APPENDIX I

TECHNICAL MEMORANDUM:
End-of-Life Approach for the DfE Computer Display Project

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APPENDIX I

TECHNICAL MEMORANDUM:
End-of-Life Approach for the DfE Computer Display Project

I. INTRODUCTION

The Computer Display Project, sponsored by the U.S. Environmental Protection Agency (EPA) as part of its Design for the Environment (DfE) program, is investigating the life-cycle impacts of cathode ray tube (CRT) displays and liquid crystal displays (LCDs) for use in desktop computers.

A meaningful comparison of the two technologies from the environmental perspective can be made only if the life-cycle impacts associated with various stages, namely, raw material extraction, materials processing, manufacture, use, and end-of-life (EOL), are evaluated. The functional units being compared are the 17-inch CRT display monitor and the 15-inch active matrix liquid crystal display (AMLCD) monitor. The two are considered to be functionally equivalent with respect to the viewing area available to the user. EOL issues are of growing interest to manufacturers nowadays due to Extended Producer Responsibility (EPR) concerns (Fishbein 1998) and the consequent higher expectations from manufacturers for influencing the ultimate fate of their products.

The purpose of this memorandum is to describe the approach for evaluating the EOL life-cycle stages of CRTs and AMLCDs for the Computer Display Project. This approach includes:

(1) developing scenarios to represent reasonable EOL alternatives; and
(2) collecting life-cycle inventory (LCI) data for the EOL alternatives.

1.1 Background

Estimates from 1998 revealed that more than 20 million personal computer central processing units (CPU) became obsolete in that year (NSC 1999). Earlier estimates indicated that approximately 10 million television sets and 12 million computer monitors reach the end of their useful lives each year (MCC 1996). Assuming that one monitor became obsolete for every CPU in 1998, and since LCDs have not been in existence long enough to have attained "end-of-life" (EOL) status in sufficiently large numbers, it is expected that approximately 20 million CRTs are retired annually. There is not much information available on the disposition options for LCDs.

The major existing EOL environmental concern associated with CRTs is disposal of leaded glass. LCDs, on the other hand, do not contain any leaded glass and are much lighter in weight, but contain other materials of concern, such as mercury used in the backlights.

1.1.1 CRT EOL Issues

According to practices followed by leading CRT recyclers such as Envirocycle (Envirocycle 1999), the material of greatest value recovered from CRTs is leaded glass (which is also the major component by weight), followed by small quantities of metals. Also, whenever the incoming EOL product is a complete computer monitor, some plastics and metals can be recovered from its outer casing and other parts.

The closed loop recycling of leaded glass involves recovering and processing the material for use as cullet in the manufacture of new CRTs. CRT manufacturers will use the cullet if it meets quality standards and is of the same chemistry and type as required by them in their manufacturing operations. Thus, effective recycling of post-consumer CRT glass requires very careful sorting and separation into various types, followed by decontamination (removal of coatings). Resmelting (for lead recovery) and downcycling (into other glass applications) are some of the other "open loop recycling" alternatives. In 1997 and 1998, CRT computer monitor recycling was done for 1.3 million units (46 million pounds) and 1.5 million units (51 million pounds), respectively (NSC, 1999).

1.1.2 Regulations Regarding CRT Disposal

Color CRTs may fail the EPA Toxicity Characteristic Leachate Procedure (TCLP) test, and therefore may be classified as hazardous waste under current EPA regulations. Some experts believe that this classification poses barriers to the effective recycling of CRTs, on account of special permits and transportation requirements for handling hazardous waste (EPA-CSI 1999). However, EPA has implemented a glass-to-glass recycling exception.

In order to landfill CRTs in accordance with EPA regulations, they must be dismantled, and the glass crushed and stabilized by micro-encapsulation in cement. However, this method has some drawbacks. Crushing increases surface area and, consequently, the potential to leach lead. Though cement encapsulation is the required method, it has been found that cement disintegrates faster than glass (MCC 1994).

To encourage recycling, some states have developed new initiatives that will ease some of the regulatory barriers. Massachusetts, for example, has proposed to specifically exempt "intact" CRTs from being classified as hazardous waste and simultaneously banned them from disposal in municipal landfills and combustion facilities (MDEP 1999). These measures could promote the recycling of CRTs by making the process of handling and transportation much easier, and the paperwork less cumbersome.

1.1.3 LCD EOL Issues

Currently, no infrastructure or established process exists for recycling LCDs specifically. Of the small numbers of LCDs that have reached the EOL stage (predominantly as notebook computers), a much smaller number is likely to have reached recycling facilities. No specific details are available on the materials recovered from them as they are expected to have been processed along with other electronic products, with some valuable and/or potentially recyclable materials removed. The following components and materials of potential reuse or recycling value found in LCDs have been identified by MCC (MCC 1994):

- Thin film transistors (TFTs).
- Color filters.
- Glass.

The toxicity potential of heavy metals is of concern in the EOL stage. The heavy metals found in the LCD monitors are identified in the main body of this LCA report. This study will consider the presence of heavy metals or other materials of potential concern in the wastes and emissions generated.

