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Fluorescent lights: collection models and recycling.

A desktop study

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IN CONFIDENCE

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Disclaimer

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Glossary of Terms and Acronyms

µg (microgram)	Microgram (µg) = one thousandth of a milligram (mg).
Commingled recycling	Common recyclables, mostly packaging; such as glass, plastics, aluminium, steel, liquid paper board (milk cartons). Commingled recycling may include paper but often, and particularly in offices, paper and cardboard are collected separately.
CFL	Compact Fluorescent Lamp. Domestic fluorescent lamps commonly used to replace standard incandescent light bulbs. Light is produced by passing an electric current through mercury vapour
DEWHA	Department of the Environment, Water, Heritage and the Arts (Australian Federal Government)
EPHC	Environment Protection and Heritage Council, with the objective of ensuring the protection of environment and heritage of Australia and New Zealand
EPR	Extended Producer Responsibility - a strategy designed to promote the integration of environmental costs associated with products and to encourage manufacturers to take greater responsibility for environmental outcomes of their products
General Waste	Material that is intended for disposal to landfill (or in some States, incineration), normally what remains after the recyclables have been collected separately.
Halogen lamp	An incandescent type of lamp that uses a tungsten filament in a mixture of inert gas and a halogen such as iodine or bromine
Hg	Chemical symbol for mercury. A metal used in the manufacture of fluorescent lights. Mercury is liquid at room temperature and can readily vaporise. Mercury is toxic to humans in relatively small quantities; exposure can occur through inhalation, skin absorption or ingestion.
Incandescent lamp	Standard light bulbs commonly used for domestic purposes until the ban by the Federal Government (November 2009). Light is produced by heating a coiled tungsten filament so that it glows white hot.
Kerbside Collection	Regular collection of waste and/or recyclables from the front of each house or dwelling in a local government area
LED	Light Emitting Diode. A relatively new technology of highly efficient light production
MGB	Mobile Garbage Bin – A wheeled bin with a lid often used for kerbside collection of waste or recyclables. (Often called a 'wheelie bin').
OECD	The Organisation for Economic Co-operation and Development (OECD) brings together countries that are committed to democracy and the free market economy to foster prosperity and fight poverty through economic growth and financial stability
Recyclable	Material that can be collected separately from the general waste and sent for recycling. The precise definition will vary, depending upon location (i.e. systems exist for the recycling of some materials in some areas and not in others).

Recycling	Where a material or product undergoes a form of processing to produce a feedstock suitable for the manufacture of new products.
Re-use	The transfer of a product to another user, with no major dismantling or processing required. The term "re-use" can also be applied in circumstances where an otherwise disposable item is replaced by a more durable item hence avoiding the creation of waste (e.g. using a ceramic coffee mug in place of disposable cups).
Transfer Station	Location where waste and recyclables are collected and stored temporarily before transport to final destination. Transfer stations may be at a landfill premises or at an independent site. Some sorting of recyclables may occur at these sites.
Verge side Collection	Sometimes known as 'hard waste' or 'bulky waste' collection. The collection of bulky items of discarded 'junk' (e.g. furniture, TVs, barbeques etc.) from households on a regular, but infrequent basis (generally about 4 times per year).
WEEE	Waste Electronic and Electrical Equipment (definition commonly used by European Union).
WHO	World Health Organisation

Executive Summary

The Australian Government has introduced a ban on sale and import of incandescent (standard) lamps from November 2009. EMRC are looking to establish a trial for the collection and recycling of compact fluorescent lamps (CFLs) in publicly accessible areas in the Eastern region, focussing on retail centres.

Encycle Consulting and Eco Change Consulting have been engaged by EMRC to firstly, undertake a review of CFL collection systems and then to establish the pilot scheme to collect lamps for recycling that will run over a 12 month period.

This document reviews issues, concerns and considerations for developing a successful collection and recycling system for CFLs. There are a few types of mercury containing lamps available including standard, straight fluorescent tubes, circular or specially shaped tubes and CFLs. For this project, the focus has been placed upon CFLs as these are the main type of mercury-containing lamp that will be generated by householders. Fluorescent tubes also contain mercury but are generally found in commercial and industrial settings. Household-generated fluorescent tubes do not form a significant part of the municipal waste stream and are not considered as part of this study as they can be disposed of using existing systems at transfer stations.

CFLs contain small amounts of mercury, a metal that is potentially toxic to humans. There is understandable concern in the community about handling a product that contains mercury. Reviewing the existing literature, including World Health Organisation standards for mercury exposure it would seem that the health risks may be a concern if there are multiple broken lamps or a broken lamp is not dealt with appropriately. Compared to the quantities of mercury in fluorescent tubes (15 mg) or mercury thermometers (500 mg), the amounts of mercury found in CFLs are very small (3-5 mg).

Whilst the risks from mercury vapour escaping from broken CFLs are relatively small, it remains important to minimise the chance of breakage of the lamps and to limit the exposure of humans to mercury vapour. The consideration of risk limitation from collection to transportation of the lamps will dictate the design of the bins to be used in the pilot scheme.

It is recommended that bins should be:

- Stable and placed in a location unlikely to be knocked over
- Able to provide collection volumes that are <200 units to minimise breakage in transport and manual handling issues
- Designed so that once deposited, the lamps cannot be retrieved
- Plastic lined so that broken lamps can be contained
- Located in an area that is regularly monitored by staff with a responsibility for the bin and not left unattended overnight or out of shopping hours

Recyclers of CFLs indicated that they preferred the concept of transporting the lamps in cardboard boxes of 100 – 150 lamps that could be stacked onto pallets as this would limit breakage by reducing the mass of lamps resting upon each other and moving around in the collection box. Boxes or bins of about 100 lamps are relatively easy to handle and would place less burden upon staff collecting and moving them.

The two main recyclers of mercury containing lamps in Australia (CMA Ecocycle and Chemsal) use the same markets for the materials recovered and are able to achieve 100% recovery. Key markets are glass fibre insulation for the glass, dental amalgam for the mercury and aluminium products for the aluminium.

Key financial considerations for the operation of a CFL recycling system relate to the transport and actual recycling of the lamps. Recycling was quoted to cost between $1.95/kg and $4.50/kg. It is likely that costs for recycling will reduce as volumes of material recycled across Australia increase and the potential for economies of scale are realised.

Communication and awareness-raising is critical to the success of any recycling campaign. In Victoria, the Flashback trial was advertised in local papers but received most of the lamps from either passing trade (people shopping for new lamps and bringing the old one with them) or were identified through local government contact.

In Maine, USA, there is a ban on disposal of CFLs to landfill, a state-wide advertising campaign and availability; yet the CFL recycling rate remains very low.

1 Introduction and background

The Eastern Metropolitan Regional Council (EMRC) commissioned Encycle Consulting to undertake a desktop review of fluorescent lamp recycling including potential collection mechanisms occurring elsewhere and considerations for implementing a public place system in Perth's Eastern Region.

This desktop review forms part one of a project made possible by grants from the Strategic Waste Initiatives Scheme run by the Waste Authority of Western Australia and from the WA Government Sustainable Energy Development Office (SEDO) (now integrated into the Office of Energy). The second part of this project will run trials of different collection systems in various public locations in the EMRC region over a 12 month period. The trials will be managed by Eco Change Consulting.

Fluorescent lamps are significantly more energy efficient than standard incandescent light bulbs as they use electricity to 'excite' mercury vapour so that it glows. Incandescent light bulbs use electricity to heat up a coiled tungsten filament in the lamps so that it is so hot that it glows white with heat.

