United States
Environmental Protection
Agency

Office of Pollution
Prevention and Toxics
(7409)

EPA/742-R-93-003
September 1993

EPA

The Use of Life Cycle Assessment in Environmental Labeling

THE USE OF LIFE CYCLE ASSESSMENT IN ENVIRONMENTAL LABELLING PROGRAMS

prepared for:

Julie Winters Lynch
Pollution Prevention Division
Office of Pollution Prevention and Toxics
United States Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460
U.S.A.

Principal Investigator: Gary A. Davis, Director
Center for Clean Products and Clean Technologies
University of Tennessee
327 South Stadium Hall
Knoxville, Tennessee 37996
U.S.A.

September 1993

EPA Project No. X 820663-01-0

Printed on Recycled Paper

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Objectives of Project

This report documents the methodologies used by independent, third-party environmental labelling programs for the development of criteria for certification of products for environmental labelling. In particular, the project investigated the extent to which life cycle assessment (LCA) methodologies are being used in environmental labelling programs worldwide. The report also describes alternative methodologies that are being used or that could potentially be used for environmental labelling.

1.2 Overview of Environmental Labelling

This report focuses on the methodologies used by environmental labelling programs that operate as some form of independent third-party certification of the environmental attributes of products (and sometimes, services). The terms "ecolabelling" and "environmental labelling" are intended to be interchangeable in this report.

Seal-of-approval programs, single-attribute certification programs, and product environmental information ("report card") labelling programs can be categorized together as third-party certification programs, while environmental labelling performed by marketers themselves can be considered "first-party" activity. Like third-party certifications, however, labels produced or claims made by a first party may also be based upon objective criteria that are developed internally.

Seal-of-approval programs identify products or services as being less harmful to the environment than similar products or services with the same function. **Single-attribute certification** programs typically indicate that an independent third party has validated a particular environmental claim made by a manufacturer. Both of these types of labelling are often referred to as "seal programs", since some type of seal of approval is awarded that can be displayed on the product label to indicate that the product meets predefined environmental criteria. **Product environmental information labelling (report cards)** offer consumers information on the label about a product's and/or a company's environmental performance in multiple categories (e.g., energy consumption, water pollution) without necessarily awarding a seal that denotes relative superiority (US EPA 1993a).

All of the programs discussed in this report are voluntary, although some environmental labelling has been made mandatory (e.g., energy efficiency labelling, CFC labelling). Product environmental labelling in general can be positive, neutral, or negative--meaning that labelling information can promote positive environmental attributes of products, can disclose information that is neither inherently good nor bad, or can require (negative) warnings about the hazards or environmental impacts of products (e.g., "contains CFCs"). The labelling programs discussed in this report, with the exception of report card type programs, which are intended to be neutral, are all positive programs, offering label information as a means of promoting the purchase of cleaner products.

All environmental labelling programs that have some type of official governmental sanction are third-party seal-of-approval programs. These include the European Communities Eco-labelling Program, the Nordic Countries program, and the national programs of Canada, France, Germany, Austria, the Netherlands, Singapore, New Zealand, and Japan. There are other third-party seal-of-approval programs operated as unofficial labelling programs, such as the Green Seal program in the United States, which does not have a government-sanctioned program.

The history and structure of existing environmental labelling programs have been described in detail elsewhere (OECD 1991; Danish Technological Institute 1990; Environmental Data Services 1989; US EPA 1990; US EPA 1993a). There are currently around 13 third-party certification environmental labelling programs in existence worldwide (US EPA 1993a).

Third-party seal-of-approval programs of the type considered in the first part of this report operate through the development of objective criteria for product categories that determine eligibility for a seal of approval denoting that the product is environmentally superior to others in its class. In most of the product criteria developed to date, only a limited number of aspects of the product's life cycle environmental impacts are considered. For instance, some criteria for paper products include only the recycled content. The environmental impacts considered in developing labelling criteria for different products can include a wide variety, such as ozone depletion, global warming, smog formation, human toxicity, noise, energy use, and non-renewable resource depletion.

1.3 Overview of Life Cycle Assessment

EPA defines life cycle assessment (LCA) as follows:

> A concept and methodology to evaluate the environmental effects of a product or activity holistically, by analyzing the whole life cycle of a particular product, process, or activity. The life-cycle assessment consists of three complementary components--inventory, impact, and improvement--and an integrative procedure known as scoping (US EPA 1993b).

The definition/description of life cycle assessment developed internationally through the Society for Environmental Toxicology and Chemistry (SETAC) is as follows:

> Life cycle assessment is an objective process to evaluate the environmental burdens associated with a product, process or activity by identifying and

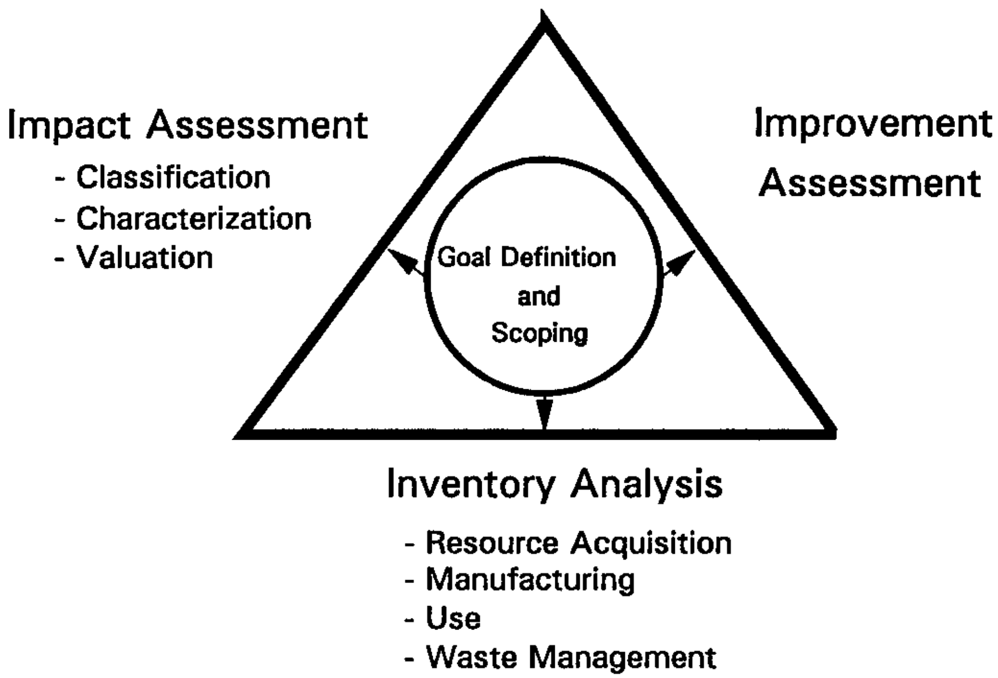
quantifying energy and materials used and wastes released to the environment, to assess the impact of those energy and material uses and releases to the environment, and to evaluate and implement opportunities to affect environmental improvements. The assessment includes the entire life cycle of the product, process or activity, encompassing extracting and processing raw materials; manufacturing, transportation and distribution; use, re-use, maintenance; recycling and final disposal (SETAC 1993).

In the last three years a major effort nationally and internationally has been undertaken by the United States EPA, the Society for Environmental Toxicology and Chemistry, and other national and international organizations to develop the tool of LCA to the point of scientific acceptance and policy relevance (US EPA 1993a; SETAC 1991; SETAC 1992; CML 1992). The most recent international activity was the SETAC LCA Code of Practice Workshop held in March 1993, in which LCA experts developed a consensus on guidance for practitioners in the performance of life cycle inventory analysis and on the need for further developments in impact analysis and improvement analysis (SETAC 1993). The details of the development of a scientific consensus concerning LCA are beyond the scope of this report, but the basic elements of LCA and their status of development are central to the use of LCA as part of the methodology for environmental labelling.

LCA is composed of four components as illustrated in Figure 1, below:

Figure 1

PRODUCT LIFE-CYCLE ASSESSMENT



Source: SETAC 1993

- goal definition and scoping;
- inventory analysis;
- impact analysis (assessment); and
- improvement analysis (assessment) (US EPA 1993b; SETAC 1993).

Full life cycle assessment has been represented visually as involving the three analytical processes with goal definition and scoping taking place throughout all three (See Figure 1).

1.3.1 Goal Definition and Scoping

This component consists of the definition and purpose of the study, the scope of the study, the establishment of the functional unit being considered, and the procedure for the quality assurance of the results. Goal definition and scoping take place throughout the LCA study. The scope of the study defines, first and foremost, the system boundaries that are necessary to ensure that the analysis addresses the purpose of the study. The scope also includes definition of assumptions, data requirements, and limitations of the study. The functional unit is the measure of performance that the system being studied delivers. For instance, "the amount of detergent necessary for a standard household wash" or "the coating of a surface area with paint for a defined period of time" (US EPA 1993b; SETAC 1993). Goal definition and scoping in LCA studies is considered well-defined as a process (SETAC 1993).