1.2 EOL Disposition Options

In the past, landfilling has been the prevalent method for the disposition of post-use computer monitors (i.e., those re-used after being resold or donated). However, with increasing awareness of potentially harmful life-cycle environmental impacts, dwindling natural resources, government regulations against disposal of toxic substances in landfills, and the consequent development of markets for recycled components and materials, more options are now available for the disposition of post-use computer monitors. They are briefly described below.

1.2.1 Reuse

Reuse, often as a result of reselling, involves continued use of the monitor for the purpose for which it was built, and is considered to occur within its originally intended useful life. Reuse does not usually entail major repairs or modifications, and is a preferred EOL option because the original materials contained in it are put to use for an extended period of time, thus conserving valuable natural resources (energy and raw materials) needed to manufacture new monitors or to dispose of discarded ones. However, reuse could result in reduced energy efficiency during the use stage as monitor manufacturers continually strive to improve the energy efficiency of their products.

1.2.2 Remanufacturing

Remanufacturing is a viable option for monitors that are no longer functional but could be refurbished (upgraded or restored to working conditions) at a cost lower than that of manufacturing a new monitor, to be sold again in domestic or foreign markets.[1] Here again, energy and raw materials are conserved, though some new parts/components may be required. Another important benefit of remanufacturing is solid waste reduction, achieved by diverting the monitor materials away from the landfill. Remanufacturing processes span a wide range of activities, from as little as replacing button tops to as extensive as testing and replacing PCBs or transformers.

[1] In addition to cost, the arrival of new technology is another factor that inhibits remanufacturing. In such cases, remanufacturers seek to find markets where products based on old technology are still in demand.

1.2.3 Recycling

Recycling involves recovering the individual materials from EOL monitors, to be used in the production of new monitors (closed-loop recycling) or in other products (open-loop recycling). Identification, sorting, cleaning, and further processing (e.g., smelting) are often required before the recovered materials can be used again. Though materials recycling involves several processing steps, it results in the conservation of energy and raw materials, and diversion of materials that would otherwise have been landfilled, through the creation of new, desirable products that are in-line with current market demand.

1.2.4 Waste-to-Energy (WTE) Incineration

A portion of municipal solid waste (MSW) is routinely sent to incinerators or municipal waste-to-energy (WTE) facilities for energy recovery. The quantity of ash (bottom ash and fly ash) left over is a small fraction, around 25% (EPA 1998) of the original waste input, and can be disposed of either as non-hazardous or hazardous waste, depending on whether it passes the TCLP test or not. The obvious benefits are reduced solid waste and the energy produced, which is often counted as a credit in life-cycle energy calculations.[2]

1.2.5 Landfilling

Landfilling solid waste in Subtitle C (for hazardous) or D (for non-hazardous) landfills is the least preferred option, since all the other options have some expected environmental benefits. The disposal of waste in Subtitle C landfills is usually the most undesirable, as it often involves treatment to immobilize the hazardous materials before they can be landfilled, thus increasing the quantity and cost of disposal. Also, hazardous waste sites have the potential to turn into high liability ("Superfund") sites. Some states have regulatory activities that might not accept monitors in Subtitle D landfills.

2. METHODOLOGY

This section outlines key assumptions, defines conceptual models proposed for determining the flow of materials through the EOL processes, and highlights some important issues pertaining to CRTs and LCDs.

The major steps are listed below:

- Assumptions about the distribution of EOL options were made.
- Data were collected for various disposition options using existing inventory reports and inventory questionnaires sent to recyclers.
- Data were normalized to the functional unit and included as the EOL inventories.

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[2] The energy used in different life-cycle stages is summed up to arrive at the total energy used in the life cycle of the product. In case of WTE incineration, where energy is recovered instead of being used up, it is treated as a negative value and subtracted from the total.

2.1 EOL Conceptual Models

A monitor is assumed to have reached EOL status when:

- It has served its useful life and/or is no longer functional.
- Technological obsolescence renders it unusable.

The EOL options for CRT and LCD monitors are graphically depicted in Figure 1. Estimates of the percent distribution of monitors going to each EOL option are presented below. As the functional unit in this study is one monitor over its lifetime, the percentages are used as probabilities for the EOL disposition of a particular monitor.