Image 1: Incandescent light bulb with glowing filament (Image from University of British Columbia, Canada)

Image 2: Fluorescent tube (Image from www.typesoflightbulbs.com)

Image 3: A range of compact fluorescent lamps (CFL).

(Image from www.DIYTrade.com)

In February 2007 the Federal Environment Minister announced a commitment to phase out incandescent lamps because of their inefficient use of electricity. The Australian Government has remained committed to phasing out incandescent lamps commencing with import restrictions from February 2009 and finally an expected retail ban from November 2009. Home-owners and businesses have already started switching to the more energy efficient CFL for the economic benefits of reduced electricity bills. Studies have shown the payback period for CFLs to be 3-6 months for an average household (Queensland Government, 2009; Parsons, 2006).

CFLs contain small amounts of mercury. Mercury is a potentially toxic metal which can be harmful due to skin contact, inhalation or ingestion. It is not considered good environmental practice to dispose of mercury-containing fluorescent lamps to landfill and this practice is banned in some states (DEWHA, 2009). EMRC are seeking to develop a safe, effective and inexpensive recycling system for their residents by providing public place recycling options.

1.1 Project Aims

The Scope of this project is to undertake a desktop study on CFLs to address:

- Models of extended producer responsibility or collaborations/partnerships with producers, and retailers and local/state governments in undertaking collections
- Risk assessment of collection systems for CFLs - identifying potential health and safety issues to staff and users
- The quantity of waste fluorescent lamps likely to be generated in Perth and the expected volumes that might be received by a recycling collection point
- Plant and equipment requirements, in terms of storage and collection
- Staff requirements
- Logistics – including how the material might be collected, what form of receptacles are available, how the material will be stored and then transported for recycling
- Financial considerations such as costs for staff, locations, licensing, equipment, safety training and equipment (if relevant) and transport
- Relative environmental and social impacts of different collection systems; this will not entail a full life cycle assessment of each system but rather a consideration of impact areas such as:
    - extent of recycling and recyclability of end products
    - transport
    - energy intensity of process
- Community engagement and education techniques that have been used elsewhere to encourage the recycling of fluorescent lamps. This will include examples of promotional activities, the associated costs and where possible, an evaluation of the effectiveness of the campaigns/activities

1.2 Waste Management Policy in Western Australia

The Western Australian State Government has committed to a policy of "Towards Zero Waste". This means that activities to promote recycling and waste minimisation are encouraged. New legislation was enacted in 2007: the *Waste Avoidance and Resource Recovery Act* 2007 (WARR Act), which provides State Government with greater powers to require reporting and enforce regulations that will drive the reduction of waste to landfill. The State Government of WA and indeed most international governments adopt a hierarchy of preferred waste management options which are: Avoid, Reduce, Reuse, Recycle, Dispose.

2 Policy approaches including Extended Producer Responsibility/Product Stewardship

2.1 Extended Producer Responsibility and Product Stewardship in Australia

Extended Producer Responsibility (EPR) is a policy approach under which producers accept significant responsibility - financial and/or physical - for the treatment or disposal of post-consumer products. Assigning such responsibility could provide incentives to prevent wastes at the source, promote product design for the environment and support the achievement of public recycling and materials management goals (OECD, 2001).

The WARR Act (2007) provides the State Government with greater powers to put EPR Schemes in place in Western Australia. Under the WARR Act, manufacturers or importers of a product may put in place a voluntary 'Product Stewardship Scheme' whereby the industry self-regulates (with the approval of the CEO of the Department of Environment and Conservation) to achieve similar goals to that which might be expected from a formal EPR scheme in terms of material recovery.

In May 2009 The Environment Protection and Heritage Council (EPHC) announced its support for a project led by the Australian Government to establish partnerships with industry to increase recycling of mercury-containing lamps in Australia. The project is aimed at the commercial and public lighting generators of waste mercury-containing lamps although a related initiative is also being developed to recycle CFLs from the domestic sector.

2.1.1 "Flashback" – A collaboration between Sustainability Victoria and Retailers

In Victoria in 2009, the State government agency Sustainability Victoria led a trial CFL collection project which involved retailers Coles Supermarkets and Beacon Lighting stores. The project was called '*Flashback'* and retailers were involved by allowing bins to be placed in their stores and by marketing the service. Sustainability Victoria coordinated and mostly funded the project. Bins at the Beacon Lighting store worked well and were located near to the point of sale so that staff could promote the service. At the Coles sites, the bins were unable to be located near to either light globe aisles or to the point of sale, but were placed at the store entrance. Coles have very specific requirements regarding any messaging within stores, which prevented the use of standard 'Flashback' signage in favour of more 'Coles-style' messaging. It is possible that the CFL bins in Coles supermarket locations did not engage customers sufficiently to encourage a high usage.

Information about the brand owners of the waste lamps collected during the trial was collated and the key brand owners were approached for assistance with developing a product stewardship scheme. Unfortunately, in this instance, brand owners showed little interest in the development of product stewardship for mercury-containing lamps.

2.2 Policy approaches overseas

2.2.1 USA

In the USA, lighting manufacturer members of the National Electrical Manufacturers Association (NEMA) have voluntarily capped the amount of mercury used in CFLs.

In the state of Maine, legislation was passed in May 2009 that requires CFL manufacturers to share the costs and responsibility for recycling of mercury containing lamps (Natural Resources Council of Maine, 2009). Other states are expected to follow suit within the next year, including: Massachusetts, Vermont and California.

In June 2008, a large, national US home ware retailer, 'The Home Depot' was the first retailer to make CFL recycling options widely available (Home Depot media release, 2008).

2.2.2 Canada

No existing legislation requires collection and recycling of mercury containing lamps although in many states there are moves to implement a product stewardship system. In British Columbia, The Stewardship Agency will implement a five-year programme plan to establish and operate a collection system to collect end of life lamps (Product Care 2009).

2.2.3 European Union

In the EU a cap on mercury content of CFLs is required by the Regulation of Hazardous Substances (RoHS) law. CFLs are one of many products subject to the Waste Electronic and Electrical Equipment Directive (WEEE) 2002/96/EC. The WEEE Directive is an extended producer responsibility (EPR) tool and as such requires that manufacturers, importers and retailers of products are part of a system to ensure that certain percentages of electronic and electrical waste (including fluorescent lamps and CFLs) are recycled. The retail price of each lamp includes a small levy which is used to pay for recycling systems. Manufacturers and importers both have obligations under the WEEE Directive to collect and recycle CFLs.

3 CFLs: risks to human health and to the environment

There is some level of awareness in the community that fluorescent lights contain mercury, glass and aluminium. There are many myths and misinformation relating to fluorescent lights and their environmental or health impacts due to their mercury content. It is likely that a large section of the community is not aware that there is any potential cause for concern. Developing a marketing and communications strategy for recycling of mercury containing lamps will need to find a balance between allaying disproportionate fears and encouraging recycling (reducing disposal to landfill).

This section discusses the findings of a literature review of scientific and technical documents relating to fluorescent lights and to mercury.

3.1 Fluorescent lamps: project context

Generally, the higher the power usage, the more mercury required to operate a fluorescent lamp. Mercury containing lamps include:

- high intensity discharge (HID) lamps, such as mercury vapour lamps used for street lighting, which contain between **50 and 1000 milligrams** (mg) of mercury

- linear fluorescent tubes, as used in most commercial and public buildings; required by an Australian standard to contain **less than 15 mg**
- compact fluorescent lamps (CFLs), used mostly in homes, which are required under a new Australian Standard to have a **maximum of 5 mg** some neon tubes, as used in signs (concentration dependant upon size of tube)

(DEWHA, 2009)

This study will focus mainly on CFLs as these are the main type of lamp that will be targeted by the EMRC recycling campaign from domestic users. Some consideration will be given to other types of fluorescent lamps for additional context.

