Report on the Management of Mercury-Containing Lamps

(Fluorescent and high-intensity discharge lamps)

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Introduction

The purpose of this report on fluorescent and high-intensity discharge (HID) lamp management is to explore and recommend to the Legislative Commission on Waste Management (LCWM) a system for managing used fluorescent and HID lamps in such a manner that the toxic materials contained in lamps are not placed in the solid waste stream. The legislative mandate for this study is:

> "The office of waste management, in consultation with the pollution control agency and manufacturers of fluorescent or high intensity discharge lamps that contain mercury, shall study and report to the legislative commission on waste management by January 1, 1993, with recommendations for fully implementing, by January 1, 1996, a system for ensuring that the toxic materials contained in lamps that are replaced are reused, recycled, or otherwise managed to ensure they are not placed in the solid waste stream or a wastewater disposal system, as defined in Minnesota Statutes, section 115.01, subdivision 8."

The Minnesota Office of Waste Management (OWM) has involved affected and interested parties in this fluorescent and HID lamp management study. In addition to the Minnesota Pollution Control Agency (MPCA) and lamp manufacturers specified in the legislative directive, the OWM has consulted with representatives from a variety of other state agencies, local government staff, recyclers, building managers and affected parties. The findings outlined in this report are based on meetings with the these representatives and from scientific studies of mercury's behavior in the environment.

Key findings

Toxicity of mercury

Mercury has become recognized as a health concern over the last 25 years. Cases of severe mercury poisoning resulting from ingestion of organic mercury have been reported in many places. From these incidents, health scientists have learned about the impacts of methyl mercury ingestion in humans and have developed consumption standards. Concentrations of methyl mercury in fish caught in many of Minnesota's lakes exceed those consumption levels.

Physical behavior of mercury in the environment

Mercury that ends up in the waste stream exists in three general forms: elemental mercury and amalgams, organic mercury and mercury salts. Waste-to-energy incinerator temperatures are much higher than the boiling point of mercury, so some elemental mercury in any waste that is sent to an incinerator is released as a vapor into the atmosphere. Air pollution control equipment catches some of the mercury, but some escapes into the atmosphere. Although research is being done to improve the capture rate of mercury by pollution control equipment on incinerator stacks, the equipment being used now in Minnesota captures from 10

to 50 percent of the mercury emitted, depending on the type of equipment.

Organic mercury occurs when mercury reacts with organic chemicals. Organic mercury is responsible for the biomagnification of mercury in fish. Potential adverse health effects to humans and fish-eating wildlife result from eating fish that have accumulated high levels of mercury in their tissue. Whereas humans can read and respond to fish advisories and thereby avoid accumulating excessive amounts of mercury, fish-eating wildlife must rely on the food that is available to them every day.

Mercury salts either enter the waste stream in discarded products, such as mercuric oxide batteries, or are present because elemental mercury has reacted chemically with other components of the waste stream.

Distribution of mercury in the environment

A recent study of mercury in Minnesota lakes by Minnesota researchers shows that mercury deposition to lakes has risen to 3.7 times background levels over the last 140 years. The researchers suggest that the increase indicates mercury emissions from industrial sources have resulted in deposition increases of an average two percent per year over the period, with much higher rates of deposition occurring after 1950.

Mercury in the environment comes from natural sources as well as human activity. A recent report on mercury contamination in the United States by Clean Water Fund and Clean Water Action cites recent studies that estimate that about 60 percent of the total global emissions are from human activity and 40 percent from natural sources. Sources of mercury in the environment that are due to human activities include latex paint, agricultural applications, mercury electrolytic cells used in the industrial production of chlorine gas and products such as thermometers, mercury switches, mercury-containing batteries and fluorescent and HID lamps.

Mercury is also found in coal deposits, and when coal is burned to generate electricity, mercury is released as a vapor to the atmosphere. Coal-fired generation of electricity is the largest anthropogenic source of mercury in the environment. Other fossil fuels also contain varying amounts of mercury. Consequently, any measures to reduce the amount of electricity needed in Minnesota will reduce releases of mercury to the atmosphere. The literature consulted and the participants in this study have stressed the importance of replacing incandescent lighting with energy-efficient lighting, because it is a good management decision, both fiscally and environmentally. Energy-efficient lighting provides savings in electricity and in labor, since these lights last longer and require less maintenance.

Some of the sources of mercury are a result of a process, such as generating electricity or producing chlorine gas. Others are the result of a product's being discarded at the end of its useful life. A recent study commissioned by the U.S. Environmental Protection Agency (EPA) has identified electric lighting as the second largest source of mercury in the solid waste stream, after batteries.

The other sources of mercury in Minnesota's solid waste stream besides

fluorescent and HID lamps, such as mercury batteries, switches, thermometers and thermostats, have already been addressed in Minnesota through legislation to remove them from the solid waste stream. As the effect of the provisions of that legislation becomes greater, those sources of mercury will fall in comparison to fluorescent and HID lighting.

The focus of this report is on collection and management programs for fluorescent and HID lamps, with the goal of further reducing the quantity of mercury in the solid waste stream and wastewater treatment facilities.

Proposed management options for fluorescent and HID lamps

The MPCA and OWM believe that the most important aspect of mercury's effect on the environment is bioaccumulation of mercury in aquatic ecosystems, and that even minute concentrations are significant. Elemental mercury does not leach well, but it does evaporate, and small amounts of mercury can have significant effects. The fact that mercury accumulates in the environment over time and magnifies in the food chain gives a significant reason to reclaim and reuse the mercury from as many lamps as possible.

Source reduction of mercury in the manufacture of fluorescent and HID lamps is the first and best approach to addressing mercury in lamp waste. Lighting manufacturers are conducting research on ways to reduce the amount of mercury in each lamp, but eliminating it altogether seems not to be feasible. Manufacturers have already reduced mercury levels and expect to achieve more significant reductions by 1995.

Mercury-containing lamps should not be incinerated. The OWM recommends separate collection and recycling of used fluorescent and HID lamps, while retaining for businesses the option of sending used lamps to permitted hazardous waste landfills.

The primary focus of this study is on the commercial sector, since at least 80 percent of used fluorescent and HID lamps are generated in offices and commercial establishments. The proposals for management of fluorescent and HID lamps generated by households are discussed in a separate section of the report (see page 8 of the executive summary).

Options for storing, collecting and transporting used lamps generated by businesses

Proper management of used fluorescent and HID lamps rests initially on the users (generators) of the lamps. The primary barrier to on-site storage is space in buildings. Participants in meetings held with affected parties, referred to in this report as stakeholder meetings, and members of the lamp study group have stressed the importance of making lamp management requirements conducive to proper management. Although some cost and effort will be required to manage lamps, too much unnecessary cost or bother will prove to reduce the effectiveness of any program designed for keeping mercury out of the waste stream.

Third-party storage opportunities are currently being developed by the private sector as part of an overall infrastructure for collecting and transporting used

fluorescent and HID lamps. Opportunities for effective programs in Minnesota exist and are promising.

Issues to consider regarding an infrastructure for collection, transport and storage include:

- The need to regulate those collecting lamps to ensure that the lamps are handled properly and delivered to appropriate processors.
- The need to be careful when storing lamps to prevent implosions of the fluorescent lamps.
- Concerns of those who generate used fluorescent and HID lamps that they may incur liability in the future if the waste is not handled properly by transporters or recyclers.
- Complications that might occur at recycling facilities as a result of the fact that under hazardous waste recycling facility standards, recycling facilities must process any lamps they receive within 24 hours.

The following points have been identified as important to the development of the infrastructure for collecting used fluorescent and HID lamps:

■ The MPCA has set up a system which requires storage facilities and transporters to sign a compliance agreement with the MPCA specifically stating that they will manage the lamps according to MPCA guidelines. This is a sound approach that addresses the issues described above and should be encouraged.

■ Lamp distributors should be encouraged to take back used fluorescent and HID lamps.

■ Lamp manufacturers and distributors should continue to assist in the development of a management infrastructure for their customers' used lamps and should continue to provide technical assistance and information to customers about management options.

■ The state and local units of government should continue to provide technical assistance and education to Minnesota commercial, industrial, institutional and residential sectors through an outreach program. Such a program must be given appropriate funding in order to be effective.

Management of used lamps after collection

For this report the OWM collected information about the following management methods:

■ Disposing of spent mercury-containing lamps in a hazardous waste landfill.

■ Recycling or reclaiming spent mercury-containing lamps.

Lamp disposal in hazardous waste landfills. Disposing of used fluorescent and HID lamps in hazardous waste landfills is one option currently available to Minnesota businesses. Lamps that test hazardous under the EPA toxicity characteristic leaching procedure (TCLP) test may not be managed in any other type of landfill.

Fluorescent and HID lamps are among a group of newly identified mercury wastes testing hazardous under the toxic characteristics leaching procedure test which are exempt from a requirement to treat mercury wastes before placing them in a hazardous waste landfill. Within a year the status of this requirement with respect to fluorescent and HID lamps should be clarified by the EPA. Households are exempt from such requirements.

Lamp recycling. Opportunities for recovering mercury from fluorescent and HID lamps exist and have been demonstrated in Europe and the U.S. When fluorescent and HID lamps are processed for recycling, the materials to manage and market are glass, metal, mercury and phosphor powder. Many technologies for separating glass, metal, mercury and phosphor powder have been developed, and more technologies are currently under development. All processes must collect mercury vapor by passing the process air through a carbon filter. One of the goals of a recycling program for Minnesota is to separate the mercury effectively enough that all by-products are marketable materials.

Generators of lamps have expressed a need for assurance that recycling facilities in Minnesota are managing fluorescent and HID lamps properly. The MPCA and metro area counties are presently working extensively with fluorescent and HID lamp recyclers. The facility operators must share test data with the MPCA staff. Recycling facilities must meet Occupational Safety and Health Administration standards for ambient mercury concentrations, as well as other worker health and safety standards. The MPCA is considering developing regulations for hazardous waste recycling facilities that would better monitor and control their operations.

Once a material such as mercury has been reclaimed, it can in most cases be considered a product. Once it is declared a product, chances of liability to a generator of lamps would likely be reduced in the event that the product was handled improperly. In a letter to a mercury refinery, the U.S. EPA has stated that mercury that is 99 percent pure becomes a product, not a waste, and after that point it is not subject to hazardous waste regulations.

System finance considerations. The cost savings from using energy- efficient lamps versus incandescent lamps are substantial, even when disposal costs are figured into the business decision equation. Roughly 88 percent of the cost of lighting is the cost of the electricity to operate the lights, according to General Electric's business lighting brochure. Purchasing energy-efficient lighting fixtures that last longer saves more money through electricity and labor savings than the disposal costs of the used lamps, according to Northern States Power Co. officials.

Some lighting distributors who participated in stakeholder meetings stated that they have offered businesses that buy lamps from them the service of taking used lamps back when delivering new ones.

Participants in the stakeholder meetings held in August 1992 gave a unified opinion that financing should be left to free market forces. This system would be similar to present systems that generators already

follow for the management of most other hazardous and solid waste materials.

Key recommendations

Based on the facts gathered through this study and discussion with stakeholders, the following are recommended actions for the Legislature to take with respect to fluorescent and HID lamps:

Source reduction

Source reduction of mercury in the manufacture of fluorescent and HID lamps is the first and best approach to managing mercury in lamp waste. Lighting manufacturers are conducting research on ways to reduce the amount of mercury in each lamp without sacrificing longevity, but eliminating it altogether seems not to be feasible. The goal is to achieve the most energy-efficient lighting with the least amount of mercury.

■ Lighting manufacturers are working with the EPA to establish federal standards for mercury content in fluorescent and HID lamps. The OWM supports these efforts. However, the OWM believes that the state should act if federal standards are not developed in a timely manner. The Legislature should enact legislation that directs the OWM to recommend mercury limits for fluorescent and HID lamps to the 1995 Legislature if federal standards have not been established by December 31, 1994.

■ Electrical manufacturers are working with the EPA to establish federal labeling requirements for fluorescent and HID lamps. The OWM supports these efforts. However, the OWM believes that the state should act if federal standards are not developed in a timely manner. The Legislature should enact legislation which directs the OWM to recommend to the 1995 Legislature labeling requirements for mercury-containing lamps sold in Minnesota if no federal requirements have been established by December 31, 1994.

The required labels would identify the type of lamp and provide information about the benefits of using energy-efficient lighting and the proper management of spent fluorescent and HID lamps.

Separate collection and management

■ Currently, lamps that test as hazardous must be managed under the MPCA's lamp management policy or the hazardous waste regulations discussed within the body of this report. Consequently, these lamps may not be managed with mixed municipal solid waste. However, the potential exists for some lamps to test as nonhazardous and still end up in the solid waste stream. More lamps may, in the future, test as nonhazardous as a result of manufacturer toxicity reduction efforts.

Since mercury can bioaccumulate in aquatic ecosystems and even minute concentrations can cause significant damage to the environment, the OWM believes that even lamps that test as nonhazardous should be separately collected and managed. Consequently, the OWM recommends that the Legislature immediately prohibit all lamp generators from placing a fluorescent or HID lamps in mixed municipal solid waste, in or on the land, or in a solid waste processing or disposal facility.

The OWM feels that the private sector is developing an adequate infrastructure to ensure that lamps from businesses can be managed. However, the OWM also believes that adequate collection systems and storage outlets do not exist for the collection of household lamps. This infrastructure needs more time to develop.

To facilitate concerns from households, the OWM recommends that household lamps be exempt from the prohibition recommended above until July 1, 1995. The two-year exemption will allow for development of a system to manage household lamps in a cost-effective manner.

Recycling

■ Recycling and reclaiming mercury from the lamps should be the preferred management method, because it better accomplishes the purpose of keeping mercury out of the environment and because recycling is preferred over landfilling in Minnesota's established hierarchy of waste management methods. However, hazardous waste landfilling should remain an option for businesses.

■ When fluorescent and HID lamps are processed for recycling, the materials to manage and market are glass, metal, mercury and phosphor powder. Reclaiming the mercury from lamps and using it in other products reduces the overall mercury burden in the environment. All lamp recyclers should be required by legislation to remove all but trace amounts of mercury from any of the other components of fluorescent and HID lamps, so that they can be reused in other products without defeating the purpose of keeping mercury out of the environment.

System finance for business lamps

In many cases where a front-end fee is assigned to a problem material, the goals are to provide revenue to pay for disposal and to discourage use of the problem material if another alternative exists. In this situation, fluorescent and HID lighting is the preferred product. It is thus important that the cost of managing the used lamps not be a deterrent to their use.

The cost savings of using energy-efficient lamps versus incandescent lamps are substantial, even when disposal costs are figured into the business decision equation. Proper lamp management practices discussed in this report, however, requires more money to accomplish than previous management practices, and the OWM has examined who should bear the cost. The three mechanisms explored for business lamps have been:

- Require manufacturers to pay a fee to cover the recycling of lamps sold in Minnesota.

- Require either manufacturers, distributors or retailers to collect a deposit at purchase to cover the recycling of lamps with a partial rebate to generators for delivering the lamps to a recycler. Administrative details for such a deposit system could be handled by public or private means.

- Allow market forces to determine the most cost-effective management method for lamps generated by businesses, as long as lamps are managed according to specified criteria. Generators would be required to arrange for proper

management of the lamps and would pay for the service at the time of disposal.

■ Most participants in this study voiced support of the proposal to allow market forces to determine the most cost-effective management for lamps generated by businesses. The OWM recommends that this option be followed. This system would be similar to present systems that generators already follow for the management of most other hazardous and solid waste materials.

The OWM believes that requiring businesses to manage lamps provides a sufficient incentive to manage them properly, and an infrastructure is already developing in the private sector to collect and manage lamps. The present infrastructure, however, needs to be adjusted to accommodate small businesses so that they can manage their lamps in a cost-effective way. Currently, most lamp transporters and recyclers require a minimum pick-up fee for small quantities of lamps.

Fluorescent and HID lamps generated by households

Lamps generated by households can be appropriately managed by expanding the already established household hazardous waste collection programs throughout the state. However, the infrastructure that would support such a program is not fully in place at this time. Household hazardous waste facilities need more storage space and more funding to manage fluorescent and HID lamps. No system exists yet that would assist counties to store large enough quantities of fluorescent and HID lamps to allow cost-effective transport to a recycler.

Funding is needed in order to expand Minnesota's household hazardous waste programs to include management of used fluorescent and HID lamps. The OWM recommends that the Legislature consider the following options to help finance this expansion:

■ Provide funding for management of household quantities of fluorescent and HID lamps through a fee placed on lamp distributors. The fee would be assessed on the total number of lamps sold in Minnesota at the retail level. At present this number is 12 percent of the lamps sold in Minnesota. This fee could be integrated into any broader problem materials fee that is established.

The advantage of this mechanism is that it would raise funds for management of lamps. The disadvantages are that passing the fee on to the consumer would create a disincentive for purchasing energy efficient lighting; and many distributors who serve Minnesota businesses are based in other states, making it difficult to collect and administer the fees.

■ Provide funding for management of household quantities of fluorescent and HID lamps through a fee placed on lamp manufacturers. The fee would be assessed on the total number of lamps sold in Minnesota at the retail level. This fee could be integrated into any broader problem materials fee that is established.

Since there are fewer lamp manufacturers than distributors, administering the fee would be simpler than a distributor fee, and it may encourage lamp manufacturers to develop alternative lighting systems based on lower levels of mercury. This mechanism, however, would still

potentially create a disincentive for purchasing energy-efficient lighting if the lamp manufacturers passed the fee on to fluorescent and HID lamp purchasers.

If the manufacturers spread the cost over all lamps, businesses would be paying twice -- once when they paid more for their lamps and again when paying for the management of the spent lamps. It also would have many of the other disadvantages the distributor fee would have.

■ Provide funding for management of household quantities of fluorescent and HID lamps by placing a flat fee on all residential electric utility customers. This mechanism would provide funds for managing energy-efficient lamps by charging energy users, thereby assessing a fee on the mercury released to the atmosphere at electric power plants. A disadvantage of this mechanism is that Minnesota has more than 100 electric utilities, many of them cooperatives, which are not regulated by the Public Utilities Commission. A fee assessed on those utilities would most likely be difficult to administer.

■ Provide funding for management of household quantities of fluorescent and HID lamps by charging all residential electric utility customers a fee based on the amount of electricity consumed, such as a kilowatt-hour surcharge. This option could include an exemption from the fee for very small electrical users similar to the conservation rate break that some state utilities offer.

This mechanism creates an incentive to use less energy, which will reduce mercury in the environment. It will consequently provide people an incentive to use energy-efficient lighting. The disadvantages are the same as those for a flat utility fee.

Chapter 1: Introduction

The purpose of this report on fluorescent and high-intensity discharge (HID) lamp management options is to explore and recommend to the Legislative Commission on Waste Management a system for managing used fluorescent and HID lamps in such a manner that the toxic materials contained in lamps are not placed in the solid waste stream. This type of management of used lamps requires care at the source of generation, at interim storage sites and at processing or disposal sites.

Scope of the study

The legislative mandate for this study is:

> "The office of waste management, in consultation with the pollution control agency and manufacturers of fluorescent or high intensity discharge lamps that contain mercury, shall study and report to the legislative commission on waste management by January 1, 1993, with recommendations for fully implementing, by January 1, 1996, a system for ensuring that the toxic materials contained in lamps that are replaced are reused, recycled, or otherwise managed to ensure they are not placed in the solid waste stream or a wastewater disposal system, as defined in Minnesota Statutes, section 115.01, subdivision 8. The director of the office of waste management shall submit a preliminary report to the commission by October 1, 1992."

Research process

The Minnesota Office of Waste Management (OWM) has involved affected and interested parties in this study. In addition to the Minnesota Pollution Control Agency (MPCA) and lamp manufacturers specified in the legislative directive, the OWM has consulted with representatives of the Minnesota Technical Assistance Program, Minnesota Department of Public Service, Minnesota Department of Administration, Minnesota Department of Transportation, the Hennepin County Department of Environmental Management and the Ramsey County Department of Public Health. Representatives of these agencies participated in a fluorescent and HID lamp study group that met regularly to discuss issues and contribute information and ideas to this report.

The study group began meeting during the 1992 Minnesota legislative session to prepare public information materials about fluorescent and HID lighting. The group continued to meet to develop focus questions and gather information and opinions from interested parties. The group then met in May to develop a work plan and focus questions to be addressed by the study. Those focus questions were sent to a wide range of potentially interested parties, inviting their participation.

The National Electrical Manufacturers Association (NEMA) has been a very active participant in the gathering of information, as has been the General

Electric Company. National and local representatives have participated in the study group meetings and meetings with affected parties, referred to in this report as stakeholder meetings. They have provided information and technical data.

Regular meetings of the study group were conducted throughout the summer and fall with representation from both the MPCA and NEMA. During August two stakeholder meetings were conducted: one on the topic of collection and storage; the other on the topic of recycling used lamps. Participants in these stakeholder meetings included, in addition to the study group, representatives from the Building Owners and Managers Association (BOMA), the National Electrical Contractors Association (NECA), Minnesota Retail Merchants, Northern States Power Company (NSP) and individual lamp distributors, transporters and processors.

A draft report was sent to interested parties, and public meetings for discussion of the draft report were held during November.