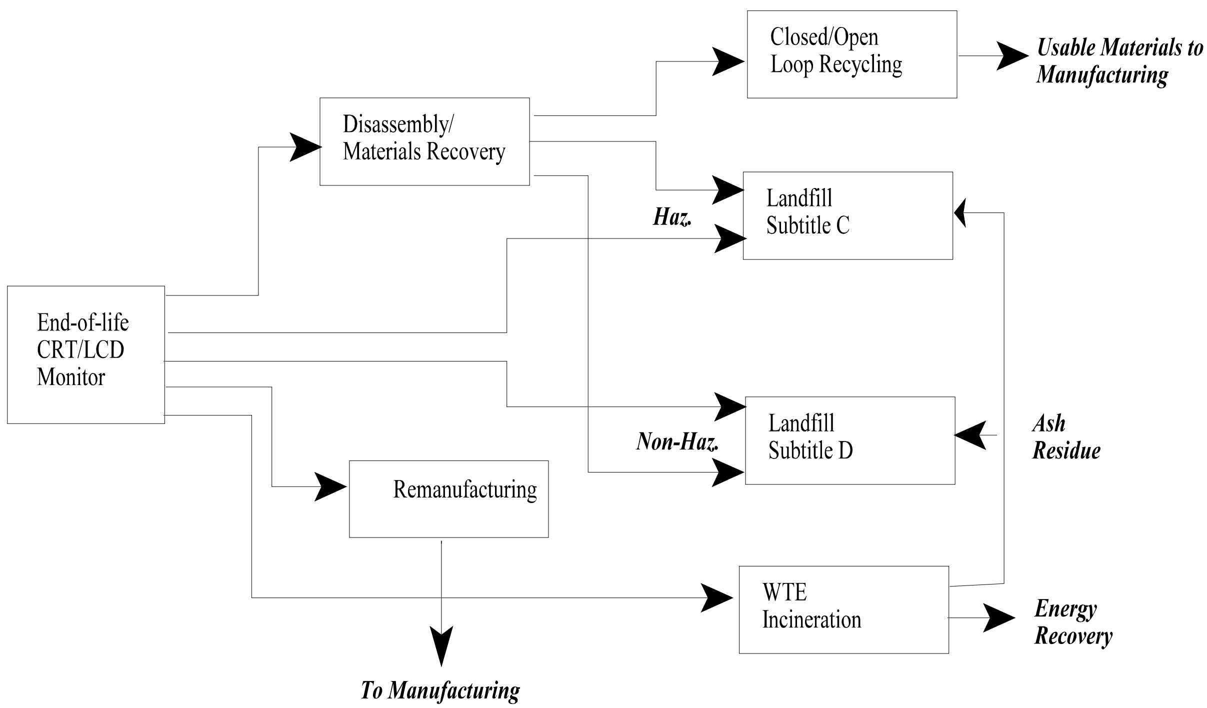

Figure 1. Conceptual Model Showing End-of-Life Disposition Options for CRT and LCD Monitors

2.2.1 CRT

The National Safety Council (NSC 1999) reported that 11% of all personal computer CPUs are recycled. Assuming one monitor is recycled with every CPU, and assuming these represent CRTs, we assume 11% of CRTs go to recycling. The NSC report also stated that 3% of personal computers are "refurbished and resold or donated." We thus used 3% as an estimate of the CRT monitors that are remanufactured, although we recognize this might be an overestimate, as we do not know if those resold and donated are also remanufactured. Given that this is a small percentage, this error is not expected to have a large effect. Further data are lacking on the percent of monitors being incinerated or going to landfills. To estimate the percent incinerated, we used the percent of all municipal solid waste in the United States being incinerated, which is estimated at 15% (EPA 1998). Summing the percents for recycling, re-manufacturing, and incineration equals 29%. This leaves 71% that is assumed to be landfilled. In the life-cycle analysis in this study, only one landfilling process is modeled, which is assumed to represent both hazardous waste and solid waste landfilling. The landfilling process is derived from Ecobalance data and is a combination of four major materials in a CRT (glass, steel, plastic, and aluminum), based on the proportion of each of those materials in the CRT. The inventories for each material are of generic materials (not necessarily the precise materials in the CRT). For example, the glass is generic glass, and not leaded glass, and the plastics are generic "plastic" and may not represent the exact plastics in the CRT.

Although the percentage of monitors that are landfilled are not separated into hazardous and non-hazardous waste landfilling processes, we have still attempted to estimate the proportion of CRTs that go to each landfill. Due to a lack of data, we assumed as a best estimate that the percent of monitors that are in households are equivalent to the percent of landfilled monitors that would be disposed of in a solid waste (Subtitle D) landfill and the percent of monitors that are in businesses would be disposed of in a hazardous waste (subtitle C) landfill. As presented in the Use Stage discussion in the main body of this report (Section 2.4.1.2), 35% of monitors are in households and 65% are in office and other environments. Therefore, of the 71% of monitors assumed to going to landfills, 25% are assumed to be sent to solid waste landfills and 46% to hazardous waste landfills. To summarize, the EOL dispositions assumed for the CRT are as follows:

- Incineration: 15%
- Recycling: 11%
- Remanufacturing: 3%
- Hazardous waste landfill: 46%
- Solid waste landfill: 25%

2.2.1 LCD

Data were even more lacking for the EOL dispositions of LCDs. The same 15% of municipal solid waste incinerated in the United States was assumed for LCD incineration as it was for the CRT. An individual in the monitor recycling business estimated that no more than 5% of LCDs are sent to hazardous waste landfills and that essentially none are currently being recycled (Vorhees 2000). Given this limited data, the remaining 80% needed to be split between solid waste landfilling and remanufacturing. Given no other data, we assumed half of the remaining 80% goes to solid waste landfills and half to remanufacturing. Assuming that 40% are remanufactured is likely an overestimate; however, no supporting data were available to modify this estimate. Therefore, in the baseline analysis of this study, the following percentages have been used:

- Incineration: 15%
- Recycling: 15%
- Remanufacturing: 15%
- Hazardous waste landfill: 5%
- Solid waste landfill: 50%

Sensitivity analyses have been conducted to determine the effects of these assumptions on the results and are discussed in Chapters 2 (LCI) and 3 (LCIA) of the main report.