3.2 Fluorescent lamps: health considerations

All fluorescent lamps including CFLs contain small amounts of elemental mercury (i.e. in a metallic form as opposed to as a salt or other compound). Mercury is known to be toxic to human health. The main exposure risk relating to fluorescent lamps is from inhalation of mercury vapour from a broken lamp (although there is a very slight risk of absorption of mercury through the skin if the powder inside a CFL is handled directly). Of the <5 mg of mercury contained in a CFL, 60% of it is adsorbed onto the white phosphor powder contained in the lamp or onto the glass; leaving 40% or <2 mg of mercury vapour (DEWHA, 2009). As a comparison with fluorescent lamps, traditional mercury thermometers contain about 500 mg of mercury.

World Health Organisation (WHO) guidelines and Worksafe Australia recommendations both focus upon long term (chronic) exposure. There are no 'safe limits' for acute exposure to mercury, although there are documented examples of poisonings when humans have been exposed to 0.8mg/m^3 over a 24 hour period (WHO, 2003). Acute exposure complications related to mercury are mostly observed associated with people working with mercury or using mercury compounds 'therapeutic' agents. The WHO (2003) cites a 'No Observed Adverse Effects' limit of 0.23 mg/day.

The literature search identified no documented evidence of any mercury poisoning incident from exposure to broken fluorescent lamps.

WHO Guideline Values

Water: 1 µg/litre for total mercury

Air: 1 µg/m^3 (annual average)

WHO estimated a tolerable concentration of 0.2 µg/m^3 for long-term inhalation exposure to elemental mercury vapour, and a tolerable intake of total mercury of 2 µg/kg bodyweight per day.

Worksafe Australia

The eight-hour time weighted average (TWA) exposure limit is 0.05mg/m^3.

The Australian Government is currently working on a new standard for CFLs that includes a maximum mercury content aligned with the European Commission standard at 5 mg of mercury per lamp. Fluorescent tubes entered the market over 40 years ago and are widely used in Australian homes and workplaces. The average fluorescent tube contains approximately 15 mg per tube of mercury. According to Department of the Environment, Water, Heritage and the Arts (DEWHA), old mercury thermometers contain approximately 500 mg of mercury (DEWHA, 2009). Mercury is used in a variety of everyday products including: watch batteries, various medical instruments (e.g. blood pressure monitors), and dental fillings.

3.3 Fluorescent lamps: environmental considerations

Over the lifetime of a fluorescent lamp, the environmental impacts compared to standard incandescent lamps are significantly lower. CFLs use about 20% of the energy to produce the same quantity of lamp and last 6-10 times longer than an incandescent lamp (Parsons, D., 2006). DEWHA estimates that across Australia, the change to CFLs is expected to save around 30 terawatt hours (30 million megawatt hours) of electricity and 28 million tonnes of greenhouse gas emissions between 2008 and 2020. This saving is equivalent to decommissioning a small coal-fired power station.

There are significant community concerns about the mercury content of CFLs and other fluorescent lamps. In Australia much less mercury enters the environment from fluorescent lamps than from the use of incandescent lamps. Burning coal for energy production releases significant amounts of mercury, which naturally occurs in coal (DEWHA 2009, Parsons, D., 2006). Since fluorescent lamps use less electricity, the total mercury entering the environment is reduced in comparison to using incandescent lamps, even when taking the mercury content of fluorescent lamps into consideration.

3.3.1 Landfilling fluorescent lamps

The environmental impact of landfilling large quantities of fluorescent lamps is not well documented in scientific literature, indicating a lack of research in this area. Mercury can exist in various forms in the natural environment. Methylmercury is more biologically available and will accumulate in plants and animals more readily than metallic mercury or inorganic mercury salts (US EPA, 2009). The conditions that are most conducive to the formation of methylmercury are: low pH, anaerobic (oxygen-free) conditions and the presence of organic acids (Gilmore and Henry, 1991) which are the conditions found in most landfills. Methylmercury is prone to be bioaccumulated and as such could cause environmental damage if a point source of mercury were to be leaked from a landfill. The composition waste entering putrescible landfills in Australia would contain only tiny proportions of fluorescent lamps and it would be difficult to link elevated mercury levels in landfill leachate directly to landfilling of fluorescent lamps other than by undertaking a substantial research project that measured lamps entering a site over many years.

In some parts of Western Australia, Class II landfills are able to receive mixed waste but are unlined (by comparison, Class III and Class IV landfills have an impermeable liner) (see Department of Environment, 1996 for definitions of landfill class). The lack of a landfill liner in Class II landfills and the inability to manage leachate produced by the site may increase the risk of environmental exposure as leachate could leak into the surrounding environment and carry metal contaminants such as mercury with it.

3.3.2 Alternative Waste Treatment and fluorescent lamps

Perth waste management systems rely to a significant and increasing extent, upon Alternative Waste Treatment (AWT). AWT technologies divert organic material from landfill by separating this material from the municipal general waste bin and biologically processing it into an organic soil conditioning product. In this way, AWT has a positive impact upon greenhouse gas emissions from landfill.

The use of mixed municipal waste as the feedstock to the AWT process means that there is a low to moderate probability that CFLs could enter the process. In Perth, AWT systems sort and screen the material as a standard part of the process. The sorting process is likely to remove the majority of CFLs from the feedstock and the likelihood of significant quantities of mercury entering the soil conditioning product is minimal to low.

3.4 Recommendations for risk management of fluorescent lamp collection systems

The existing literature has identified only slight potential health risks associated with the breakage of a single CFL, particularly if cleared up appropriately (DEWHA, 2009; Energy Star, 2008). The mercury vapour concentrations directly over a broken CFL would, for a very short time exceed international recommended threshold limits. However, DEWHA consider there to be lower risk from broken CFLs than the risk associated with long term exposure to mercury vapour from dental amalgam fillings.

EMRC have already taken the responsible step of ensuring that all published literature for residents relating to CFLs includes standard guidelines about dealing with broken lamps.

DEWHA recommendations for dealing with broken CFLs:

- Open nearby windows and doors to allow the room to ventilate for 15 minutes before cleaning up the broken lamp. Do not leave on any air conditioning or heating equipment which could re-circulate mercury vapours back into the room
- Do not use a vacuum cleaner or broom on hard surfaces because this can spread the contents of the lamp and contaminate the cleaner. Instead scoop up broken material (e.g. using stiff paper or cardboard), if possible into a glass container which can be sealed with a metal lid
- Use disposable rubber gloves rather than bare hands
- Use a disposable brush to carefully sweep up the pieces
- Use sticky tape and/or a damp cloth to wipe up any remaining glass fragments and/or powders
- On carpets or fabrics, carefully remove as much glass and/or powdered material using a scoop and sticky tape; if vacuuming of the surface is needed to remove residual material, ensure that the vacuum bag is discarded or the canister is wiped thoroughly clean
- Dispose of cleanup equipment (i.e. gloves, brush, damp paper) and sealed containers containing pieces of the broken lamp in your outside rubbish bin - never in your recycling bin

While not all of the recommended cleanup and disposal equipment described above may be available (particularly a suitably sealed glass container), it is important to emphasise that the transfer of the broken CFL and clean-up materials to an outside rubbish bin (preferably sealed) as soon as possible is the most effective way of reducing potential contamination of the indoor environment.