Structure of the report

This report details the research process, the findings of the study and recommendations to the Legislature. The section that discusses the findings of the study includes environmental considerations regarding mercury: the toxicity of mercury, the physical behavior of mercury in the environment, the distribution of mercury in the environment and the distribution of used fluorescent and HID lamps in Minnesota.

The report continues with descriptions of traditional fluorescent and HID lamp management practices, the current regulation of mercury-containing lamps and proposed management options. It includes discussion of issues associated with lamp on-site storage, collection, interim storage, transportation, recycling and disposal in hazardous waste landfills. The report concludes its findings with a discussion of considerations related to financing fluorescent and HID lamp management. Following the discussion of management options are recommendations for the options that the OWM considers most effective in managing the mercury contained in used lamps in Minnesota.

Chapter 2: Environmental Considerations Regarding Mercury

Toxicity of mercury

Mercury has become recognized as a health concern over the last 25 years as more information is accumulated about organic forms of mercury, such as methyl mercury and phenyl mercuric acetate. Cases of severe mercury poisoning resulting from ingestion of organic mercury have been reported in Minamata, Japan, and in Iraq. From these tragic incidents, health scientists have learned about the impacts of methyl mercury ingestion in humans and have developed consumption standards.

Concentrations of methyl mercury in fish caught in many of Minnesota's lakes have resulted in the need to advise citizens to reduce their consumption of fish from those lakes.[1] Fish advisories are regularly issued by the Minnesota Department of Natural Resources recommending that citizens restrict their fish intake.

Health effects of mercury exposure

Long-term exposure to either organic or inorganic mercury can permanently damage the brain and kidneys and can cause severe defects in developing fetuses. The form of mercury and the way people are exposed to it determine which of these health effects will be more severe.[2]

For example, organic mercury that is eaten in contaminated fish or grain may cause greater harm to the brain and developing fetuses than to the kidneys; inhaled metallic mercury vapor may cause greater harm to the brain; and inorganic mercury salts that are eaten in contaminated food or drunk in water may cause greater harm to the kidneys. Maternal exposure to organic mercury may lead to brain damage in fetuses; adults exposed to metallic mercury vapor may develop shakiness (tremors), memory loss and kidney disease. Short-term exposure to high levels of inorganic and organic mercury will have similar health effects.

Mercury is eliminated from the body through the kidney and intestines. Damage to the nervous system or to a developing fetus occurs when the amount of mercury entering the body exceeds that which can be cleared. When the amount of mercury in the blood crosses a threshold for toxicity, the resulting damage may be permanent. Symptoms can subside but may recur later in life. Mercury has not been shown to cause cancer in humans.[3]

Physical behavior of mercury in the environment

Mercury holds a unique place in the universe. As noted by Stephen G. Zemba and Laura C. Green,[4] mercury has for centuries connoted elegance and swiftness as the mythological messenger of the gods, the fastest planet in our solar system and a brand of automobiles. The dictionary definition of "mercurial" speaks of the characteristic of being quick and changeable. It is the only metal that is a liquid at room temperature.

Mercury's high vapor pressure compared to other metals and a related property -- the particular spectrum of ultraviolet light that the vapor gives off when excited by electricity -- make mercury an essential component of fluorescent and HID lamps. Electrical discharge excites electrons in the mercury vapor atoms, and when they fall back to their normal places, they emit ultraviolet light. The ultraviolet light strikes the phosphor coating of the lamp, and the phosphor converts the ultraviolet light to visible light.

Mercury that ends up in the solid waste stream exists in three general forms: elemental mercury and amalgams, organic mercury and mercury salts.

Elemental mercury

Elemental mercury, either as a liquid or amalgamated with other metals, is fairly insoluble in water. On the other hand, mercury's vapor pressure is high compared to other metals. Mercury evaporates at room temperature and ambient atmospheric pressure.

Mercury boils at 357 degrees Celsius (675 degrees Fahrenheit). Since waste-to-energy incinerator temperatures are much higher than this, elemental mercury can be easily released as a vapor into the atmosphere. Air pollution control equipment in incinerators can capture anywhere from 10 to 95 percent of the mercury, depending on the type of control equipment. The rest enters the atmosphere as a vapor.

Although research is being done to improve the capture rate of mercury by pollution control equipment on incinerator stacks, the equipment being used now in Minnesota captures from 10 to 50 percent of the mercury emitted, depending on the type of equipment.[5] Electrostatic precipitators capture roughly 10 percent of the mercury, and wet scrubbers and dry scrubbers capture around 50 percent of the mercury emitted.

Organic mercury

Organic mercury occurs when mercury reacts with organic chemicals. Some forms are human-made, and some, such as methyl mercury, are produced from elemental mercury by bacteria in the environment. This has been illustrated in sulfate-reducing bacteria found in sediments in aquatic ecosystems.

Organic mercury is responsible for the biomagnification of mercury in fish. Potential adverse health effects to humans and fish-eating wildlife result from eating fish that have accumulated high levels of mercury in their tissue. Whereas humans can read and respond to fish advisories and avoid eating fish that contain excessive amounts of mercury, fish-eating wildlife must rely on the food that is available to them every day.

Mercury salts

Mercury salts either enter the waste stream in discarded products, such as mercuric oxide batteries, or are present because elemental mercury has reacted chemically with other components of the waste stream. Some mercury salts are very soluble in water and others are not.

Theoretical speculation about mercury's behavior in waste-to-energy facilities suggests it oxidizes (or burns) to form mercury oxides and salts. A 1992 study by A. Greenberg of Rutgers University of the

impact of a municipal waste-to-energy facility on atmospheric levels of mercury[6] indicates that soluble mercury levels in rainwater collected 1/4 mile downstream from a waste-to-energy facility in western New Jersey were up to 30 times the "background levels."

The researchers felt that the observation was consistent with a near-constant mercury output of .05 lbs/stack/hour for two stacks and the fact that most of the emission is believed to be water-soluble. Levels of elemental mercury at four air monitoring sites also showed significant variation, but much less than the rainwater samples.

Distribution of mercury in the environment

A recent study of mercury in Minnesota lakes by Minnesota researchers[7] shows that mercury deposition to lakes has risen to 3.7 times background levels over the last 140 years. The researchers suggest that the increase indicates mercury emissions from industrial sources have resulted in deposition increases of an average two percent per year over the period, with much higher rates of deposition occurring after 1950. Dr. Thomas Clarkson has noted that the increase of mercury in the environment in the industrial era is a problem as important as global warming.[8]

Estimates of global emissions of mercury to the environment through natural causes indicate that nature contributes more mercury to the environment than does human activity. One such claim is that if all the mercury contained in one year's production of fluorescent and HID lamps were directly released into the open environment, it would represent an estimated 0.2 percent of the total global annual releases of mercury from all sources.[9]

A recent report on mercury contamination in the United States by Clean Water Fund and Clean Water Action, however, cites recent studies that estimate that about 60 percent of the total global emissions are from human activity, with only 40 percent from natural sources.[10] This new information indicates that it is necessary to reconsider fluorescent and HID lamps' contributions to the global emissions of mercury.

Sources of mercury from human activity

Sources of mercury in the environment that are due to human activity include thermometers, mercury switches, mercury-containing batteries, and fluorescent and HID lamps. Phenyl mercuric acetate has been used as a fungicide in latex paint and agricultural applications, and mercury electrolytic cells are used in some of the industrial installations producing chlorine gas. Paint and chlorine manufacturers are changing their practices to eliminate mercury from these sources to reduce environmental damage.

Mercury is also found in coal deposits, and when coal is burned to generate electricity, mercury is released as a vapor to the atmosphere. Other fossil fuels also contain varying degrees of mercury.

The Clean Water Fund/Clean Water Action report summarizes current research on the degree of mercury contamination in the U. S. and sources of mercury in the environment.[11] Estimates of mercury

released from anthropogenic sources (those caused by human activities rather than natural sources) placed coal-fired utilities as the leading source of mercury, with latex paint and municipal waste incinerators as the second and third highest sources of emissions. Fluorescent and HID lamp breakage is estimated by the authors to rank as the sixth highest source of mercury from human activities.[12]

A recent study commissioned by the U.S. Environmental Protection Agency (EPA)[13] has identified used electric lighting equipment as the second largest source of mercury in the municipal solid waste (MSW) stream, after batteries. According to the study, 1989 statistics show that household dry cell batteries contribute the most mercury to the MSW stream (88 percent of total discards of mercury), followed by fluorescent lighting (five percent), thermometers (two percent), thermostats (two percent), pigments (two percent) and other products.

The other sources of mercury aside from fluorescent and HID lamps -- such as mercury batteries, switches, thermometers and thermostats -- have already been addressed in Minnesota by legislation to remove them from the solid waste stream (Minn. Stat. §§ 115A.9325 and 116.92). After all the reductions of mercury from those sources have taken effect, the percentage of mercury in the solid waste stream resulting from fluorescent and HID lamps is expected to increase to 25.5 percent of total discards of mercury in the solid waste stream by the year 2000.[14]

The Clean Water Fund/Clean Water Action report offers suggestions for several actions that should be taken at the federal level to reduce the quantity of mercury that reaches the atmosphere each year. The measures they recommend include changing the emission standards for coal-fired power plants, changing industrial production of chlorine to eliminate the use of mercury cells, reducing the amount of mercury used in products and managing the mercury that is needed in products through separate collection and management programs. The focus of this report is on the separate collection and management programs for fluorescent and HID lamps.

Mercury in lamps

Each 4-foot x 1½-inch diameter fluorescent lamp has an average of 42 mg of mercury. HID lamps include mercury vapor, metal halide and high-pressure sodium lamps. Mercury vapor and metal halide lamps contain a quartz arc tube, containing an amount of mercury which varies from 20 mg in a 75-watt lamp up to 250 mg in a 1,000-watt lamp. In high-pressure sodium lamps the ceramic tube contains a small amount of sodium/mercury amalgam, ranging from 8.3 mg of mercury in a 50-watt lamp up to 25 mg in a 1,000-watt lamp.[15]

These amounts are small compared with 2,800 mg of mercury for a thermostat and anywhere from 3,500 mg for a small mercury switch to several pounds of mercury for larger switches. However, there are significantly more fluorescent and HID lamps discarded each year.

Mercury emissions from power generation

One of the ironies of lighting technology is that because fluorescent and HID lamps

are so much more efficient than incandescent lights, they greatly reduce the amount of electricity needed, and, consequently, coal-burning power plants release less mercury to the atmosphere. However it should be noted that electric lighting comprises only a portion of Minnesota's electric energy demand. According to the U.S. EPA Green Lights Program, about 25 percent of the total national energy consumption goes to electric lighting. Even if the mercury in the lamps is not captured, the Rocky Mountain Institute estimates, coal-fired power plants emit six to 10 times less mercury to the atmosphere to provide electricity for fluorescent and HID lighting, compared to that for incandescent lighting.[16] If a business changes from standard fluorescent lamps to more energy-efficient fluorescent lamps, such as a "T-8 system," which has thinner, more energy-efficient lamps, even less mercury is released to the atmosphere from coal-fired power plants.

The actual mercury content of coal is highly variable, ranging in subbituminous coal from 0.01 to 8.0 parts per million.[17] Coal burned in Minnesota at NSP plants has an approximate concentration of 0.015 parts per million, and, consequently, a comparison between the effects of incandescent and fluorescent lighting on mercury in the atmosphere in Minnesota would be different from the Rocky Mountain Institute estimates.[18]

Robert Clear of Lawrence Laboratory in Berkeley, California, is conducting a study to make his own computations of mercury emissions from power generation in the U.S., using weighted averages of fuels used. Clear's work puts the mercury emissions from power plants powering incandescents at three to four times the amount of those powering fluorescents, depending on the specific lamp and ballast types selected for comparison.[19]

A study sponsored by the Ministry of Housing, Physical Planning and the Environment of the Dutch government[20] indicates that mercury releases from the use of incandescent lighting are 4.3 times as great as those associated with use of fluorescents.

Distribution of used lamps in Minnesota

The distribution of used lamps in Minnesota has been estimated by the MPCA, the National Electrical Manufacturers Association (NEMA), NSP and the Building Owners and Managers Association (BOMA). NEMA's and MPCA's estimates represent a measure of all the lamps used annually in Minnesota. The other estimates relate only to the portion of lamps that are used by NSP customers or BOMA-member office buildings.

NEMA's and MPCA's estimates are derived from the total number of lamps sold in the U.S. per year (about 600 million lamps) and the proportion of Minnesotans (4.4 million) to the U.S. population (250 million). This estimate is 10,600,000 lamps, or a bit more than two lamps per person. The OWM agrees with these estimates.

Examples of lamp generation from specific sectors come from NSP, the Minnesota Department of Administration, BOMA and the Minneapolis Public Schools. BOMA representatives estimate a total of 2,064,000 lamps needing replacement each year by the private sector office space

users in Minnesota.[21] NSP staff estimates that buildings existing in 1989 in the NSP service area use 57,000 HID lamps per year, 2.5 million 4-ft. fluorescents per year and 800,000 8-ft. fluorescents per year.

The Department of Administration estimates that 431,800 fluorescent and 3,550 HID lamps are used each year in state of Minnesota buildings. The Minneapolis Public Schools replace 25,000 lamps per year.

Fluorescent lamps account for approximately 96 percent and HID lamps for approximately four percent of total mercury-containing lamps shipped in the U.S. annually. The commercial and industrial sector buys 80 percent of the lamps. Hardware/home center distributors receive 12 percent, serving both the consumer and commercial/industrial sectors, and other consumer channels receive the remaining eight percent of the lamps sold.

Chapter 3: Current Fluorescent and HID Lamp Management

Traditional fluorescent and HID lamp management practices

Fluorescent and HID lamps from businesses, street lighting, tanning booths, etc., have in the past been discarded along with other municipal solid waste (MSW) and have been transported in packer trucks to a resource recovery or land disposal facility. In many cases this is still happening.

When lamps are discarded this way, a small amount of the mercury contained in the lamps evaporates when lamps are broken on the way to the facility, and the remainder is mixed in with the other waste in the truck. The fate of the mercury from then on depends on the type of facility to which the waste is delivered. Possible scenarios are described below.

Landfills

If the facility is a landfill, further breakage occurs as the waste is being discarded in the landfill cell and compacted with a bulldozer. No measure of the amount of mercury entering the air during transport of waste has yet been attempted. The mercury that stays in the waste either stays where it is, is attenuated by soils, makes its way to ground water or leachate collection systems or makes its way to the atmosphere.

MPCA calculations based on the estimated number of lamps generated annually in Minnesota show that approximately 200 kg, or roughly 440 pounds, of mercury makes its way to the air per year from used lamps in Minnesota, assuming that half of the mercury in lamps is emitted as a vapor to the atmosphere.

The assumption that half the mercury in lamps is vaporized
deserves further scrutiny. One measure of the tightness with which phosphor powder binds elemental mercury in lamps is the vapor equilibrium, or amount of mercury vapor in a closed container of mercury-containing phosphor powder. The vapor equilibrium for a freshly crushed lamp at room temperature is above the threshold limit value of 0.05 mg per cubic meter, the concentration established by the National Institute for Occupational Safety and Health.[22]

The vapor pressure of mercury doubles as the ambient temperature goes up by 10 degrees Celsius. What this means is that in the winter, very little mercury might be leaving the phosphor powder, whereas on a 95-degree summer day, the amount would quadruple. Temperatures at landfills and compost facilities are elevated by bacterial action, and the vapor pressure of mercury increases with the increased temperature, causing more mercury to evaporate than if the temperature remained low.

The fate of the mercury that ends up in leachate depends on the type of leachate treatment facility to which the leachate is delivered. At Western Lake Superior Sanitary District's wastewater treatment facility, 65 percent of the mercury that enters the facility ends up in the sludge.[23]

The sludge at that facility is burned, so some of the mercury is captured in a wet scrubber. The scrubber water is then treated again. At each step, opportunity exists for mercury to enter the atmosphere.

Mercury vapor has been measured over land disposal sites in southern Sweden.[24] Average concentrations in air above landfills or in the wind blowing off them were measured, using long path absorption techniques. Concentrations were found to be in the range of 10 to 25 nanograms (ng) (10^{-9} gram) per cubic meter. Measurements of the mercury content in methane extracted from a covered landfill for energy recovery gave values of three micrograms (10^{-6} grams) per cubic meter.

Two other studies also document mercury emissions from landfills. Methane gas collected from a landfill in Florida for the purpose of energy recovery showed mercury levels in the water condensate.[25,26] These data suggest that mercury does evaporate from landfills.

Information presented in a report prepared for Waste Management of North America, Inc.,[27] included landfill leachate test results that showed widely varying concentrations of mercury in the leachate[28]. According to EPA reports, measurements of mercury content in leachate from sanitary landfills[29] and from hazardous waste landfills also show broad ranges of concentration.[30]

The toxicity characteristic concentration limit for mercury is under discussion at EPA. Some believe that the concentration of 0.2 mg per liter as a toxicity characteristic is too low because it does not accurately reflect the behavior (fate and transport) of mercury in a landfill or in ground water. They believe the connection between mercury sources and atmospheric loads of mercury is at this time unsubstantiated.

The MPCA and OWM believe, however, that the most important aspect of mercury's effect on the environment is due to bioaccumulation of mercury in aquatic ecosystems, and even minute concentrations are significant. Elemental mercury does not leach well, but it does evaporate, and small amounts of mercury can have significant effects. The leachate concentrations listed above seem very low until one realizes that the average leachate concentration of 0.002 mg per liter is 2,000 ng per liter, about 300 times higher than Minnesota's surface water standard of 7 ng per liter. Highly contaminated fish are found in lakes with mercury concentrations of only 2 ng per liter.[31]

Mass-burn incinerators

If the waste is burned in an incinerator, mercury in the waste vaporizes and enters the atmosphere or is captured in the pollution control equipment.

The mercury that is captured by the emission control equipment is held in the fly ash and managed along with it. Ash deposited in a dedicated ash cell in a landfill has the benefit of being kept away from the bacterial action that takes place in MSW landfills, and so the temperature is less likely to be elevated.

Refuse-derived fuel facilities

Waste delivered to a refuse-derived fuel (RDF) facility gets shredded and travels along a moving grate, where heavier

particles drop out and lighter, combustible materials are fluffed and separated for burning.

The components of fluorescent and HID lamps in such a facility are distributed between the fluff, which is lighter, and the heavier residuals that fall through the grate. Lighter components are burned, and in this case the mercury follows the same path as with mass-burn incinerators. Heavier components are either composted or landfilled. Each step provides opportunities for mercury to be released to the atmosphere.

MSW compost facilities

Whatever mercury is in the waste either evaporates or ends up in the finished product. Since temperature elevations occur during the composting process, and since the windrows are frequently aerated, the tendency for mercury to evaporate from the waste is enhanced. Details from a paper presented at the August American Chemical Society meeting[32] discuss metals remaining in compost after processing.

Current regulations concerning mercury wastes

The current regulations governing management of mercury wastes are derived from the Minnesota hazardous waste rules, Minn. Rules Chapter 7045. The Minnesota hazardous waste rules are required by EPA to be at least as stringent as the federal hazardous waste rules associated with the Resource Conservation and Recovery Act (RCRA).[33] Minnesota rules may be more restrictive than RCRA.

Definition of hazardous waste

Minnesota is a RCRA-authorized state under federal hazardous waste regulations and therefore has authority to operate its own hazardous waste management program. Hazardous waste is defined under current federal and state law.[34] A waste is hazardous if it exhibits characteristics of a hazardous waste[35] or if it is specifically listed as a hazardous waste.[36] A characteristic hazardous waste is defined by Minnesota Rules as any waste which exhibits the characteristics of ignitability, corrosivity, oxidativity, reactivity, lethality, and/or toxicity. Toxicity is measured by Method 1311 Toxicity Characteristic Leachate Procedure (TCLP).[37].

Waste that fails the TCLP test

Federal law requires that small and large-size generators whose waste fails the TCLP test manage their waste according to the hazardous waste generator regulations codified in 40 CFR 262. This section includes Subpart A - General Requirements[38], Subpart B - The Manifest[39], Subpart C - Pre-Transport Requirements including packaging, labeling, marking, placarding and accumulation time[40], and Subpart D - Recordkeeping and Reporting.[41]

Operators of treatment, storage and disposal facilities

Federal regulations set forth standards for owners and operators of hazardous waste treatment, storage and disposal facilities.[42] Any treatment, storage or disposal (TSD) facility receiving hazardous waste is required to have a permit under federal law.[43]

Owners or operators of facilities that store recyclable materials before they are recycled are also regulated under 40 CFR.[44]

Worker safety

There are several federal Occupational Safety and Health Administration (OSHA) regulations pertaining to worker protection.[45] Three primary rules affecting hazardous materials management include Hazardous Waste Operations,[46] Toxic and Hazardous Substances,[47] and Hazard Communication.[48]

Transport

Federal regulations dealing with transportation of hazardous waste[49] incorporate the federal Department of Transportation (DOT) regulations.[50] Minnesota has also incorporated the federal DOT regulations.[51] In cases where the MPCA requires that hazardous waste be accompanied by a manifest[52] or by DOT shipping papers,[53] the transporter is required to be licensed as a hazardous waste transporter under Minnesota law.[54]

Federal law[55] prohibits a transporter from accepting hazardous waste from a generator unless it is accompanied by a manifest signed in accordance with the provisions of 40 CFR 262.20. It includes manifest requirements for the generator[56] and the transporter[57] on the subject of intrastate transportation of spent lamps requiring shipping papers.

