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This text is based on extracts from *Outdoor Lighting Principles for Australia in the 21st Century* which is obtainable free via email through the website of the Astronomical Society of Victoria Inc. at <www.gsat.edu.au/astrovic>.

OUTDOOR LIGHTING AND CRIME

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Summary

This document is an extended version of one submitted in May 2000 to the Drugs and Crime Prevention Committee of the Parliament of Victoria.

The proliferation of artificial outdoor lighting in the 20th century was fostered by the lighting industry with sometimes questionable propaganda and little regard for the environmental consequences. As a result, the natural spectacle of the night sky has virtually been blotted out for urban populations in developed countries. Other adverse effects of excessive artificial light at night are known or are still being investigated in humans and other species.

Contrary to widespread belief, intense or continuous lighting is generally unnecessary for personal or property security, and may even encourage crime because fear of crime is allayed and probably because commission is facilitated. In some circumstances, darkness can inhibit crime. Especially when displacement is taken into account, *there is no reliable evidence that more or brighter outdoor lighting reduces crime rates. Seclusion rather than dim lighting favours crime. Crime is a social problem, not a lighting problem.*

Coloured lighting to discourage illicit drug injections merely displaces the activity, advertises the area for drug dealers, and engenders unease for passers-by.

Outdoor lighting decisions need to be made in full awareness that outdoor lighting has little influence on the crime rate. In many cases, bright existing illumination could actually be reduced or eliminated altogether without increasing crime in the vicinity. But lighting, preferably glare-free, remains important for mobility safety. National and regional strategies for outdoor lighting are sorely needed on environmental grounds. Their existence could also help to avoid substantial waste on misguided schemes for crime reduction that require more and brighter lighting.

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1. INTRODUCTION

This document was originally prepared as an input to the joint all-party Drugs and Crime Prevention Committee of the Parliament of Victoria in response to a call in May 2000 for submissions, including options for crime reduction. Some additional material gathered since then has been added to this version. This document presents the views of the Astronomical Society of Victoria Inc. through its Outdoor Lighting Improvement Section.

Improvements to outdoor lighting are frequently proposed in the news media and government planning documents as an option for crime reduction. Unfortunately, misguided interpretation of ‘improvements’ as ‘more and brighter’ in this context is likely to be counterproductive. Outdoor lighting across the whole of Victoria and much of the rest of Australia is already seriously degrading the environment. This document indicates how genuine improvements in outdoor lighting can be pursued with multiple beneficial outcomes, including economic and environmental advantages (Hunter and Crawford 1989).

Public and private outdoor lighting in Australia often lags well behind world’s best practice. Far too much unused and waste light illuminates the night sky, needlessly degrades the environment in other ways or is otherwise obtrusive. Producing this light wastes energy and unnecessarily increases greenhouse gas emissions. Artificial sky glow, one of many undesirable consequences, hampers astronomical observation and research and also degrades the aesthetic beauty of the night sky. Careless installation and overuse of outdoor lighting adversely affects many species of plants and animals and can degrade human health, safety and recreation. The problem is growing at an alarming rate in Australia and the rest of the world, a result of a century of sometimes questionable propaganda by the lighting industry, beginning with Edison himself. As a result, the natural spectacle of the night sky has been largely blotted out for urban populations. Adverse effects of excessive artificial light-at-night include sleep disorders in humans and other species. Light-at-night is actively being investigated at the Harvard Medical School and elsewhere as a risk factor for breast and other cancers (NAPBC 1997). Light-at-night disrupts daily and annual natural photoperiods and thereby affects sleep and

health (Dement and Vaughan 1999). In particular it appears to lead to obesity and consequent obesity-related disease (Wiley and Formby 2000).

Control of obtrusive lighting and lighting waste is relatively simple and economical (IDA IS12 1996, SA 1997, IESNA 1999, IDA IS152 1999). Inclusion of such control in future outdoor lighting strategies has a low technical risk and will result in a more attractive, comfortable, safe and healthy visual environment for residents, workers, shoppers, travellers and tourists. Comprehensive regional outdoor lighting codes and a national code could assist commerce, improve liveability and assist Australia to meet its greenhouse gas emission targets. But inevitably, people will object because they think that crime will increase if outdoor lighting is reduced in any way. The facts indicate quite differently (eg ICOLE 2000).