1.3.2 Inventory Analysis

The inventory analysis component of an LCA is a "technical, data-based process of quantifying energy and raw material requirements, atmospheric emissions, waterborne emissions, solid wastes, and other releases for the entire life cycle of a product, package, process, material or activity" (US EPA 1993b). The life-cycle inventory (LCI) methodology has been evolving since the 1960's, although the initial focus was on energy use, with major companies using LCI to make internal product improvement decisions. Most LCA studies, to date, have really been LCI studies, since they did not go beyond the quantification of resource and energy inputs and pollutant releases throughout the life cycle.

The methodology for inventory analysis is considered to be well-defined and understood, but there are some key issues that are still being discussed in the practitioner community. These include the sources, availability and quality of data, the allocation procedures for co-products, the inclusion of waste management impacts, and the allocation of inputs and outputs in a system involving recycling (SETAC 1993).

1.3.3 Impact Analysis (Assessment)

Impact analysis in LCA is "a systematic process to identify, characterize, and value potential ecosystem, human health, and natural resource impacts associated with the inputs and outputs of a product or process system" (US EPA 1993c). SETAC uses the term "impact assessment" instead of analysis to connote the sometimes qualitative nature of the process (SETAC 1993). Impact analysis is used to evaluate the significance of the results of a life cycle inventory, which typically are long tables of quantities of resources and energy used and specific pollutants or wastes released to air, water, or soil during the stages of the life cycle. In studies of the past, these were merely aggregated and summed as total energy used, total mass of natural resources used, total mass of air pollutants, total mass of water pollutants, and total mass of solid wastes generated. This "less is best" approach does not allow for evaluation of trade offs between totally different types of potential impacts, such as global warming versus human toxicity.

Impact analysis is currently under development, and there is, as yet, no generally accepted methodology (SETAC 1993). Nonetheless, there are practitioners using various types of impact analysis methodologies in LCA studies that are being used for making real decisions in product design and, in some cases, the development of environmental labelling criteria.

The conceptual framework for life cycle impact analysis that has received some degree of consensus includes three steps: classification, characterization, and valuation (US EPA 1993c; SETAC 1993). Classification is the assigning of inventory items (quantitative inputs and outputs from the LCI) to impact categories based upon an elaboration of impact networks, which are the potential cause-and-effect linkages between inventory items and ultimate impacts on human health, the ecosystem, and resources. For instance, in the classification step, air pollutants that can cause ozone depletion are assigned to the ozone depletion impact category, and air pollutants that cause acid precipitation are assigned to an acid precipitation impact category. A single pollutant may give rise to more than one type of impact (e.g., NO_x, which can cause acidification and can also participate in the formation of photochemical smog) (US EPA 1993c).

Characterization is the process of aggregating and quantifying impacts within the impact categories, where possible, which involves an understanding of the environmental processes that lead from the inventory item to the ultimate impact of concern. For instance, the global warming potential of several different greenhouse gases released during the life cycle can be aggregated and expressed as CO_2 equivalents. This step is much less defined for outputs that may cause only localized impacts, such as releases of acutely toxic, non-persistent chemicals, since life cycle studies are rarely site-specific and aggregating toxic chemical releases over different stages of the life cycle that would be conducted in different locations does not present an accurate picture of the risk created by the releases in any one location.

Finally, valuation is the step where the different impact categories are considered in relation to each other in order to further aggregate the results of the impact assessment or to allow for further interpretation of the results (US EPA 1993c; SETAC 1993). The valuation step is not an objective process, but depends upon social and cultural values and preferences. For instance, the importance ascribed to human health impacts versus ecological impacts is a cultural, ethical, and political issue.

1.3.4 Improvement Analysis (Assessment)

The improvement analysis is the component of LCA in which options for reducing the environmental impacts throughout the life cycle of the system under study are identified and evaluated (US EPA 1993b). Again, SETAC uses the term assessment instead of analysis to connote the sometimes qualitative nature of the exercise (SETAC 1993). The inventory analysis, alone, may be used to reveal aspects of the product life cycle that can be improved. The use of impact analysis may be necessary when the inventory results present a "mixed bag" of inputs and outputs, with no clear picture of the most significant stages of the life cycle or the most significant impacts. Although the methodology for improvement analysis has not been elaborated in the way the inventory and impact analysis components have, improvement analyses based upon life-cycle studies have been conducted and are being used today (SETAC 1993).

1.3.5 "Streamlined" LCA

A full life cycle assessment, as that term has been defined, requires a tremendous amount of data to complete even the inventory component for all of the inputs and outputs for every component of a product in every stage of the life cycle. The impact analysis and improvement analysis components require even more hard-to-obtain data and, as noted above, require methodologies that have not been fully developed. For some purposes, the use of "streamlined" LCA, which does not attempt to collect data for every input and output for every component of a product in every stage of the life cycle, may be sufficient, although there is no agreement among the life cycle practitioner community about whether such a streamlined LCA should be done or about the methodology for performing one. Forms of streamlined LCAs are being used, however, by environmental labelling programs in the development of product labelling criteria, as discussed below. Some form of streamlined LCA can make the use of LCA in environmentally labelling more practicable.

1.3.6 Life Cycle Concept

The life cycle concept is simply the holistic approach to evaluating the environmental impacts of a product system from cradle to grave. Life cycle assessment in its fully quantitative form is the rigorous analytical application of the life cycle concept. It should be recognized that the life cycle concept can be utilized without the application of full quantitative life cycle assessment.

1.4 Previous Statement From the United States EPA About the Use of LCA in Making Environmental Claims

The United States EPA has previously stated a position about the use of LCA in making environmental claims. In his testimony before the Federal Trade Commission (FTC) Hearings on Environmental Labeling, Deputy Administrator F. Henry Habicht II stated that "EPA believes it is premature for a company to use the results of lifecycle analysis to promote its product as better for the environment than another." He stated further that, "Lifecycle analysis simply is not well enough developed as a technical tool to allow such kinds of specific comparisons" (Habicht 1991).

1.5 Statements From the LCA Community About the Use of LCA in Environmental Labelling

The potential use of LCA in environmental labelling has been recognized from the beginning of the recent discussions about LCA methodology. The recently developed SETAC Guidelines for Life-Cycle Assessment contain the following statement:

> The use of LCA results in the public domain such as setting criteria for Eco-labelling or to substantiate environmental claims is cause for debate. Even with great care of disclosure, information from certain applications such as the use of LCI information as the only basis for broad sweeping environmental claims should be used and interpreted with caution. The use of LCA to support these activities should be subject to the guidance provided herein. However, it is recognized that the LCA methodology may influence the way in which labeling programs are designed (SETAC 1993).

The recent United Nations Environment Programme Expert Seminar on Life Cycle Assessment and its Applications, held June 9-10, 1993, in Amsterdam, resulted in the following conclusions related to environmental labelling:

> An important application concerns the (use) in ecolabelling schemes . . . It should be clear however that LCA never can be a substitute for decision making. LCA can be a decision support tool only.
>
> The methods used to support the rewarding or refusing of ecolabels now differ strongly between countries. Therefore there is a need for a guidance document, as by the EC (European Communities), to standardize the way LCA is used here . . . LCA can also play a role in supplying information for product certification, for instance the minimum percentage of recycled material to be used.
>
> Sometimes a product scores better on one environmental aspect and a second product on another . . . One then has to compare apples and pears.

In such case a balance may be struck by an independent representative panel of experts (Udo de Haes 1993b).

As discussed below, although some organizations and some LCA practitioners may have reservations about the use of LCA in environmental labelling, the methodology is currently being used to support the development of product criteria in several environmental labelling programs.

2. LABELLING PROGRAMS AND METHODOLOGIES

2.1 International Declarations on Environmental Labelling Methodologies

Environmental labelling methodologies have received attention in the last three years as more and more programs have been developed. Following are some international declarations concerning these methodologies, with the European Communities having embodied the life cycle concept in an EC Directive that is binding on the twelve member countries.

2.1.1 Berlin Statement on Environmental Labelling:

The following consensus statement resulted from an early environmental labelling conference held in Berlin in 1990:

> Objective environment-related product labelling demands that the products and/or product groups be looked at in a comprehensive and technically sound way. The products to be labelled are therefore to undergo a thorough assessment taking the form, for example, of an ecological balance sheet, where possible comprising the entire life-cycle of a product and the relevant environmental aspects which apply, and depending on the nature of the product, the suitability for use and safety (German Federal Ministry 1990).