Under state law[58] and federal law,[59] the generator is required to comply with certain recordkeeping requirements. Specifically, the generator and the transporter must retain a copy of the manifest for a minimum of three years.

Fluorescent lamps that test hazardous

Federal hazardous waste rules require fluorescent lamps that test as hazardous to be managed according to 40 CFR 261 - 268. These regulations allow for exclusions for very small quantity generators (VSQGs) and households. Generators are identified as VSQGs if they generate less than 100 kilograms (220 pounds) of hazardous waste per month.[60] However, Minnesota does not allow this exemption and regulates all non-household generators of hazardous waste.[61]

Testing lamps with the TCLP test

Some spent lamps are hazardous because of the presence of mercury. Since fluorescent and HID lamps are not specifically listed as a hazardous waste, the generator is required to determine whether the waste exhibits hazardous characteristics for toxicity using the TCLP test. If a representative sample of the spent lamps passes the TCLP test, then generators may legally manage their waste as nonhazardous waste under both state and federal law.

The TCLP test on fluorescent and HID lamps involves breaking lamps under controlled conditions and tumbling them with an acetic acid solution and testing the leachate using atomic absorption analysis. Whenever the concentration of mercury in the solution extracted from spent lamps is equal to or exceeds 0.2 mg per liter, the lamps are identified as hazardous waste.[62]

TCLP test results have been shown to vary significantly from laboratory to laboratory, and this has caused much confusion within the regulated community. Problems inherent in using the TCLP testing procedures probably have more to do with the opportunity for mercury to be lost in the handling than with anything wrong with the test itself.[63] In an attempt to reduce variability, EPA has had a laboratory develop additional steps to be used when doing a TCLP test for fluorescent and HID lamps. A copy of the laboratory report is included in Appendix A.

Regulations could change

Currently, several management options for spent fluorescent and HID lamps are legally available under state and federal law, including disposal as a hazardous waste, disposal as a solid waste if TCLP tests indicate they are nonhazardous, or recycling.

EPA currently permits the disposal of fluorescent lamps in hazardous waste landfills, as long as they pass the previously used Extraction Procedure Toxicity (EP Toxicity) Test, although those regulations may change when EPA promulgates a package of regulations for certain newly listed wastes and contaminated soil. Newly listed wastes are those that pass the EP Toxicity Test but fail the TCLP test.

EPA regulation revisions are expected for these so-called "newly identified" wastes, those that fell under regulation when the TCLP test replaced the EP Toxicity Test, and this could have an effect on mercury disposal options. Notice of proposed rulemaking relating to these regulations will be published soon, and the final rule is due to be issued in mid-1993.

The current best demonstrated available technologies for those mercury wastes that must be treated before disposal in a hazardous waste landfill include retorting the waste to reclaim the mercury or stabilizing the mercury as an insoluble salt, such as mercury sulfide.[64] These measures are similar to technology used in fluorescent and HID lamp recycling facilities.

Minnesota hazardous waste rules require those wastes testing positive with a TCLP test to be managed as a hazardous waste[65]. All businesses that generate hazardous waste, regardless of the amount of hazardous waste they generate, must have hazardous waste management plans approved by the county if in the Twin Cities metro area or by the MPCA if outside the metro area,[66] and all hazardous waste must be managed according to Minnesota hazardous waste rules.

These rules specify how wastes must be managed. They are the same as the EPA regulations except in the regulation of VSQGs. Minnesota does not allow VSQGs to manage their waste as nonhazardous. Appendix B of this report includes four fact sheets distributed by the MPCA entitled "Requirements of Hazardous Waste Generators," "Marking and Labeling of Hazardous Waste," "Storage of Hazardous Waste" and "Manifesting Minnesota Hazardous Wastes."

Permitting

Under its RCRA authority, the MPCA administers the facility permitting

requirements. These include general permit requirements[67] and additional requirements for TSD facilities.[68] No hazardous waste facility permits are required by the MPCA or EPA for lamp recycling facilities in Minnesota at this time. These facilities are currently regulated as permit-by-rule facilities[69] and the facility operators must notify the MPCA of their location and must follow the MPCA rules for recycling facilities.[70] Those operating a facility located in a metro area county must obtain a facility processing license from the county.[71]

Permit-by-rule recycling facilities must process materials immediately. The term "immediately" as it pertains to recycling facilities is interpreted by each state, since it is not defined by EPA. The MPCA defines "immediately" as within 24 hours. If a recycling facility exceeded the 24-hour time period due to equipment failure, downtime for maintenance, weather-related delays, etc., it would not be able to accept any more shipments of lamps and could be in violation of its permit.

Minnesota's standards for management of fluorescent and HID lamps

In an effort to encourage proper management of fluorescent and HID lamps, Minnesota has developed standards and procedures specific to fluorescent and HID lamp management. Those procedures are described in the fact sheet and MPCA procedure summary included in Appendix C of this report.

Minnesota's guidelines for fluorescent and HID lamp management do not require a manifest for lamps transported within the state (see fact sheet in Appendix C of this report). Although the MPCA is adjusting the regulations with regard to hazardous waste record-keeping, storage and transportation, the purpose is to promote sound management of lamps. The MPCA is taking active measures to prevent environmental contamination.

The fact sheet describes options available to businesses with respect to on-site storage, off-site storage and recycling in Minnesota, and out-of-state storage, recycling or disposal as a hazardous waste.

Containers

Containers for lamps must be compatible containers that prevent the lamps from breaking. They must be sturdy and made of, or lined with, materials which will not react with the waste stored in them. Boxes that new lamps came in fit the purpose.

Broken lamps must be placed in sealed, lined, leak-proof containers (not cardboard).[72] Cardboard containers used to transport broken lamps must have liners. Requirements for container labeling and shipping[73] are described in the fact sheet in Appendix C.

Storage

Storage of lamps can occur at the generator's site or at a commercial storage facility. The MPCA is requiring commercial storage facilities to sign a contract agreement (see Appendix D). The contract includes assurance that the lamps will be stored properly and delivered to a recycler within a specified time frame. Storage facilities in the Twin Cities metro area may be subject to additional requirements by their respective counties.

Chapter 4: Proposed Management Options for Fluorescent and HID Lamps

Toxicity reduction

Source reduction of mercury in the manufacture of fluorescent and HID lamps is the first and best approach to managing mercury in lamp waste. Lighting manufacturers are conducting research on ways to reduce the amount of mercury in each lamp, but eliminating it altogether seems not to be feasible. Currently manufactured 4-foot x 1½-inch lamps contain an average of 42 mg of mercury, and lamp manufacturers estimate that source reduction of mercury in those specific lamps to an average of 27 mg per lamp is feasible without compromising lamp efficacy and life span.[74]

Recommendation

Source reduction of mercury in the manufacture of fluorescent and HID lamps is the first and best approach to managing mercury in lamp waste. Lighting manufacturers are conducting research on ways to reduce the amount of mercury in each lamp without sacrificing longevity, but eliminating it altogether seems not to be feasible. The goal is to achieve the most energy-efficient lighting with the least amount of mercury.

■ Lighting manufacturers are working with the EPA to establish federal standards for mercury content in fluorescent and HID lamps. The OWM supports these efforts. However, the OWM believes that the state should act if federal standards are not developed in a timely manner. The Legislature should enact legislation that directs the OWM to recommend mercury limits for fluorescent and HID lamps to the 1995 Legislature if federal standards have not been established by December 31, 1994.

■ Electric manufacturers are working with the EPA to establish federal labeling requirements for fluorescent and HID lamps. The OWM supports these efforts. However, the OWM believes that the state should act if federal standards are not developed in a timely manner. The Legislature should enact legislation which directs the OWM to recommend labeling requirements for mercury-containing lamps sold in Minnesota if no federal requirements have been established by December 31, 1994. The required labels would identify the type of lamp and would provide information about the benefits of using energy efficient lighting and the proper management of spent fluorescent and HID lamps.

Separate collection and management

Mercury-containing lamps should not be incinerated. NEMA has advocated to the EPA that fluorescent and HID lamps be banned from incinerators.[75] Municipal solid waste composting is not viable, either, since such processes do not remove mercury. Elemental mercury does not leach well, but it does evaporate, and small amounts of mercury can have significant effects, since mercury accumulates in the environment over time

and magnifies in the food chain in aquatic ecosystems.

Currently, lamps that test as hazardous must be managed under the hazardous waste regulations discussed in this report. Consequently, these lamps may not be managed with mixed municipal solid waste. However, the potential exists for some lamps to test as nonhazardous and still end up in the solid waste stream. More lamps may, in the future, test as nonhazardous as a result of manufacturer toxicity reduction efforts.

Recommendations

■ The OWM considers the damage to the environment to be significant enough that even lamps which test as nonhazardous should be separately collected and managed. Consequently, the OWM recommends that the Legislature immediately prohibit all lamp generators from placing a fluorescent or HID lamp in mixed municipal solid waste, in or on the land, or in a solid waste processing or disposal facility.

The OWM feels that the private sector is developing an adequate infrastructure to ensure that lamps from businesses can be managed. However, more development is needed to facilitate the management of lamps from small businesses. Currently, most lamp transporters and recyclers require a minimum pickup fee for small quantities of lamps. Small businesses need a system for accumulating enough lamps to allow cost-effective transport to a recycler. Consolidation points, such as those envisioned under the MPCA's program for VSQGs, would help small businesses manage their spent lamps in a cost-effective manner. They would be allowed to deliver the lamps to a consolidation point, where they could pay a delivery fee but not the extra pickup fee required under current practices of transporters and recyclers.

■ The OWM also believes that collection systems and storage outlets do not exist for the collection of household lamps. This infrastructure needs more time to develop. Household hazardous waste management programs need both storage space for lamps and funding for transport and delivery to a recycler.

To facilitate concerns from households, the OWM recommends that household lamps be exempt from the ban described above until July 1, 1995. The two-year exemption will allow for development of a system to manage household lamps in a cost-effective manner.

Some household hazardous waste collection sites are beginning to accept used fluorescent and HID lamps from residents, and some electric utility companies are considering collecting and storing used lamps for their customers. Recommendations for management of household quantities are further discussed on page 41 of this report.

Commercial/Industrial lamp management

The primary focus of this study is on the commercial sector, since by far the largest numbers of used fluorescent and HID lamps are generated in offices and commercial establishments. The following proposals are for management of fluorescent and HID lamps generated by the commercial/industrial and institutional sectors in Minnesota.

The proper management of used fluorescent and HID lamps rests initially on the generator of the lamps. As pointed out by researchers in Sweden,[76] trying to separate lamps from mixed waste is counterintuitive. They should be source-separated and handled carefully to minimize breakage. Steps for proper management have been described in the fact sheet in Appendix C.

Lamp on-site storage

A number of vendors of recycling containers have shown an interest in custom-designed storage containers for used lamps. These vendors have designed containers that are made of plastic and have inserts for protecting the used lamps. Instructions and logos, etc., can be silk-screened on the boxes, and they are durable and waterproof.[77]

The boxes lamps came in can also be used for storing used lamps as they are replaced. Representatives of building owners and managers urge that the same care be given to used lamps that is currently given to new lamps, with no more and no less concern shown the used product than the new one.

The primary barrier to on-site storage is space in buildings. The larger business, retail and institutional sites need large areas for storage that in many cases they do not have. In cases where storage space is available, it is often dedicated to other needs, such as inventory.

Costs of on-site storage are directly related to space in buildings, and if leasing additional space is required, additional costs are involved.

Participants in stakeholder meetings and members of the lamp study group stressed the importance of making the fluorescent and HID lamp management requirements conducive to proper management. Although some cost and effort will be required to manage lamps, too much unnecessary cost or bother will prove to reduce the effectiveness of any program designed to keep mercury out of the waste stream.

The following points with regard to storage of used fluorescent and HID lamps have been identified:

- Businesses need to be able to store a sufficient number of lamps on-site to make collection cost effective, and they need to keep the boxes that new lamps came in for storage.

- Procedures outlined in the fluorescent lamp management fact sheet and MPCA procedure summary should be followed in storing lamps on-site in order to protect them from breakage.

- Used lamps should not be crushed or broken on-site for safety reasons.

- Broken lamps should be managed in such a manner that the mercury from the lamps is contained as much as possible. Procedures are outlined in the fact sheet.

- Care should be take when storing lamps to prevent implosions of the fluorescent lamps and to protect workers from breakage in the event of an implosion of large numbers of lamps. Undue pressure on the lamps, either from too tightly packing them or from stacking them too high, can cause implosions. Any shrink

wrap should cover the entire lamp to contain broken glass.

Lamp collection, storage and transport

An infrastructure for collecting, storing and transporting used fluorescent and HID lamps is now developing in Minnesota. Transporters for business generators of lamps include lighting distributors, people already engaged in collecting other recyclables, and hazardous waste transporters. Some of the transporters deliver lamps to a recycler without storing them, and others store lamps at sites that have been licensed by metro county waste management staffs or by the MPCA.

Opportunities for effective programs are promising. To be most effective, programs need to have relatively inexpensive and abundant transportation available. The more painless the collection system can be made for the generator, in dollars and in operation, the more likely the generator is to use it.

The costs of collection include capital and operating costs of vehicles, labor and other related expenses. The costs of transportation vary, depending on distances lamps are being transported. Because present recyclers are located near the Twin Cities, lamp management in Greater Minnesota will cost more because of transportation costs.

Third-party storage opportunities are currently being developed by the private sector. Storage at third-party sites needs to be readily available to businesses throughout the state.

Participants in stakeholder meetings stressed that state regulators should specify how lamps should be handled but should not otherwise restrict service providers. Market forces, they maintain, will provide the most efficient management.

Issues to consider regarding an infrastructure for collection, transport and storage include:

- The need to regulate those collecting lamps to ensure that the lamps are handled properly and delivered to appropriate processors. Rules for lamp transporters and interim storage facilities will need to be adequate to protect the environment and the health of workers. At the same time, they cannot be so cumbersome that they provide a disincentive for proper management. Care of used fluorescent and HID lamps should be the same as for collection and transport of new lamps.

- The need to be careful when storing lamps to prevent implosions of the fluorescent lamps and to protect workers from breakage in the event of an implosion of large numbers of lamps.

- Concerns of those who generate used fluorescent and HID lamps that they may incur liability in the future if the waste is not handled properly by transporters or processors. Anyone involved with management of hazardous waste is subject to potential liability in the future if the waste is not handled properly. Such

liability is of concern to the many commercial establishments that have not previously dealt with federal and state hazardous waste laws and regulations. On-site storage may increase the cost of a business's liability insurance.

- Complications that might occur at recycling facilities as a result of the fact that under hazardous waste recycling facility standards, recycling facilities must process any lamps they receive within 24 hours; consequently, lamps must be delivered to the facilities according to a schedule. The one lamp recycling facility that is currently operating in Minnesota has chosen to be classified as a permit-by-rule recycling facility. Operators of the facility must follow the requirements in Minn. Rules 7035.2845 and 7035.2855 but do not have to go through the same permit process that a treatment, storage and disposal facility would have to go through (Minn. Rules 7001).

The following points have been identified as important to the development of the infrastructure for collecting, storing and transporting used fluorescent and HID lamps:

■ The MPCA has set up a system that requires storage facilities and transporters to sign a compliance agreement with the MPCA (see Appendix D). The agreement includes assurance that the lamps will be stored properly and delivered to a recycler within a specified time frame. Storage facilities in the Twin Cities Metropolitan Area may be subject to additional requirements by counties. This is a sound approach that addresses the issues described above and should be encouraged.

■ Lamp distributors should be encouraged to take back used fluorescent and HID lamps when they deliver new lamps. While some distributors view this activity as a business opportunity, others voice concerns about the practical aspects of collecting used lamps in the same trucks that carry new lamps.

■ Lamp manufacturers and distributors should assist in the development of a collection and transportation infrastructure for their customers' used fluorescent and HID lamps and should continue to provide technical assistance and information to customers about management options.

■ Transporters of used fluorescent and HID lamps should be able to transport lamps to a recycling facility without a hazardous waste transporter license.

■ The state and local units of government should continue to provide technical assistance and education to Minnesota's commercial, industrial, institutional and residential sectors through an outreach program. Such a program must be given appropriate funding in order to be effective.

Management of used lamps after collection

For this report the OWM collected general information about the following management methods:

- Disposing of spent mercury-containing lamps in hazardous waste landfills.

- Recycling or reclaiming spent mercury-containing lamps.

Lamp disposal in hazardous waste landfills

Disposing of used fluorescent and HID lamps in hazardous waste landfills is one option currently available to Minnesota businesses. Lamps that test hazardous under the EPA toxicity characteristic leaching procedure test may not be managed in any other type of landfill.

Fluorescent and HID lamps are among a group of newly identified mercury wastes testing hazardous under the TCLP test which are exempt from a requirement to treat mercury wastes before placing them in a hazardous waste landfill. Within a year the status of this requirement with respect to fluorescent and HID lamps should be clarified by the EPA. Households are exempt from such requirements.

The costs of landfilling fluorescent and HID lamps will depend on the type of cell that is needed for containing the mercury from the lamps. Monitoring well installation and testing, liners, leachate collection systems and daily, intermediate and final cover materials are all components of the cost of landfilling. Financial assurance for landfill closure, postclosure care and maintenance, and future contingency action costs are now standard, normal costs of landfilling.

Depending on what requirements EPA places on management of wastes containing mercury when the rules regarding land disposal restrictions become effective, additional costs for treating lamps to reclaim or stabilize the mercury may be required.

The current best demonstrated available technologies for those mercury wastes that must be treated before disposal in a hazardous waste landfill include retorting the waste to reclaim the mercury or stabilizing the mercury as an insoluble salt, such as mercury sulfide.[78] These measures are similar to technology used in fluorescent and HID lamp recycling facilities.

Transporting lamps to a hazardous waste landfill requires licensed hazardous waste transporters and other requirements described under the discussion of regulations (page 21).

Lamp recycling

Opportunities for recovering mercury from fluorescent and HID lamps have been demonstrated in Europe and the U.S. Recycling facilities have been operating in California for several years, and facilities are coming on line in Tennessee, Pennsylvania and Hawaii, as well as Minnesota, where one company has begun operation and another will be operating in early 1993.

Fluorescent lamps consist of glass, metal end pieces and phosphor powder, with mercury distributed to varying degrees among the components and in the vapor in the lamp. HID lamps contain an inner glass arc tube which contains mercury and other metal salts.

The makeup of phosphors contained in fluorescent lamps varies but is usually a calcium chlorofluorophosphate with small amounts (less than two percent of the

phosphor by weight) of antimony and manganese, also present but tightly bound in the phosphor matrix. The percentage of the minor components may change slightly, depending on the color of the lamp.[79]

There are about 1.5 grams of phosphor per foot of fluorescent tube, making around six grams for each 4-foot tube. Mercury injected into the tube during manufacture emits ultraviolet light, which hits the phosphor and is converted to visible light. Over the course of the lifetime of the tube, some of the mercury becomes bound to the phosphor coating, some remains on the glass, and some forms an amalgam with the metal components. At the normal end of the useful life of fluorescent and HID lamps, the mercury is distributed among all the components.

When fluorescent and HID lamps are processed for recycling, the materials to manage and market are glass, metal, mercury and phosphor powder. Glass from recycling operations has been marketed to fiberglass manufacturers and has been used in glasphalt, a combination glass/asphalt roadbed material. Aluminum enters the commodities market, and other metals go to steel manufacture. Markets for phosphor powder are unclear at this time, but any markets for phosphor will depend on the degree of removal of mercury from the phosphor.

Once a material such as mercury has been reclaimed, it can in most cases be considered a product. Once it is declared a product, liability to a generator of lamps would likely be reduced. In a letter to a mercury refinery, the U.S. EPA has stated that mercury which is 99 percent pure becomes a product, not a waste, and after that point it is not subject to hazardous waste regulations.[80] It can be used in a number of manufacturing processes that use mercury of lower grade than fluorescent and HID lamps need, or it can be rerefined to any required specifications of purity for use in electric lighting.

The costs of recovering mercury and recycling the components of fluorescent and HID lamps vary, depending on the buildings, equipment and technology used in the process. NEMA has estimated the cost of collecting, transporting, and recycling used lamps to range from $.51 to $.56 per lamp.[81]

Recovering and refining mercury requires energy. It is difficult to determine just how much electricity the facilities in Minnesota will require, since none have been operating up until now. As an example, the mercury recovered from lamps that are recycled can be compared to the amount of energy that would release an equivalent amount of mercury. At least one lamp recycler claims to recover 99 percent of the mercury from lamps. However, if only 20 mg (or roughly half the mercury) were recovered from each lamp, the mercury in that one lamp would be the equivalent amount of mercury released from a coal-fired power plant when generating power to supply 500 kWh of electricity. This calculation is based on the mercury emissions factor of 0.04 mg per kWh from coal-fired power plants.

This is enough electricity to power a standard 2-lamp fluorescent light fixture for two years.[82] The total mercury reclaimed from all of Minnesota's 10.6 million lamps would amount to enough

electricity to power 10.6 million 2-lamp fixtures for two years.