2.2 Assumptions

In developing the EOL model for CRT and LCD monitors, it was necessary to make several assumptions. In addition to the percent distributions presented above, the following assumptions apply to the EOL data:

- Reuse and resale are not included in the EOL scenarios modeled as these events are considered to occur within the originally intended useful life of the monitor.
- The monitors currently in storage are not considered to have reached EOL yet and have, therefore, been excluded from the EOL model. Moreover, they are assumed not to have environmental impacts while in storage, and maintenance of storage space is assumed to the beyond the scope of this study.
- Only waste-to-energy incineration is modeled because there is very limited straight incineration (without energy recovery) being done in the U.S. at present. In fact, the 1996 total U.S. WTE design capacity was 100,355 tons per day, with 110 WTE facilities in operation. In contrast, the capacity for incineration without energy recovery was only 2,451 tons per day, with a total of 19 facilities in operation. In general, WTE has become the prevalent method for MSW combustion since the 1980s (EPA 1998).

REFERENCES

CIA (Computer Industry Almanac). 1999. Web site available: http://www.c-i-a.com/19961225.htm . April 30.

Denison, R. 1996. "Environmental Life-Cycle Comparisons of Recycling, Landfilling, and Incineration." R.A. Denison, Environmental Defense Fund.

EIA (Energy Information Administration). 1999. Web site availble: http://www.eia.doe.gov/emeu/recs/recs97/appusage.html#pcusage. April 30

Envirocycle. 1999. Web site available: http://www.enviroinc.com/. March 8.

EPA (Environmental Protection Agency). 1998. "Characterization of Municipal Solid Waste in the United States: 1997 update." U.S. EPA Office of Solid Waste, Report No. EPA530-R-98-007. Prepared by Franklin Associates. May.

EPA. 1998. "Characterization of Municipal Solid Waste in the United Sates: 1997 Update." Report No. EPA 530-R-98-007.

EPA. 1999. EPA website 4/26/99. http://www.epa.gov/ooaujeag/taskforce/issppr1.htm

EPA-CSI. 1999. U.S. EPA's CSI web pages 4/26/99. http://www.epa.gov/csi/computer/accomp6.htm

Fishbein, B.K. 1998. "EPR: What Does It Mean? Where Is It Headed?" *Pollution Prevention Review.* **8** (4): 43-55. John Wiley & Sons, Inc. October.

Laboratory Network. 1999. Web site available: http://news.laboratorynetwork.com/regulatory-news/19981211-6948.html. April 26.

MCC (Microelectronics and Computer Technology Corporation). 1994. *Electronics Industry Environmental Roadmap.* Chapter 7.

MCC. 1996. "1996 Electronics Industry Environmental Roadmap." June.

MDEP (Massachusetts Department of Environmental Protection). 1999. Web site available at: http://www.state.ma.us/dep/bwp/dswm/files/crtq&a.htm. March 12.

NSC (National Safety Council). 1999. *Electronic Product Recovery and Recycling Baseline Report: Recycling of Selected Electronic Products in the United States*. Washington, DC, National Safety Council. May.

RTI (Research Triangle Institute). 1999. Personal Communication with K. Weitz. "EOL Management Options for MSW." February.

Scott, M.H., F.C. McMichael, C.T. Hendrickson, and D.J. Hart. 1997. "Disposition and End-of-Life Options for Personal Computers." Green Design Initiative Technical Report #97-10, Carnegie Mellon University.

Tufts University. 1996. "Life Cycle Assessment of the Disposal of Household Electronics." A Capstone Thesis Project for M.S. in Civil and Environmental Engineering, submitted by D. McKenna, K. Powers, and S. Reagan, p. 5-6. August.

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ATTACHMENT A TO APPENDIX EOL:
EOL QUESTIONNAIRE

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DESIGN FOR THE ENVIRONMENT COMPUTER DISPLAY PROJECT
Life-Cycle Inventory (LCI) Data Collection Questionnaire for the End-of-Life Stage

U.S. EPA

Introduction
The Design for the Environment (DfE) Program in the U.S. Environmental Protection Agency's (EPA) Office of Pollution Prevention and Toxics has begun a voluntary, cooperative project with the electronics industry to assess the life-cycle environmental impacts of cathode ray tube (CRT) and liquid crystal display (LCD) desktop monitors. The DfE Program conducts comparative analyses of alternative products or processes to provide businesses with data to make environmentally informed choices about product or process improvements. The DfE Program has no regulatory or enforcement agenda and was established to act as a partner with industry to promote pollution prevention. This environmental life-cycle assessment will address human and ecological risk, energy and natural resource use, performance, and cost of various display technologies. The University of Tennessee (UT) Center for Clean Products and Clean Technologies is conducting the life-cycle inventory (LCI), which is the data collection phase of a life-cycle assessment, with technical assistance from Microelectronics and Computer Technology Corporation, the Electronics Industry Alliance, and other partners.