2.1.2 Lesvos Statement on Environmental Labelling:

The United Nations Environment Programme, Industry and Environment Office, and the University of Lund, Sweden, sponsored an expert seminar on environmental labelling in 1991, resulting in the following declaration on methodologies for criteria development (set out in part):

> The following items were identified as characteristic of environmental labelling programmes:
>
> - determination of criteria based on life-cycle review of a product

category;

- criteria levels established to encourage the development of products/services that are significantly less damaging to the environment; . . . (UNEP 1991).

2.1.3 European Communities Eco-Label Regulation

The Council of the European Communities Regulation No. 880/92 sets out the framework for the EC Eco-Label Program (EC 1992). The regulation incorporates the product life cycle concept in its objectives and in the framework for the methodology to be used in setting product criteria.

Article 1 of the regulation states the objectives for the eco-label scheme, which are to:

- promote the design, production, marketing, and use of products which have a reduced environmental impact during their entire life cycle, and

- provide consumers with better information on the environmental impacts of products, without, however, compromising product or workers' safety or significantly affecting the properties which make a product fit for use.

Article 5, paragraph 4, of the regulations contains the requirements for the methodology for setting specific product criteria for award of the eco-label. That paragraph states:

> The specific ecological criteria for each product group shall be established using a 'cradle-to-grave' approach based on the objectives set out in Article 1, the general principles set out in Article 4 and the parameters of the indicative assessment matrix shown in Annex I. The criteria must be precise, clear and objective so as to ensure uniformity of application by the competent bodies. They must ensure a high level of environmental protection, be based as far as possible on the use of clean technology, and, where appropriate, reflect the desirability of maximizing product life.

"Cradle-to-grave", as defined in the regulation, means:

> the life cycle of a product from manufacturing, including the choice of raw materials, distribution, consumption and use to disposal after use.

Annex I to the regulation, the "Indicative Assessment Matrix", is a simple, check-the-box, type of matrix, reproduced below:

Table 1: "Cradle-to-Grave" Matrix for EC Eco-Labelling Scheme

	Stage of Product Life Cycle				
	Pre-production	Production	Distribution (including packaging)	Utilization	Disposal
Waste relevance					
Soil pollution and degradation					
Water contamination					
Air contamination					
Noise					
Consumption of energy					
Consumption of natural resources					
Effects on eco-systems					

2.1.4 International Standards Organization/Strategic Advisory Group on the Environment, Environmental Labelling Subgroup

The Strategic Advisory Group on the Environment (SAGE) has been meeting for the last two years under the aegis of the International Standards Organization (ISO) to develop strategies for standardization in the field of environmental management tools and has formed a new Technical Committee to develop ISO standards in the environmental management field. The ISO/SAGE process included a subgroup on environmental labelling, which met four times. That subgroup developed recommendations to ISO/SAGE, which included a recommendation "that the Criteria developed for [third-party seal-of-approval programs], where possible, follow scientific information relating to the life cycle of the product" (ISO/SAGE 1993).

The ISO Technical Committee, Environmental Management, established by ISO in early 1993, includes a Subcommittee on Environmental Labelling that will develop appropriate standards in the environmental labelling field. Among the recommended activities for the Secretariat of the Subcommittee, which is the organization Standards Australia, is to develop a database of environmental labelling criteria for product categories that have been adopted by the different environmental labelling programs worldwide (ISO/SAGE 1993).

2.2 Description of Environmental Labelling Program Methodologies

2.2.1 European Communities Eco-Labelling Program

2.2.1.1 General Procedure

The EC Eco-labelling program operates through official environmental labelling bodies in the member states and an approval process by the EC Commission, the governing political body of the EC. Proposals for product categories and criteria are made by member states to the Commission, which engages in consultation with a Consultation Forum of interest groups in choosing categories. A category is assigned to the participating Competent Body in a member state, which drafts criteria for certification. The draft criteria are sent back to the Commission, which consults with the Consultation Forum, and then sends them to the Committee of Member States for approval. If approved, they are adopted by the Commission.(UK Ecolabelling Board 1993a; US EPA 1993a).

The EC Program began in 1992 by assigning member countries five different classes of products for development of labelling criteria. Additional product classes have been assigned since that time. Following are products and the countries assigned (UK Ecolabelling Board 1993a):

washing machines (UK)
paints and varnishes (France)
copy paper and paper towels (Denmark)
packaging (Italy)
laundry detergents (Germany)
hair spray (UK)
soil improvers (UK)
light bulbs (UK)
dishwashers (UK)
domestic batteries (France)
solar heating systems (Germany)
insulation material (Denmark)
toilet paper (Denmark)
writing paper (Denmark)
refrigerators (Italy)
ceramic tiles (Italy)

cat litter (Netherlands)
shoes (Netherlands)
dishwasher detergents (Germany)
household cleaning products (Germany)
shampoos (France)
antiperspirants/deodorants (UK)
female sanitary products (UK)
hairstyling aids (UK)
bed linen (Denmark)
tee shirts (Denmark)

The launch for the EC scheme was planned for June 1993. As of February 1993, however, six member states of the EC had failed to designate competent bodies to administer the scheme. Two product groups, washing machines and dishwashers, have had criteria accepted by the European Environment Committee, and it is anticipated that four others (hair sprays, paper towels, toilet paper, and light bulbs) will be ready in time for the launch (Whitehead 1993).

2.2.1.2 Procedures for Setting Criteria with Examples

The development of proposed labelling criteria by the six countries that have done so has resulted in different methodologies for fulfilling the "cradle-to-grave" requirement of the EC regulation. The EC is considering the appointment of an LCA expert to advise the Eco-Labelling scheme on the application of LCA to ecolabelling (Udo de Haes 1993a).

Following is a discussion of the approaches that have been used by the EC countries contributing proposed standards to the EC Eco-Labelling scheme.

UK Ecolabelling Board "Streamlined LCA"

The UK Eco-Labelling Board, which is operating in the EC program, performs what is called a "streamlined LCA". Consultants have been contracted to perform each of the streamlined LCAs that have been used by the UK Board for developing labelling criteria, including consultants with experience in LCA (e.g., PA Consulting Group, Chem Systems, Ltd.)

Representative products from the product class are chosen and an evaluation of the life cycle is performed. The purpose of this evaluation is not to compare the products in detail or to draw conclusions about the specific products chosen, but to identify those aspects of the life cycle of the products that have the most significant environmental impacts (PA Consulting 1992; UK Ecolabelling Board 1993c).

The "streamlined LCA" methodology does not attempt to quantify every input and output from every stage of the life cycle, but instead incorporates a screening step in which the "impacts" from certain stages of the life cycle are estimated or ignored based upon information obtained and judgment by the study practitioner. For instance, in the washing machine evaluation, the environmental impacts of extraction of raw materials for production of washing machines was deemed to be minor and too difficult to quantify, although the consumption of raw materials in manufacturing was considered as a measure of environmental impact (PA Consulting 1992).

In the washing machine LCA environmental releases during the production of materials, such as steel and plastics, were quantified using existing LCA models and databases, and an estimate was made for the actual manufacturing of the washing machine as a percentage of the total materials production impacts. Estimates were made for other stages of the life cycle using existing life cycle inventories adjusted for European machines and European impact analysis methods. The study determined that the use of washing machines contributes the vast majority of environmental impacts as compared to the other stages of the life cycle, and the resulting labelling criteria focussed on energy consumption, water consumption, and detergent consumption during use (PA Consulting 1992).

In the "streamlined LCA" for hairsprays, two "typical" product formulations were selected from the product class (aerosol with ethanol solvent, butane propellant, tinplate steel can; pump with ethanol plus water and HDPE bottle) and a quantitative life cycle inventory was performed using a combination of manufacturer supplied data, in-house data, and published databases. "Minor" material uses, defined as those under 5 percent of total feedstocks to a process step, were excluded from the evaluation. Impact analysis was performed by aggregating inventory results into impact categories and using the critical volume approach to scale and aggregate toxic pollutants (UK Ecolabelling Board 1993c). The critical volume approach divides specific pollutant releases (in mass units) by established regulatory standards for the specific pollutant (in mass/volume of air or water). This results in a volume of air or water polluted at the regulatory standard and allows aggregation of these critical volumes across different types of pollutants.

Based upon the inventory and impact analysis, the criteria recommended for hairsprays were for minimization of VOC content, while precluding ingredients that deplete stratospheric ozone and limiting significant increases in constituents that contribute to global warming. Criteria for packaging emphasized maximum container weight per dose and minimum recyclability of the container (UK Ecolabelling Board 1993c).

A "streamlined LCA" was also performed for the development of criteria for light bulbs. The consultant first determined through quantitative life cycle inventory with impact analysis, using existing databases, that fluorescent bulbs, being more energy efficient during use, were preferable to incandescent bulbs. Then a more detailed evaluation of the life cycle of fluorescent bulbs was performed to identify further opportunities to improve the environmental performance of fluorescent bulbs. The resulting recommended criteria include an energy efficiency criteria that eliminates the current incandescent from consideration, limitations on heavy metal content and radioactivity, and criteria for recycled content of packaging (UK Ecolabelling Board 1993b).