Preliminary estimates of the energy needed to recover the mercury from lamps using MRT equipment at Recyclights in Minneapolis indicate that recycling Minnesota's 10.6 million used fluorescent and HID lamps will require roughly 200 kwh of electricity, which if produced at coal-fired power plants emitting 0.016 mg of mercury per kilowatt-hour, would put 3,600 mg of mercury into the atmosphere. Compared to the 500,000,000 mg (500 kilograms) present in that many lamps, reclaiming the mercury saves roughly 140,000 times as much mercury as the energy required for reclaiming it.

Mercury can be released to the environment at recycling facilities. Worker exposure to mercury vapor is a concern, and OSHA regulations must be carefully followed. If crushed fluorescent and HID lamps are stored for as long as one to two weeks without separating the components from one another, the mercury will have a chance to amalgamate with the metal end caps and be difficult to separate. Consequently, lamps should be stored whole.[83]

Residuals from the recycling process may be themselves hazardous. If the phosphor or any of the other components of fluorescent and HID lamps test positive with a TCLP test, they must be managed as a hazardous waste. One of the goals of a recycling program for Minnesota is to separate the mercury effectively enough that all by-products are marketable materials.

Testing the residual wastes from a recycling operation in laboratories and managing them accordingly will be necessary, in order to ensure that the residuals are not hazardous or that they are properly managed if they are hazardous. Residuals should be nonhazardous to ensure their reuse.

Products made from materials reclaimed during the recycling of lamps may still contain unsafe levels of mercury. Products of the recycling operation may require other analytical tests to determine their safety and appropriateness in intended reuse applications.

Lamps may contain other trace metals of concern. Lamps of different sizes and shapes may present problems in handling at the recycling facility. Equipment engineering designs must take the differences into account.

Generators of lamps have expressed a need for assurance that recycling facilities in Minnesota are managing fluorescent and HID lamps properly. The MPCA and metro area counties are presently working extensively with fluorescent and HID lamp recyclers. The facility operators must share test data with the MPCA staff.

Recycling facilities must meet Occupational Safety and Health Administration standards for ambient mercury concentrations, as well as other worker health and safety standards. The MPCA is considering developing regulations for hazardous waste recycling facilities that would better monitor and control their operations.

Liability will be a major concern if the generator of fluorescent and HID lamps delivers lamps to a recycling facility that does not manage the mercury properly. A

contract between the lamp generator and the facility that recycles the lamps and/or between the generator and the transporter of lamps with assurances of proper management is a way to minimize the risk, although it doesn't eliminate the risk altogether if a recycler becomes insolvent and leaves behind improperly managed lamps. Recyclers and transporters are entering into this kind of contract with generators, and the OWM recommends that generators require such a contract.

One of the Minnesota recycling facilities is operating on the site of an established superfund clean-up operation. The contamination at the site was from chemical solvents, and clean-up requirements at the site have been addressed. A final Record of Decision on the site was filed in September 1991. None of the solvents being cleaned up are in any way associated with fluorescent and HID lamp management, and mercury is not present at the site. Operation and maintenance of ground water pump-out and monitoring systems continue at the site.

Recycling technologies

Many technologies for separating glass, metal and mercury from the phosphor have been developed, and more technologies are currently being developed. Some technologies "disassemble" the lamps, while others crush them and vacuum the powder from the crushed lamps. Others rely on wet extraction of the powder from the glass and metal after lamps are crushed. All processes must take care to collect mercury vapor from the processes by passing the process air through a carbon filter. Recycling facilities are required to follow OSHA standards for safety and health.

NEMA representatives traveled to eight operating lamp processing facilities in Europe and California in 1991. The facilities they visited were described in a report that NEMA forwarded to the OWM.[84] Table 1 summarizes the technologies described in the report. The table was discussed at a stakeholder meeting and has been revised to include information from that discussion and from other information collected during the course of the study.

Fluorescent and HID lamp recycling facilities in the United States

Minnesota

■ **Recyclights**, located in Minneapolis, began receiving a limited number of fluorescent lamps for processing in July 1992. The company purchased MRT distillation equipment from Sweden before beginning operation and accomplished initial crushing with equipment that processed 5,000 lamps a day.

An MRT crush-and-sieve machine is expected to be installed and operating by the end of 1992. After that equipment is installed, the company will be able to handle all types of fluorescent and HID lamps, as well as other mercury wastes, such as spent mercury-containing batteries and mercury switches.

With MRT equipment, any amount or type of fluorescent or HID lamps is fed into a large crusher that breaks the lamps under a vacuum. The crushed uniform

Table 1 Fluorescent and HID lamp recycling technologies

Recycling Technology	Specifics of Process		Where Used	
	Equipment Used	Process Description	Location	Company
"De-manufacture" lamps	PROLUX	Pre-sorted lamps are fed into the stripping machine, where lamp ends are cut off, phosphor powder is blown out and lamp ends and clean glass are crushed. Powder, ends, and glass are separated and sent to different containers. Process air is sent through adsorption filter for mercury vapor.	Germany	Rundholz & Thur, OSRAM, and others
	MRT	Any amount or type of fluorescent or HID lamps are fed into a large crusher which breaks the lamps under a vacuum. The crushed uniform materials are air-stripped and separated. Pure liquid mercury is further recovered. The equipment has a capacity exceeding 21 million lamps per year. All materials exiting the MRT system can be reused in other products.	Hungary Switzerland Sweden Other sites in Europe	TUNGSRAM SOVAG MRT
	Horizontal, dry, lamp disassembly	End caps pulled off lamp without breaking the vacuum, collected and recycled. Glass ends cut off by thermal shock, collected and disposed as hazardous waste. Phosphor powder removed by suction/blower followed by wiping action via plastic "pig" being forced through tube by compressed air. Powder collected in separate room & mercury separated by a cyclone. Clean tube falls into screw auger which breaks glass and drops it into a dumpster.	California	Lighting Resources
Wet Crushing	Aqua Control mobile-unit design	Large tank with a horizontal lid incorporates a hydraulically operated crushing press. A sodium polysulfide solution is pumped into the tank from adjacent container. Lamps added, 70-80 per load and lid closed and press crushes. Step repeated until 1000 lamps crushed. Solution pumped back into container and crushate vacuumed into a transfer container which is drained of residual solution and dumped into dumpster for shipping to a central plant.	Germany	Aqua Control

Recycling Technology	Specifics of Process		Where Used	
	Equipment Used	Process Description	Location	Company
Dry Crushing	Mercury Technologies design	Lamps are fed into a crushing mechanism which breaks up the lamp to a uniform particle size. Crushate cleaned by a current of air. Phosphor powders are collected and mercury is recovered. End caps and mount assemblies separated and recycled. Crushate collected in container.	California	Mercury Technologies
	MRT		Minnesota	Recyclights
	Kusters	Large, totally enclosed crusher under negative pressure, with air filtration including extensive active carbon filters. Line handles up to 13,000 lamps per hour. Mixed HID line accepts mercury, metal halide and high pressure sodium lamps. Material crushed with no separation of components. Low pressure sodium line crushes the lamps and sprays the crushate with water in an enclosure to oxidize the sodium metal.	Netherlands	LumenEx, Philips
Shredding/washing	Recytec Design	Lamps are crushed dry under a controlled atmosphere and glass and metal end caps are separated by a sieve and directed to intermediate storage containers and later cleaned in dilute fluoroboric acid. Mercury is stripped over active carbon filters.	Switzerland	Recyctec

Information supplied by the National Electrical Manufacturers Association and fluorescent lamp recyclers.

materials are air-stripped and separated. Pure liquid mercury is further recovered. The equipment has a capacity exceeding 21 million lamps per year.

The company's license from Hennepin County is a facility license required under county ordinance. Air monitoring is performed with colorimetric testing and passes safety limits for indoor air. TCLP test results on the powder after distillation have been forwarded to the MPCA and show concentrations of leachable mercury much lower than the toxic characteristic limits.

Glass and metal are being stored for marketing. TCLP tests on those fractions are also below limits and will be even better when the additional equipment arrives.

■ **Mercury Technologies of Minnesota**, located in Pine City, intends to begin processing for recycling in late 1992, using Mercury Technologies equipment and implementing the California plant's operational plans.

The operation uses a dry-crushing techology in which lamps are fed into a crushing mechanism that breaks the lamps up into uniform particle sizes. The crushate is cleaned by a current of air, and phosphor powders are collected and mercury is recovered. The thermal

recovery process equipment is operating in California at present, and test results are favorable.

The end caps and mount assemblies are separated from the glass and marketed. Glass is stored in a roll-off container for marketing.

■ **Resource Recovery, Inc.,** is working on an application for a license from Hennepin County to operate a facility in Edina to process lamps for recycling. The processing is being organized and the equipment patented at this time. The company has not made public specific information about its process.

Facilities in other states
Facilities in California have been processing fluorescent lamps for recycling for several years but not recovering mercury. Mercury Technologies, Hayward, California, operated with a research-and-development permit from the state of California for two years and received approval for commercial applications in April 1991. The process is described under the Mercury Technologies of Minnesota description, above.

Lighting Resources, Pomona, California, uses a disassembly process to separate the components of fluorescent lamps. The end caps are removed without breaking the lamp and separated for recycling. Glass ends are cut off by thermal shock and collected for disposal as hazardous waste.

Phosphor powder is removed by a suction/blower, followed by wiping action with an implement that is forced through the tube by compressed air. The powder is collected in a separate room and mercury is separated by a cyclone. The clean tube falls into a screw auger, which crushes the glass.

Mercury Recovery, Monrovia, California, uses a dry, mechanical crushing process with a negative air vacuum to clean fluorescent lamps. The phosphor powder is captured in 55-gallon drums through the use of a cyclone separator and a bag house. Mercury vapors resulting from the process are captured in beds of activated carbon.

The design and size of the filter system allows the processing of multiple tubes instead of one tube at a time. The crushed glass and end tips are captured in a 55-gallon drum under the crushing equipment. This drum is then further processed to separate the end tips from the glass. Powder is sent to a permitted facility for reclamation of the mercury.

The two companies in the U.S. that accept fluorescent and HID lamp phosphors for further refining are Mercury Refining in Latham, New York, and Bethlehem Apparatus in Hellertown, Pennsylvania.

Technologies under development in other states and in Canada
Other companies in the United States and Canada planning to recycle fluorescent and HID lamps are located in Pennsylvania, Tennessee, Massachusetts, Utah, Arizona, and Hawaii, and in Ontario, Canada. A brief description of those facilities follows:

■ **Iowa** -- Midwest Recycling & Mercury Recovery Services, Inc., Dubuque, is working with Mercury Recovery in California and will use equipment described under the California companies above. Additional mercury reclamation equipment is expected to be operational by May 1993.

■ **Pennsylvania** -- Advanced Environmental Recycling Corp.,

Allentown, plans to use Mercury Technologies equipment and to have a franchise with the California company. This company planned to begin operations by late 1992.

■ **Tennessee** -- Nine West Technologies, Nashville, is developing a wet technology that will separate the mercury from the phosphor as an insoluble sulfide. Glass and metal will be marketable. The company intends to begin operation in November 1992.

■ **Massachusetts** -- Lighting Recycling, Inc., Boston, will begin operation in early 1993, using MRT equipment.

■ **Utah** -- American Lighting, Sandy, is developing its own equipment for processing fluorescent and HID lamps. The equipment is undergoing laboratory testing at the present time.

■ **Arizona, Hawaii and Massachusetts** -- Salesco Systems, located in Phoenix, Arizona, has completed the engineering for a process that recovers mercury and non-ferrous metals from all mercury-containing and incandescent lamps. The company has not yet made a business decision to enter into the market.

The company currently provides transportation and brokerage services to accomplish the ultimate recycling and/or disposal of a variety of spent lamps and bulbs, along with PCB ballast disposal services. The company has facilities in Phoenix, Honolulu and Boston.

■ **Ontario, Canada** -- Tallon Metal Technologies in Guelph, Ontario, has completed feasibility studies on a process for the treatment of used or manufacturing reject fluorescent tubes to produce glass, metal and mercury for recycling. Tallon's process involves the wet crushing and chemically assisted separation of mercury from the glass and metal components of the lamps.

Physical separation steps are used to produce separate dry ground glass and metal products virtually free of mercury and ready for recycling. Mercury is recovered in concentrate form with the phosphor powder or from the mercury polishing system that uses commercial adsorbents. All solutions used in the process are treated by the polishing system to remove dissolved mercury and other metals. Following treatment in the polishing system, the used solutions may be reused in the process or released for direct sewage disposal.

Recommendations

■ Recycling and reclaiming mercury from the lamps should be the preferred management method, because it better accomplishes the purpose of keeping mercury out of the environment and because recycling is preferred over landfilling in Minnesota's established hierarchy of waste management methods. However, hazardous waste landfilling should remain an option for businesses.

■ When fluorescent and HID lamps are processed for recycling, the materials to manage and market are glass, metal, mercury and phosphor powder. Reclaiming the mercury from lamps and using it in other products reduces the overall mercury burden in the environment. All lamps that are recycled should be required by legislation to be separated into marketable components with only trace amounts of mercury contamination in any of the other fractions, so that they can be reused in products without defeating the purpose of keeping mercury out of the environment.

Chapter 5: Financing Considerations

Currently all costs of managing used lamps rest with the generators of the lamps. The money goes directly to the service providers for transporting, storing and recycling the lamps.

Building owners point out that the cost of disposing of used fluorescent and HID lamps is not a cost that they budgeted for when calculating capital investment in lighting changeovers. It is an added cost of doing business in Minnesota.

The cost savings of using energy-efficient lamps versus incandescent lamps are substantial, however, even when disposal costs are figured into the business decision equation. The literature consulted and the participants in the development of this report have stressed the importance of replacing incandescent lighting with energy-efficient lighting.
A representative from the Minnesota Department of Public Service has commented: "Fluorescent lighting is very near and dear to our hearts, and anyone who is thinking of using incandescent lights to avoid the cost and hassle of properly managing fluorescent and HID lamps is making a bad management decision, both fiscally and environmentally."[85]

Roughly 88 percent of the cost of lighting is the cost of the electricity to operate the lights, according to General Electric's business lighting brochure. Replacement lamps make up about four percent of the cost, with labor using the remaining eight percent of the cost of lighting. Purchasing energy-efficient lighting fixtures that reduce electricity costs and last longer saves more money through electricity and labor savings than the disposal costs of the lamps, according to NSP officials.

Some lighting distributors that participated in the stakeholder meetings stated that they have offered businesses who buy lamps from them the service of taking used lamps back when delivering new ones. The distributors certify the used lamps will be delivered to a recycler. The cost of managing the used lamps is figured into the cost of the new lamps.

NEMA has estimated the cost of collecting, transporting, and recycling used lamps to range from $.51 to $.56 per lamp. Economic analysis of the recycling option forwarded by General Electric indicates the cost of recycling all the lamps in the U.S. would amount to $275 to $300 million annually.

Participants in the stakeholder meetings held in August 1992 gave a unified opinion that financing should be left to free market forces. They felt that competition would create the most cost-effective management for used lamps in the commercial industrial sector.

Other possible funding mechanisms include wholesalers' tax, manufacturers' tax and a front-end fee on sale of fluorescent and HID lamps.

In many cases where a front-end fee is assigned to a problem material, the goals are to provide revenue for paying for disposal and to discourage use of the problem material if another alternative exists. In this situation, fluorescent and HID lighting is the preferred product. It is important that the cost of managing the used lamps not be a deterrent to their use.

One option for financing the management system is to hold lighting manufacturers

responsible for the disposal of the fluorescent and HID lamps. However, the manufacturers feel that the disposal of spent lamps is best handled by those parties having experience in the waste management business.

Another option is to require manufacturers to include a cost at purchase to cover the recycling of lamps. Administrative options for getting the money from the manufacturers to the proper elements of the management infrastructure could be either public or private.

Some stakeholders have suggested that the cost at purchase be enough to create a rebate for delivering lamps to a recycling facility. For example, from the extra cost of the lamp, 10 cents could be dedicated to a rebate that would be offered by the recycling facility staff to the customer, whether the customer were a generator or a transporter. The transporter would already have offered the rebate to the generator and would be repaid by the recycler.

Any front-end fee on the sale of fluorescent and HID lamps which would make the differential between them and incandescent lighting even greater might provide a disincentive to using the more energy-efficient lighting. This would be counterproductive. The money would be collected at the retail or wholesale level, and the administrative details of getting the money to the transporters, storers and processors of lamps would be complex.

Recommendations

■ Most participants in this study voiced support of the proposal to allow market forces to determine the most cost effective management for lamps generated by businesses. The OWM recommends that this option be followed. This system would mirror present systems that generators already follow for the management of most other waste materials. The OWM believes that requiring businesses to manage lamps provides a sufficient incentive to manage them properly, and an infrastructure is already developing in the private sector to collect and manage lamps.

Fluorescent and HID lamps generated by households

Fluorescent and HID lamps generated by households present collection and storage problems that are different from those associated with large businesses. The number of fluorescent and HID lamps generated by households is much smaller and, consequently, the importance of managing those lamps is not as great as for the business and commercial generators of lamps.

Lamps generated by households can be appropriately managed by expanding the already established household hazardous waste collection programs throughout the state. However, the infrastructure which would support such a program is not fully in place at this time. No system exists yet that would assist counties to store large enough quantities of fluorescent and HID lamps that they could be cost-effectively transported to a recycler. Current practices require an extra deposit charge for small quantities of lamps.

Funding is needed in order to expand Minnesota's household hazardous waste programs to include management of used fluorescent and HID lamps. These programs need both storage space for lamps and funding for transport and delivery to a recycler. The OWM

recommends that the Legislature consider the following options to help finance this expansion:

■ Provide funding for management of household quantities of fluorescent and HID lamps through a fee placed on lamp distributors. The fee would be assessed on the total number of lamps sold in Minnesota at the retail level. At present this number is 12 percent of the lamps sold in Minnesota. This fee could be integrated into any broader problem materials fee that is established.

The advantage of this mechanism is that it would raise funds for management of lamps. The disadvantages are that passing the fee on to the consumer would create a disincentive for purchasing energy-efficient lighting. Also, many distributors who serve Minnesota businesses are based in other states, making it difficult to collect and administer the fees.

■ Provide funding for management of household quantities of fluorescent and HID lamps through a fee placed on lamp manufacturers. The fee would be assessed on the total number of lamps sold in Minnesota at the retail level. This fee could be integrated into any broader problem materials fee that is established.

Since there are fewer lamp manufacturers than distributors, administering the fee would be simpler than a distributor fee, and it may encourage lamp manufacturers to develop alternative lighting systems based on lower levels of mercury. This mechanism, however, would still potentially create a disincentive for purchasing energy efficient lighting if the lamp manufacturers passed the fee on to fluorescent and HID lamp purchasers. If the manufacturers spread the cost over all lamps, businesses would be paying twice - once when they paid more for their lamps and again when paying for the management of the spent lamps. It also would have many of the other disadvantages the distributor fee would have.

Such a fee would reduce the cost difference between fluorescent and incandescent lights and thereby create an incentive to purchase energy efficient lighting, but difficulties in administering the fee would be the same. Because the reason for assessing the fee would be to deal with the mercury released when generating electricity to operate the incandescent bulbs and not to manage the bulbs themselves, the fee should not be linked with other problem materials fees the state may develop.

■ Provide funding for management of household quantities of fluorescent and HID lamps by placing a flat fee on all residential electric utility customers. This mechanism would provide funds for managing energy efficient lamps by charging energy users, thereby assessing a fee on the mercury released to the atmosphere at electric power plants. A disadvantage of this mechanism is that Minnesota has over 100 electric utilities, many of them cooperatives, which are not regulated by the Public Utilities Commission. A fee assessed on those utilities would most likely be difficult to administer.

■ Provide funding for management of household quantities of fluorescent and HID lamps by placing a fee on all residential electric utility customers that is based on the amount of electricity consumed, such as a kilowatt-hour surcharge. This option could include an exemption from the fee for very small

electrical users similar to the conservation rate break that some state utilities offer.

This mechanism creates an incentive to use less energy, which will reduce mercury in the environment. It will consequently provide people an incentive to use energy-efficient lighting. The disadvantages are the same as those for a flat utility fee.

Endnotes

1. Water Quality Division, Minnesota Pollution Control Agency, "Mercury in the St. Louis River, Mississippi River, Crane Lake, and Sand Point Lake: Cycling, Distribution, and Sources," Report to the Legislative Commission on Minnesota Resources, April 1992.

2. Mercury's effects are due to the fact that it binds with sulfur in protein. Since bonds between two sulfur atoms coming from different points on a protein molecule determine the shape of the molecule, tying up the sulfur atoms with mercury deforms the protein and destroys its function in the cell. From K. Begley and T. Linderson, "Management of Mercury in Lighting Products," (Proceedings of the 1st European Conference on Energy-Efficient Lighting), May 1991, Footnote [7].

3. Agency for Toxic Substances and Disease Registry, U.S. Public Health Service, in collaboration with U.S. Environmental Protection Agency, "Toxicological Profile for Mercury," December 1989.

4. Stephen G. Zemba and Laura C. Green, "Perspectives on Mercury," Solid Waste & Power, May/June 1992

5. Cole, Henry S., Amy L. Hitchcock, and Robert Collins, "Mercury Warning: The Fish You Catch May Be Unsafe To Eat: A Study of Mercury Contamination in the United States," Clean Water Fund/Clean Water Action, August 1992, page 29, quoting two EPA documents: "A Summary of Mercury Emissions and Applicable Control Technologies for Municipal Waste Combustors," Sept. 1991, and "Municipal Waste Combustors - Background Information for Proposed Standards: Post Combustion Technology Performance," August 1989.