Boundaries
A *life-cycle* assessment considers impacts from materials acquisition, material manufacturing, product manufacturing, use, and final disposition of a product. The LCI data are intended to be used to evaluate relative environmental impacts over the entire life-cycle of a product, including transport between life-cycle stages. In this project, the product is either a color CRT or LCD monitor. Therefore, data associated with the materials and processes used directly in the manufacturing, use, and disposition of the product are relevant to the LCI and requested in this questionnaire. Please include only materials or energy *directly* used in the disassembly, remanufacturing, recycling, or disposal of the monitor or its components (e.g., *do not include* general building heating and air conditioning).

Product focus
This project focuses on 17" CRT and 15" LCD desktop monitors. We will appreciate your providing data specifically on these sizes, to the extent possible.

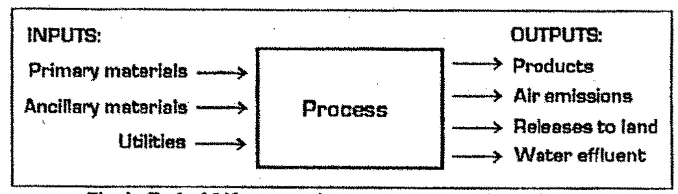

Fig. 1. End-of-Life process inventory conceptual template

Inventory data
We are asking you for data on CRT and LCD desktop monitors that you either remanufacture, or disassemble and recover, reuse, or recycle components and materials from. The inputs and outputs data (Fig. 1) that you provide will be aggregated in the LCI to quantify the overall inputs and outputs of a CRT and LCD. Additionally, transportation information is requested in the inventory.

Data sources
Much of the requested information can be drawn from existing sources, including, but not limited to the following:

1. Purchase and production records
2. Bills and invoices
3. Material Safety Data Sheets (MSDS)
4. Toxic Release Inventory (TRI) forms
5. Audit and analysis results (e.g., wastewater discharge analyses)
6. Local, state, and federal reporting forms (e.g., hazardous waste manifests)
7. Local, state, and federal permits
8. Monthly utility billing records

How the data will be used
UT will collect inventory data and tally the inputs and outputs for the different monitors. Information gathered by these questionnaires will be used to develop environmental profiles based on inputs and outputs for each stage in the life cycle of displays. The profiles will be used to evaluate environmental impacts from each product. Cost data will also be collected and presented along with environmental results. The environmental profiles can be used to encourage product design changes for product improvement. UT will aggregate data and ensure that data associated with particular companies remain anonymous to the EPA. UT can enter into confidentiality agreements where proprietary data are concerned. Please understand that accurate and representative information from you is critical for the success of this project.

Results of project
The results are intended to provide industry with an analysis of the life-cycle environmental impacts, cost, and performance of CRT and LCD computer monitors. Results will help identify areas for product and process improvement as related to risk and environmental impact (e.g., identifying material use inefficiencies) and will identify impacts from various life-cycle stages of the product systems. Use of the results will also help meet growing global demands of extended product responsibility.

Benefits of involvement
Your input will allow for your interests to be considered in the project development and data collection. By supplying data, the results will partially reflect your operations and, therefore, the results will be directly relevant to your interests. The project will allow you to directly apply results to your own processes and identify areas for improvement. You will also be recognized as working voluntarily and cooperatively with the U.S. EPA.

Deadline
Please complete this form and return it to us at the address below by ***September 30, 1999***. If this is not possible, please contact Maria Leet Socolof at 423-974-9526 or at the addresses below to discuss alternative dates.

Your cooperation and assistance are greatly appreciated.

For any questions, please contact ***Maria Leet Socolof at 423-974-9526,*** *<socolofml@utk.edu> or* ***Rajive Dhingra at 423-974-8752,*** *<rdhingra@utk.edu> at the University of Tennessee, 311 Conference Center Bldg., Knoxville, TN 37996-4134.*
For more project details, see the Project Fact Sheet, DfE Website <http://www.epa.gov/opptintr/dfe/compdisp/compdisp.html>, or the Draft Final Goal Definition and Scoping Document.

EOL Data Collection Form - p. ii

INSTRUCTIONS

1. Please be sure to read the introductory text on each page before filling out the questionnaire.
2. The data you supply in the tables should represent inputs and outputs associated only with the "**product of interest**" (**i.e., materials, components or subassemblies that are either part of, or that are itself, the desktop monitor as defined on p. i under Product focus**). If quantities provided are not specific to the "product of interest," please explain how they differ in the comments section at the bottom of the appropriate table.
3. Where supporting information is available as independent documents, reports or calculations, please provide them as attachments with reference to the associated page(s) or table(s) in this questionnaire.
4. If you have more than one product of interest to this project, please duplicate this questionnaire and fill out one questionnaire for each product.
5. If there is not adequate room on a page to supply your data (including comments), please copy the appropriate page and attach it to this packet.
6. The ensuing pages refer to the four indices shown below to detail specific information about the data. Additional information is provided below as required.
   Data Quality Indicators Index: These indicators will be used to assess the level of data quality in this questionnaire. Please report a DQI for the numerical value requested in each table on the following pages. The first category, Measured, pertains to a value that is a directly measured quantity. The second category, Calculated, refers to a value that required one or more calculations to obtain. The third category, Estimated, refers to a value that required a knowledgable employee's professional judgement to estimate. Lastly, the fourth category, Assumed, should be used only when a number had to be guessed.
   Hazardous and Nonhazardous Waste Management Methods Index: These methods are applicable to both hazardous and nonhazardous wastes (Tables 8a and 8b). Please give the appropriate abbreviation in the Management Method column on p. 8 where requested. Depending on whether the management method is on or offsite, please indicate by specifying "on" or "off" in the appropriate column on p. 8.