2. LIGHTING FOR SECURITY

Understandably, most people want the incidence of crime to be reduced. It appears to be almost universally believed that more and brighter outdoor lighting would help. Of course, extending the belief to its ultimate stage means there should be little or no daytime crime, but that is far from the facts. For example, 54% of violent crime in the USA occurred between 6 am and 6 pm, and only 20% of rapes involve unknown assailants at night (BJS 1999). Only 35% of all burglaries² in the USA are reported to have occurred at night, or 48% of all burglaries for which the time of occurrence is known (UCR 1996). During the power blackout that affected Auckland in New Zealand for several weeks in early 1998, press reports stated:

"Even criminals have deserted the darkened streets of downtown Auckland... 'It's been almost a crime free zone,' Inspector John Mitchell said... 'The normal level of muggings, violence, fights, burglary and robbery have just not happened' (ICOLE 2000).

Electric lighting manufacturers, designers and installers as well as electrical power companies collectively stand accused of promoting the myth of 'security' lighting. News media have often perpetuated this myth uncritically on the basis that it is self-evident and common sense: 'everyone' 'knows' it to be true. Likewise, many political campaigners have sought voter support by promising increased outdoor public or security lighting to deter or reduce crime. Actually a connection between lighting and crime is demonstrable only to the extent that people do tend to *feel* safer when there is enough light for easy seeing. The consistent conclusion from many independent reliable studies is that *there is no clear overall effect of the amount of outdoor lighting on actual crime rates* (Ramsay 1991, IDA IS51 1992, Shaftoe and Osborn 1996, IDA IS63 1998).

The National Institute of Justice presented a large report on crime prevention to the US Congress in February 1997 (Sherman, Gottfredson, MacKenzie, Eck, Reuter and Bushway 1997). The following quotes are from 'Conclusions for Open Urban Places' in Chapter 7:

"We can have very little confidence that improved lighting prevents crime, particularly since we do not know if offenders use lighting to their advantage. In the absence of better theories about when and where lighting can be effective, and rigorous evaluations of plausible lighting interventions, we cannot make any scientific assertions

² This figure includes what are known in some countries as housebreakings, ie a burglary committed in daylight hours.

regarding the effectiveness of lighting. In short, the effectiveness of lighting is unknown." (IDA NL41 2000)

Findings that more lighting reduces crime appear mostly to be confined to studies that are financially supported by lighting-associated companies or organisations (eg Lighting.com 1999). Other cases of pro-sponsor bias are known in industry-sponsored research; for example, in research reports sponsored by the tobacco industry claiming that cigarette smoking does not cause lung cancer and other diseases. Another example is that of reports claiming that car windshield and window tinting is not a road safety hazard: generally these have been done by or paid for by the vehicle industry while many more papers from independent vision researchers reach the opposite conclusion (Clark 1995).

Historically, urban crime rates have increased together with the growth in urban outdoor lighting although this, by itself, does not indicate a causal relationship. In particular, large peaks in crime during the 20th century appear to have no counterpart in the steadier growth of lighting, although both quantities grew substantially over the ten decades. In some more specific studies, crime actually increased as 'better' lighting brought more people into a busy area in the mistaken belief that they were now safer. Similar results have been observed when increased lighting has encouraged individuals to venture into an area that was previously shunned as secluded and unsafe. In other cases there have been relatively small displacements of crime to adjacent areas that are not necessarily darker. Even an announcement of planned lighting improvement has resulted in a displacement of this sort.

Vandalism can actually be reduced by making areas dark: vandals apparently need or like to see the damage they cause³ (IDA IS 54 1997, King 1995). A similar effect of darkness in inhibiting the incidence of burglaries has been explained as a result of the attention-drawing factor created when a burglar has to use hand-held lights such as matches or torches (flashlights) to see well enough to break in.