6. A. Greenberg, et al, "Study of the Impact of a Municipal Resource Recovery Facility on Atmospheric Levels of Mercury," presented before the Division of Environmental Chemistry American Chemical Society, August 1992.

7. Edward B. Swain, Daniel Engstrom, Mark E. Brigham, Thomas A. Henning, Patrick L. Brezonik, Increasing Rates of Atmospheric Mercury Deposition in Midcontinental North America, Science, 7 August 1992

8. Dr. Thomas Clarkson, University of Rochester, in the keynote speech for the International Conference on Mercury As a Global Pollutant, sponsored by the EPA and the Electric Power Research Institute, Monterey, CA, May 31 - June 4, 1992.

9. COMPETITEK, 1988, Rocky Mountain Institute, Snowmass, Colorado As quoted in K. Begley and T. Linderson, "Management of Mercury in Lighting Products", (Proceedings of the 1st European Conference on Energy-Efficient Lighting), May 1991, p. 398.

10. F. Slemr & E. Langer, "Increase in Global Atmospheric Concentrations of Mercury Inferred from Measurements Over the Atlantic Ocean," Nature, Vol. 355, January 1992, as cited in Cole, Henry S., Amy L. Hitchcock, and Robert Collins, "Mercury Warning: The Fish You Catch May Be Unsafe To Eat: A Study of Mercury Contamination in the United States", Clean Water Fund/Clean Water Action, August 1992, page 12.

11. Cole, Henry S., Amy L. Hitchcock, and Robert Collins, "Mercury Warning: The Fish You Catch May Be Unsafe To Eat: A Study of Mercury Contamination in the United States", Clean Water Fund/Clean Water Action, August 1992.

12. Cole, Henry S., Amy L. Hitchcock, and Robert Collins, "Mercury Warning: The Fish You Catch May Be Unsafe To Eat: A Study of Mercury Contamination in the United States", Clean Water Fund/Clean Water Action, August 1992, page 27.

13. U.S. EPA, "Characterization of Products Containing Mercury in Municipal Solid Waste in the United States From 1970 - 2000" (A.T. Kearney, Inc. and Franklin Associates, Inc.), April 1992.

14. Ibid, Page 5, Table I-2

15. National Electrical Manufacturers Association, "Management of Spent Electric Lamps Containing Mercury", October 1992.

16. COMPETITEK, 1988, Rocky Mountain Institute, Snowmass, CO

17. EPA-450/2-89-001, Estimating Air Toxics Emissions from Coal and Oil Combustion Sources, p 3-37.

18. Correspondence from Edward B. Swain, Minnesota Pollution Control Agency, to Emily Moore, September 17, 1992.

19. Memorandum from Robert Clear to Sam Berman, Rudy Verderber, & Mike Siminovitch, July 23, 1991.

20. Report #90008, H. Muis et al, "Environmental Aspects of Lighting, A Product Oriented Approach", April 1990.

21. BOMA estimates are based on research by Cognetics Real Estate, Inc. of Cambridge, Massachusetts, which placed the total occupied office space in the state of Minnesota in 1990 at 250.4 million square feet, of which 96.4 million square feet was defined as primary (high quality Class A or B). BOMA has estimated that primary office space would typically provide one 4-foot fluorescent lamp per 25 square feet and the remainder (154 million square feet) would provide one lamp per 35 square feet. Assuming that each lamp lasts approximately 4 years, an estimated total of 8,256,000 are in existence in private sector office space, with 2,064,000 lamps needing replacement annually.

22. Data from MRT, Karlskrona, Sweden, as related during a telephone conversation with Larry Homstad, chief technical officer of Recyclights, October 29, 1992.

23. Correspondence and telephone conversation with Joseph J. Stepun, Western Lake Superior Sanitary District, October 8, 1992.

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28. Ibid, Table 9 of Appendix.

29. Draft Background Document. Summary of Data on Municipal Solid Waste Characteristics. EPA 1988.

30. Composition of Leachates from Actual Hazardous Waste Sites. EPA/600/2-87/043. 1987.

31. Sorensen, et al, Airborne Mercury Deposition and Watershed Characteristics in Relation to Mercury Concentrations in Water, Sediments, Plankton, and Fish of Eighty Northern Minnesota Lakes, Environ. Sci. Technol., Vol. 24, No. 11, 1990.

32. Jon B. Reed and Jeffrey S. Eberhard, "Composting Mixed Solid Waste: Analysis of Metals, Pesticides, and Microbes Surviving the Process", Proceedings of the Environmental Chemistry Division of the American Chemical Society, Volume 32 (2), page 85, August 1992.

33. 40 CFR 271.4

34. 40 CFR# 261.3 and Minn Rules 7045.0020 Subpart 33

35. 40 CFR 261.20 through 261.24 and Minn Rules 7045.0131

36. 40 CFR 261.30 through 261.35 and Minn Rules 7045.0135

37. 49 CFR 261, Appendix II, and Minn Rules 7045.0131, Subpart 7

38. 40 CFR 262.10 through 262.12

39. 40 CFR 262.20 through 262.23

40. 40 CFR 262.30 through 262.34

41. 40 CFR 262.40 through 262.44

42. 40 CFR 264

43. 40 CFR 264

44. CFR 261.6

45. 29 U.S.C. Sections 651 through 685 and 29 CFR 1900 through 1910

46. 29 CFR 1910.120

47. 29 CFR 1910.1000

48. 29 CFR 1910.1200

49. 40 CFR 263

50. 49 CFR 171 through 199

51. Minn Stat § 221.033

52. Minn Rules 7045.0261

53. Minn Rules 7045.0125

54. Minn Rules 8870.0200 (Minn Stat § 221.035)

55. 40 CFR 263.20

56. 40 CFR 262.20 through 262.23

57. 40 CFR 263.20

58. Minn Stat § 221.033

59. 40 CFR 263.22

60. 40 CFR Parts 261.5 and 261.4 (b) (1)

61. Minn Rules Chapter 7045.0206

62. Minn Rules 7045.0131, Subpart 8

63. When testing fluorescent lamps, maintaining the specified 20:1 extract-to-solid ratio specified in the procedure and achieving quantitative transfer of all of the components of the lamp waste into the extraction bottle is critical to achieving accurate TCLP results for this waste.

64. EPA Office of Solid Waste, "Best Demonstrated Available Technology Background Document for Mercury Wastes", 1989

65. Minn Rules Chapter 7045.0214, subp 2

66. Minn Rules Chapter 7045.0225 - 7045.0245

67. Minn Rules 7001.0010 through .0210

68. Minn Rules 7001.0500 through -.0730

69. Minn Rules 7001.0520 Subpart 2 (g)

70. Minn Rules 7045.0125

71. Minn. Stat. § 473.811, subd. 5 b.

72. CFR Title 49, parts 173, 178, & 179, (1983)

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82. Correspondence from Rick Korinek, Minnesota Department of Public Service, Energy Division, September 1992.

83. Conversation with Christer Sundberg, MRT, Karlskrona, Sweden, December 11, 1992.

84. NEMA, "Methods for the Reclamation of Electric Lamps Containing Mercury", July 1992.

85. Jim Alan, Minnesota Department of Public Service, Energy Division, August 1992.

Appendix A

6.0 Summary Guidelines for the Extraction of Fluorescent Lamps

A summary of the procedural guidelines for the TCLP extraction of fluorescent lamps is presented below. These guidelines are intended to supplement the TCLP, by supplying specific instructions on the application of this method to fluorescent lamps. All extractions must be performed on the entire lamp, in an extraction vessel large enough to contain a volume of extraction fluid equal to 20 times the weight of the lamp. These specifications should decrease the interlaboratory variability of the results of TCLP extractions of fluorescent lamps.

1) Clean surface of lamp with a clean paper towel dampened with de-ionized water to remove dust or dirt.

2) After weighing the entire lamp, place lamp on a clean sheet of plastic lined laboratory bench paper approximately 10 inches wide by 55 inches long, with the plastic side toward the lamp.

3) With a pair of needle-nose pliers, remove the electrical posts from one end of the lamp by twisting the posts outward. Place these into the extraction vessel. Carefully remove the aluminum end cap by inserting the pliers into the hole that is left from the removal of the posts. Twist off the cap, taking care to recover the bonding material used to bond the end cap to the lamp. Cut the aluminum end cap into pieces no larger than 1 - 2 cm in total area and place pieces into extraction vessel.

4) Crush the fused nipple on the end of the exposed lamp to release the internal reduced pressure within the lamp. This should leave the lamp fully intact. Remove the other end aluminum cap as described above, cut, and place it in the vessel.

5) Place the lamp on the bench paper, fold the edges of the paper around the lamp and staple the edges together to form a loose envelope or tube around the lamp. Fold excess paper onto the lamp.

6) While holding one end of the lamp, lightly strike the end of the lamp with a hammer or similar object to break the lamp. Continue to strike the lamp approximately every 3 to 4 inches. At the end of this procedure, the lamp should be reduced to pieces of no more than 2 to 3 inches in length.

7) Lift the paper tube in the center and gently shake to move the material within the tube to either side of the center. With a pair of scissors cut the paper tube in two at the center.

8) From one half of the tube, carefully pour the pieces of the lamp into the extraction vessel. Extreme care should be taken to assure that none of the powder-like material is lost during the transfer. After the contents have been transferred to the extraction vessel, gently tap the paper tube to dislodge any loose particles that may be adhering to the surface. Repeat this procedure with the other half of the tube.

9) Tightly twist the cap onto the extraction vessel. Hold the vessel with both hands and shake vigorously for one to two minutes. This action should reduce the particle size of the lamp to pieces no larger than 1 - 2 cm. in size.

10) Add a volume of the appropriate extraction fluid (see TCLP step 7.1.4) equal to 20 times the weight of the lamp to the extraction vessel and extract the lamp as described in the TCLP method. Vessels must be monitored frequently for gas production and vented as required.

11) At the end of the extraction period, record the final pH of the extract. Allow the extract to settle for a period of approximately 30 minutes prior to filtration. Decant a volume of extract sufficient to perform all analyses, including quality control samples, into a filtration device fitted with a 0.6-0.8 μm glass filter and proceed with the filtration as described in TCLP method.

7.0 Conclusion

The TCLP is a test to determine if a waste is characteristically hazardous. The application of this method to fluorescent lamps is made more difficult by the unusual physical nature of the material. As a result, conflicting data have been generated by laboratories performing the TCLP on fluorescent lamps.

To standardize TCLP determinations, SAIC has developed procedural guidelines that have been shown to produce reliable and consistent data for the TCLP. These procedures have focused on the particle size reduction step for fluorescent lamps and the liquid-to-solid ratio used in the extraction. It is believed that a variation in the performance of these steps could account for the high variability seen in past evaluations. SAIC recommends that these procedures be used to obtain accurate TCLP results for fluorescent lamps.

SAIC notes that fluorescent lamps are made of recyclable and recoverable resources. As noted in the documentation from the August 6, 1991 meeting between EPA and NEMA, a number of processes have been/are being developed for recycling the glass, end caps, and filaments and for recovering the solid phosphor and mercury powder from spent fluorescent lamps. SAIC believes that recovery of these resources is beneficial not only to decrease the costs associated with the management and disposal of hazardous waste, but also to conserve virgin materials.

Requirements of Hazardous Waste Generators

Who is a Generator?

Minnesota Hazardous Waste Rules (Chapter 7045) state that "anyone who produces or manages a waste must evaluate that waste." Evaluating a waste means determining whether or not the waste is hazardous. "Any person (or company), by site, whose act or process produces hazardous waste" is a *generator*. Included in this definition are businesses who are serviced by companies which regularly provide clean solvent and pick up used solvent for recycling. Households producing normal household refuse are not generators. Businesses run out of a home may be generators. To determine whether or not you are a generator, evaluate each waste you produce using Step 1 below.

What is a Generator Required to Do?

Follow these steps to comply with Minnesota Hazardous Waste Rules:

STEP 1: Evaluate Your Waste.

In order to evaluate your waste, first inventory and assemble information about your waste. An inventory consists of identifying all wastes that your business discards including sewered and recycled waste, off-specification or unusable products, and by-products.

Information can be found in the Material Safety Data Sheets (MSDSs) for raw materials which are used in on-site processes. If you have no information about a waste, it may be necessary to have the waste analyzed by a laboratory. For a list of testing laboratories, see fact sheet 6.05.

To determine whether or not your waste is hazardous, answer the following four questions for each waste on your inventory. Use the information you have assembled.

1) **Is the waste exempt from regulation?** (See Table 1.)

2) **Is the waste listed as a hazardous waste?** (See Table 2.)

3) **Is the waste hazardous because it exhibits a hazardous characteristic?** (See Table 3.)

4) **Does the waste contain Polychlorinated Biphenyls (PCBs) at a concentration of 50 parts per million or greater?**

If your waste is not exempt, and if you answered yes to question 2, 3, or 4 for any waste produced by your business, then your company is a generator of hazardous waste. Complete steps two through ten.

If you have determined that you produce no hazardous waste, you may stop here.

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STEP 2: Obtain an Environmental Protection Agency Identification (EPA I.D.) Number.

Complete an EPA Notification Form (fact sheet 7.09) in order to obtain an EPA I.D. Number free of charge. This is a one-time notification unless any of the information provided on the form changes. If any of the information changes, renotify the EPA by using the same form and checking the *subsequent notification* box. **EPA I.D. numbers are specific to the site so if you move to a new location you must get a new EPA number.**

STEP 3: Determine Generator Size; Disclose and Report Your Waste.

Disclosing means notifying the Minnesota Pollution Control Agency (MPCA) or appropriate metropolitan county staff of the kinds and amounts of hazardous waste you generate. For generators in greater Minnesota, use Table 4 below to determine your size and how to disclose. If you are disposing of hazardous waste only one time, complete and return a One-Time-Only Disposal Form *(available from the MPCA).* Generators in the seven county metropolitan area should contact their county hazardous waste official for instructions on disclosing.

STEP 4: Place Waste in a Labeled, Leakproof Container.

The label should include:

- the words *Hazardous Waste;*
- a description of the waste; and,
- the date the waste is first put into the container (accumulation start date).

Prior to shipment, follow additional DOT labeling requirements. Your transporter should be familiar with these requirements. See fact sheet 1.02 for more information.

TABLE 4: SIZE AND DISCLOSURE

If you generate:	Then your size is:	And you disclose by:
More than 1,000 kilograms per month (about 4 drums) of hazardous waste,	**LQG** (Large Quantity Generator)	Contacting the MPCA for disclosure forms (fact sheet 7.01). Complete and return a waste inventory form and a management plan for each hazardous waste and oil waste on the inventory form. Update your disclosure by completing an Annual Report each spring.
More than 100 kilograms* but less than 1000 kilograms per month (about 1/2 to 4 drums) of hazardous waste,	**SQG** (Small Quantity Generator)	
Less than 100 kilograms* per month (1/2 drum or less) of hazardous waste,	**VSQG** (Very Small Quantity Generator)	Contacting the MPCA for a Waste Certification Form (fact sheet 7.06). Update your disclosure by completing a report when requested.

** 100 kilograms is approximately 220 pounds or 22 gallons.*

STEP 5: Store Waste Properly; Accumulate Up to Limits Only.

Indoor storage of hazardous waste is regulated by fire codes and building codes. In addition:

- keep containers closed;
- provide adequate aisle space for easy access and visibility; and,
- store containers in an area without floor drains.

Restrict access of hazardous waste stored outdoors to those persons responsible for the waste. Also, when storing outdoors:

- store waste on a curbed, impermeable surface;
- protect waste from the elements and from inadvertent damage.

See Table 5 to determine your storage and accumulation limits. For more information, see fact sheet 1.02.

TABLE 1: EXEMPT WASTES

- normal household refuse;
- nonhousehold refuse (unusable paper, cardboard, untreated wood, and plastic);
- recycled used oil (cannot contain listed hazardous waste);
- recycled scrap metal;
- demolition debris;
- hazardous waste generated in storage tanks, transport vehicles or pipelines until it leaves these units;
- waste discharged to surface waters under a National Pollution Discharge Elimination System (NPDES) permit;
- air emissions permitted by the MPCA;
- mining overburden and certain wastes from processing ores;
- fly ash and related waste from burning of fossil fuels;
- waste from spill cleanups approved by the MPCA commissioner; and,
- certain wastes containing chromium III.

For more information see Minnesota Hazardous Waste Rules part 7045.0120.

TABLE 2: LISTED WASTES

- Hazardous wastes from non-specific sources such as:
  - F001: spent halogenated solvents used in degreasing such as trichloroethylene, methylene chloride, 1,1,1-trichloroethane and carbon tetrachloride;
  - F002: spent halogenated solvents such as those above but *not* used as degreasers; other examples are 1,1,2-trichloro-1,2,2-trifluoroethane and chlorobenzene;
  - F003: spent nonhalogenated, ignitable-only solvents such as xylene, acetone, methanol and methyl isobutyl ketone;
  - F004: spent nonhalogenated solvents such as cresols, cresylic acid and nitrobenzene;
  - F005: spent nonhalogenated solvents such as toluene, methyl ethyl ketone, carbon disulfide and benzene;
  - Spent solvent mixtures/blends containing 10% *before use* of F001, F002, F004 and/or F005; and,
  - Distillation bottoms from recovering solvents.

- Hazardous waste from specific sources such as certain plating bath solutions; wastewater treatment sludges; and, wastes from the heat treatment of metals (see K-list).

- Discarded commercial chemical products, off-specification products, containers and/or spill residues (see P- and U-lists).

For a complete listing, see Minnesota Hazardous Waste Rules part 7045.0135.

TABLE 3: CHARACTERISTIC WASTES

- **Ignitable waste** - D001
a liquid waste having a flash point less than 140 degrees Fahrenheit; or, a non-liquid waste which is capable, under standard temperature and pressure of causing fire through friction, absorption of moisture, or spontaneous chemical changes and, when ignited, burns so vigorously and persistently that it creates a hazard; or, an ignitable compressed gas.
- **Oxidizing waste** - D001
wastes which add oxygen to a fire. Oxidizing substances often have *per* as the beginning of the name, *oxide* as the ending of the name, or *ate* in its chemical name.
- **Corrosive waste** - D002
water-based waste having a pH of less than or equal to 2.0 (strong acids) or greater than or equal to 12.5 (strong bases); also, any liquid able to corrode 1/4 inch of steel per year.
- **Reactive waste** - D003
unstable or explosive wastes; wastes which react violently in the presence of water; and, sulfide or cyanide bearing wastes which, when exposed to pH conditions between 2.0 and 12.5, liberate toxic vapors.
- **Lethal waste** - MN01
wastes which have been found through testing to cause death when eaten, touched, or inhaled.
- **Toxicity Characteristic waste** - D004-D043
waste which releases toxic metals, pesticides or volatile organic chemicals above certain limits under acidic conditions. See fact sheet 4.20.

See also Minnesota Hazardous Waste Rules part 7045.0131.

TABLE 5: ACCUMULATION & STORAGE LIMITS		
If your size is:	**Accumulation Limits are:**	**Storage Time Limits are:**
VSQG	1000 kg	Ship stored waste within 180 days* after 1000 kg has been accumulated.
SQG	3000 kg	Ship stored waste within 180 days* after the waste was first put into the container (accumulation start date).
LQG	No limit	Ship 90 days after accumulation start date unless storage facility permit is obtained.

**270 days if the facility is located more that 200 miles from the generation site.*

STEP 6: Transport and Dispose of Waste Properly.

A generator is forever responsible for his or her hazardous waste. To help ensure the waste is transported and disposed of properly and to reduce generator liability, choose a transporter who fulfills the following requirements:

- is currently licensed by the Department of Transportation;
- has fulfilled specific training requirements;
- has adequate liability insurance;
- displays a hazardous waste transporter decal on the vehicle; and,
- transports the waste to a permitted facility.

Generators should contact the facility after shipment to ensure the waste was received and properly disposed of.

See fact sheets 1.04, 1.05, 6.02, and 6.03.

STEP 7: Manifest Shipments of Hazardous Waste.

A manifest is a multi-copy shipping paper which must accompany all off-site shipments of hazardous waste. Manifests and instructions are available from Minnesota's Bookstore. Your transporter may also provide you with one. For more information, request fact sheet 1.03.

STEP 8: Plan for Emergencies.

Notify local authorities of the kinds and amounts of hazardous waste stored at your site. Have appropriate emergency response and spill equipment available.

If you are a SQG or a LQG:

- designate an emergency coordinator;
- post emergency information by the telephone; and,
- provide and document adequate training for personnel handling hazardous waste.

For more information on planning, request fact sheet 1.055 (VSQGs); 1.06 (SQGs); or, 1.07 (LQGs).

STEP 9: Train Personnel Handling Hazardous Waste.

Hazardous waste training is not the same as employee right-to-know training. Training requirements depend upon generator size. VSQGs have no training requirements; however, the MPCA strongly recommends that personnel handling hazardous waste become knowledgeable of the hazards associated with the waste and with appropriate safety procedures. For more information on training, request fact sheet 1.075 (SQGs) or 1.075 (LQGs).

STEP 10: Keep Records; Pay Fees.