Danish "Quantitative and Qualitative" Life Cycle Assessment

The Danish Environmental Protection Agency is the participating body from Denmark in the EC Ecolabelling scheme. Denmark has been designated the lead country on thermal insulation materials, paper products, and textile products. The Danish EPA has contracted with consultants to perform the environmental evaluations of these classes of products (Jensen 1993).

The "cradle-to-grave" methodology used by the Danish in evaluating paper products, the first group of products evaluated, could also be described as a streamlined LCA, since it focusses on particular stages of the life cycle. In addition, it does not rely exclusively on quantitative data, but also makes use of qualitative information on environmental impacts (Danish EPA 1991). For subsequent groups of products, a more complete life cycle inventory is being performed. Based upon the inventory, key features of the life cycle are selected for more in-depth impact assessment and the development of criteria for labelling. The purpose is still to identify the most significant stages of the life cycle and the most significant impacts for development of criteria (Jensen 1993).

The Danish methodology differs from others in its inclusion of the concept of "hurdles" and "points" in the recommended criteria for labelling. "Hurdles" are specific criteria that must be met for the award of a label, such as compliance by the manufacturing facility with all applicable EC environmental regulations. The "point" system assigns scores to certain environmental attributes of the life cycle of a product, such as the level of water pollution or the amount of energy used throughout the life cycle, and sets a maximum total number of points as a criterion for labelling (Danish EPA 1991). In principle, such a point system would give manufacturers flexibility to balance materials and manufacturing processes in the different stages of the life cycle to meet the overall performance standard. It may be difficult to implement such a performance-based standard, however, and the concept has not yet been adopted by the EC Eco-label Program.

The concept has recently been refined to include a weighting of the various parameters (e.g., emissions of SO_2 or use of non-renewable resources) by both a "Production Improvement/Impact" weighting and a "concern factor" weighting. The "Production Improvement/Impact (P/I)" factor is the relative importance of moving the particular industry from the "worst" to the "best" in relation to the total impact of the particular parameter. The P/I factor for paper products, for instance, for a particular pollutant "X", is defined as the difference in emissions of X in the "worst" (i.e. dirtiest) mills as compared to the emissions of X in the "best" (i.e. cleanest) mills divided by the total emissions of X from all sources, globally or regionally. The P/I factors are calculated for each parameter and ranked in orders of magnitude with the highest P/I being ranked "large" and lower orders of magnitude ranked "medium", "small", and "non-significant". The "concern factor" is a subjective ranking of the importance of the particular parameter in four steps: "large, medium, small, and non-significant" (dk-Teknik 1992).

The overall weight factor to be applied to the "load points" for each parameter is a combination of the P/I and the concern factor rankings, so that a large P/I and a large concern factor will give an overall weight factor of 3, and a small P/I and a small concern factor will give an overall weight factor of 0.03. Non-significant in either category will yield a weight factor of 0 (dk-Teknik 1992).

The Danish approach also differentiates between impacts that are considered global or regional versus those that are considered local. Local impacts are sometimes not considered in the eco-labelling criteria, since it is assumed that the purpose of the eco-labelling program is to deal with global and regional impacts and that regulations will take care of local impacts. For instance, in the proposed paper criteria, discharges to water of biological oxygen demand (BOD) and total suspended solids are deemed local impacts and not considered, while discharges of chemical oxygen demand (COD) and chlorinated organics are considered global or regional impacts and are included in the criteria setting (dk-Teknik 1992).

A recent draft by the Danish consultant working with the Danish EPA on ecolabelling criteria for thermal insulation materials adopts the points and hurdle system and separates impacts into categories of resource consumption, global, regional, and local, including occupational exposure, indoor air pollution, and fire behavior. A life cycle inventory was performed by another consultant for representative insulation materials, and the results were evaluated using a form of impact assessment. Labelling criteria, developed through application of a point system, are proposed for the use of fossil fuels per unit of product, for percentage of recycled material, for global warming potential of emissions per unit of product, for ozone depletion potential of emissions per unit of product, for SO_2 emissions per unit of product, and for VOC emissions per unit of product. Weighting factors were then applied to the points, with global warming pollutants and SO_2 emissions being weighted less than fossil fuel use, emissions of VOCs and emissions of ozone depleting chemicals. Hurdles are proposed by the Danish consultant for the use of chlorinated organics and heavy metals as flame retardants, for occupational exposures to man-made mineral fibers, styrene, phenol, methylene diphenyl diisocyanate, boron, organic dust and cellulose, and for both occupational exposures and indoor air exposures to formaldehyde (dk-Teknik 1993).

The points system allows there to be one set of criteria for products made up of very different materials, instead of simply selecting preferred materials. The goal is to create an incentive to improve the environmental attributes of all insulation materials during the whole life cycle (Jensen 1993).

French "Ecobalance"

The French have developed draft criteria for labelling paints and varnishes in the EC program and are also developing criteria for shampoos and batteries. The French have a national environmental labelling program, called the NF Environment Mark (described below), that operates separately from the EC program. Both the EC participation and the NF Environment Mark are managed by the Association Française de Normalisation (AFNOR), the French standards organization, with participation and funding by French governmental agencies (French Ministry of the Environment 1993).

The approach used by the French program, both in the EC Eco-labelling scheme and in the national program (since June 1992), includes the use of life cycle inventories for every product category for which labelling criteria are developed. The French use the term "ecobalances" for these life cycle inventories.

LCI is used in the French labelling programs in a five-step procedure:

1. A market and product survey is performed for the product group in question.
2. Products are selected that are representative of the market and of environmental issues for the product group in question.
3. Life cycle inventories are conducted for the representative products.
4. The results of the life cycle inventories are evaluated in order to identify the main environmental issues associated with the products throughout their life cycles.
5. A discussion is held in a representative group of experts concerning the product group to draft the labelling criteria taking into account: the main environmental issues identified in the LCI; the available technologies for alleviating those main environmental problems; and the economic feasibility of meeting labelling criteria.

The evaluation of paints and varnishes was performed by the consulting firm Ecobilan under contract with the French Ministry of the Environment. Ecobilan performed a life cycle inventory for eleven representative products in the paints and varnishes category (Ventère 1993). A functional unit was chosen for the paint products, and data was gathered from the actual manufacturers on the resource inputs, environmental releases and energy use for most ingredients. The data was aggregated to insure confidentiality (Ecobilan 1992). Funding for this first life cycle labelling effort was provided by the public authorities, including the French Ministry of the Environment, the Ministry of Industry, the Ministry of Consumer Affairs, and the Agency for Environment and Energy Conservation (ADEME) (Ventère 1993).

The life cycle inventories developed by Ecobilan were used to:

- determine inputs and outputs in different stages of the system;
- define the relative contribution of each stage and of each input and output to different impacts (global warming, ozone depletion, depletion of natural resources); and
- evaluate the contribution of the product system to the overall impacts considered (e.g., total releases of greenhouse gases) (Ecobilan 1992).

The representative group formed by AFNOR to develop criteria from the inventory results included manufacturers, consumer organizations, environmental organizations, retailers, and three government agencies (Ministries of Environment, Industry, and Consumer Affairs). The representative group attempts to develop a consensus, first on the most important environmental impacts to be addressed in the labelling criteria, and second on the criteria to address those impacts. The draft criteria for paints and coatings are still under discussion within the EC, where they are being evaluated by an EC-wide representative committee of over 40 experts (Ventère 1993).

The French program has also sponsored ecobalances for shampoo products for the EC program, but in this case, the manufacturers of shampoos shared the approximately $170,000 cost of the LCI studies with the government agencies (Ventère 1993).

2.2.2 German "Blue Angel" Program

2.2.2.1 General Procedures

The German environmental labelling program, that has become known as the "Blue Angel" Program, has been in operation since 1978. The decision-making process for establishing criteria for environmental labelling is a joint effort of the German Federal Ministry of the Environment, including the Federal Environmental Agency, the German Institute for Quality Control and Labelling, and a representative Environmental Labelling Jury. Although the government is involved in the process, the Environmental Labelling Jury and the Institute for Quality Control, which make decisions on criteria and administer the program, are non-governmental (German Ministry for Environment 1990).

The Federal Environmental Agency provides the initial scientific review of the product category and drafts the labelling criteria. Then, the Institute for Quality Control and Labelling convenes expert hearings to discuss the criteria proposed by the Environmental Agency. The representative Environmental Labelling Jury, which has members from industry, environmental organizations, consumer associations, trade unions, environmental professional associations, and the federal states, makes the final decisions on criteria for product categories based upon the proposal by the Environmental Agency and the comments in the expert hearings (German Ministry for Environment

1990).