Crimes other than burglary are also generally more difficult to commit in darkness and again the use of hand-held artificial light sources tends to attract attention. Dark alleys, sideways, parks etc in an otherwise brightly lit area may favour the concealment of lawbreakers. However there is often enough ambient stray light to improve visibility from more brightly lit areas, especially if minimal supplemental lighting is used. Nevertheless, comparable or better results are often possible simply by ensuring that the more brightly lit area is glare-free. *Seclusion rather than dim lighting favours crime.* Most so-called security lighting currently in use has been installed to allay fear, with little or no consideration of glare, light spill, economy, efficiency or even effectiveness in reducing crime. High-glare outdoor lighting tends to provide deep shadows for criminals to hide in. Insofar as they might be needed at all, future security light installations need to be controlled much more closely to avoid degrading the overall quality of an urban lighting scheme. Actual security is thereby more likely to be improved than decreased (IDA IS104 1996). Several interesting discussions are available

³ A variation on this is that graffiti vandals are apparently deterred if they cannot distinguish which colours they are using. Accordingly, the solution in areas prone to graffiti attacks is to use *low pressure* sodium lamps. These electrically efficient lamps emit quasi-monochromatic yellow light and consequently have exceptionally poor colour rendering properties. However, it is not known whether this strategy reduces overall graffiti vandalism or merely displaces the end result.

about campus lighting and crime in IDA IS23 (1996), IDA IS 27 (1997) and IDA IS 31 (1997). A related issue, the amount of lighting at petrol filling stations and convenience stores, is discussed in IDA IS145 (1998).

In recent years, places such as alcoves, recessed doorways and public toilets with night lighting have become favoured areas for drug addicts to inject themselves. Owners of these areas have attempted to discourage this use by using saturated red- or blue-coloured lighting that reduces, or is supposed to reduce, the visibility of subcutaneous blood vessels. (Red light actually enhances the visibility of veins but reduces the visibility of arteries.) The strategy works only to the extent that it merely displaces some of the illicit activity to somewhere else, usually close by. It is easily defeated by addicts who outline targeted blood vessels beforehand with ballpoint pens. It also advertises the availability or presence of illicit drugs in the area and seems likely to make passers-by uneasy. Blue-violet light is the worst possible colour in terms of its effect on visibility, legitimate or otherwise, for persons whose vision is affected by cataracts.

One of the arguments for more light for security is that video surveillance cameras (or closed circuit television, CCTV) can be used more effectively. For instance, metropolitan railway stations in Melbourne have video cameras installed. Excessively bright *high pressure* sodium lighting has also been installed at the stations, albeit in fittings that confine the directly emitted light to the horizontal direction and below. But bright lighting is an ineffective measure for controlling crime, and video cameras appear either to be ineffective (KDIS 1997) or of limited value (Sherman et al. 1997, Chs 7 and 10; Munro 2000)!

An indication of the extent to which outdoor lighting is out of control in Victoria at least is the almost inevitable installation of low-mounted security floodlights around every new industrial building. The economic and environmental costs of providing, installing and operating these floodlights are far from trivial and there is no known actual security advantage. The inevitable conclusion is that the lighting industry's fostering of the security myth adds to building and operating costs and thereby reduces the state's industrial competitiveness.

The main conclusions of this section are that *lighting does not decrease crime but only allays the fear of crime*, and that *crime is a social problem rather than a lighting problem*. It is also extraordinary how much public and private funding is wasted in Victoria and elsewhere through entrenched ignorance of these facts.

3. GLARE REDUCTION

Glare results from having an excessively bright light or illuminated object in the field of view. Glare can cause annoyance and discomfort, and reduce the ability to see in the circumstances. If criminals wish to hide to conceal criminal acts or to increase their prospects of successfully committing a crime, they can usually find somewhere suitable if dark shadows are available. Dark shadows generally occur when one or more light sources are substantially brighter than other lighting in the vicinity. This is typically the case with inadequately shielded floodlamps and overlit advertising signs. Shadows tend to become much less effective for hiding when lamps are adequately shielded and overlighting is reduced towards the mean luminance level in the area.