Maintain these records *for a minimum of three years:*

- manifests;
- manifest exception reports;
- disclosures/licenses;
- annual reports;
- analytical and other reports;
- training documents; and,
- inspection logs.

for a minimum of five years:

- Land Disposal Restrictions (LDR) Forms.

In addition, the MPCA strongly

recommends keeping *for a minimum of three years:*

- pertinent material safety data sheets (MSDSs); and,
- correspondence.

In 1983 the legislature required the MPCA to assess fees to hazardous waste generators to recover a portion of the state's cost of administering the hazardous waste program. Fees are issued once a year and are based on the generator size, the volume of hazardous waste, and the method of waste management. Fees help to pay for:

- *Generator News*, a newsletter sent free of charge to generators who have completed disclosure requirements;
- fact sheets such as this one sent free upon request;
- workshops put on by MPCA staff at various locations through-out the state;
- technical assistance; and,
- administrative costs.

For more information on fees, see fact sheet 1.13.

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Disposal of Used Oil & Used Lead-acid Batteries

Minnesota Pollution Control Agency (MPCA)
612/296-6300*

Employee Health & Safety

Minnesota Department of Labor and Industry - Occupational Safety and Health Enforcement Division
612/296-4017*

Manifest Forms

Minnesota's Bookstore
612/297-3000
800/657-3757

Non-regulatory Technical Assistance

Minnesota Technical Assistance Program (MnTAP)
612/627-4646
800/247-0015

Pesticides

Minnesota Department of Agriculture (MDA)
612/296-6121*

Pollution Prevention

Grants, Assistance & Fees:
Minnesota Office of Waste Management (OWM)
612/649-5750*

Plans & Annual Reports:
MPCA
612/296-6300*

Regulations

Metro Counties

Anoka	422-7069
Carver	448-1217
Dakota	891-7556
Hennepin	348-2556
Ramsey	292-7898
Scott	496-8177
Washington	430-6655

Greater Minnesota
MPCA
612/296-6300*

Sewering Industrial Waste

Metro Counties
Metropolitan Waste Control Commission (MWCC)
222-8423

Greater Minnesota
MPCA
612/296-6300*

Toxic Release, SARA Title III, "Community Right-to-Know"

Minnesota Department of Public Safety - Emergency Response Commission
612/643-3000*

Transportation

Minnesota Department of Transportation (MnDOT)
612/296-7109*

*In greater Minnesota, call the state operator toll-free at 800/652-9747 and ask for the agency of your choice.

Marking and Labeling Hazardous Waste

Minnesota hazardous waste regulations and the Minnesota Department of Transportation (DOT) regulations require marking or labeling containers at two different times:

- when waste is first put into the container; and,
- before waste is shipped.

Labeling identifies the materials being stored or shipped and, in case of an accident, helps first responders to know how to handle the chemicals. Check the DOT Hazardous Materials Table to determine which materials require labeling when shipped and which labels to use. For more assistance, consult your hazardous waste transporter, the DOT, the Minnesota Pollution Control Agency (MPCA) or your metropolitan county official.

WHEN WASTE IS FIRST PUT INTO THE CONTAINER

Mark the container with:

- the words *Hazardous Waste;*
- a clear **description** of the waste; and,
- the **accumulation start date*** *(for satellite accumulation,write the date the container is filled).*

Writing a description of the waste and the accumulation start date on a Hazardous Waste Label satisfies these requirements; however, it is also acceptable to legibly write or stencil the required information directly onto the container.

*The **accumulation start date** for SQGs and LQGs is the date the waste is first placed in the container. The accumulation start date for VSQGs is the date that the 1000kg (about 4 drums) limit is reached.

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BEFORE WASTE IS SHIPPED

All hazardous waste or materials must have the following:

- **DOT Hazard Labels;**

DOT Hazard Labels are 4 by 4 inch labels stating DOT hazards such as *flammable, corrosive,* or *oxidizer.* Check the Hazardous Materials Table available from DOT to determine which label to use. Also, consult your hazardous waste transporter. Some wastes require no DOT Hazard Labels; some require more than one label. If more than one label is required, place them side by side so both are easily visible at the same time.

- **DOT Identification (I.D.) Number***; DOT I.D. Numbers are assigned to each material to indicate what the material is and how to handle the material in case of an accident. I.D. numbers begin with the letters NA *(North America)* or UN *(United Nations for international numbers)* and end with four digits. For example, a paint thinner may have an I.D. number UN1993.
- **Company name and address***;
- **EPA I.D. Number***;
- **Manifest Document Number***;
- **Accumulation Start Date***; and,
- **The words*** *Hazardous Waste - Federal Law Prohibits Improper Disposal. If found, contact the nearest police or public safety authority or the U.S. Environmental Protection Agency.*

All information noted by an asterisk (*) may be written legibly or stenciled on the side of the container away from the bung. Place all labels and markings in the same area so all are easily visible at the same time. Or, you may choose to mark by clearly writing this information on a 6 by 6 inch Hazardous Waste Label. If you used a Hazardous Waste Label during accumulation and storage and it is in good, readable condition, you may fill out the rest of the information on the label, add hazard labels, and the container will be ready for shipping. There is also room on a Hazardous Waste Label to write the DOT shipping name which appears on the manifest. Although not required, this information allows cross-referencing of containers listed on the manifest.

Labeling Hints

- Drums of virgin hazardous materials are already labeled with a DOT Hazard Label and the DOT shipping name when you get them. If you reuse the drum for waste material, simply add the Hazardous Waste Label and the required information.

- The Hazardous Waste Labels required for shipping are difficult to write or type on. An all-purpose felt tip pen works best.

- Many solvents will easily dissolve labels. Protect labels by placing them on the side of the drum opposite the bung and covering them with a thin coat of spray varnish or clear packing tape.

- Check the market for the many types of labels available. Many of the Hazardous Waste Labels have additional health information about the material shipped.

- For inventory purposes you may wish to include both the initial start date and the fill date on the label.

- For quick identification, put all labels and marks close together on the same side of the drum (away from the bung).

- Just prior to shipment, check to make sure labels are complete, readable, and still well attached.

Sources of Hazardous Waste Packaging, Labels, Placards & Forms

The following sources are provided for your convenience. (This list is not exhaustive.)

	Labels	Placards	Packaging	Forms
D.A. Schultz Company 801 Southeast Eighth Street Minneapolis, MN 55414 612/379-7701 800/927-7701	✔	✔		
J.J. Keller 3003 West Breezewood Lane P.O. Box 368 Neenah, WI 54957-0368 414/722-2848 800/558-5011	✔	✔		✔
Labelmaster 5724 North Pulaski Road Chicago, IL 60646 312/478-0900 800/621-5808	✔	✔	✔	
Lab Safety Supply P.O. Box 1368 Janesville, WI 53547-1368 608/754-2345 800/356-0783	✔	✔		
Tursso Companies, **Dawson Patterson Division** Bridget Leibold 223 East Plato Boulevard St. Paul, MN 55107 612/222-8445	✔	✔	✔	
Unz and Company 190 Baldwin Avenue Jersey City, NJ 07306 201/795-5400 800/631-3098	✔	✔		✔

For Further Information:

- In the metropolitan counties, contact the appropriate county hazardous waste office;
- In greater Minnesota, contact the MPCA Enforcement Unit at 1-800/652-9747; or,
- Contact the Minnesota Department of Transportation at 612/296-7109.

Storage of Hazardous Waste

The hazardous waste rules contain few storage requirements because storage regulations already exist in most areas. Municipalities have fire prevention and building regulations (such as those required by the National Fire Protection Association) governing the storage of chemicals, stacking of drums and storage area size. In addition, Minnesota Hazardous Waste Rules require the following:

1) Keep hazardous waste containers closed except to add or remove waste. After adding or removing waste, remove funnels and replace the container's "bung" or lid. *(Sealable funnels may remain in the container.)*

2) Maintain adequate aisle space in the hazardous waste storage area to ensure unobstructed movement of personnel and fire and spill control equipment in an emergency. Keep each drum easily accessible with labeling clearly visible.

3) Store waste in drums or containers made of a material compatible with the waste to prevent deterioration of the drum. *(Example: Don't store acids in metal containers.)*

4) Inspect containers weekly for possible leaks or deterioration. Keep a log of weekly inspection results.

5) Separate incompatible hazardous wastes by a dike, berm or wall within the main storage area. (An example of incompatible wastes needing to be separated are strong acids and organic solvents.) You may also wish to separate barrels into *live* and *dead* drum areas.

Dead drums are empty drums. Tip them over and store them horizontally so they don't collect a mixture of materials which will require analyzing the contents before disposal. Dead drums may be split into two areas: a money deposit drum area (drums that companies pay a deposit on), and a scrap drum area (drums that will be sold for scrap to barrel refinishers).

Live drums are drums containing chemicals. Live drums deserve your attention to prevent accidents and avoid costly mistakes. Two types of drums are:

- virgin chemical drums, and
- waste chemical drums.

Accidently mixing chemicals or chemicals and waste can cause severe reactions, including explosions, or can ruin hundreds of dollars worth of inventory.

Adequately label and separate live drums. Keep virgin and waste chemical drums in two different storage rooms if possible. If only one storage room is available, separate virgin and waste drums in different areas or by placing a sheet of plywood between them. Store drums with labels clearly visible.

6) Store wastes on-site in limited quantities for a limited time. Time and quantity storage limits are determined by how much waste is produced each month. Use the table on the back of this page to determine when hazardous waste must be shipped.

When storing waste inside a building refer to numbers 7 and 8:

7) Store waste in an area with no floor drain to prevent possible leaks or spills from escaping.

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STORAGE LIMITS FOR GENERATORS

GENERATOR SIZE	ACCUMULATION LIMIT	STORAGE TIME LIMIT
Very Small Quantity Generator (VSQG) Generates fewer than100 kg* of waste per month (less than 1/2 drum).	**1000 kg** If a generator exceeds this limit, waste must be managed according to small quantity generator guidelines.	Less than 1000 kg of waste may be stored indefinitely. Once 1000 kg of waste have accumulated, ship the waste off-site within 180 days. If the receiving facility is more than 200 miles from the generation site, the VSQG may store waste up to 270 days.
Small Quantity Generator (SQG) Generates between 100 kg* and 1000 kg of waste per month (about 1/2 to 4 drums).	**3000 kg** If a generator exceeds this limit, waste must be managed according to large quantity generator guidelines.	Ship waste off-site within 180 days after the waste was first placed in a container. If the receiving facility is located more than 200 miles from the generation site, the SQG may store wastes up to 270 days.
Large Quantity Generator (LQG) Generates more than 1000 kg of waste per month (more than 4 drums).	**No limit**	Ship accumulated hazardous waste off-site within 90 days of the accumulation start date. If the 90-day deadline is not met, the generator is required to obtain a hazardous waste storage facility permit.

**100 kg (kilograms) is approximately 220 pounds or 22 gallons.*

When storing waste outside a building refer to numbers 8, 9, and 10:

8) Restrict access to the storage site to prevent vandalism and accidental damage from vehicles or equipment. A simple chain link fence with a pass gate is adequate.

9) Store waste containing free liquids on an impermeable, curbed, and nonreactive surface to ensure the waste will be contained in case of a leak or spill. *Impermeable* means the surface does not allow the liquid to pass through. For example, do not store solvents on an asphalt surface nor acids on concrete because they react and seep through. Usually a simple concrete or asphalt curbed pad is adequate.

10) Shade ignitable wastes from direct sunlight to prevent the drums from heating and building up pressure. A corrugated aluminum sheet roof may be adequate. Labels should be easily visible.

Storage Extension

If your hazardous waste cannot be shipped off-site within the time limit due to unforeseen, temporary and uncontrollable circumstances, you may request a storage extension. Write a letter to the MPCA commissioner explaining the need for an extension, the types and amounts of waste affected, and the date you anticipate shipping. The MPCA may grant a 30-day extension which would allow you to keep the waste on-site without over-accumulating.

Satellite Accumulation

Because some wastes accumulate very slowly, a special provision known as *satellite accumulation* may allow for longer accumulation. Satellite accumulation requirements include:

- waste is stored at or near the point of generation;
- waste is under direct control of the process supervisor;
- waste accumulation is limited to 55 gallons;
- date is marked on the container when filled; and,
- waste is moved to permanent storage within 3 days of fill date.

Further Information can be obained by contacting the Minnesota Pollution Control Agency Hazardous Waste Enforcement Units at 1-800/652-9747 or by contacting the appropriate metropolitan county officials.

Hazardous Waste Fact Sheet for Minnesota Generators

MANIFESTING MINNESOTA HAZARDOUS WASTES

What is a "manifest"?

A "manifest" is a shipping paper which must accompany all off-site shipments of hazardous waste. It may also be used when shipping nonhazardous waste.

Who uses a manifest and when is it used?

In Minnesota, a company or "generator who transports or offers for transportation hazardous waste for off-site treatment, storage, or disposal must prepare a manifest before transporting the waste off-site." This means that any person or company producing a hazardous waste must manifest whenever shipping hazardous waste off-site either for disposal **or** for recycling. NOTE: Companies must also manifest hazardous waste produced from leased materials, for example, waste solvent from a parts washer.

When shipping hazardous waste, which manifest is used?

Only one manifest needs to accompany each shipment of hazardous waste. Minnesota generators must use either the Minnesota manifest or another state's manifest, according to the following rules.

1. Minnesota generators who ship hazardous waste to a final treatment, storage or disposal facility in one of the following states must use that state's modified Uniform Hazardous Waste Manifest: AL, AR, CT, DE, GA, IL, LA, ME, MD, MA, MI, MN, MO, NH, NJ, NY, PA, RI, SC, TX, VT, and WI. These manifests may be obtained from that state's regulatory agency, the facility or the transporter.
2. Minnesota generators who ship hazardous waste to another location in Minnesota or a state **not** having its own manifest must use Minnesota's manifest (Minnesota Form PQ-00371-01). Minnesota manifests may be obtained from:

   Department of Administration
   Documents Center
   117 University Avenue
   St. Paul, MN 55155
   (612) 297-3000

What types of information are required on a Minnesota manifest?

All the white lines and the gray lines lettered "H" and "I" must be properly completed. These lines describe those parties that handle the waste, describe the waste itself, and certify that 1) the information provided is accurate 2) the production of hazardous waste has been minimized and 3) the waste arrived safely at the designated facility. Specifically, this information includes:

- names, addresses, telephone numbers and US EPA ID numbers of the generator and hazardous waste facility (lines 1-4, 9, 10, & H);
- the name and US EPA ID number of each transporter;
- the quantity (weight or volume) of each hazardous waste being shipped (lines 13-14);

- the types and number of containers loaded into or onto the transport vehicle (line 12);
- the proper US Department of Transportation (DOT) description of each waste (line 11, in part);
- the proper US DOT and EPA waste identification number for each waste (lines 11 in part and line I);
- a certification statement signed and dated by the generator (line 16); and
- the dated signatures of the transporter(s) and facility operator (lines 17, 18, and 20);

NOTE: If you find that you must use another state's manifest, then check on that manifest to see what information is required in the gray lines.

How is a manifest filled out?

Clear instructions for completing each line of the Minnesota manifest are printed on the back of the manifest itself. However, you should be especially careful to:

- **type in or firmly print all the information** (check copy "8" for clarity);
- **enter accurate US EPA ID numbers** for generator, transporter and facility;
- **enter the proper US DOT name and numbers in line 11.** You may obtain these from
  — the hauler or facility which you have selected,
  — your trade association
  — the Minnesota DOT **(612) 297-8958,** the MPCA (612)296-6300 metropolitan county officials, or
  — Title 49 CFR, 171 through 177 (available at larger libraries).
- **enter the correct US EPA waste number in line "I".** You may find these numbers by
  — contacting the MPCA Disclosure Unit(612)642-0457,643-3484 or the appropriate metro county hazardous waste staff, or by
  — consulting the Minnesota Rules parts 7045.131 – 7045.0141.
- **enter the quantity of each waste** (gallons for liquids, usually pounds for solids).
- **sign and date the certification statement** (line 16);

What other rules pertain to manifesting?

When using a Minnesota manifest, you must:

- tear off and **give copies 1-5 of the manifest to the transporter;**
- **send copy "7" within five days** of shipment to the MPCA, Hazardous Waste Division, 520 Lafayette Road, St. Paul, MN 55155, ATTN: HWIMS.
- **retain copy "8" of each manifest for three years:** and
- **have copy 1 returned to you by the designated facility**

If you have not received copy 1 of the manifest signed by the facility owner/operator within 35 days of shipment, then you must check on the **status** of your waste shipment. You must then send MPCA an **"exception report"** regarding this manifest. This must be done within 45 days of the original shipment.

These rules also apply when you use another state's manifest, except that the various manifest copies may be distributed differently. For example:

If you are shipping waste to Wisconsin using their manifest:

- tear off and give copies 3-6 to the hauler;
- send copy 1 to the Wisconsin DNR, Bureau of Solid Waste Management;
- retain copy 2
- send a photocopy of copy 2 to the MPCA, attention HWIMS;
- expect copy 5 to be returned by the facility, and;
- photocopy copy 5 and send it to the MPCA, attention HWIMS.

If you are shipping waste to Illinois:

- tear off and give copies 1-4 to the hauler;
- send copy 5 to the Illinois EPA;
- retain copy 6;
- send a photocopy of copy 6 to the MPCA, attention HWIMS;
- expect to receive copy 1 from the facility, and;
- make a photocopy of copy 1 and send it to the MPCA, attention HWIMS.

Regardless of which manifest is used, the MPCA must receive a copy of the manifest within five days of the shipment and another copy which has been signed by the facility owner/operator.

Why is hazardous waste manifesting required and so important?

Generators of hazardous waste are considered forever responsible for the proper handling and disposal of that waste. They are responsible for the waste from the time and place the waste is produced ("the cradle") through the time and even after the time it is delivered to the final treatment, storage or disposal site ("the grave"). Manifesting provides the generator (and regulatory agency) with a means of keeping track of the waste after it leaves the production site. This "tracking" of hazardous waste is for your protection and to ensure that no hazardous waste is mishandled or mismanaged so that it endangers human health or the environment.

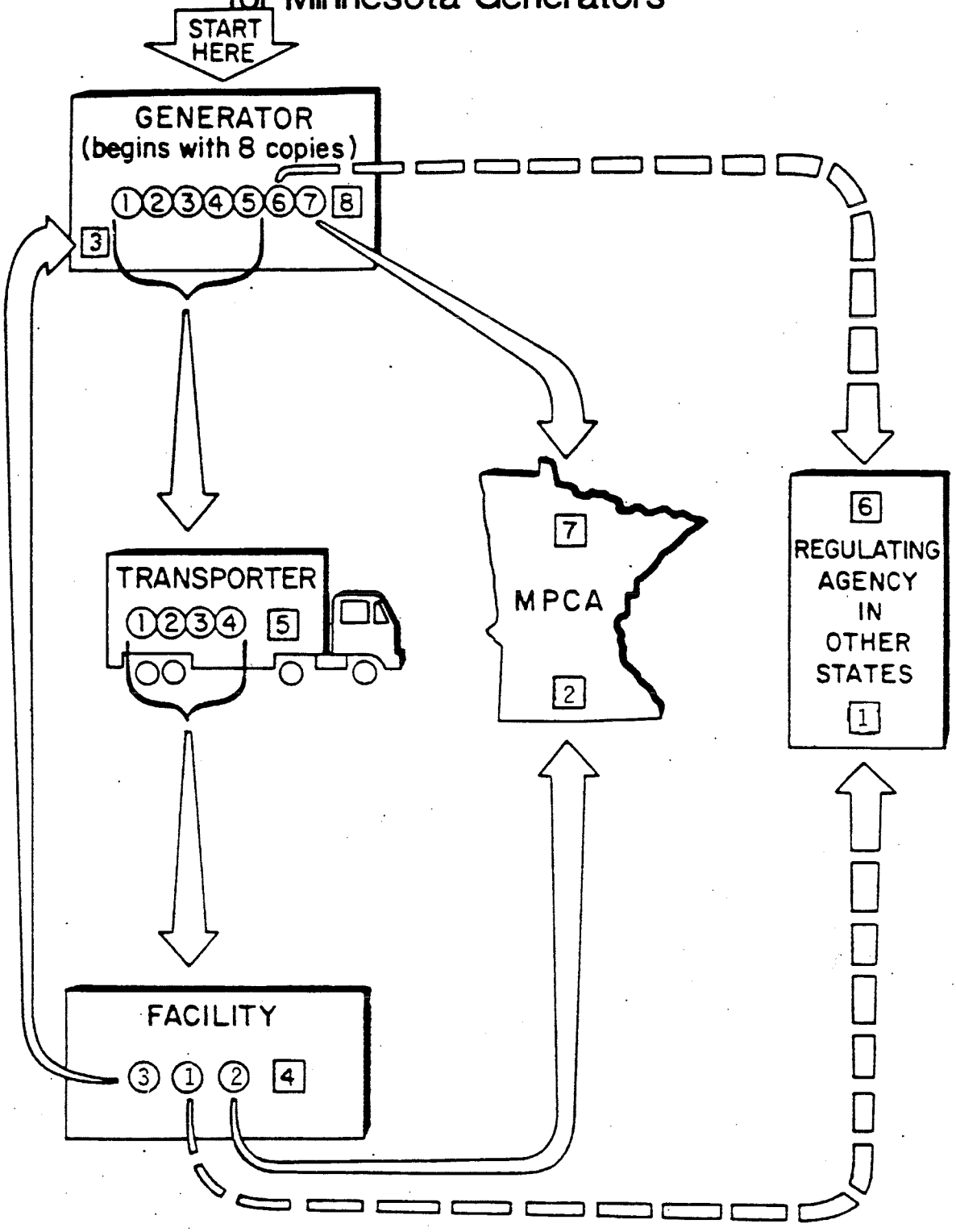
Questions about manifests should be directed to the MPCA Disclosure Units at (612) 643-3481 or (612) 643-3488or the appropriate metro country hazardous waste staff.