2.2.2.2 Procedures for Setting Criteria

The Blue Angel Program has issued more than 75 sets of labelling criteria, many of which focus on a limited number of attributes of the product class. The Program states, however, that it has always considered the life cycle of the product in establishing criteria, usually by the use of a simple qualitative matrix of environmental impacts in each of the life cycle stages. The criteria that are ultimately developed are oriented toward the "state-of-the-art" technology and are intended to create significant environmental benefits as compared to the generally used technologies (Neitzel 1992a). The "life cycle" matrix that is used is presented in Table 2 below.

Table 2: "Life Cycle" Matrix Used by German Program (OECD 1991)

	Production	Use	Disposal
Hazardous Substances			
Emissions air water soil			
Noise			
Waste Minimization			
Resource Conservation			
Fitness for Use			
Safety			

In the further development of the Blue Angel Program a more detailed life cycle evaluation is now used for development of criteria for certain products, especially where there is a need for quantitative data for determining impacts of competing ingredients or materials. For instance, the Program is doing a quantitative LCI for evaluating laundry detergents and hand drying systems (e.g., electric dryers versus cloth towels). A screening approach is still used for products that present fairly clear pictures of environmental benefits that result from relatively simple criteria (e.g. recycled paper) (Neitzel 1992b).

The current procedure has been described as stepwise, first using the checklist or matrix approach to identify important parts of the life cycle and the most significant environmental attributes of the product class. This is supplemented by the use of expert panels. If there is insufficient information to develop criteria from this screening approach, an LCA will be done or an existing LCA will be relied upon. As an example, the Program utilized an existing LCA on hand drying systems and determined that there were no significant environmental differences among the various options. Therefore, criteria were set to improve the environmental attributes of each option (Neitzel 1992b).

Most of the Blue Angel standards do not deal directly with the production process, and the Blue Angel is one of the few programs that does not require producers to demonstrate that they meet national environmental standards in the production process. Two reasons are given for this omission: (1) analytic methods are frequently unavailable to separate the impacts of the product being considered from the whole manufacturing facility's impacts; and (2) such manufacturing standards would penalize countries with less stringent environmental standards and may constitute a trade barrier contrary to GATT regulations (Neitzel 1993).

When a quantitative LCA is done in the German Program, it is for the purpose of defining the scope of the product category and for identifying the stages of the life cycle and the most significant environmental impacts for development of product criteria. The product criteria are then developed through expert judgment and a consensus-building process with the use of the Environmental Labelling Jury and expert hearings. There has been no attempt to create a direct connection between LCA and the criteria for labelling (Neitzel 1993).

2.2.2.3 Example

The Federal Environmental Agency has performed a "stepwise" life cycle assessment to aid in the development of the criteria for laundry detergents. The three steps in the process are as follows:

- Screening Step: an evaluation matrix/check list approach is used in a qualitative analysis to attempt to identify the most significant stage(s) of the life cycle. Available data is used to assess the impacts of the priority life cycle stage(s). Criteria can be developed for reducing the impacts in the priority stage(s).
- Refined Step: this is a confirmatory step for the priority life cycle stage(s) with collection of missing data and further quantification of inputs and outputs and their impacts. Criteria can be revised and updated for the priority stage(s).
- Detailed Step: this is a full, quantitative life cycle assessment, including some form of impact assessment. Additional stages of the life cycle are considered as are additional, more global impacts, such as global warming and resource depletion. Such an assessment may be necessary to set criteria that prefer certain raw materials, processes, or disposal processes. (Poremski 1991).

In applying this approach to laundry detergents, the Federal Environmental Agency first performed an evaluation matrix qualitative approach and a screening LCA for the energy consumption and water pollution for the surfactant component of detergents. In the screening LCA three life cycle stages were determined to be the most significant for energy use: surfactant production, raw materials production, and use in the washing machine. For water pollution, the use stage was determined to be the most significant (Poremski 1991).

The Agency recommended that labelling criteria could be set based upon the screening LCA and that a refined step and detailed step could follow to revise the criteria later. Criteria recommended included the use of a component system (detergent, bleach, and water softener as separate components) so that only ingredients that are needed are actually used; a limit on the dosage per load; exclusions of certain compounds that can cause water pollution impacts, such as phosphates; biodegradability requirements; aquatic toxicity limits; and packaging recycled content requirements (Poremski 1991).

2.2.3 French National Environmental Labelling Program

2.2.3.1 General Procedures

The French standards organization Association Française de Normalisation (AFNOR) is the secretariat for the French environmental labelling program (NF Environnement Mark), which was launched in June 1992. This program is a national, voluntary, seal-of-approval labelling program, which has chosen to develop French standards in addition to the French participation in the EC program (French Ministry of the Environment 1993).

AFNOR is the convener of a Labelling Committee for each of the product groups being considered. This representative Committee includes the manufacturers of the products in the groups (particularly those companies whose products are selected as representative products for life cycle studies), retailers, consumer and environmental organizations, and the French Ministries of Environment, Consumer Affairs, and Industry. The labelling criteria are developed in a consensus process by these Committees, an open meeting is held to discuss the draft criteria, and the final criteria are submitted to the three Ministries for final approval.

2.2.3.2 Procedures for Setting Criteria

Since June 1992, the NF-Environnement has decided to perform a life cycle inventory (called "ecobalance" in France) for each product category for which labelling criteria are being developed (Proia 1993; Ventère 1993). The program began by using the life cycle matrix approach (similar to the German program) for the development of criteria for labelling, then suspended work in June 1992 to develop a new methodology which involves the use of quantitative life cycle inventories. The life cycle inventory is performed using industry data from actual companies for representative products in the product category being considered (Heintz 1992). The five-step process discussed in Section 2.2.1.2, above, under the EC Eco-labelling Program, is used to develop labelling criteria from the inventory results.

AFNOR is also working on a methodological framework for "public oriented" LCA, as compared to internal use of LCA. The framework is intended to define ethical rules for conducting LCAs for public decisions, like ecolabelling, including the manner in which LCA results are communicated (French Ministry of Environment 1993).

2.2.3.3 Example

The only NF-Environnement labelling criteria published to date is for paints and coatings, which was developed without the full use of the LCI process that is now being used. The program has completed LCIs for trash bags and is in the process of developing the criteria in the representative Committee. The LCI studies performed looked at seven representative products, and the seven companies whose products were being evaluated participated with the French Ministries in financing the studies. The seven studies cost approximately $96,000. These seven companies have also participated on the representative Labelling Committee developing the labelling criteria (Ventère 1993).

2.2.4 Dutch Ecolabel Program

2.2.4.1 General Procedures

The Dutch ecolabelling program was started in 1992 to be the implementing organization for the EC Eco-label and to operate a separate national program in the Netherlands. The program is administered by Stichting Milieukeur, a non-profit foundation independent of the government. The program is financed initially by the Ministry of Housing, Physical Planning and the Environment and the Ministry of Economic Affairs but is expected to become financially independent in five years (Stichting Milieukeur 1993).

Criteria for labelling are set by a Board of Experts representing different segments of society, including consumer groups, environmental groups, manufacturers, the government, and retailers. A consultant first performs an environmental evaluation of the product class and recommends criteria for labelling to the Board of Experts. The Board of Experts then reviews the evaluation and recommendations and develops consensus criteria from them (Verhees 1993a). Before criteria are finalized there is an opportunity for comments from the public and a public hearing (Wijnen 1993).

2.2.4.2 Procedures for Setting Criteria

In the Dutch program the research to support development of criteria for labelling is performed by consultants who make use, to the extent possible, of existing life cycle assessment studies dealing with the class of products. The program, however, does not require a full, quantitative LCA for every product category, but seeks to ensure that a "cradle-to-grave" approach has been pursued (Giezeman 1993).

The program, therefore, does not depend on the development of the perfect LCA methodology, but uses the available information to develop product criteria with expert judgment. The program recognizes that an LCA does not automatically make the choices of the greatest opportunities for environmental improvements in product classes that have to ultimately be made by the Board of Experts based on the available information (Giezeman 1993).

The first step is the selection of a product group, which is a group of products that, according to the consumer, have the same practical purpose and belong to the same market sector. An environmental label can only be set up for a product group in which products differ in degrees of environmental impacts (Giezeman 1993).

The core of the life cycle evaluation that is performed by the consultant is a matrix of 6 life cycle stages and 25 environmental aspects that must be considered. Research is divided into two parts. In the first part, as much quantitative information as possible is generated on the environmental impacts in each stage and each impact category, and the most important environmental aspects of the product group are selected based upon this information. This is done on the basis of a defined functional unit, so that different products in the class can be evaluated in the same framework (Giezeman 1993).