For Tables 2, 3a, 3b, 4, 5, 8a, and 8b:

Transportation Modes Index	
A	- Large truck (18-wheeler), diesel
B	- Small truck, diesel
C	- Small truck, gasoline
D	- Rail, diesel
E	- Barge, diesel
F	- Ocean freighter, diesel
G	- Other (please specify in comments section)

For Table 7b:

Wastewater Treatment/Disposal Methods Index	
A	- Direct discharge to surface water
B	- Discharge to offsite wastewater treatment facility
C	- Underground injection
D	- Surface impoundment (e.g., settling pond)
E	- Direct discharge to land
F	- Other (please specify in comments section)

For Tables 3a, 3b, 4, 5, 6, 7a, 8a and 8b:

Data Quality Indicators Index	
M	- Measured
C	- Calculated
E	- Estimated
A	- Assumed

For Tables 8a and 8b:

Hazardous and Nonhazardous Waste Management Methods Index	
RU	- Reused
R	- Recycled
L	- Landfilled
Iv	- Incinerated - volume reduction
Ie	- Incinerated - energy conversion
S	- Solidified/stabilized
D	- Deep well injected
O	- Other (please specify in comments section)

IF YOU HAVE QUESTIONS, PLEASE CONTACT EITHER:

Maria L. Socolof (Project Manager): Phone: 423-974-9526 Email: socolofml@utk edu

OR

Rajive Dhingra (Project Engineer): Phone: 423-974-8752 Email: rdhingra@utk.edu

1. FACILITY & CONTACT INFORMATION

Table 1.

Facility Information		Contact Information	
1. Company name:		5a. Prepared by:	Date:
2. Facility name:		5b. Title:	
3 Facility address (location):		5c. Phone number:	Ext.:
		5d. Fax number:	
		5e. Email address:	
4. Products handled onsite:			

2. PRODUCT OF INTEREST INFORMATION

Table 2.

1. Product of interest: ______________________
   E.g., End-of-Life CRT/LCD desktop monitor

2. No. of monitors processed annually (e.g., units, kg, lbs): ______________________

3. Facility's percent global market share for handling product of interest: ______________________

4. Product of interest unit weight: ______________________

5. Brief description of the main operations/subprocesses required to process the product of interest: ______________________

____

____

6. Product transport information. In this table, please list the top five locations (by quantity) from where you receive the product of interest. See Transportation Modes Index on p. iii for modes' abbreviations. Percent capacity represents what percent of the transport vehicle's total load was carrying the products of interest.

Location (City, State)	Mode	Number of trips annually	Percent capacity
1)			
2)			
3)			
4)			
5)			

EOL Data Collection Form - p. 2

3. PRIMARY & ANCILLARY INPUTS

1. Primary & Ancillary Materials: Primary materials are defined as those materials that become part of a product output. Ancillary materials are those material inputs that assist in a process, yet do not become part of the final product. Please include the trade name and the generic name of each material where applicable.
2. CAS # or MSDS: Please include either the CAS (Chemical Abstract Service) number of each material (fill in the blank with the number), or state "MSDS" and append a copy to this document.
3. Annual quantity/units & Density/units: Please specify the amount of material consumed annually. Please use the units of mass-per-year (e.g., kg/yr, lb/yr). If you specify units of volume in lieu of mass, please provide the density.
4. Data quality indicators: See the Data Quality Indicators Index on p. iii for abbreviations. Please supply the DQI for the *annual quantity* value given.
5. Recycled content: Please specify the recycled content of each material identified. For example, 60/40/0 would represent a material that has 60% virgin material, 40% pre-consumer recycled and 0% post-consumer recycled content. Enter N/A (not applicable) for all components that are assemblies.
6. Transportation information: See the Transportation Modes Index on p. iii for mode abbreviations. Please specify where the material is coming from (location) and the number of trips made to your facility on an annual basis. % capacity represents what percent of the transport vehicle's total *load* was carrying the materials of interest.

Table 3a. Primary Materials[1]		CAS # or MSDS[2]	Annual Quantity[3]	Units	Density[3]	Units	DQI [4]	Recycled Content[5]	Transportation Information (Receiving)[6]			
									Location	Mode	# trips	% cap.
1.												
2.												
3.												
4.												
5.												
6.												
7.												

Primary material comments:

Table 3b. Ancillary Materials[1]		CAS # or MSDS[2]	Annual Quantity[3]	Units	Density[3]	Units	DQI [4]	Recycled Content[5]	Transportation Information (Receiving)[6]			
									Location	Mode	# trips	% cap.
1.												
2.												
3.												
4.												
5.												
6.												
7.												