This fact sheet was contributed by Minnesota Pollution Control Agency as part of a joint project undertaken by the Small Quantity Generator Activities Group composed of staff members from the:

Metropolitan Counties
Minnesota Pollution Control Agency
Minnesota Technical Assistance Program
National Electric, Inc.
Waste Management Board
Other industry representatives

10/86

Distribution of Minnesota's Uniform Hazardous Waste Manifest for Minnesota Generators



September, 1988

Minnesota Pollution Control Agency
Solid and Hazardous Waste Division
520 Lafayette Road
St. Paul, Minnesota 55155
ATTN HWIMS

For MPCA use only

Please print or type. (Form designed for use on elite (12-pitch) typewriter.) Instructions on back of form

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. | Manifest Document No. | 2. Page 1 of | Information in shaded area not required by Federal law. Minnesota rules require items H. and I.

3. Generator's Name and Mailing Address

4. Generator's Phone ( )

A. State Manifest Document Number: MN 0032619

B. State Generator's ID

5. Transporter 1 Company Name | 6. US EPA ID Number | C. State Transporter's ID | D. Transporter's Phone

7. Transporter 2 Company Name | 8. US EPA ID Number | E. State Transporter's ID | F. Transporter's Phone

9. Designated Facility Name and Site Address | 10. U.S EPA ID Number | G. State Facility's ID | H. Facility's Phone

	11. US DOT Description (Including Proper Shipping Name, Hazard Class, and ID Number) HM	12. Containers No	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
a.						
b.						
c.						
d.						

J. Additional Descriptions for Materials Listed Above

K. Handling Codes for Wastes Listed Above

15. Special Handling Instructions and Additional Information

16. GENERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.

Unless I am a small quantity generator who has been exempted by statute or regulation from the duty to make a waste minimization certification under Section 3002(b) of RCRA, I also certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and I have selected the method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment.

Printed/Typed Name | Signature | Date: Month Day Year

GENERATOR

17. Transporter 1 Acknowledgement of Receipt of Materials

Printed/Typed Name | Signature | Date: Month Day Year

18. Transporter 2 Acknowledgement of Receipt of Materials

Printed/Typed Name | Signature | Date: Month Day Year

TRANSPORTER

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19.

Printed/Typed Name | Signature

FACILITY

In case of spill or emergency, immediately call the Minnesota Pollution Control Agency at 612/296-7373; the Minnesota Division of Emergency Services at 612/778-0600; the National Response Center at 800/424-8802. Outside Minnesota, call the National Response Center and appropriate state agency.

SAMPLE

Minnesota Form PQ-00371-01(10 84)

COPY 1: TSDF MAIL TO GENERATOR

FACT SHEET

What to do with used fluorescent and high-intensity discharge lamps

Businesses in Minnesota are increasingly using fluorescent lighting because it is energy-efficient and saves money on electricity bills. Compared to incandescent lighting, fluorescent lighting significantly decreases power plant emissions of a variety of air pollutants such as mercury, lead, nitrogen oxides and sulfur dioxide.

However, used fluorescent and high-intensity discharge (HID) lamps have recently been identified as an environmental concern, and many are now subject to hazardous waste management requirements in Minnesota. The change has raised questions for business about proper management of used lamps.

Fluorescent and HID lamps contain small amounts of mercury, lead and sometimes cadmium. Several million fluorescent and HID lamps are discarded in Minnesota each year. A 1988 study showed them to be the second largest source of mercury in household and commercial garbage, after batteries.

Why is mercury an environmental concern?

Mercury is a heavy metal that can accumulate in living tissue and cause adverse health effects. Sources of mercury in the environment from human activity include coal-burning power plants, batteries and fluorescent and HID lamps. In Minnesota, mercury contamination in lakes has been detected. The Minnesota Pollution Control Agency (MPCA) and Department of Health have issued warnings in recent years about mercury concentrations in fish from Minnesota lakes.

A small amount of mercury is an essential component in these lamps, but when a lamp is broken or disposed of in a landfill or incinerator, it can contaminate air, surface water and ground water. Therefore, it is good policy to keep the mercury in fluorescent lamps out of the waste stream.

Is fluorescent and HID lighting still a good environmental and economic choice?

Absolutely. The use of energy-efficient lighting is one of the best choices a business can make to protect the environment, and it saves money. Businesses that replace used lamps regularly should continue that practice, and those considering the switch to high-efficiency fluorescents should not hesitate to make the change.

Here are some of the reasons why using efficient lighting makes good sense.

- **Energy-efficiency means less mercury is released into the environment.** New technologies in fluorescent lighting are reducing the amount of energy used to run the lights.

  In Minnesota, 69 percent of our electricity is generated by coal-burning plants. Since coal contains mercury, the energy-efficiency of fluorescent lighting means less mercury is released when power is generated to run the lamps -- about 50 percent less than

Minnesota Pollution Control Agency

Minnesota Office of Waste Management

Minnesota Department of Public Service

Minnesota Department of Administration

Minnesota Technical Assistance Program

Hennepin County Department of Environmental Management

continued on other side

running the equivalent five to nine incandescent bulbs, even when the mercury contained in the fluorescent lamp is counted.

- **Other harmful emissions are also reduced.** Reducing power consumption significantly reduces production of greenhouse gases and other pollutants, as well.

  Over the lifetime of a 28-watt compact fluorescent, for example, 1,020 pounds less carbon dioxide and three pounds less nitrogen oxide are released from power plants. Radioactive wastes and other toxic and solid waste by-products of power generation are also reduced.

- **Fewer new power plants are needed.** When less energy is demanded, electric utilities need less new generating capacity, resulting in more savings for customers.

Fluorescent and HID lamps have always contained mercury. Why is management of these lamps suddenly a concern?

The U.S. Environmental Protection Agency (EPA) developed the Toxicity Characteristic Leaching Procedure (TCLP) Test, a new test for determining whether a waste is hazardous. The new test is more sensitive to hazardous contaminants than the old one. Many fluorescent and HID lamps fall under hazardous waste regulation because they are determined to be a hazardous waste as shown by their TCLP results.

Minnesota has been in the forefront of responding to growing public concern about mercury and other metals in the environment, as well being a leader in other waste issues, and has acted more quickly than most states to address management of fluorescent and HID lamps.

How should hazardous lamps be handled, transported and disposed?

Used mercury-containing lamps from business, industry and institutions may not be placed in the trash unless they test non-hazardous by the TCLP test. To avoid release of mercury, lamps should not be broken or crushed.

The following lamp management options are available to business.

1. **On-site storage.** Store the lamps on-site, properly labeled as hazardous waste and packed to prevent breakage, to await the opening of a recycling plant in Minnesota. The storage area must be marked with notices instructing employees how to pack and label the lamps. Records also must be kept on stored tubes, keeping track of the number of lamps removed from service each year and the storage location.

Suggested storage methods

Companies currently storing used fluorescent and HID lamps for recycling have found the following practices work well.

- Waste lamps are replaced by a maintenance worker or electrical contractor, and are placed into storage boxes.
- Waste lamps can be stored in the same boxes that new lamps were shipped in, or in other boxes of similar size. Box spacers may be needed to prevent breakage. Storage boxes can be custom-ordered or purchased from carton distributors -- see "Boxes" in the Yellow Pages.
- Boxes are kept in a designated storage location. Either the storage area must be marked as a hazardous waste storage area, or each box must be labeled as hazardous waste and dated.
- Filled boxes are stacked five across, with each row perpendicular to the one below it. Stacks are piled no higher than five feet so tubes on the bottom are not crushed by the weight.
- A log is kept of the location and quantity of stored lamps.

2. **Off-site storage and recycling in Minnesota.** Send the lamps to another site in Minnesota for storage or recycling. Labeling and packing requirements are the same as for on-site storage. For transport within the state, shipping documents are required. Records kept on these lamps must include when and where the lamps were shipped as well as the number removed from use and the storage location. Businesses planning to store used lamps for others should contact their county offices or the MPCA for information on hazardous waste storage licenses.

3. **Out-of-state storage, recycling or disposal.** Ship used lamps to a recycling facility or to a storage or treatment and disposal facility outside of Minnesota. They must be packed to prevent breakage and labeled as hazardous waste. A licensed hazardous waste transporter must be used, and hazardous waste manifest papers must be filed for any transport of used fluorescents out of the state. Any land disposal or other state restrictions must also be met.

A business or institution that replaces the equivalent of more than 1,000 four-foot fluorescent lamps per year must have a hazardous waste license and report to the MPCA or appropriate metro-area county on what it does with the used lamps. Smaller quantities need not be reported, but must still be managed properly, as described in this fact sheet.

Is the current policy likely to remain in effect?

The requirements for managing fluorescents may change again. Minnesota's policy is intended to provide the best possible management of used lamps under current regulations.

The Minnesota Office of Waste Management (OWM) is currently preparing a study for the Minnesota Legislature on management options for fluorescent lamps. A draft of the report will be available in October 1992.

Even though most used fluorescents have come under hazardous waste regulation, energy-efficient lighting is still the most environmentally sound choice for businesses and residences. The energy that fluorescents, compact fluorescents and HID lamps save means less mercury and other pollutants released into the environment as well as lower costs for electricity.

If you have information or comments about fluorescent or HID lamps or the TCLP test, the MPCA would like to hear from you. Please call at 800-657-3724. Response from industry and trade groups is especially invited.

For more information on fluorescent and HID lighting

- **Energy use comparisons** for different types of lighting: Minnesota Department of Public Service, 612-296-5175; in Greater Minnesota, call 800-652-9747 and ask for "Energy." Or, call your power utility or lighting consultant.

- **Non-regulatory technical assistance**, call Minnesota Technical Assistance Program (MnTAP), 612-627-4646 or 800-247-0015.

- **The fluorescents study:** OWM, 612-649-5750 or 800-652-9747.

- **Hazardous waste regulations**
  Anoka County: 422-7069.
  Carver County: 448-1217.
  Dakota County: 891-7556.
  Hennepin County: 348-4919.
  Ramsey County: 292-7898.
  Scott County: 496-8177.
  Washington County: 430-6655.
  Greater Minnesota: MPCA, 800-657-3724.

- **Procedures and disposal options for state agencies:** 612-296-2600. State agencies will receive updated information through broadcast bulletins on the Department of Administration's fax system.

- **Transporting and recycling contacts:** See list on back of this fact sheet.

Recycling contacts for used lamps

The following list of fluorescent and HID lamp recycling companies is provided as a service to organizations seeking information about lamp management. The information is given voluntarily by the companies listed, and they should be contacted personally about the services offered and the facility's compliance with laws applying to the management of hazardous waste. The appearance of a company's name on this list does not constitute endorsement by any of the participating agencies, nor does it imply that the company is in compliance with all applicable laws. This list is not represented as being complete. For information regarding transporters, please contact the recyclers.

Lighting Resources, Inc.
386 S. Gordon St.
Pomona, CA 91766
800-572-9253
John M. Chilcott

Mercury Recovery Services
2021 S. Myrtle
Monrovia, CA 91016
818-301-1372
Bob Roberts

Mercury Refining Co., Inc.
790 Watervliet-Shaker Road
Latham, NY 12110
518-785-1703
Karen McHugh

Mercury Technologies Corp.
140 W. Industrial Way
Benicia, CA 94510
707-745-5173
Paul Abernathy

Mercury Technologies of Minnesota, Inc.
2320 County Lane J
White Bear Lake, MN 55110
612-426-2102
Raymond Hite, Sue Yarusso

Recyclights
2010 E. Hennepin Ave.
Minneapolis, MN 55413
612-378-9571
Joe Bester

Silver Celebration 25/20

Minnesota Pollution Control Agency

Celebrating our 25th anniversary and the 20th anniversary of the Clean Water Act

September 1992

Summary of Management Requirements for Fluorescent Lamps

(Attachment to "What to do with Used Fluorescent and High-Intensity Discharge Lamps" Fact Sheet)

The following information is a summary of the Minnesota Pollution Control Agency's (MPCA) requirements for fluorescent lamps and high-intensity discharge (HID) lamps for businesses. The requirements and additional information are discussed in the fact sheet, "What to do with Used Fluorescent and High-Intensity Discharge Lamps" which was developed through a cooperative effort between the Minnesota Pollution Control Agency, Minnesota Office of Waste Management, Minnesota Department of Public Service, Minnesota Department of Administration, Minnesota Technical Assistance Program and the Hennepin County Department of Environmental Management.

The following information may be used as a guideline for managing lamps from your business. Each business, organization or governmental unit has the option of either managing their lamps as described below or evaluating their lamps using the Toxicity Characteristic Leaching Procedure (TCLP) to determine if their lamps are hazardous or nonhazardous. If the lamps are nonhazardous, the requirements below would not apply. Everyone that chooses to test their lamps needs to realize that the TCLP gives variable results for the mercury in lamps. As a result, several or even many tests may be needed to clearly show that a particular lamp type and model is not hazardous. (For more information on TCLP, request MPCA fact sheet 4.20.)

Required Management of Lamps from Businesses

The MPCA staff requires the following for lamps, unless laboratory tests clearly show they are nonhazardous:

1. Do not break or crush.
2. Store for recycling.
3. If storage is not feasible, ship out of Minnesota to an existing recycling facility. (Comply with the transportation requirements listed below.)
4. If lamps break, store in a sealed container for recycling or ship, using a manifest and a licensed transporter, to a hazardous waste landfill.

Transportation Requirements for Lamps from Businesses

1. Pack lamps in a way to protect them from breaking.
2. Use shipping papers when shipping lamps within the State of Minnesota. On the shipping paper, include the following information:
    a. Date of shipment
    b. Location from which they were shipped
    c. Destination location
    d. Number of lamps shipped
3. Use a licensed hazardous waste transporter and a manifest when transporting lamps to locations outside of Minnesota for recycling or for disposal in a hazardous waste landfill.

520 Lafayette Rd.; St. Paul, MN 55155-3898; (612) 296-6300; Regional Offices: Duluth • Brainerd • Detroit Lakes • Marshall • Rochester

Storage Requirements for Lamps

The regulatory time limits for storage on site stated in the hazardous waste rules will not be strictly enforced until after one or two recycling facilities become fully operational in Minnesota. However, the MPCA staff will require the following:

1. Store in an area and a manner that will prevent breakage.
2. Use signs and notices that show employees where and how to store lamps.
3. Label the lamp storage area or each container as hazardous waste.
4. If on-site storage is not possible, transport the lamps to a storage location. A manifest is not needed as long as lamps are transported to a site within Minnesota, but shipping papers are required.

NOTE: The requirements for businesses that are storing or would like to store other businesses' lamps are in the process of changing. If you are transporting and/or storing lamps from other businesses or if you are interested in transporting and/or storing lamps from other businesses, please contact the MPCA staff for further information and requirements.

Record Keeping

Any time lamps are stored or shipped off site, records need to be kept. Businesses should keep track of three things:

1. The number of lamps removed from service during each calendar year
2. The storage location of the lamps
3. Shipping papers

Generator License

A business or institution that replaces or removes from service the equivalent of more than 1,000 four-foot fluorescent lamps per year must have a hazardous waste generator license. Smaller quantities need not be reported, but must still be managed properly, as described above. For further information regarding licensing, please contact MPCA staff or the hazardous waste staff from the appropriate Metro Area county. For metropolitan county staff phone numbers, see page 3 of the fact sheet.

If you have any additional questions, call:	Jim Brist	612/297-8331
	Paula Peterson	612/297-8330
	In Greater Minnesota, toll free:	800/657-3724

Appendix D

MINNESOTA POLLUTION CONTROL AGENCY

COMPLIANCE AGREEMENT

REGARDING

SHORT-TERM STORAGE OF MERCURY-CONTAINING WASTE LAMPS

I. RECITALS

A. Parties. The parties to this Compliance Agreement (Agreement) are the Minnesota Pollution Control Agency (MPCA) and _____ (Company).

B. MPCA Authority. The MPCA is the agency of the State of Minnesota with the duty to administer and enforce the laws and rules relating to the prevention, control, or abatement of water, air, noise, and land pollution and to the generation, collection, transportation, storage, disposal, and other management of hazardous waste in the state. This Agreement is entered into pursuant to the authority vested in the MPCA by Minn. Stat. chs. 115 and 166 (1988).

C. Rules. The MPCA, after legal notice and hearing thereon, has adopted and has filed in the Office of the Secretary of State, rules regulating hazardous waste activities that have the force and effect of law and general application throughout the State of Minnesota, which rules are set forth in Minn. Rules ch. 7045, et seq.

D. Definitions. Unless otherwise explicitly stated, the definitions in Minn. Stat. chs. 115 and 116 (1988) and in Minn. Rules pts. 7045.0020 and 7001.0010 shall control the meaning of the terms in this Agreement. All references to this Agreement shall be deemed, unless clearly inappropriate, to include all exhibits hereto. In addition, for the purpose of this Agreement, these terms have the following meanings:

1. Lamp. A fluorescent lighting tube or high-intensity discharge light bulb.

2. Lamp Storage Facility. A permanent structure or a structurally sound and secure trailer designated to store lamps prior to recycling.

E. Statement of Facts. For the purpose of this Agreement, the following constitutes a summary of the background upon which this Agreement is based.

II. BACKGROUND

Because of their mercury content, fluorescent lamps often test as hazardous under current federal and state hazardous waste rules. Due to the widespread use of fluorescent lamps and the large numbers of lamps generated as waste, the MPCA has developed a policy which pertains to the management of fluorescent lamps. The policy is aimed at ensuring proper management of fluorescent lamps through recycling. In its efforts to facilitate the recycling process the MPCA has identified a need to introduce special requirements for businesses storing fluorescent lamps from other generators prior to recycling, which requirements are set out in this agreement. Businesses that wish to store more than 1,000 lamps generated at another location for more than 24 hours must enter into and comply with this Agreement or obtain a Resource Conservation Recovery Act hazardous waste storage facility permit. The MPCA anticipates that a federal or state regulatory framework will supersede this Agreement in the future.

III. AGREEMENT

NOW, THEREFORE, the MPCA and the Company hereby agree and stipulate as follows:

A. Purpose. The Purpose of this Agreement is to establish the conditions under which the Company may operate a Lamp Storage Facility(ies) located at

_____

_____.

EXHIBIT 1 to this Agreement is a description of each Facility(ies) (prepared by the Company) which includes each Facility's size and general manner of construction and maximum lamp storage capacity in standard four-foot tube lamp equivalents.

B. Company Requirements.

1. **Maximum Capacity of Lamp Storage Facility.** The maximum storage capacity of the Company's Lamp Storage Facility(ies) is the equivalent of

_____

standard four-foot tube lamps. The Company may not accumulate more than this quantity at the Lamp Storage Facility(ies) at any time.

2. **Agreement Between Company and Recycling Facility.** Prior to the execution of this agreement, the Company must execute a written agreement with a lamp recycler(s) which certifies to the MPCA that such recycling facility(ies) will accept lamps from the Company for proper recycling and states the rate at which the recycling facility has the capacity to accept lamps from the Company. A copy of this agreement is attached hereto as **EXHIBIT 2.**

3. **Financial Assurance.** The owner or operator of a Lamp Storage Facility shall establish financial assurance for closure of the facility, including any cleanup or environmental remediation as may be necessary, prior to accepting any lamps for recycling. The amount of financial assurance to be provided must be greater than or equal to the closure cost derived by multiplying the MPCA's estimate of the per lamp statewide average cost of closure by the maximum number of lamps that may be accepted by the Lamp Storage

Facility. The owner or operator shall obtain a letter of credit in at least the amount required by the MPCA and in the form of the MPCA's sample letter of credit. A copy the letter of credit is attached hereto as **EXHIBIT 3**. At any time that a letter of credit is to be renewed or extended, and in any case not less than once each year, the amount of the letter of credit shall be subject to adjustment based on changes in the estimated amount of the Lamp Storage Facility.

In addition to the foregoing within 60 days after an increase in the current closure cost estimate to an amount greater than 120 percent of the amount of the letter of credit for any reason, the owner or operator shall cause the amount of the letter of credit to be increased to an amount at least equal to the sum of the current closure cost estimate and submit evidence of the increase to the MPCA. Whenever the current closure cost estimate decreases, the amount of the letter of credit may be reduced to the sum of the current closure cost estimate following written approval by the MPCA.

The letter of credit shall be issued to the MPCA by an institution which has the authority to issue letters of credit, and whose letter of credit operations are regulated and examined by a federal or state agency.

The owner or operator shall also establish a standby trust fund and the terms of the letter of credit shall direct the letter's issuing institution to deposit all amounts paid pursuant to the letter of credit directly into the standby trust fund in accordance with instructions from the MPCA. An originally signed duplicate of the standby trust fund agreement must also be submitted to the MPCA with the letter of credit prior to acceptance of any lamps by the facility. The standby trust fund agreement must be in the form of the MPCA's sample standby trust fund agreement. A copy of the Standby Trust Fund agreement is attached hereto as **EXHIBIT 4**.