The consultant relies as much as possible upon existing studies. If a cell from the matrix cannot be filled in quantitatively, the approach is to consider the matter qualitatively (Giezeman 1993). If insufficient information exists overall, then the development of product criteria for that class of products is deferred (Verhees 1993a). A complete LCI is not required in order to fill in the matrix. A less detailed approach can be used because the purpose is not to compare every aspect of two or more actual products, but to select the most important environmental aspects for development of product criteria (Giezeman 1993).

After the inventory, those cells are selected that provide the greatest environmental benefit. The point is to determine whether a product, as a whole, causes significantly less environmental damage. This does not mean that the product has to score more favorably in every stage and with regard to every environmental impact (Giezeman 1993).

In the second part of the study the criteria for labelling and the methods of measuring compliance with the criteria are formulated. In this stage the product performance is also considered to determine whether functional requirements have an impact on the environmental attributes and to insure that inferior products are not awarded the label. In this stage, the following considerations are used to formulate criteria:

- the environmental requirements aim at the largest possible reduction of environmental damage;
- the environmental requirements are within the reach of manufacturers;
- the environmental requirements are higher than those of statutory requirements;
- at least one product or brand for sale has to be able to meet the requirements within the foreseeable future;
- functional quality has to be sufficient; and
- it is possible to set requirements for labelling information and packaging (Giezeman 1993).

2.2.4.3 Example

As of August 1993, the Dutch program has criteria for the following products: light bulbs, shower heads, writing paper, paints, and coffee makers (Verhees 1993b). The light bulb criteria illustrate the way in which the methodology functions. The environmental evaluation indicated that the most significant opportunities for environmental improvements were the energy use during use of the lamps, the heavy metal and radioisotope content of the lamps that could be released through incineration or disposal, and the useful life of the lamps, which influences material use in manufacturing as well as volume of solid waste for disposal. Criteria for labelling focussed on energy use per lumen of illumination and on heavy metal and radioisotope concentrations, with label information provided to encourage consumers to dispose of the lamps in the Dutch collection system for small quantity hazardous waste (Giezeman 1993).

2.2.5 Nordic Council "White Swan" Program

2.2.5.1 General Procedures

The Nordic Council Ecolabelling program is a joint program of Sweden, Finland, Norway, and Iceland, founded in 1989. Just as in the EC program, lead countries take responsibility for certain product groups. Within each country an organization is set up to administer the program. In Sweden and Finland the program is administered through the standards-setting institutes, with an Environmental Labelling Board established to provide representative decision-making from different interested sectors of society (consumer and environmental organizations, government, businesses, and research institutes); in Norway through a special Foundation for Environmental Product Labelling, also with a representative board; and in Iceland through the Ministry of the Environment (Nordic

Council 1991).

2.2.5.2 Procedures for Setting Product Criteria

The criteria for products in the Nordic program are established based upon an evaluation of the life cycle of the product class, including production, use, and disposal stages, and take into account factors such as consumption of natural resources and energy, emissions to air, water, and soil, and generation of waste and noise (Nordic Council 1991). In principle, this entails an assessment of the whole life cycle. In practice, product criteria are set in a pragmatic fashion for those stages of the life cycle and environmental impacts that are deemed through expert judgment to be the most significant. Where insufficient information exists to set criteria for certain stages of the life cycle, then no criteria are set for that stage, but other stages are still addressed.

The Swedish Standards Institute refers to the evaluation as a "life cycle review" (Assarsson 1993a). Some of the earlier product evaluations reviewed leave out whole stages of the life cycle where, in the judgment of the evaluator, the life cycle stage does not contribute significantly to overall environmental impacts or is not significantly different for different products within the product group. Some of the evaluations also leave out certain environmental parameters, such as energy use, where sufficient information is not available to form conclusions. Quantitative information is obtained for the environmental impacts within the life cycle stages that are deemed to be the most significant. Since no detailed elaboration of the methodology used was available, descriptions of examples are used to illustrate the approach.

2.2.5.3 Examples

Fine Papers for Printing, Writing, and Copying

The environmental evaluation of fine papers and the resulting criteria for labelling focussed principally on the emissions and use of chemicals during manufacturing. The evaluation excluded energy use in the life cycle due to the difficulties and expense of performing the detailed evaluation necessary. The evaluation also excluded consideration of the impacts of producing the chemicals used in the production of paper. Nor did the evaluation attempt to compare the environmental attributes of recycled fiber versus virgin fiber. Instead, fine paper from virgin fiber is accepted provided that it meets the criteria for emissions and chemical use and can be recycled. On the other hand, tissue paper, which cannot be recycled, must be produced from recycled fiber to meet the criteria for labelling (Norwegian Foundation 1991; Assarsson 1993b).

The criteria for labelling include the following:

- restrictions on the chemicals that can be used in manufacturing, including restrictions on solvents used to clean equipment and on surfactants used for deinking recycled fiber;

- a limit on the combination of total organic halogens (AOX) and COD water discharges and sulphur air and water emissions per ton of paper; and
- a prohibition on the use of chlorine to bleach recycled fiber (Norwegian Foundation 1991).

Marine Engines

The evaluation of marine engines appears to have been more comprehensive. It looked at the pollution, material consumption, and energy consumption during the manufacturing stage and evaluated the emissions during use. The evaluation found no significant differences in the manufacturing processes of different engines that could be used to set criteria for labelling. The resulting criteria for labelling focussed on limits on emissions during use, on extending the life of the engines, and on provisions for recycling the engines after use (Norwegian Foundation 1992).

Dishwashers

The life cycle review for dishwashers appears to have been performed principally in qualitative fashion, with an approximate calculation of energy use during the different life cycle stages. The review identified the following as the most significant environmental impacts throughout the life cycle:

- energy consumption during use;
- consumption of detergent, water, and rinsing agent during use
- noise from use;
- emissions of solvents and heavy metals from surface coating in manufacturing; and
- disposal of dishwashers at the end of their useful life.

The resulting criteria focussed on detergent use, water use, and energy use, but also included a requirement that plastic parts be coated with solvent-free methods, that plastic parts be identified as to type of plastic to make recycling easier, and that transport packaging contain no products for which CFCs were used in the manufacturing (SIS 1991).

2.2.6 Austrian Program

2.2.6.1 General Procedures

The Austrian Eco Label Program was created in 1991. The Eco Label is awarded by the Minister for Environment, Youth and Family for a period of validity of two years (Wendler 1993). Four groups are involved in the process of developing and approving product labelling criteria: the Federal Environmental Agency suggests product categories for labelling; the Austrian Consumer Organization, a non-profit, non-governmental organization, works out criteria with experts and representative groups; a representative Eco Label Committee makes recommendations on criteria; and the final decision on labelling criteria is made by the Ministry for Environment, Youth and Family. The Austrian Quality Certifying Institute administers the application and label contract process (Wendler 1993, Reuter 1992).

The representative Eco Label Committee, which meets twice a year, is composed of representatives of industry, the Ministry of Economic Affairs, consumer organizations, government procurement offices, environmental organizations, the Austrian Institute for Standardization, the Austrian states, scientific organizations, the Ministry for Environment, Youth and Family, the Federal Environmental Agency, the Working Panel on Product Quality, and the Austrian Consumer Organization (Wendler 1993). Labelling criteria have been established for the following product categories:

- refrigerators and appliances for cooling
- varnishes
- sanitary paper
- fine paper
- exercise books
- washing machines
- wood
- wooden furniture
- filing systems
- sealing varnishes
- water-saving toilets made of non-PVC plastics
- electronic control systems for sanitary installations
- reprocessing of toner-modules, ribbon cassettes and ink-cartridges

2.2.6.2 Procedures for Setting Criteria

The Austrian Program has decided that a quantitative life cycle assessment is not necessary for setting criteria for all products, although the life cycle is considered in the criteria development. Where certain product improvements have clear environmental advantages, criteria are developed without the use of LCA. LCAs are being performed for some product categories, including baby diapers and insulating materials. The Federal Ministry of the Environment has provided funding for the diaper LCA through the Consumer Organization (Reuter 1992).

2.2.7 Canadian Environmental Choice Program

2.2.7.1 General Procedures

The Canadian Environmental Choice Program has been operating since 1988 with labelled products first appearing on the shelf in 1990. The Environmental Choice Program is a government-based program located in, funded by, and indemnified by Environment Canada, the federal environmental agency of Canada (OECD 1991).

An independent representative Board originally managed the Program and made preliminary decisions on product criteria for labelling that were adopted by the Minister of the Environment. Since a change in the process in June 1992, the Board serves as more of an advisory body to the Minister of the Environment than as a management group. Members include representatives of environmental, manufacturing, retailing, and consumer groups.