Lamps shielded and mounted so that no direct rays from the lamp are emitted above the horizontal are called 'full cutoff'. Cutoff angles even lower than horizontal (eg 10 or 20 degrees down) can usefully be specified and there is generally little or no capital cost differential. If a suitably shaped light shield with a glossy surface intercepts the near horizontal light, the available illumination can actually be more effectively used instead of being wasted. In turn, a lower power lamp may be substituted, resulting in a significant decrease in lighting costs. Such 'cutoff' shielding is the most direct way of reducing glare from outdoor light fittings, including street lights, pedestrian lights, floodlights and sports lights. Upwards waste light limits for many of these luminaires are specified in Australian Standards (SA 1999) but these limits represent minimal performance. Better is readily achievable, often with savings in money or energy or both.

There can be excellent community and economic value in specifying increased shielding against spill light to give less glare. In the present context, reduced glare is generally accompanied by lighter shadows. Therefore a reduction of glare from outdoor lighting can certainly reduce the opportunity for a surprise criminal attack. Public education about this aspect of glare should link low-glare lighting with reduced opportunity for attack.

Brightly lit billboards and other illuminated advertising also tend to create an environment with increased opportunities for criminals to conceal themselves. AS 4282-1997, *Control of the obtrusive effects of outdoor lighting* (SA 1997), does set limits for spill light including glare effects on drivers at nearby roads but the glare test is necessarily a little complex and not easy for non-specialist readers to follow. AS 4282 is not yet mandatory in most municipalities, but identical limits for glare are set in AS/NZS 1158.1.1 (SA 1999), a usually mandatory standard for road lighting. In the several years since its introduction, initially as an interim standard prior to 1997, AS 4282 has apparently done little or nothing to curb the upwards 'ratcheting' of billboard brightness and size that passes for competition in the outdoor advertising industry (IDA IS35 1997). The outdoor advertising industry in Australia has argued for self regulation but it is now clearer than ever that lighting, size and placement of billboards and other advertising signs needs to be under stringent mandatory control to limit the occurrence of glare and deep shadows, quite apart from the environmental problems caused by present unconstrained practices such as overlighting and excessive upwards spill light. The need for mandatory control is reinforced by the results of a recent email survey by the Royal Automobile Club of Victoria. The responses have led the RACV to formulate proposals for controlling the form and placement of roadside billboards affecting road safety and scenic and historic aspects (Lay 2000).

The single most important improvement that can be made to urban outdoor lighting is to eliminate glare. This requires all light sources to be shielded so that intensely bright areas such as lamps, reflections of lamps and over-illuminated areas close to lamps are not seen in normal circumstances. Not only would this greatly improve the amenity of areas so lit but unfortunate people with significantly reduced vision⁴ would often be able to see better than is usually the case at present. Older and handicapped persons are over-represented in this population. As older or handicapped people appear to be chosen by some criminals as easy

⁴ Subnormal vision generally involves one or more of the following: visual field losses, reduced visual acuity, reduced contrast sensitivity, acquired losses in colour perception, or reduced sensitivity to low light levels. Depending on definitions, as much as 10% of the population has subnormal vision.

targets, people in this population are also supposed to be over-represented as victims of assault and robbery. Better lighting, not necessarily brighter lighting but glare-free lighting, would appear to reduce their vulnerability to some extent by allowing better visual performance but this is speculative. Their mobility safety would certainly be better.

It appears that the crime rate might be unaffected, or even reduced a little, by less rather than more outdoor lighting if national and regional lighting strategies were introduced with reduced glare as a key element. Substantial reductions in glare are possible by the use of full cutoff road lighting, as is currently being applied in many states in the USA (Clark 2000), by eliminating the large peaks in illumination resulting from overlighting of architectural and advertising items, and by reduction of spill light from all outdoor lighting including sports lighting installations. A positive consequence of such a strategy would be better visual functioning for many of the persons who are potentially vulnerable to criminal acts. At least such persons would be less fearful of outdoor crime at night if the reduced glare environment allows them to see more.

Security lighting that is switched off unless triggered by motion or presence sensors is now in common use. It has several commendable aspects from the environmental viewpoint. However, such lighting should still be subject to limit controls on maximum intensity, aiming angles and spill light.