(From www.environment.gov.au)

Health implications could potentially arise from continued exposure to multiple, broken CFLs. Should a collection bin contain a number of broken CFLs, this would potentially present a health risk to staff and to the public.

Suitable systems should be established to:

- Minimise breakage of collected CFLs, and if breakage occurs,
- Arrangements should be in place for storage of the broken lamps in a secure container, in a well-ventilated area, away from human exposure

Potential environmental risks relating to the collection of CFLs for recycling relate to potential leaks of mercury and should be minimal, provided due care is taken during collection, transport and processing of the units.

4 Generation of fluorescent lamps in Western Australia

This section discusses the generation of waste lamps (CFL, tubes and incandescent) that are likely to be generated in Perth over the next few years. This report will focus upon mercury containing lamps that are generated from households (i.e. CFLs). Other studies (e.g. the *Flashback* pilot in Victoria) found that it is highly likely that a significant number of non-CFL units will be placed in recycling bins including incandescent and halogen bulbs. All lamps can be recycled through the same system so non-CFLs are not a major contamination issue, but collection of large numbers will increase the cost of the programme.

It should be noted that data relating to fluorescent light and incandescent light bulb use in Western Australia are currently sparse. Data limitations relevant to this project are discussed in more detail in Appendix 1.

4.1 Fluorescent light sales and recycling rates

There are only a few sources of data regarding the sale and disposal of lighting products. Table 1 presents figures from the Australian Bureau of Statistics, on imports of lighting products into Australia in 2002.

Table 1: Number of lamps imported to Australia (2002) (ABS figures)

Lamp type	Number imported to Australia (2002)
Incandescent	77 million
CFL	8 million (of which about 20% were for residential use)
Fluorescent tubes	12 million

Non-CFL units are likely to form a significant quantity of material collected over the next few years. With the ban on sale of incandescent lamps being introduced in November 2009, it is likely that over the next two years, as stocks of bulbs in people's homes run out, the quantities of incandescent lamps in the waste stream will quickly dwindle.

CFLs are quoted as having a 6-10 year life expectancy which is, 6-10 times longer than the life expectancy for an incandescent lamp (ABS, 2008). In general terms, the longer life expectancy of CFLs indicates that about one-tenth of the number of units will enter the waste stream each year once the ban on incandescent lamps takes full effect.

4.1.1 Likely collection quantities

The Australian Greenhouse Office numbers from 2004 suggest that there was a stock of nearly 80 million incandescent bulbs in Australian households. The Australian Greenhouse Office (2004) suggests that lighting use currently grows at a rate of 4% per annum. If all incandescent lamps are replaced by CFLs by 2013, there would be over 11 million CFLs per year generated in Australia (assuming that CFLs last 10 times longer than incandescent

lights). By population, EMRC is about 13.5 % of the population of WA, so on a per capita basis, about 130,000 – 200,000 CFL units (approx 8-9 tonnes of material) will be generated in Perth's Eastern Region in one year, once incandescent lamps are mostly removed from the waste stream.

Potential generation of CFLs in WA is discussed in Appendix 2. On average it seems likely that one bin might collect about 60 mixed CFL and incandescent lamps per month (assuming that a total of about 190,000 mixed lights are generated in the Eastern Region in 2010). This figure is an estimated average and the actual quantity might be significantly higher or lower than this value depending upon the suitability of bin location and the success of the advertising campaign.

Over time, the number of lights entering the waste stream will decrease as incandescent lights are replaced by CFLs which will last approximately 10 times as long. Over the same period it is likely that awareness of the programme will be raised so that a higher number of CFLs are captured by the recycling stream.

4.1.2 Comparison with Victoria

The *Flashback* programme in Victoria collected 589 kg of lights over a 13-month period using four locations. On average, this would be about 11 kg per month, per bin (about 183 units). One site (the lighting specialist retailer, Beacons was responsible for 92% of the material collected). The programme was advertised using local papers and other media although respondents to the programme survey indicated that they had mostly brought the lamp with them to ensure they purchased the correct replacement or had found out about the scheme by enquiring at their local council.

The *Flashback* trial found many incandescent lamps were collected through the CFL collection bins and it seems likely that these lamps will be a common contaminant. Between 30% and 70% of the lamps collected in Victoria were incandescent lamps.

5 Community Engagement

5.1.1 Barriers to CFL recycling

The main barriers to using a CFL recycling bin are likely to be the same as most recycling schemes. A survey of West Australians in 2007 revealed these key reasons for not recycling:

- **Lack of Knowledge** – not knowing how, where or why to recycle
- **Apathy** – a lack of interest in where a product ends up
- **Too hard** – recycling will involve a greater effort than simply putting item in the bin
- **Why bother?** - response to the common misconception about recyclables going to landfill or it not really being more 'environmentally friendly' to recycle)

(Synovate, 2007)

Additional standard barriers to recycling include:

- Perceptions of normality – if no other residents nearby are recycling; there is little motivation to attempt to recycle. This contrasts with the situation when recycling is considered 'normal behaviour' and it would be strange not to
- Lack of knowledge about why recycling is important
- Cynicism about the benefits or the likelihood of material actually being recycled

5.1.2 Sustainability Victoria '*Flashback*' findings

The communication campaign for Sustainability Victoria's *Flashback* programme found that most people (59% of those who had heard about the programme) found out about the ability to recycle CFLs through their local council (12%), conducting web search (21%) or just word of mouth (26%) than through the direct advertising (23%) and advertorial/article in local paper (18%) (Sustainability Victoria, pers. comm.).

The survey of the *Flashback* recycling programme users found that the vast majority of people (70%) did not know of the *Flashback* service prior to entering the store and therefore their primary purpose for attending the store was to purchase a product or service.

Respondents to a survey about the programme in Victoria were polled as to what their main motivating factor was for accessing the *Flashback* service. The responses received included:

- 'Free service' (59%)
- 'Doing the right thing' (27%)
- 'Close by/convenient to access' (14%)

It should be noted that since 70% of those surveyed were unaware of the service prior to entering the store, this group had no particular motivation for using the service they were not aware of other than it was being provided free of charge.

Image 4: Flashback collection bins at Beacon Lighting store in Victoria

6 Equipment, staffing and location requirements for bins and storage

6.1 Considerations

In establishing a suitable location and method for collecting CFLs from public places, it is important to identify the main risks and areas of concern. With CFLs the main risks arise from broken glass (cut hazard) and mercury vapour (human health risk over prolonged exposure period) although these risks are not considered to be very high (see Material Safety Data Sheets in Appendix 4)

In locating and collecting material from bins the following factors will need to be considered:

- Safety
- Environmental protection
- Logistics
- Staffing
- Bin visibility and contamination issues
- Bin location
- Public perception of health risks
- Barriers to recycling

These factors are discussed here with some risks and suggestions for risk minimisation.

Safety

Key safety risks are:

- Bins are knocked over or that vandals can reach into bins and access/break the units
- Handling of large bins that are filled with material can be a manual handling risk, particularly if lifting of bulky objects is involved
- Although the quantity of mercury in a lamp is relatively small, it is not ideal for broken lamps to be stored for prolonged periods in areas that are not well ventilated and might cause illness to staff working all day in this area

Environment

Environmental risks are:

- Bins are knocked over or that vandals can reach into bins and break the units
- Broken lamps around bins would reduce the aesthetic of the area and may be a hazard to humans and local fauna (particularly if bins are at an outside location)

The pollution hazards from broken lamps are: mercury entering water courses or causing localised contamination to land. The relatively small quantities of mercury present in CFLs

would mean that a significant quantity would need to be broken for a significant incident to be caused.