The technical evaluation and development of labelling criteria was originally performed by the Canadian Standards Association (CSA) under contract with the Program. CSA is an independent standards-setting organization and is the Canadian member body of the International Standards Organization. CSA is serving as the Secretariat of the new ISO Technical Committee on Environmental Management recently created to set standards for environmental management tools, including life cycle assessment and environmental labelling. Following the change in structure of the program, CSA is no longer directly involved and criteria are now developed by Environmental Choice staff and consultants working with product category review committees composed of representatives from affected manufacturers and environmental and consumer groups (Douglas 1993; Novak 1993).

Anyone may propose a product category for labelling. The Environmental Choice staff reviews all proposed categories, assesses their potential market impacts based on market/environmental impact analysis, and recommends those with the greatest potential impacts to the Board. The Board reviews the information from the staff and may accept or reject recommended categories or request more technical information (Novak 1993).

If the Board accepts a product category the Environmental Choice Program employes a consultant to prepare a "briefing note", which assesses the environmental, technical, market, and economic considerations associated with the product category. The environmental part of this assessment is called a "life cycle review" by the Program (Douglas 1993; Novak 1993).

With input from this briefing note and other sources, the Board determines whether to proceed to the development of draft criteria. The drafting of the criteria is done by the specially convened review committees working with the Program staff (Novak 1993).

The Board considers the draft criteria and may accept them, suggest revisions, or send them back for further work. If the Board accepts the draft criteria, an announcement that they are available for public review and comment is published and the criteria are circulated to interested parties for a 60-day public comment period. After the comments are reviewed, the Program staff may make amendments before presenting them to the Board for approval. When the Board approves the criteria, they receive a final review by the Minister of the Environment, who then promulgates them as final and publishes an approval announcement in the official government administrative journal (Novak 1993).

2.2.7.2 Procedures for Setting Criteria

The "life cycle review" in the briefing note performed by the consultant and the Program staff forms the basis for the setting of criteria for labelling. It is not a formal quantitative life cycle assessment, but seeks through a qualitative and quantitative review of each stage of the life cycle to identify the most significant environmental impacts of the product for the development of criteria (Douglas 1993).

There are three guiding principals for labelling criteria:

- Long-term environmental issues are given precedence, instead of short-term issues that are likely to be addressed through regulations.
- The entire life cycle of the product should be considered, although the criteria developed will not necessarily address all of the product's environmental aspects.
- The criteria set should promote industry leadership by identifying and certifying existing environmentally superior products (Novak 1993).

The "life cycle review" portion of the briefing notes are relatively short, mostly qualitative reviews of the most significant environmental "issues" associated with each of the life cycle stages. They consider for both product and packaging the manufacturing impacts, the use impacts, and disposal impacts. For each stage, there is a consideration of resource and energy use, chemical and biophysical impacts, and occupational health and safety. The determination of the significance of particular environmental issues is based upon the judgment of the consultant performing the review (Marbek 1991).

2.2.7.3 Example

Laundry Detergents

The Environmental Choice criteria for laundry detergents was adopted in December 1993 after over two years of evaluation and discussion (Environmental Choice Canada 1993). The original Briefing Note was prepared by a consultant, who identified principal ingredients, profiled the market, and qualitatively assessed the environmental parameters of each stage of the life cycle of the principal ingredients (Environmental Choice Canada 1991). Stages of the life cycle and environmental impacts within those stages that were addressed are listed below:

- Resource Issues

  Feedstocks (renewability, energy consumption, environmental burdens)
  Packaging (solid waste disposal, heavy metals content, concentration of product)

- Manufacturing

  Environmental impacts (water pollution, air pollution)

- Use of Product

  Energy Consumption (efficacy at lower temperatures)
  Environmental impacts (biodegradability, eutrophication, aquatic toxicity, human health effects)

The Briefing Note also addressed socio-economic issues, including product efficacy and impacts on manufacturing, markets, and employment.

The Briefing Note recommended that Environmental Choice consider the following labelling criteria:

- use of renewable resource feedstocks
- complete biodegradability within a given period
- minimal nutrient contribution to algal plant growth (eutrophication)
- good ecotoxicological profile
- no unacceptable human health impacts
- concentrated formulation
- good performance in cooler washwater temperatures
- low impact packaging (e.g., minimal materials, recycled materials, reusable, recyclable) (Environmental Choice Canada 1991).

Draft labelling criteria were developed based upon the Briefing Note and circulated for public comment. Discussions were also held with representatives of detergent manufacturers and with the environmental community. These draft criteria included a list of acceptable and unacceptable ingredients, a limit on phosphorous and nitrogen builders, limits on heavy metal content, biodegradation criteria, aquatic toxicity criteria, bioaccumulation limits, and a packaging reduction requirement (Duffy 1992). The comments on the draft criteria were evaluated by a consultant and an options paper was prepared for the Environmental Choice Program (Duffy 1992).

After additional input from manufacturers and the public, final criteria were adopted that have the following main attributes:

- Choice to either demonstrate that ingredients meet "environmental protection factor tests" or are on a list of "acceptable ingredients". The environmental protection factor tests include acute and sub-chronic aquatic toxicity and bioaccumulation.
- Prohibition on ingredients that are designated as carcinogens.
- Biodegradation requirements.
- Prohibition on EDTA.
- Packaging criteria, which include a weight/dose limit to reduce packaging by approximately 50%, recycled content requirements, and heavy metal limits.
- Performance requirements for performance at two temperatures, one of which corresponds to heated water. (Environmental Choice Canada 1993).

2.2.8 Green Seal

2.2.8.1 General Procedures

Green Seal is an independent, non-profit environmental labelling program operating in the United States. Green Seal makes all decisions on criteria for labelling internally after soliciting input from affected industry groups, environmental organizations, government agencies, consumer groups, and other interested members of the public. Green Seal was formed by environmental and consumer organizations and is overseen by a Board of Directors that includes the directors of several of these organizations.

Criteria for labelling are developed by Green Seal through a technical evaluation of the product category that may be conducted by Green Seal staff or by outside consultants. Draft criteria are circulated for comment, and final criteria are developed after careful review of the comments received. A document responding to and discussing substantive comments on the draft criteria is also prepared at the same time that the final criteria are prepared. The testing of products and the monitoring of compliance with certification standards for those products and manufacturers that apply for and receive the Green Seal is performed generally by Underwriters Laboratories, Inc. under contract with Green Seal (Green Seal 1992a).

2.2.8.2 Procedures for Setting Criteria

Green Seal has not performed quantitative life cycle assessments in the development of product labelling criteria, but has used an "environmental impact evaluation", which attempts to identify the most significant environmental impacts in each stage of the product's life cycle. The intent is to "reduce to the extent technologically and economically feasible, the environmental impacts associated with the manufacture, use, and disposal of products" (Green Seal 1992c). Although Green Seal has attempted to utilize formal LCA studies in its environmental evaluations if those studies are made available by manufacturers, Green Seal states that it does not attempt to perform LCA for each of its product categories because LCA is not yet fully developed as a tool (Weissman 1993).

These environmental impact evaluations have utilized published information on products and their production processes and information provided by product manufacturers. Both quantitative and qualitative information is utilized in the evaluations. Where quantitative life cycle inventories have been performed on behalf of manufacturers or trade associations, Green Seal has attempted to obtain these for use in the criteria development process. For instance, in the evaluation of windows for labelling Green Seal relied upon an LCA performed by the University of Amsterdam in the Netherlands to focus the criteria on the use stage of the life cycle (Green Seal 1993a).

Once Green Seal staff or consultants have evaluated the environmental impacts of the product category throughout its life cycle, criteria are drafted that aim to reduce the most significant impacts identified. The criteria are based upon expert judgment and attempt to use standard tests and methodologies whenever available.

The criteria developed may address only one or two stages of the life cycle if the evaluation shows that the most significant impacts are in those stages. For instance, the proposed Green Seal criteria for household appliances (washing machines, refrigerators, dishwashers, etc.) focus on energy efficiency during use as the major source of environmental impacts (Green Seal 1993b). Furthermore, if there is great uncertainty concerning choices between materials or ingredients in a stage of the life cycle, and if that stage is not clearly the most significant stage in terms of overall environmental impacts, Green Seal may choose not to address that stage in its criteria, calling for more input and more study.

Informal consultations with manufacturers and others take place during the environmental evaluation and in the development of the criteria. The formal comments on the proposed standard are an important part of the criteria development, since they give affected manufacturers and others an opportunity to present scientific information that may have been overlooked in the evaluation and to comment on the technical and economic feasibility of the criteria.

2.2.8.3 Examples

Tissue Paper

In the environmental impact evaluation for tissue paper, Green Seal's consultant evaluated the process of manufacturing tissue paper from both virgin pulp and recycled fiber. Data was obtained on the resource and energy use of both processes and on the emissions from both processes. The evaluation identified significant reductions of most toxic pollutants and of use of energy, water, trees, and other natural resources by manufacturing tissue from waste paper as compared to virgin fiber. The evaluation also noted that recycling mills can produce significant impacts, such as the toxic water pollutants from bleaching recycled pulp with chlorine and the water pollutants, sludge, and air pollution from deinking recycled pulp with chlorinated solvents. Finally, the evaluation addressed the packaging of tissue products and additives that do not contribute to their function (Green Seal 1991).

