directive, most sections connecting urban areas.		At the "main" Junctions in the national road network; Parking areas in motorways; service areas on motorways; Sections of secondary road network contacting motorways; Any section constructed to connect private businesses with the national road network has to be provided with lighting. As for the lighting in the provincial road network and in urban areas decision is taken by the local authorities.			At all interchanges in motorways and dual carriegeways			

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	APPENDIX 4 - 2								
	Urban Area	Rural Areas	General	At Roundabouts & At-	Junctions with	Motorways, Duals	Grade separated	Between lit interchanges	Above-average history of night time accidents,
Iceland	All national roads roads (even some up to 80 km/h)	In rural areas lighting is, in general, only provided at the following locations: 1) At roundabouts, 2) At junctions with raised islands 3) At other junctions only if certain conditions apply, f.ex. bad geometry or bad accident record.	At other junctions only if certain conditions apply, for example, bad geometry or bad accident record.	Yes	Yes	One major road outside an urban area is lit, the road to the Keflavik International Airport. A political decision - traffic volume on this road was less than 6000 cars/day when the lighting was provided. Preparations underway to light another road, having less than 1400 cars/day!			At other junctions only if certain conditions apply, for example, ba geometry or bad accident record.
Ireland	street lighting on all roads	Infrequently applied, except above-average history of night time accidents, and an examination of the crash history at those locations indicates that improved lighting should reduce the possibility of collisions	At junctions where the mainline flow > 12,000 and the sideline flow > 3,500	Yes. At-grade junctions on dual carriageways where there is a median break for use by turning traffic	Yes	No	Yes - start of the diverge taper to the end of the merging manoeuvre	when the distance between them < 1.5 km	Yes, wherer there is an above-average history of night time accidents, and the crash history at location indicates that improved lighting should reduce the possibility of collisions
Italy			Attachments in Italian - no translations.			mandatory lighting for all grade separated interchanges.	mandatory lighting for all grade separated interchanges.		
Luxembourg	street lighting on all roads	Lighting outisde urban areas is infrequently applied - only in case of roundabouts , dangereous crossings and points recognized having a high rate of accidents	Older motorways completely lit.	Yes		A6, A4, A13 (Esch - Pétange are lit completely, on A3, A1, A7 and A13 Remerschen - Esch) only interchanges are lit.		Partly done, depending on environmental criterias	
Norway	street lighting on all roads	Two-lane roads with central reserve (annual average daily traffic 8 000 – 12 000 and speed limit 90 kph).	In general, lighting should be provided at pedestrian crossings, where cycle/footpaths crosses a road, toll areas and at ferry connections,	Yes	Yes	annual average daily traffic over 20 000 and speed limit 80 kph. Motorways with speed	Yes (implied)	Short distances (< 500 m) between lighted areas to obtain continuity	
Switzerland	street lighting on all roads		Switzerland is complicated: Swiss norm/standard for lighting public roads (based on the European norm EN 13201). The Swiss Association for Lighting (a PPP association) published explanations and additional recommendations. Some Citys or Cantons seem to have a						Some Citys or Cantons seem to have a sophisticated approach (including lighting of black spots in rural areas),
UK	street lighting on all roads	The need for lighting at 'junctions' is based on a site specific analysis and evaluation undertaken by a Road Safety Engineer, not solely by a contractor's lighting engineer's assessment.	Approximately 1/3rd of the strategic network is lit. Recent analysis of night-time accidents on lit and unlit strategic roads has shown that the accident saving benefits previously assumed by lighting have not been achieved in practice, on links between junctions. New standard now talks about 'Conflict Areas' -include: single level					There should not be an unlit gap of less than four times the stopping sight distance between lit sections.	

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