Logistics

Recycling companies indicated that collection and transport of lamps should use solid containers where possible, plastic bags were deemed too flimsy to be safe for transportation of lamps and breakage to be a potential problem. Transportation containers that can be stacked on to pallets were preferred by most recycling companies.

Breakage of lamps in transport is more likely when large quantities are stored together (reported from recycling company representative). Transportation of lamp quantities of about 100 in one container was felt to be ideal. Transportation of more than 150 lamps at one time increases the weight of lamps smashing against one another, causing breakage.

Use of larger bins would increase the distance that a lamp would be dropped into the bin and potentially increase the chances of breakage (however, Sustainability Victoria used 240L wheelie bins and reported no major breakage issues).

Recycling companies indicated that lining bins with heavy duty clear plastic bags was a way to contain the lamps should there be any breakage.

Visibility and contamination

Bins that are <u>not</u> clearly signed and of a suitable colour are likely to:

a) received significant quantities of contamination (general waste)

b) not be noticed and therefore collect little or no target product

Bin location

In the Victorian *Flashback* programme, 61% of survey respondents indicated that they preferred to recycle via a retail store. However this result may reflect a bias given that the survey was conducted at a retail store.

Other major options for bin location indicated by survey respondents included:

- 'return to manufacturer' (10%)
- 'waste transfer station' (6%).
- Many respondents nominated kerbside collection as a suitable recycling route

Public perception of health risks

Some EMRC residents have voiced concerns about mercury containing lamps. These concerns may act as a barrier to recycling. There is a risk that negative media stories about the project might be released.

Barriers to recycling

Key barriers to the successful use of a recycling bin for CFLs are discussed in Section 5.1.1. There is a risk that these barriers will impact upon project success.

6.2 Alternative bin option: "Tube Terminator®"

The Tube Terminator® is a crushing technology designed for CFLs and other fluorescent lamps that contains the mercury and other materials within the vessel for volume reduction during transport.

Image 5: tube terminator being operated

The Tube Terminator® is a system based upon a 240L wheelie bin with a chute for lamps and tubes. The system shreds the material under vacuum and separates out the mercury and filters through activated carbon. The benefits and features are listed on the manufacturer's website www.eco-safe.com.au.

The main benefits of the Tube Terminator® are:

- That the material is reduced in volume and can be easily shipped (although only about 11 kg of material can be contained in the system at one time)
- That mercury is contained by bonding to activated carbon for safe transport

Other considerations

The mechanism of crushing lamps in the Tube Terminator® is not guaranteed to contain all glass shards and safety equipment for face and hand protection (e.g. safety face shield and gloves) is required in order to operate the system.

The Tube Terminator® will cease operation if:

- The unit is moved
- The micro-computer is electrically overloaded
- The lid is opened
- The carbon filter reaches use-by date or capacity. Code recognition ensures spent filters cannot be reused
- The secondary filter becomes blocked
- The collection bag reaches a specific weight or is not in place
- The carbon filter is not in place
- The secondary filter is not in place
- Carbon filter screen is not closed
- If adaptor lid is not in place

The factors for the Tube Terminator® to cease operation listed above are good safety checks but mean that specific training is required to operate the unit. Training for the Tube Terminator® must be provided by the product supplier, Ecosafe, based in Victoria.

6.3 Recommendations

Considerations when designing the bins and identifying suitable location and logistics options include:

Bin design:

- A stable design, or even secured to the ground/wall, in a location that is not at high risk from accidental knocks
- Have small opening designs such as 'rosettes' or bristles that prevent removal of lamps once deposited and are located high enough to be out of reach of small children
- Bins should be brightly coloured and well signed so that they do not appear to be general waste bins and are easily noticed by users. If 'wheelie' bins are used, then bin bodies which are black, brown, green, pale blue and yellow should be avoided as these are already used for common waste or recycling streams in WA
- Signage should be clear about what is accepted and information about recycling should be included

Location:

- Retailers that sell lighting appear to be the most successful location for recycling collection bins
- Placing bins in areas that are well-ventilated would be prudent and responsible
- If placing bins at a retail location, they should be given a specific site and remain there throughout the trial. Moving bins is likely to cause confusion amongst users and reduce effectiveness

Staff:

- To minimise breakage risk, there should be staff in the vicinity of a bin with a specific responsibility for the correct use of the bin. Bins should not be left in public areas with free access (e.g. in a shopping precinct or car park area)

Logistics:

- Lamps should be transported in solid containers (such as recyclable cardboard box or re-usable plastic container) lined with a plastic bag to contain any breakage
- Minimisation of breakage during transport and also reduced manual handling risks could be achieved by transporting lamps in quantities of about 100 units per box – transport economies would be achieved by using stackable boxes on pallets

Communication:

- Some literature will need to be available (either at the bin location or on the EMRC website/standard literature) to address public health risk concerns and to demonstrate that EMRC is adopting a responsible approach to collection and recycling (health risks are discussed in Section 3 of this document)
- Literature will need to consider the material on the environmental impact of CFLs compared with incandescent lamps as discussed in Section 3.3
- The signage and communication approach and project design (e.g. bin location) should consider the barriers discussed in Section 5.1.1 of this document

Communication campaigns from Australia and overseas are discussed in Section 9.

Tube Terminator

- The Tube Terminator must be operated by a fully trained member of staff, equipped with personal protection equipment (safety face shield and gloves). The unit must be kept in a location where it is not able to be knocked, moved during operation or misused to avoid locking the operating computer
- The unit is probably useful at transfer stations or at household hazardous waste drop off day locations by trained and equipped staff

7 Recyclers of fluorescent lamps in Australia

There are two recyclers of mercury containing lamps who operate for Western Australia: CMA Ecocycle and Chemsal. CMA Ecocycle are based in Victoria but have an office and representatives in Perth. Chemsal are based in New South Wales and operate through a third party agent (Envirowipe – a cleaning cloth recycler) in Perth.

CMA Ecocycle and Chemsal have different technologies for recycling of mercury-containing lamps although both have the same markets for the materials. In both cases, lamps are crushed and the materials (glass, mercury, plastics, aluminium and phosphorus) are separated.

The end markets for recycling material from mercury-containing lamps are:

- Mercury is sold to the Australian Dental Association for use in dental amalgam. (Australia is a net importer of mercury)
- Aluminium is sold to Australian based metals recycling companies
- Glass is sold to the glass fibre insulation industry in Australia
- Plastics and circuitry are sold to markets in China (under license)
- Phosphorus from the phosphor powder is sold to the fertilizer industry.

Chemsal use the Balcan process (a European technology that crushes and separates lamps within a single contained system). Chemsal are certified to:

- ISO 14001
- AS 4801
- ISO 9001

Downloadable from: http://www.chemsal.com.au/accreditation.html

CMA EcoCycle have a crusher and separator based in Wangara, WA that crushes the units under vacuum. The crushed and separated material is transported to the CMA plant in Victoria for further processing to prepare for sending to the appropriate market. Powder and other mercury contaminated lamp parts enter a Continuous Flow Distiller where the mercury is vaporised and distilled into pure mercury liquid for transport to market.

All materials entering the processes are recycled.