4. OUTDOOR LIGHTING STRATEGIES

National and regional lighting strategies would provide a means of guarding against economic waste and environmental degradation resulting from inappropriate and misguided attempts to reduce crime with brighter and more numerous outdoor lights. By itself, the implementation of such strategies would be likely to have no effect on the crime rate or perhaps lead to a small reduction. It would help to allay the fear of crime, especially in the more vulnerable members of the community. More tangible effects of such implementation are expected to be fewer mobility accidents and the freeing up of resources that would otherwise be wasted and unavailable for dealing with the social issues that lead to crime.

There is no doubt that displacement of crime sometimes occurs following outdoor lighting changes. In that expenditure on lighting intended to reduce crime brings about no overall crime reduction benefit but merely moves some of the crime problem to adjacent areas, it is a government responsibility to block such wasteful and antisocial lighting changes. The simplest way of doing this is by mandatory application of appropriate regional lighting strategies (ie statewide or municipal). What happens at present is that any neighbouring areas affected by crime displacement tend to respond by applying their own lighting changes, setting in motion a perpetual brighter lighting competition in the region with the inevitable outcome of environmental degradation, reduced quality of life and at least as much crime overall.

Modern artificial light at night has certainly brought about a profound and beneficial transformation of human life. But as indicated above, it is not necessarily without its downside. Large commercial entities often seek the greater profits achievable by a 24-hour operating and trading advantage that forces small competitors out of business and provides maximum utilisation of fixed assets. Extended hours requires shiftwork, but shiftworkers are generally considered not to be as contented and as well as people with equivalent day jobs and there is often a social cost of reduced contact with their families.

Customers shopping during extended opening hours at night require a continuation of daylight-like indoor lighting conditions. In turn this results in commercial-ratepayer pressure on city authorities to increase outdoor illumination levels. However, bright light at night extends the body's waking arousal beyond the onset of natural darkness and, if carried to excess, sets the stage for subsequent sleeping problems (Dement and Vaughan 1999), and obesity and disease (Wiley and Formby 2000). These are relatively recent views, not firmly established but profound for their implications about current lifestyles. Regardless, extended hours of business, retail and entertainment activity in cities currently results in increasing numbers of individuals and groups being present late at night. Criminals presumably find it easier to be less conspicuous in crowds, and increased pedestrian traffic late at night could be thought to increase the opportunity for crimes against individuals in secluded places.

The extent to which extended hours in urban centres is a factor in urban crime is speculative. But it is unlikely that urban centres would retain shopping and entertainment crowds for long after all outdoor lighting dimmed or ceased in accordance with a curfew. This is not a suggestion for the introduction of presence curfews or lighting curfews. However, the point is that even a 'soft' curfew such as a lighting curfew is likely to have a substantial effect on an out-and-about population and could conceivably allow manipulation of variables in large-scale field experiments on urban crime control measures. Another relevant point is that AS 4282-1997 includes lighting curfews as a standard requirement for certain types of outdoor lighting, with default curfew times such as 10-30 or 11-00 pm. However, as already mentioned this standard is not mandatory unless called up in laws or regulations.

The several other Australian Standards that deal with outdoor lighting, including sports lighting, generally range from marginal to quite deficient in reference to the need for stringent control of light pollution and light trespass. They barely mention what is now a greenhouse gas crisis in Australia. For example, in Victoria the increase in electrical power generated since 1990 is about 33%. On a pro-rata basis, this is 7.5 times greater than the 8% maximum growth by 2008 in greenhouse gas emissions over the 1990 value, the international obligation accepted by Australia under the Kyoto protocol. The writer's analysis of two sets of observations of actual light pollution observed from Melbourne suburbs in that time shows that the amount of light pollution has increased by about 90%. The unnecessary generation of greenhouse gases implied during 2000 is therefore about 20 times as much as the 4.4% pro-rata obligation! In other words, 19 lamps need to be decommissioned for every 20 lamps of a given energy consumption installed in Victoria since 1990, or equivalent savings should be made in other areas of energy consumption, an unlikely prospect.