Ancillary material comments:

4. UTILITY INPUTS

1. Annual quantity/units: Please specify the amount of each utility consumed annually. If possible, please exclude nonprocess-related consumption. If not possible, please include a comment that nonprocess-related consumption is included.
2. Data quality indicators: See the Data Quality Indicators Index on p. iii for abbreviations. Please supply the DQI for the *annual quantity* value given.
3. Transportation information: See the Transportation Modes Index on p. iii for mode abbreviations. Please specify where the fuel is coming from (Location) and the number of trips made to your facility on an annual basis. Percent capacity represents what percent of the transport vehicle's total *load* was carrying the fuel of interest.
4. Individual Utility Notes:

Electricity:
The quantity of electricity should reflect only that used toward manufacturing the product of interest (identified on p. 2). One approach would be to start with your facility's total annual electrical energy consumption, estimate and remove nonprocess-related consumption, then estimate what portion of the remaining consumption is related to the specific operations of interest (if you manufacture more than one product). Please include consumption in all systems that use electricity for process-related purposes. Some examples include compressed air, chilled water, water deionization and HVAC consumption where clean or controlled environments are utilized.

Natural gas and LNG:
Please exclude all use for space heating or other nonprocess-related uses. If you choose to use units other than MCF (thousand cubic feet), please utilize only units of energy content or volume (e.g., mmBTU, therm, CCF).

Fuel oils:
Please use units of either volume or energy content (e.g., liters, cubic meters, mmBTU, MJ). Additionally, if the fuel oil is delivered by pipeline, enter "pipeline" in the Transportation Information space; if not delivered by pipeline, please include the associated transportation information.

All waters (e.g., deionized, city):
Please include all waters received onsite for process-related uses. Please indicate consumption in units of mass or volume.

Table 4.		Annual	Units	DQI[2]	Transportation Information (Receiving)[3]			
	Utilities[4]	Quantity[1]			Location (City, State)	Mode	# trips	% cap.
1.	Electricity		MJ					
2.	Natural gas		MCF					
3.	Liquified natural gas (LNG)		MCF					
4.	Fuel oil - type #2 (includes distillate and diesel)		liters					
5.	Fuel oil - type #4		liters					
6.	Fuel oil - type #6 (includes residual)		liters					
7.	Other petroleum-based fuel		liters					
8.	Water		liters					
9.								
10.								
11.								
12.								
13.								

Utility comments:

EOL Data Collection Form - p. 4

5. PRODUCT OUTPUTS

1. Product Outputs: Product outputs are defined as useable products, materials, components or sub-assemblies.
2. CAS # or MSDS (if applicable): Please include either the CAS (Chemical Abstract Service) number of each material (fill in the blank with the number), or state "MSDS" and append a copy to this document.
3. Annual quantity/units & Density/units: Please specify the amount of material produced annually. Please use the units of mass-per-year (e.g., kg/yr, lb/yr). If you specify units of volume in lieu of mass, please provide the density.
4. Data quality indicators: See the Data Quality Indicators Index on p. iii for abbreviations. Please supply the DQI for the *annual quantity* value given.
5. Recycled content (if known): Please specify the recycled content of each material identified. For example, 60/40/0 would represent a material that has 60% virgin material, 40% pre-consumer recycled and 0% post-consumer recycled content. Enter N/A (not applicable) for all components that are assemblies.
6. Transportation information: See the Transportation Modes Index on p. iii for mode abbreviations. Please specify where the material is being sent (location) and the number of trips made on an annual basis. % capacity represents what percent of the transport vehicle's total *load* was carrying the materials of interest.

Table 5. Product Outputs[1]	CAS # or MSDS[2]	Annual Quantity[3]	Units	Density[3]	Units	DQI[4]	Recycled Content[5]	Transportation Information (Shipping)[6]			
								Location	Mode	# trips	% cap.
1.											
2.											
3.											
4.											
5.											
6.											
7.											

Product output comments:

6. AIR EMISSIONS

1. Air emissions: The emissions listed in the table below are some of the more common ones found in air release inventories; if you have information on other specific emissions, please include that information in the space provided. If you have any recent reporting forms or other air emission records, please attach copies to this questionnaire. Also, if you have information on stack* as well as fugitive* emissions, please copy this page and place each set of emissions on a different page. The energy consumed in any equipment used onsite to treat air emissions should be included in the utilities values on p. 4.
   *Stack emissions** are releases to air that occur through confined air streams, such as stacks, vents, ducts, or pipes.
   *Fugitive emissions** are all releases to air that are not released through a confined air stream. Fugitive emissions include equipment leaks, evaporative losses from surface impoundments and spills, and releases from building ventilation systems.
2. Annual quantity/units: Please specify the amount of air emissions generated annually. Please use units of mass-per-year (e.g., kg/yr, lb/yr).
3. Data quality indicators: See the Data Quality Indicators Index on p. iii for abbreviations. Please supply the DQI for the *annual quantity* value given.