CMA EcoCycle have an operating licence from the Victorian Environmental Protection Authority. CMA EcoCycle's process meets European Economic Community Directive on Machinery and OSHA Guidelines.

Information downloadable from: http://www.cmaecocycle.net/op_fluoro.html

CMA EcoCycle are not certified to ISO 14001.

8 Financial considerations for recycling of CFLs

The cost implications for running a recycling collection program are listed in Table 2.

Table 2: Cost implications for CFL collection and recycling

Cost item	Description	Approximate cost
Administration	Data collation, invoicing etc	Local government staff @ 2-3 hours per week
Bin purchase	May need to be constructed or specially designed	$10,000 for "Tube terminator" (lamp crushing and separation) ~$100/bin for standard MGB
Recycling	Processing of material	$2.50 - $4.50/kg (Chemsal) $4.50/kg (EcoCycle)* EcoCycle also offer a pre-paid box for 100 units: delivered and collected for $95/box
Space	Can be cost-neutral unless space is required that might have been used for other activity (e.g. car parking at retail collection points)	None/Variable – may need consideration
Special equipment	Possibly none, may include fork lift vehicles or trolleys	None/Variable – may need consideration
Security	There may be a need for increased security to protect collected material	None/Variable – may need consideration
Staffing costs	Sites will generally have staff on site already that may be able to deal with the material collected	None/Variable – may need consideration
Training	Sites with bins should train staff in techniques for dealing with breakages of CFLs and about the recycling programme so that customer assistance can be provided	1-2 hours per staff member plus trainer at approx $400 - $800
Transport to recyclers	Can be arranged through recycling companies or independent waste collection contractors	~$25/kg variable dependent upon frequency of collection and quantity collected
Promotion	Promotional materials can be expensive if a significant campaign is required.	Variable, potentially up to $10,000 per campaign

*Sustainability Victoria '*Flashback*' costs are quoted as $1.95 - $2.90 per kg – costs should be investigated with recycler

9 Communication and promotion

An effective communications campaign will maximise the community engagement, provide positive feedback and information about the benefits of CFL recycling and ultimately maximise the quantity of material that is collected.

Communication and promotion can be very expensive. Extensive promotion will generally correlate with high participation rates assuming that the system is otherwise convenient to residents. High participation may actually be a problem in the implementation and establishment phase of the collection system and greater promotion may be better rolled-out once the system is well-established and running smoothly.

Messages in any communication campaign should be **clear, concise and consistent**. With environmental issues, positive messaging is often more effective than negative, as this can simply turn people off.

Promotional opportunities could include:

- Brochures available at point of sale
- Press releases
- A Ministerial launch event
- Website
- Call centre (with a 1300 number)
- Paid or Council subsidised advertising in local newspapers
- Television adverts (can be very costly)
- Editorials in the Council section of local newspapers
- Directional and location signs at collection sites

It is important that the communication style addresses the issue of mercury in CFLs but is not alarmist and puts the risks in proportion to other everyday items (e.g. mercury thermometers have more than 100 times the quantity of mercury compared to a CFL). The Federal Government DEWHA website is a good source of clear information on the risks of mercury toxicity from CFLs. Since many people in the community are not aware of a significant risk from CFLs, a good communication campaign should probably be careful not to create a false concern where one does not currently exist.

9.1 Campaigns

Image 6: Flashback signage

9.1.1 Australia

Very few CFL recycling programmes have been run so far in Australia the most significant trial of CFL collection for recycling was the ***Flashback*** programme which was run in 2008/09 by Sustainability Victoria. The *Flashback* programme focussed on awareness-raising through local newspaper adverts and advertorials. On conducting a survey of people using the service, less than one-fifth of respondents to a programme survey said that they had heard about the programme through the local

paper. Most CFL recycling service users had heard about the service through word of mouth or by undertaking their own web-searches (Sustainability Victoria, pers. comm. 2009). Supermarkets are probably responsible for the majority of sales of CFLs. Interestingly, the *Flashback* trial programme found that the collection bins placed in 3 Coles supermarkets collected very low volumes of lamps. The low success of Coles supermarket collection points may be attributable to the fact that: a) few people take used lamps to the supermarket, b) the bins were not located in the lighting area of the store and bins did not remain in a constant location, or c) the signage was not sufficiently visible.

9.1.2 Cape Town, South Africa

The "Be Bright, Recycle" campaign is run in partnership with a manufacturer (Philips) (Appendix 3). This campaign was run as a sub-set of the wider Pick 'n' Pay (a major retail chain in South Africa) campaign for all recyclables. The campaign involved having temporary bins launched into all Pick 'n Pay stores. Amplux (Philips merchandising support company) managed the collection of material for recycling, including the transportation from stores to Amplux offices where a waste company collected the CFLs for disposal. A Philips manufacturing facility in neighbouring Lesotho is to establish a recycling facility shortly.

9.1.3 Europe

The European Union has the WEEE Directive legislation (EU 2002) that requires manufacturers and retailers to collaborate in order to recycle electronic and electrical waste (including CFLs). Since recycling is mandated by legislation there are a variety of systems across Europe. There are a few campaigns, including the campaign in France discussed in Section 9.1.4. Of the European nations, Sweden has one of the highest recycling rates (Intelligent Energy Europe, 2008). Sweden's good recycling rate may be attributable to the commitment of Ikea, the national home ware chain which has recycling stations at all stores. There does not appear to be a strong advertising campaign for recycling alone. Ikea ran the recycling in support of a campaign to encourage people to use CFLs by giving away free lamps (IAEEL Newsletter, 1997). The Ikea recycling system has been operating in stores since 2001 in Sweden (and since 2008 in WA) and over time appears to have developed strong support and awareness.

9.1.4 France

'Recylum' is a partnership formed between 22 different regions across France using the tag line '*Les lampes recyclent aussi – c'est clair!*' (Translation: '*It's clear, lamps are recyclable too*!') (www.recylum.com). Boxes are located in retail stores and a levy is placed on each lamp that is sold, which is used to fund the programme. The 'Recylum' campaign augments existing legislation formed under the EU WEEE Directive.

Image 7: Lamp recycling messaging - France

9.1.5 Maine, USA

A State-wide recycling education campaign is underpinned by legislation that bans CFL disposal to landfill. State Environmental Services have been educating and delivering recycling buckets to participating retail stores (for free disposal). All stores in the program accept CFLs for free and are trained in accordance with requirements by the Maine Department of Environmental Protection.

Maine developed a strong campaign including a website with information about recycling and CFL information in general (www.lamprecycle.org). Although Maine still has a relatively low CFL recycling rate, a study on the effectiveness of the recycling campaign concluded that convenience of drop off location was one of the key factors to determine campaign success (Wagner, 2009)

Image 8 (above): Lamprecycle icon (USA)

9.1.6 USA

Green Action Project in USA has developed a free marketing campaign for users in the States to access including signage and cardboard bin design as depicted in the photo. Note that the bins (pictured, right) hold leaflets on the side with information about CFL recycling. Advertising material uses pictures of the recycling collection bins so that people are aware to look out for these systems.

Image 9: Green Project bin

9.2 Summary of communication and awareness-raising campaigns

There have been very few successful awareness-raising campaigns for CFL recycling conducted to date. Most recycling of CFLs appears to be achieved by placing bins in locations where residents may go to purchase new lamps (e.g. Beacon Lighting in Victoria), but collection bins need to be prominent and well signed to ensure that customers are aware of their function.

10 Summary

Collection of CFLs for recycling is likely to be a popular service for the community. CFL use for energy efficiency and the appropriate disposal is likely to have an increased profile as the ban on importing incandescent lamps takes effect in November 2009.