The standards do not mention what is now a pressing need to limit the use of outdoor lighting to the absolute minimum required for cultural purposes and mobility safety. Environmentalist representation appears to be needed in the committees that draft and maintain Australian lighting standards: at present the committees are largely made up of lighting and power industry representatives. As a concrete and highly relevant example of the pro-light-at-night consequences, AS/NZS 1158.3.1: 1999 on public area lighting consistently propagates and perpetuates the myth that outdoor lighting prevents or reduces crime and reduces the risk of crime, and Standards Australia endorses this in its advertising. Until Standards Australia radically improves the situation, minimal reliance should be placed on the standards in ensuring effective and economical outdoor lighting. National and regional lighting strategies should therefore follow the increasingly common overseas practice of incorporating at least the major

technical constraints against glare, spill light, overlighting and other unnecessary and wasteful practices in the applicable laws. Stringent control of waste and excess is certainly an increasingly important aspect of limiting excessive greenhouse gas emissions, and communities must learn to live with the change.

Lighting curfews do make good environmental sense for items such as decorative and billboard lighting. An even better alternative that has recently become popular in some parts of the USA is to require billboard lighting and shop or office signs and lighting to be switched off outside the times that the advertised company or shop has its doors open to the public. Such requirements reinforce the need for minimal interference by decorative and advertising lighting with the illuminated properties of public areas- there can be little or no justification for the presence of uneven lighting and deep shadows caused by a nearby sign or floodlight during its operating times.

Given that there is a strong environmental case for national and regional lighting strategies, it is suggested that some aspects of such strategies could also be useful in the study and possible reduction of the crime rate. This strengthens the case for suitable strategies to be considered. Many precedents already exist elsewhere. Numerous complete texts of state, county and town lighting laws, ordinances and regulations are readily accessible (Clark 2000). Nevertheless the main thrust of drug and crime prevention strategies needs to be concentrated on social rather than lighting issues. Conversely, even severe environmental constraints can be applied to outdoor lighting in the knowledge that crime is unlikely to become worse.

5. CONCLUSIONS AND RECOMMENDATIONS

Intense or continuous lighting does not necessarily assist personal or property security. On a historical basis, urban crime rates have increased together with the growth in urban outdoor lighting but a causal link has not been established. *There is no reliable evidence that increased outdoor lighting reduces actual crime rates. Seclusion rather than dim lighting favours crime. Crime is a social problem, not a lighting problem.*

There appears to be no general prospect of reducing the crime rate by the installation of more or brighter outdoor lights. Small improvements in the crime rate and better insights into factors controlling crime appear possible by genuine improvement of outdoor lighting, particularly the reduction of glare and the reduction of waste by imposition of lighting curfews. Outdoor lighting aspects that are especially in need of improvement are overbright floodlighting of architectural items and advertising billboards. Reduction of excessive spill light from these and from sports lighting could reduce a tendency of these installations to form deep shadows nearby. In turn this is thought likely to have some positive effect on reducing opportunities for crime.

Specific recommendations are that the Commonwealth, states and individual municipalities should:

- a. Consider application of mandatory outdoor lighting strategies, including provisions to:
 - i. conserve energy and assist seeing by reducing glare, limiting spill light and preventing overbright lighting,
 - ii. increase the use of *low pressure* sodium lamps for energy efficiency and graffiti deterrence,

- iii. deprecate the use of coloured lighting as an attempted means of discouraging illicit drug injections,
 - iv. specify curfew times for certain types and locations of outdoor lighting,
 - v. avoid waste of resources by inappropriate use of lighting to try to control crime, and
 - vi. cap outdoor lighting energy usage in line with Australia's international obligations.
- b. Educate the public about lighting effects on crime and the fear of crime.
 - c. Investigate lighting curfews as a means of manipulating variables in crime reduction research, but otherwise concentrate on the social aspects of crime causation.
 - d. Explicitly include mandatory technical constraints on spill and intensity in laws and regulations implementing national and regional lighting strategies rather than simply calling up relevant but currently somewhat flawed Australian Standards.

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