Table 6. Air Emissions[1]	CAS number	Annual Quantity[2]	Units	DQI[3]
Total particulates	-----			
Particulates < 10 microns (PM-10)	-----			
Sulfur oxides (SOx)	-----			
Nitrogen oxides (NOx)	-----			
Carbon monoxide	630-08-0			
Carbon dioxide	124-38-9			
Methane	74-82-8			
Benzene	71-43-2			
Toluene	108-88-3			
Xylenes	1330-20-7			
Naphthalene	91-20-3			
Total nonmethane VOCs	-----			
Other speciated hydrocarbon emissions:				
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

Table 6 (continued). Air Emissions[1]	CAS number	Annual Quantity[2]	Units	DQI[3]
Ammonia	7664-41-7			
Arsenic	7440-38-2			
Chromium	7440-47-3			
Copper	7440-50-8			
Lead	7439-92-1			
Manganese	7439-96-5			
Mercury	7439-98-7			
Nickel	7440-02-0			
Other emissions:				
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

Air emission comments:

EOL Data Collection Form - p. 6

7. WASTEWATER RELEASES & CONSTITUENTS

1. Annual quantity/units: Please specify the amount of wastewater(s) generated annually. Please use units of mass-per-year (e.g., kg/yr, lb/yr). If multiple streams exist, please copy this page and fill it out for each stream.
2. Data quality indicators: See the Data Quality Indicators Index on p. iii for abbreviations. Please include one DQI for the annual wastewater stream quantity value supplied, and one DQI for the wastewater constituents information supplied. If more than one DQI is applicable to the wastewater constituents data, please clarify this in the comment section.
3. Wastewater constituents: Please let us know what type of values you are supplying (e.g., daily maximums, monthly averages, annual averages). Additionally, if you have any recent reporting forms or other wastewater constituent records, please attach them to this questionnaire. The energy consumed in any equipment used onsite to treat wastewater releases should be included in the utilities values on p. 4.
4. Concentration/units: Please specify the concentration of wastewater constituents generated annually. Please utilize the units of mass-per-volume (e.g., mg/liter, lb/gal).
5. Wastewater treatment/disposal (WW T/D) method: See the Wastewater Treatment/Disposal Methods Index on p. iii for method abbreviations.

Table 7a. Wastewater Stream	Annual Quantity[1]	Units	DQI for Wastewater Annual Quantity[2]	DQI for Wastewater Constituents[2]

Table 7b. Wastewater Constituents[3]	CAS number	Concen-tration[4]	Units	WW T/D Method[5]
Dissolved solids	-----			
Suspended solids	-----			
Chemical Oxygen Demand (COD)	-----			
Biological Oxygen Demand (BOD)	-----			
Oil & grease	-----			
Hydrochloric acid	7647-01-0			
Sulfuric acid	7664-93-9			
Other acids (please specify):				
1.				
2.				
Phosphorus	7723-14-0			
Phosphates	-----			
Sulfates	-----			
Fluorides	-----			
Cyanide	-----			
Chloride	-----			
Chromium	7440-47-3			
Iron	7439-89-6			
Aluminum	7429-90-5			
Nickel	7440-02-0			

Table 6b (continued). Wastewater Constituents[3]	CAS number	Concen-tration[4]	Units	WW T/D Method[5]
Mercury	7439-98-7			
Lead	7439-92-1			
Nitrogen	7727-37-9			
Zinc	7440-66-6			
Tin	7440-31-5			
Ferrous sulfate	7720-78-7			
Ammonia	7664-41-7			
Nitrates	-----			
Pesticides	-----			
Other constituents:				
1.				
2.				
3.				
4.				
5.				
6.				

Wastewater comments:

8. HAZARDOUS & NONHAZARDOUS WASTES

1. Hazardous wastes and EPA hazardous waste numbers: Please list your waste streams that are considered hazardous by the U.S. EPA. Include the hazardous waste codes for any hazardous waste you include.
2. Annual quantity/units & Density/units: Please specify the amount of waste generated annually. Use units of mass-per-year (e.g., kg/yr, lb/yr). Please also provide the density for each waste.
3. Data quality indicators: See the Data Quality Indicators Index on p. iii for abbreviations. Please supply the DQI for the *annual quantity* value given.
4. Management method: See the Management Methods Index on p. iii for abbreviations. If none are applicable, please indicate other and use the comments section to expound.
5. Transportation information: See the Transportation Modes Index on p. iii for abbreviations. Please specify where the waste is sent (location) and the number of trips made from your facility on an annual basis. % capacity represents what percent of the transport vehicle's total *load* was carrying the waste of interest.

Table 8a. Hazardous Wastes[1]	EPA Haz. Waste #[1]	Annual Quantity[2]	Units	Density[2]	Units	DQI[3]	Mgmt. method[4]	On or offsite?	Transportation Information (Shipping)[5] Location	Mode	# trips	% cap.
EXAMPLE: Spent solvent (toluene)	*F005*	*20,000*	*kg/yr*	*0.9*	*kg/liter*	*M*	*Ie*	*off*	*Indianapolis, IN*	*A*	*24*	*40*
1.												
2.												
3.												
4.												
5.												
6.												
7.												
8.												

Hazardous waste comments:

Table 8b. Nonhazardous Wastes	Annual Quantity[2]	Units	Density[2]	Units	DQI[3]	Mgmt. method[4]	On or offsite?	Transportation Information (Shipping)[5] Location	Mode	# trips	% cap.
EXAMPLE: Waste metal chips	*22,000*	*kg/yr*	*1,000*	*kg/m3*	*C*	*R*	*off*	*Scottsdale, AZ*	*A*	*2*	*100*
1.											
2.											
3.											
4.											
5.											
6.											
7.											

Nonhazardous waste comments:

this page intentionally left blank