CFLs contain small amounts of mercury which has raised understandable concern with some members of the community. Many members of the community are not currently aware of the mercury content of these lamps and it is important that EMRC is able to educate residents so that CFLs are treated appropriately, but such that undue anxieties are not raised.

The key health risk from CFLs comes from breakage of lamps and release of the mercury vapour. Although only about 40% of the mercury content is in vapour form, this level of mercury can still have a potential health risk if not handled appropriately.

Breakage of mercury containing lamps upon deposit into a collection bin or during transport should be avoided and bin design and location will need to take breakage minimisation into consideration.

It is recommended that bins should be:

- Stable and placed in a location unlikely to be knocked over
- Able to provide collection volumes that are <200 units to minimise breakage in transport and manual handling issues
- Designed so that once deposited, the lamps cannot be retrieved
- Plastic lined so that broken lamps can be contained
- Located in an area that is regularly monitored by staff with a responsibility for the bin and not left unattended overnight or out of shopping hours

Recyclers of CFLs commented that they liked the concept of transporting the lamps in cardboard boxes that could be stacked onto pallets as this would limit breakage by reducing the mass of lamps resting upon each other and moving around in the collection box. Smaller boxes or bins are relatively easy to handle and would place less burden upon staff collecting and moving them.

Key financial considerations for the operation of a CFL recycling system relate to the transport and actual recycling of the lamps. Recycling was quoted to cost between $1.95/kg and $4.50/kg. It is likely that costs for recycling will reduce as volumes of material recycled across Australia increase and potential for economies of scale are realised.

There have only been a few CFL recycling campaigns conducted globally and many appear to have struggled to realise good recycling rates. The main routes to success appear to relate to:

- Clear, simple messaging of collection bins that are placed in obvious-to-see locations
- Locating bins at retail sites that sell CFLs and placing messaging about recycling at point of sale
- Engaging local government to provide information on websites

It is likely that successful awareness-raising will require several points of potential contact of a clear, succinct message.

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Appendix 1: Data limitations

This project has been undertaken as a piece of desktop research. The only novel research has been conducted as part of this work has been to gather some observations and comments from some of the industry stakeholders. Only credible reports and data sources have been used in the development of this work. Every effort has been made to identify sources of information and to be clear about the methods used for arriving at the 'metadata' or final numbers produced.

Financial data are based upon information obtained verbally from CFL recyclers in Australia. These figures were considered reasonable at the time of writing but may vary in future.

Appendix 2: Calculation of quantity of CFLs generated in the recycling stream 2010 onwards

- In 2004 there were about 218 million lamps (of all types, including incandescent lamps and CFLs) being used in Australia. About half of these lamps were in the residential sector (Australian Greenhouse Office, 2004)
- The lighting sector has been estimated to grow about 4% each year which indicates both population growth and increased lighting use (Australian Greenhouse Office, 2004). So by 2010/11, there are likely to be about 276 million lamps (assuming that there has not been a slow-down in purchase of incandescent in favour of longer life lamps)
- Since there are no CFL sales figures, calculation of CFL sales in 2010/11 will be taken from projections of incandescent figures. Assuming that following the standard trend (and without a ban), in 2010/11 about 100 million incandescent lamps would have been sold in Australia. To calculate number of CFL, this would be about one eighth of this figure or 12.5 million CFLs sold in 2010/11
- By population this is about one-tenth or 1.25 million CFLs sold in WA in 2010/11
- EMRC (population about 290,000 people, in about 120,000 dwellings) is about 13.5% of the population of WA, therefore all EMRC would be in the range of 150,000 – 180,000 lamps in Eastern Region households that would be expected to enter the waste stream in 2010/11 (approximately 10 tonnes)
- With even very high profile advertising, most European countries expect about 10% of all light globes to be recycled (Intelligent Energy Europe, 2008) (probably less than 19,000 units or about one tonne)
- Assuming one bin location in EMRC might attract 5% of the region's residents, this would be 15,000 x 5% = 750 lamps (of all types) in one year or just over 60 per month (this is likely to be an upper range estimate)
- During early stages of the programme, it is likely that only relatively small quantity of lamps will be collected for recycling and the increase in number will depend upon the success of the campaign to raise awareness and encourage appropriate bin use
- Since an average light unit weighs about 60g, Collecting 60 units would weigh about 3.6 kg
- It is likely that 30% - 70% of the lamps collected in the first 2-3 years of the pilot will be incandescent lamps (as per the Sustainability Victoria trial findings)
- As CFLs replace incandescent lights, the total number of waste lights generated will decrease. As any recycling programme becomes established, the number of lights collected should increase which could potentially mean that a greater number of lights are collected but that a higher proportion will be the CFL type.
- The figures used here are averages; it is likely that some bins will collect substantially more/less than the figures estimated here (as found by Sustainability Victoria with the *Flashback* pilot project)

Estimated lamp sales in Australia (millions of units) – extrapolated from 2002 figures (assuming phase-out of incandescent globes from 2009 onwards)

	Incandescent bulbs (million units)	CFL (million units)		CFL (Tonnes)		CFL in EMRC region (Tonnes)	
		Low range	High range	Low range	High range	Low range	High range
2002	77	1.6	1.6	96	96	1.30	1.30
2003	80.1	1.7	1.8	104	106	1.40	1.43
2004	83.3	1.9	2.1	112	127	1.51	1.71
2005	86.6	2.0	2.3	121	139	1.63	1.88
2006	90.1	2.2	2.6	131	153	1.76	2.07
2007	93.7	2.4	2.8	141	169	1.90	2.28
2008	70.3	2.5	3.1	152	186	2.06	2.50
2009	52.7	2.7	3.4	165	204	2.22	2.76
2010*	39.5	4.1	5.6	244	336	3.29	4.53
2011	4.0	7.6	12.7	457	763	6.17	10.30
2012	0.4	8.0	13.4	478	805	6.46	10.87
2013	0.0	8.3	14.0	497	838	6.72	11.31
2014	0.0	8.6	14.5	517	871	6.98	11.76
2015	0.0	9.0	15.1	538	906	7.26	12.23
2016	0.0	9.3	15.7	560	942	7.55	12.72
2017	0.0	9.7	16.3	582	980	7.86	13.23

***Incandescent light bulb ban commences

A 10 % recycling rate is likely to be very high as an assumption in the first few years of operation of the scheme. It is more likely that even if bins were placed across the whole region, less than 5% recycling would be achieved. Since bins are really only likely to cover a small proportion of total EMRC population, it is realistic to assume that only a few hundred CFLs will be collected by the trial. It should be remembered that it is likely that a few hundred standard incandescent lamps are likely to be collected by the trial, in addition to the target CFLs.