The letter of credit must be irrevocable and issued for a period of at least one year, and must provide that the letter's expiration date will be extended automatically for a period of at least one year unless, at least 120 days before the current expiration date, the issuing institution notifies both the owner or operator and the MPCA by Certified Mail of a decision not to extend the expiration date. Under the terms of the letter of credit, the 120 day period must begin on the date when the MPCA received the notice, as evidenced by the return receipt.

The MPCA may draw on the letter of credit at any time when the MPCA has determined that the owner or operator has failed to perform closure when required to do so in accordance with Section III.B.7. or at any time within 30 days of the expiration date of the letter of credit if a suitable substitute letter of credit has not been provided by the owner or operator to the MPCA.

At such time as proper closure of the Lamp Storage Facility has been completed, the MPCA shall return the letter of credit to the issuing institution or to the owner or operator who posted it.

An owner or operator shall notify the MPCA by Certified Mail of the commencement of a voluntary or involuntary proceeding under United States Code, Title 11, Bankruptcy, naming the owner or operator as a debtor, within 10 days after commencement of the proceeding. If the financial institution which issued

the letter of credit becomes a debtor in a bankruptcy proceeding or if that institution's authority to issue the letter of credit becomes a debtor in a bankruptcy proceeding or if that institution's authority to issue the letter of credit is revoked or suspended, the owner or operator shall, within 60 days thereafter provide a substitute letter of credit which complies with all the requirements of this agreement.

4. Receiving Lamps. The Company may only accept lamps at the Lamp Storage Facility accompanied by a shipping paper (in a form approved by the MPCA) and from a generator transporting its own lamps or from a transporter acting on behalf of the generator.

5. Operation of Lamp Storage Facility. The Company must operate the Lamp Storage Facility and manage lamps according to the following:

(a) Lamps must be stored in an indoor location or in a sturdy, locked trailer parked in a secured area and managed in a manner that prevents breakage.

(b) All lamp storage areas must be conspicuously posted as hazardous waste storage areas.

(c) All lamps accumulated at the Lamp Storage Facility must be recycled in a manner acceptable to the MPCA; however, no recycling or treatment activity may occur at the Lamp Storage Facility.

(d) All broken lamps must be properly containerized, properly managed, and recycled or properly disposed as a hazardous waste.

(e) The number of lamps accumulated at the Lamp Storage Facility must not exceed the maximum capacity of the Lamp Storage Facility stated in part III.B.I or the number the Company has contracted with a recycling facility to process in 90 days in accordance with part II.B.2., whichever is less. The Financial Assurance provided by the Company must be based upon the larger number of lamps which may be accumulated. If for any reason, a contract between a storage facility and a recycling facility is canceled, or altered to reduce the amount of lamps which may be stored, the Company shall promptly notify the MPCA, and proportionately reduce the number of lamps it accepts.

6. Storage Time Limits. The Company must ship lamps off-site within 90 days after receipt of the lamps.

7. Closure. If the Company ceases to operate the Lamp Storage Facility, or if the MPCA determines, in its discretion, that the Facility shall close in accordance with part 8. below, the Company shall remove all hazardous waste and hazardous waste residues from the Facility within 90 days after closure or after receipt of notice from the MPCA that the Lamp Storage Facility must close, whichever comes first.

8. Failure to Comply. Failure to comply with the terms of this Agreement constitutes noncompliance with the Hazardous Waste Rules. If the Company fails to comply with the terms of this Agreement, the Company shall immediately cease accepting lamps until such time as the Company resumes compliance. During the period of noncompliance, the Company shall continue to

deliver lamps to a recycling facility at a rate greater than or equal to the contracted rate. If the MPCA staff determine that the Company has failed to comply with any provision of this Agreement, the MPCA staff shall give written notice to the Company of such failure and the MPCA shall be entitled to exercise any and all remedies available to it in a case of violation of the Minnesota Hazardous Waste Rules or law, including closure of the Lamp Storage Facility.

9. Recordkeeping. The Company must maintain records at the Lamp Storage Facility that document the receipt of lamps, including quantity, source and date received, the number of lamps in storage, the source of the lamps, the date shipped to the recycling facility and the location of the recycling facility.

10. Retention of Records. The Company shall retain in its possession all records, documents, reports and data related to this Agreement for AT LEAST three years and shall make all such documentation available to the MPCA promptly upon request therefor.

11. Access. The Company shall allow the MPCA or any authorized representatives, employee or agent thereof, upon presentation of credentials, access at reasonable times to the Company's property and facilities to obtain such information and documentation as may be deemed by the MPCA staff to be relevant to a determination that the Company is in compliance with this Agreement. This paragraph is not intended to limit any authority which the MPCA may have under any existing law or rule.

12. Stipulated Civil Penalties for Violation of this Agreement

If the Company fails to make any submittal required in this Agreement, or to complete any other requirements in this Agreement, the Company shall pay into the Environmental Response, Compensation and Compliance Fund of the Treasury of the State of Minnesota the sum of One Thousand Dollars ($1,000) for each submittal not received by the MPCA, or each requirement not completed by the Company in a timely manner, for each day or portion thereof that such submittal is not received or such requirement is not completed. The Company shall not be liable for payment under this paragraph if it has submitted to MPCA staff a timely request for an extension of time for such submission and such extension has been granted.

If the MPCA staff determine that the Company has failed to make any required submittal or to complete any other requirement of this Agreement, the MPCA staff shall give written notice to the Company of such failure, specifying the provision(s) of this Agreement with which the Company has not complied. Payments required by the preceding paragraph shall accrue from the date on which the delinquent submittal was to have been made or the requirement was to have been completed and shall cease to accrue upon receipt of the required submittal by the MPCA staff or upon completion of the requirement. The Company shall pay any required sum WITHIN THIRTY (30) CALENDAR DAYS after receipt of notification from the MPCA staff that such payment is due. The Company retains the right to dispute the factual basis for the MPCA staff determination that the Company failed to satisfy a requirement of this Agreement, but the Company waives any right it may have to challenge, on legal grounds, the requirement that it pay a penalty pursuant to this Section 12.

The MPCA does not waive any of its rights to enforce this Agreement or to seek redress for any violation of this Agreement or for any other violations of statutes, ordinances, or rules. However, upon tender by the Company of a required payment for a violation of this Agreement, and acceptance thereof by the MPCA, the Company shall not thereafter be subject to any additional civil penalty for that violation for which payment was made.

13. Sampling and Data Availability. The Company shall make available to the MPCA staff the results of sampling, tests, or other data generated by or for the Company, or on its behalf, in connection with the requirements of this Agreement.

14. Reporting Noncompliance. As used herein, the term "noncompliance" refers to any failure, intentional or unintentional, avoidable or unavoidable, to satisfy any requirement of this Agreement.

a. If the Company discovers that noncompliance with a condition of the Agreement has occurred, which could endanger human health, or the environment, the Company shall, WITHIN 24 HOURS after the discovery of the noncompliance, orally notify the Commissioner. WITHIN 5 DAYS of the discovery of the noncompliance, the Company shall submit to the Commissioner a written description of the noncompliance, the cause of the noncompliance, the exact dates of the period of noncompliance, and, if the noncompliance has not been corrected, the anticipated time it is expected to continue and steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance.

b. For noncompliance occurrences not required to be reported under item III.B.14.a. above, the Company shall submit a written report to the Commissioner WITHIN 30 days after the noncompliance is discovered.

15. Personnel Training. The Company shall train all lamp storage facility personnel in the technique and the hazards of handling lamps. The Company must maintain documentation of this training.

16. Contingency Plan. The Company shall maintain a plan that describes the appropriate environmental and human health safeguards that will be in place and the procedures and equipment that will be employed in the event of an emergency. This plan shall be prepared in accordance with Minn. Rules pt. 7045.0572.

C. General Provisions.

1. Remedies of the Parties. The terms of this Agreement shall be legally enforceable in a Court of appropriate jurisdiction and the Commissioner retains the right to assert any legal, equitable or administrative right of action or defense that may be available by law or in equity in order to implement or enforce the terms of this Agreement.

2. Liability and Obligation. This Agreement shall not release the Company from any liability or any obligation imposed by Minnesota statutes, rules, or ordinances now in effect or which may be adopted in the future.

3. Emergency Powers. Nothing in this Agreement shall prevent the MPCA from exercising its emergency power pursuant to Minn. Stat. § 116.11 (1990).

4. Amendments. This Agreement may be amended at any time by written agreement between the parties.

5. Hold Harmless Agreement. The Company agrees to indemnify, save and hold the MPCA, its agents and employees harmless from any and all claims or causes of action arising from or on account of acts or omissions of the Company, its officers, employees, agents or contractors in implementing the requirements of or activities conducted pursuant to this Agreement. The Company shall not indemnify the MPCA nor save nor hold its employees or agents harmless from any claims or causes of action to the extent arising out of the acts or omissions of the MPCA or its employees or agents.

6. Other Claims. Nothing herein is intended to or shall release any claims, causes of action or demands in law or equity against any individual, firm, partnership or corporation not a signatory to this Agreement for any liability it may have arising out of or relating to the release of any pollutant or contaminate at, to or from the facility. The MPCA shall not be held as a party to any contract entered into by the Company to implement the requirements of this Agreement.

7. Successors. This Agreement shall be binding upon the Company, its successors and assigns, and upon the MPCA, its successors and assigns. Should the Company sell or otherwise convey or assign any of its right, title or interest in the site, such conveyance shall not release the Company from any obligation imposed by this Agreement, unless the party to whom the right, title or interest has been transferred or assigned agrees in writing to fulfill the obligations of this Agreement and MPCA staff approve such transfer or assignment.

8. Extension of Time. MPCA staff may grant extensions of time schedules stated herein in the event that the Company demonstrates good cause for granting such extensions and provided that any such extension shall not have any adverse effect upon the environment. Any request for extension must be submitted in writing and received by the Commissioner AT LEAST THREE (3) WORKING DAYS PRIOR to the applicable deadline.

9. Effective Date. The parties hereto understand that this Agreement is intended to state a short-term and temporary understanding regarding lamp storage facilities and is expected to be superseded by a more permanent agreement or storage permit, as the case may be. This agreement shall be effective upon the date it is signed by the MPCA Commissioner and shall remain in effect until such time that a regulatory framework is in place that supersedes this agreement, or at any time and for any reason upon notification to the Company by MPCA staff. Such a notification by the MPCA shall terminate this Agreement.

BY THEIR SIGNATURES HEREON, THE UNDERSIGNED REPRESENT THAT THEY HAVE THE AUTHORITY TO BIND THE PARTIES THEY REPRESENT, THEIR AGENTS, CONTRACTORS, AND SUBSIDIARIES

_____(Company)	MINNESOTA POLLUTION CONTROL AGENCY
By _____	By _____
Title _____	Title _____
Dated _____, 1993.	Dated _____, 1993

LANGUAGE REQUIRED FOR LETTER OF CREDIT.

A letter of credit, as specified in section 3, must be worded as specified in this part. The instructions in brackets must be replaced with the relevant information and the brackets deleted.

IRREVOCABLE STANDBY LETTER OF CREDIT

(Agency Commissioner)
Minnesota Pollution Control Agency
6th Floor
520 Lafayette Road
St. Paul, Minnesota 55155

Dear Commissioner:

We hereby establish our Irrevocable Standby Letter of Credit No. _____ in your favor, at the request and the account of [owner's or operator's name and address] up to the aggregate amount of [in words] U.S. dollars $_____, available upon presentation of:

1. your sight draft, bearing reference to this Letter of Credit No. _____, and

2. your signed statement reading as follows: "I certify that the amount of the draft is payable pursuant to the Minnesota Pollution Control Agency's Compliance Agreement Regarding Short-Term Storage of Mercury-Containing Waste Lamps, and entered into with_____.

This Letter of Credit is effective as of [date] and shall expire on [date at least one year later], but the expiration date shall be automatically extended for a period of [at least one year] on [date] and on each successive expiration date, unless, at least 120 days before the current expiration date, we notify you by certified mail that we have decided not to extend this Letter of Credit beyond the current expiration date. In the event you are so notified, any unused portion of the credit shall be available upon presentation of your sight draft for 120 days after the date of receipt by you, as shown on the signed return receipt.

Whenever this Letter of Credit is drawn on and under and in compliance with the terms of this credit, we shall duly honor the draft upon presentation to us and we shall deposit the amount of the draft directly into the standby trust fund of [owner's or operator's name] in accordance with your instructions.

[SIGNATURE(S) AND TITLE(S) OF OFFICIAL(S) OF ISSUING INSTITUTION]
[DATE]

This credit subject to (insert the most recent edition of "the Uniform Customs and Practice for Documentary Credits, published by the International Chamber of Commerce," or "the Uniform Commercial Code published in Minnesota Statutes, chapter 336").

LANGUAGE REQUIRED FOR TRUST AGREEMENT.

A trust agreement for a trust fund as specified in section 3 must be worded as specified in this part. Instructions in brackets must be replaced with the relevant information and the brackets deleted.

TRUST AGREEMENT

This Trust Agreement (the "Agreement") is entered into on (date) by (name of the owner or operator), a (name of state) (insert "corporation," "partnership," "association," or "proprietorship"), the "Grantor," and (name of corporate trustee), (insert address) "incorporated in the state of _____" or "a national bank"), the "Trustee."

WITNESSETH:

RECITALS:

- The Minnesota Pollution Control Agency (Agency), an agency of the State of Minnesota, requires an owner or operator of a mercury-containing fluorescent lamp storage Facility ("Facility" or "Facilities", as the case may be) to provide assurance that funds will be available when needed for closure for the Facility(ies).

- The Grantor has chosen to provide an irrevocable standby letter of credit (the "Letter of Credit") to provide the financial assurance for the Facility(ies) identified in this Agreement, and has agreed that: (a) if the Agency shall at any time make a draft or drafts upon said Letter of Credit the proceeds of each such draft shall be paid into a trust fund as established by this Agreement; and (b) the Agency may thereafter direct the Trustee hereunder to make payments from said trust fund to cover or reimburse for costs incurred in closure of the Facility(ies).

- The Grantor, acting through its duly authorized partner or officer, has selected the Trustee to be the trustee under this Agreement, and the Trustee is willing to act as trustee, and to make such payments as directed by the Agency.

AGREEMENT:

The Grantor and the Trustee agree as follows:

Section 1. Definitions. As used in this Agreement, the term "Grantor" means the owner or operator who enters into this Agreement and any heirs, successors or assigns of the Grantor, the term "Trustee" means the Trustee who enters into this Agreement and any successor Trustee, and the term "beneficiary" means the Agency.

Section 2. Identification of Facilities and Cost Estimates. This Agreement pertains to the Facilities and cost estimates, if any, identified on attached Schedule A [on Schedule A, for each Facility list the name, address, and the current closure cost estimate for which financial assurance is demonstrated by this Agreement].

Section 3. Establishment of Fund. The Grantor and the Trustee hereby establish a standby, but presently unfunded, trust fund (the "Fund"), for the benefit of the Agency, and for the purpose of satisfying the obligations of Grantor under that Compliance Agreement Regarding Short-Term Storage of Mercury-Containing Waste Lamps, between Grantor and the Agency, dated _____. The Grantor and the Trustee intend that no third party have access to the Fund except as provided in this Agreement. Any money transferred to the Trustee at any time in connection herewith, together with all earnings and profits, less any payments or distributions made by the Trustee under this Agreement, is referred to as the Fund. The Fund shall be held by the Trustee, IN TRUST, as provided in this Agreement. The Trustee shall not be responsible or undertake any responsibility for the amount or adequacy of, or any duty to collect from the Grantor, any payments necessary to discharge any liabilities of the Grantor established by the Agency.

Section 4. Payment for Closure. The Trustee shall make payments from the Fund as the Agency Commissioner shall from time to time direct, in writing, to provide for the payment of the costs of or related to closure of the Facilities covered by this Agreement. The Trustee shall reimburse the Grantor or other persons as specified by the Agency Commissioner shall direct in writing. In addition, the Trustee shall refund to the Grantor the amounts the Agency Commissioner specifies in writing. Upon refund, these funds shall no longer constitute part of the Fund.

Section 5. Payments Comprising the Fund. Payments made to the Trustee for the Fund shall consist of cash, including, without limitation, proceeds from any draft upon the Letter of Credit.

Section 6. Trustee Management. The Trustee shall deposit all cash in the Fund in interest-bearing accounts maintained or savings certificates issued by the Trustee, in its separate corporate capacity, or in any other banking institution affiliated with the Trustee, in its separate corporate capacity, or in any other banking institution affiliated with the Trustee, in each case only to the extent insured by an agency of the federal or state government.

Section 7. Taxes and Expenses. All taxes of any kind that may be assessed or levied against or in respect of the Fund shall be paid from the Fund. All other expenses incurred by the Trustee in connection with the administration of this Trust, including fees for legal services rendered to the Trustee, the compensation of the Trustee to the extent not paid directly by the Grantor, and all other proper charges and disbursements of the Trustee shall be paid from the Fund.

Section 8. Annual Valuation. The Trustee shall annually, at least 30 days prior to the anniversary date of establishment of the Fund, furnish to the Grantor and to the Agency Commissioner a statement confirming the amount of the Trust. The failure of the Grantor to object in writing to the Trustee within 90 days after the statement has been furnished to the Grantor and the Agency Commissioner shall constitute a conclusively binding assent by the Grantor, barring the Grantor from asserting any claim or liability against the Trustee with respect to matters disclosed in the statement.

Section 9. Advice of Counsel. The Trustee may from time to time consult with counsel with respect to any question arising as to the construction of this Agreement or any action to be taken hereunder. The Trustee shall be fully protected, to the extent permitted by law, in acting in good faith upon the advice of counsel.

Section 10. Trustee Compensation. The Trustee shall be entitled to reasonable compensation for its services as agreed upon in writing from time to time with the Grantor.

Section 11. Successor Trustee. The Trustee may resign or the Grantor may replace the Trustee, but the resignation or replacement shall not be effective until the Grantor has appointed a successor trustee acceptable to the Agency and this successor accepts the appointment. The successor trustee shall have the same powers and duties as those conferred upon the Trustee hereunder. Upon the successor trustee's acceptance of the appointment, the Trustee shall assign, transfer, and pay over to the successor trustee the funds then constituting the Fund. If for any reason the Grantor cannot or does not act promptly in the event of the resignation of the Trustee, the Trustee may apply to a court of competent jurisdiction for the appointment of a successor trustee or for instructions. The successor trustee shall specify the date that it assumes administration of the trust in a writing sent to the Grantor, the Agency Commissioner and the present Trustee by certified mail ten days before the change becomes effective. Any expenses incurred by the Trustee as a result of any of the acts contemplated by this Section shall be paid as provided herein.

Section 12. Instructions to the Trustee. All orders, requests, and instructions by the Agency Commissioner to the Trustee shall be in writing, signed by the Agency Commissioner, and the Trustee shall act and shall be fully protected in acting in accordance with the orders, requests, and instructions. The Trustee shall have the right to assume, in the absence of written notice to the contrary, that no event constituting a change or a termination of the authority of any person to act on behalf of the Grantor or the Agency under this Agreement has occurred. The Trustee shall have no duty to act in the absence of orders, requests, and instructions from the Agency Commissioner except as provided in this Agreement.

Section 13. Amendment of Agreement. This Agreement may be amended by an instrument in writing executed by the Grantor and the Trustee, and with the written approval of the Agency Commissioner, or by the Trustee and the Agency Commissioner, if the Grantor ceases to exist or cannot reasonably be located.

Section 14. Irrevocability and Termination. Subject to the right of the parties to amend this Agreement as provided herein, this Trust shall be irrevocable and shall continue until terminated by the written agreement of the Grantor, the Trustee, and the Agency Commissioner or by the Trustee and the Agency Commissioner if the Grantor ceases to exist or cannot reasonably be located. Upon termination of the Trust, all remaining trust property, less final trust administration expenses, shall be delivered to the Grantor or any heirs, successors or assigns of the Grantor.

Section 15. Immunity and Indemnification. The Trustee shall not incur personal liability of any nature in connection with any act or omission, made in good faith, in the administration of this Trust, or in carrying out any directions by the Agency Commissioner issued in accordance with this Agreement. The Trustee shall be indemnified and saved

harmless by the Grantor or from the Trust Fund, or both, from and against any personal liability to which the Trustee may be subjected by reason of any act or conduct in its official capacity, including all expenses reasonably incurred in its defense in the event the Grantor fails to provide a defense.

Section 16. Choice of Law. This Agreement shall be administered, construed, and enforced according to the laws of the State of Minnesota.

Section 17. Interpretation. As used in this Agreement and as appropriate, words in the singular include the plural and words in the plural include the singular. The descriptive headings for each Section of this Agreement shall not affect the interpretation or the legal efficacy of this Agreement.

The parties have caused this Agreement to be executed by their respective officers or partners, as the case may be, duly authorized and their corporate seals, if appropriate, to be affixed and attested on the date first above written. The parties below certify that the wording of this Agreement is identical to the wording specified by the Minnesota Pollution Control Agency.

[SIGNATURE OF GRANTOR]
[TITLE]

Attest:

[TITLE]
[SEAL]

[SIGNATURE OF TRUSTEE]

Attest:

[TITLE]
[SEAL]

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