Appendix 3: Population and area for WA local governments and Regional Councils

REGIONAL COUNCIL	MEMBERS	POPULATION*	AREA (km²)**
Eastern Metropolitan Regional Council	Town of Bassendean	13,285	11
	City of Bayswater	55,362	32.8
	City of Belmont	32,491	40
	Shire of Kalamunda	48,881	349
	Shire of Mundaring	36,931	644
	City of Swan	100,801	1,043
	TOTAL	287,751	2,119.8
Southern Metropolitan Regional Council	City of Canning	87,754	65.4
	City of Cockburn	80,921	148
	Town of East Fremantle	6,697	3.2
	City of Fremantle		18.86
	Town of Kwinana	20,812	118
	City of Melville	99,713	52.7
	City of Rockingham	91,702	261
	TOAL	387,599	667.16
Mindarie Regional Council	City of Wanneroo	124,887	687.5
	City of Stirling	189,083	100
	City of Perth	13,486	8.8
	City of Joondalup	157,203	96.8
	Town of Cambridge	25,448	22
	Town of Vincent	26,904	10.4
	Town of Victoria Park	28,738	17.62
	TOTAL	565,749	943.12
Western Metropolitan Regional Council	Town of Claremont	8,873	4.9
	Town of Cottesloe	7,223	4
	Town of Mosman Park	8,214	4.3
	Shire of Peppermint Grove	1,570	1.5
	City of Subiaco	17,835	7.1
	TOTAL	43,715	21.8
Rivers Regional Council	City of South Perth	41,572	20
	City of Armadale	53,445	560.40
	City of Gosnells	97,408	127
	City of Mandurah	55,815	173.5
	Shire of Serpentine-Jarrahdale	13426	905
	Shire of Murray	13,000	1,821
	TOTAL	274,666	3606.9
	City of Nedlands	21,852	20.6
TOTAL		1,581,332	7,379.38

*2007 Census data

**From 2006/2007 Local Government Directory

Appendix 4: Material Safety Data Sheet for CLFs

From: Technical Consumer Products Incorporated, USA

TCP

Compact Fluorescent Safety Specifications

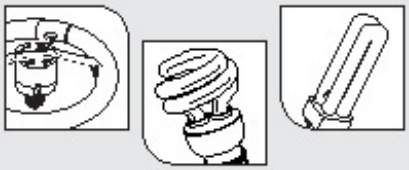
Material Safety Data Sheet (MSDS)

MSDS-001 - Issue Date: 1-16-05

Compact Fluorescent Lamps – Spring Lamps, Floods, Globes, A-Bulbs, Torpedoes, Circline and PL Lamps

INFORMATION AND APPLICABILITY

Technical Consumer Products believes that under the Occupational Safety and Health Administration (OSHA) Hazards Communications Standard, a lamp (light bulb) is exempted as an "article", and that as such, does not require an MSDS. The original OSHA Standard defined an article as something that: 1) is formed to a specific shape and design, 2) has end use functions dependent upon its shape and design, and 3) does not release or otherwise result in an exposure to a hazardous chemical under normal conditions of use. In February 1994, OSHA amended the Hazard Communication Standard and modified part 3 of the above to read: 3) does not release more than very small quantities of a hazardous chemical under normal conditions of use. State and local regulations also contain similar exemptions for such articles.



Materials contained in the lamp are not released during normal use and operation. The following information is provided as a courtesy to our customers.

PRODUCT AND COMPANY IDENTIFICATION

Description: Trade Name (as labeled) TCP SpringLamps or Circline (For general lighting application). Consists of lamp ballast / adapter as a unit or lamp alone, no ballast / adapter.	Manufacturer: Technical Consumer Products, Inc. 325 Campus Drive | Aurora, Ohio 44202 | 1-800-324-1496

COMPOSITION/INFORMATION ON INGREDIENTS

THERE ARE NO KNOWN HEALTH HAZARDS FROM EXPOSURE TO LAMPS THAT ARE INTACT.

Lamp Assembly – Glass and Metal – The glass is made from soda lime similar to that used throughout the glass industry for other common consumer items. The metals for end caps and filaments are generally made from various amounts of aluminum, tin, lead, copper, zinc, and nickel. None of these materials would present a potential hazard in the event of breakage of the lamp, aside from the hazard due to broken glass.

Mercury – Small amounts of mercury is used in all fluorescent lamps. Generally around 0.025% by weight. The amount of mercury present in any given lamp will vary depending on both the size of the lamp and on the equipment that was used in its manufacture. TCP continues to reduce the amounts of mercury used in fluorescent products.

Phosphor – (nuisance dust) phosphate mix using manganese, rare earth elements such as lanthanum, and yttrium as either an oxide or as a phosphate, along with a barium/aluminum oxide all are tightly bound in the phosphor matrix. These phosphors produce better lamp efficiency and color rendition. The phosphor components may vary slightly depending on the color of the lamp. Some lamps may contain a thin coating of tin oxide inside the glass.

PHYSICAL PROPERTIES

Not applicable to intact lamp.

EXPLOSION HAZARDS

When exposed to high temperature, toxic fumes may be released from broken lamps.

HEALTH CONCERNS

THERE ARE NO KNOWN HEALTH HAZARDS FROM EXPOSURE TO LAMPS THAT INTACT. No adverse effects are expected from occasional exposure to broken lamps. As a matter of good practice, avoid prolonged or frequent exposure to broken lamps unless there is adequate ventilation. The major hazard form broken lamps is the possibility of sustaining glass cuts.

Mercury	The mercury in the air as a result of breaking one or a small number of fluorescent lamps should not result in significant exposures to an individual. However, when breaking a large number of lamps for disposal, appropriate industrial hygiene monitoring and controls should be implemented to minimize airborne levels or surface contamination. We recommend a well-ventilated area, and local exhaust ventilation or personal protective equipment.
Phosphor	There have been no significant adverse effects on humans by ingestion, inhalation, skin contact, or eye contact. Antimony, manganese, yttrium and tin compounds are characterized by OSHA as hazardous chemicals, however, due to their insolubility, relatively low toxicity and small amount present in the phosphor and lamp, these materials do not present a significant hazard in the event of breakage of the lamp.
Glass	Glass dust is considered to be physiologically inert and as such has an OSHA exposure limit of 15-mg/cubic meter for total dust and 5-mg/cubic meter for respirable dust. Perform normal first aid procedures. Seek medical attention as required.
Inhalation	If discomfort, irritation of symptoms of pulmonary involvement should develop, remove from exposure and seek medical attention.
Ingestion	In the unlikely event of ingestion of a large quantity of material, seek medical attention.
Contact Eye/Skin	Wash eyes/skin, including under eyelids, immediately with copious amounts of water and seek medical attention.

PROCEDURES FOR DISPOSAL OF LAMPS

Take usual precautions for collection of broken glass. Place materials in closed containers to avoid generating dust. A Toxicity Characteristic Leaching Procedure (TCLP) was conducted on these products showing a result of mercury content that is not considered hazardous waste. For field disposal the lead in the soldering is considered hazardous waste and must be disposed of by applicable federal, state and local regulations.

ALTHOUGH TECHNICAL CONSUMER PRODUCTS, INC. attempts to provide current and accurate information herein, it makes no representation regarding the accuracy of completeness of the information and assumes no liability for any loss, damage or injury of any kind which may result from or arise out of the use of/or reliance on the information by any person.

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Appendix 5: Cape Town, South Africa campaign for recycling of CFLs

(Campaign carried out in partnership with Philips)

Pick n Pay
Inspired by you

Be Bright. Recycle.

On June 4, a press release will announce a new Pick n Pay recycling initiative for energy efficient bulbs and batteries.

This will be supported by the following campaign elements:

- Recycling bins – delivered between 13 – 16 June
- Website information – live by 17 June
- Billboards (only at Longmeadow and Kensington Head Office) by 17 June
- Hypers and Supers Press Ad panels (w/c 17 June)
- Pick n Patter July
- Part of Your Life June newsletter
- Junxion – live by 17 June

As an environmentally aware and caring company, we're asking customers to bring in their used energy efficient bulbs and batteries, and place them in two specially designed recycling bins so that we can recycle them – instead of customers throwing them away in their normal household rubbish bins.