The standard that was ultimately adopted required 100 percent recovered paper material, including 10-20 percent post-consumer material; a limit on the amount of organic halogens (AOX) in the effluent from bleaching the paper, with an ultimate restriction on the use of chlorine or its derivatives for bleaching; a restriction on the use of added pigments, inks, dyes, or fragrances; a minimum square footage of tissue per package to reduce packaging waste; and a requirement that the packaging should be made of recycled fiber and not contain excessive levels of heavy metals (Green Seal 1992a).

Compact Fluorescent Lamps

Green Seal recently published criteria for labelling of Compact Fluorescent Lamps (CFLs) (Green Seal 1992c). Concluding after a preliminary evaluation that the use stage for electric lamps presents the most significant environmental impacts because of energy use, Green Seal excluded incandescent lamps from labelling after an evaluation of the energy use per lumen of light delivered by incandescent lamps as compared to CFLs. The evaluation also showed that CFLs would likely have advantages from a manufacturing and disposal perspective, because they last significantly longer than incandescent lamps.

Once the decision was made that CFLs had the better overall environmental profile, aspects of the life cycle of CFLs that could be improved by setting labelling criteria were evaluated. To insure that CFLs with the Green Seal provided benefits during use, an energy per lumen of light delivered standard was set, plus other performance criteria, including operating life. Criteria to address manufacturing and disposal impacts were also included, such as mercury content and radioisotope content. Finally, labelling language was included to instruct the consumer on the most efficient usage of CFLs (Green Seal 1992c).

General Purpose Household Cleaners

Green Seal has also developed draft criteria for labelling general purpose household cleaners. These criteria were drafted initially for Green Seal by the University of Tennessee Center for Clean Products and Clean Technologies after a review of the life cycle environmental attributes of representative products and their packaging. The class of products is extremely diverse, and it was impossible to cover all possible ingredients, so major ingredients were evaluated as to reported environmental impacts in raw materials extraction and manufacturing. An evaluation was also performed of the potential impacts from use and disposal of major ingredients and of the life cycle impacts of packaging alternatives (UT 1992).

There were no existing LCA studies available that could be used to perform a comprehensive quantitative evaluation, although a major household cleaner manufacturer provided a summary of the results only of two studies: one which compared different surfactants, and one which compared a typical commercial household cleaner formulation with a "make-your-own" formulation. The summary of the results presented for the surfactant LCA indicated that it was difficult to differentiate gross levels of environmental releases and energy use for surfactants using natural oils or fats as basic raw materials when compared to those using petrochemicals as raw materials. The summary of the results of the typical household cleaner LCA that were made available indicated that if any household cleaner required the use of hot water for dilution, the energy use for heating the water would be a significant source of gross environmental releases (UT 1992).

The initial recommendations for labelling criteria attempted to include criteria for each stage of the product life cycle. Although surfactants with natural oils as raw materials were not preferred over those with petrochemical raw materials from a renewable resource perspective, the release of carcinogens and reproductive toxins from the manufacturing process was recommended as an exclusion criteria for ingredients, which would have resulted in the exclusion of most ingredients made from petrochemicals. For the use and disposal stage for the cleaner itself, exclusions for toxic ingredients and limits on VOCs were recommended as well as criteria for biodegradation and aquatic toxicity. For packaging, an exclusion for PVC and aerosol cans was recommended as well as recycled content requirements for other packaging materials. It was also recommended that the label contain a statement that only cold tap water should be used for dilution (Green Seal 1992b).

The household cleaner criteria have undergone public review and are being redrafted by Green Seal. Several comments were received concerning the toxics releases in manufacturing criteria, stating that there was not enough basis for selecting toxic chemical releases as the sole environmental indicator for the production process without a life cycle assessment (Green Seal 1993c).

The development of the household cleaner criteria demonstrates the difficulties of developing criteria for product categories that are characterized by several different types of formulations with competing raw materials and competing packaging materials. Most of the criteria that are being considered in the final standard are intended to improve the environmental attributes of any formulation in the use and disposal stages and to improve the environmental attributes of any packaging material.

2.2.9 Japanese Eco Mark Program

2.2.9.1 General Procedures

Japan's Eco Mark Program was launched in 1989 to encourage conservation of the environment by certifying products and services deemed relatively beneficial to the environment. The program is operated by the Japan Environment Association (JEA), a non-governmental organization operating under the guidance of the National Environment Agency.

Two Committees operate within the JEA: the Promotion Committee and the Expert Committee. The Promotion Committee is responsible for selecting product categories for labelling and for developing labelling criteria in consultation with the Expert Committee. It is a representative committee with members from academia, local governments, manufacturers and distributors, the Environment Agency, and the National Institute for Environmental Studies (Hashimoto 1990).

The Expert Committee determines whether products qualify for the label. This committee is more technically based, including representatives from consumer organizations, local governments, environmental researchers, and technical experts from the Environment Agency and the National Institute for Environmental Studies (OECD 1991, Hashimoto 1990). Manufacturers apply to the Expert Committee submitting relevant information, and the Committee may request testing by a third party. There is no public comment process for the setting of criteria or the award of the label to particular products (OECD 1991).

2.2.9.2 Procedures for Setting Criteria

Rapid procedures that do not involve life cycle assessment are used by the Eco Mark Program for setting criteria. As a result, there were 49 product categories for which criteria had been developed and over 2,300 products certified by the end of August 1992 (US EPA 1993a). In general, detailed environmental evaluations of classes of products are not performed to identify significant environmental impacts and means to reduce those impacts. Instead, whole categories of products, such as compost bins, are awarded the label because they meet certain general environmental criteria (US EPA 1993a).

The general criteria used to select product categories for labelling are as follows:

- minimal environmental impact from use;
- significant potential for improvement of the environment by using the product;
- minimal environmental impact from disposal after use; and
- other significant contributions to the environment.

Additional criteria that are required for approval include:

- appropriate pollution control measures at the production stage;
- ease of treatment for disposal of product;
- energy conservation during use of the product;
- compliance with regulations and standards for quality and safety; and
- price not extraordinarily higher than comparable products (Hashimoto 1990).

The idea behind the program appears to be to label products that call attention to an "environmental" life style, more than to try to reduce the environmental impacts of general consumer products. Activities considered as part of this "environmental" life style may also receive the label. The Eco Mark program has studied LCA but has decided that the methodology is not yet ready to be used for environmental labelling (US EPA 1993a).

2.2.9.3 Examples

Examples of product criteria, which illustrate the methodology used, include the following (OECD 1991):

- personal care aerosol sprays without CFC-11, 12, 113, 114, or 115
- beverage cans with stay-on tabs
- home compost bins (no criteria for materials of construction)
- soap made from used cooking oil (at least 50% of the fat and fatty acids from used cooking oil from homes or industry)
- Toilet paper with 100 percent recycled fiber and produced in compliance with local environmental regulations, which can be more stringent than national regulations
- printing paper with 35 percent recycled fiber and produced in compliance with local environmental regulations, which can be more stringent than national regulations
- "green books" -- books and magazines of environmental subject matter printed on paper containing 10% recycled fiber
- solar heating systems for home use that provide a reasonable return on investment through fuel savings
- products using solar batteries that do not contain cadmium, organic halogens, or harmful chemical substances

2.2.10 Singapore Green Labelling Scheme

2.2.10.1 General Procedures

The Singapore Green Labelling Scheme was created in May 1992 and is administered by the Ministry of the Environment. For each product category selected by the Secretariat of the program a workgroup is formed to develop draft criteria comprising experts from within the Ministry of Environment and the academic institutions. The draft criteria are then reviewed by the Advisory Committee, which is composed of representatives of manufacturers, academic institutions, and government organizations, and includes organizations such as the Singapore Institute of Standards and Industrial Research, the Trade Development Board, the National University of Singapore, the Consumer Association of Singapore, the Singapore Manufacturers Association, and the Ministry of the Environment. Once draft criteria are developed, they are released for public comment, then revised and approved by an Approving Board headed by the Permanent Secretary for Environment (Singapore Ministry 1992).

2.2.10.2 Procedures for Criteria Development

The Green Label program does not use quantitative life cycle assessment, nor does it always consider all stages of the life cycle. This choice has been made because of the state of development of LCA and because it is difficult to weigh different environmental impacts of different substances (Loo Hak Jan 1993).

The program uses instead what it calls a "simplified LCA". The few most important parameters from the raw material, production, and distribution to disposal stages are carefully reviewed by a technical workgroup. The workgroup develops labelling criteria that address the parameters that it considers necessary to make the product "environmentally friendly" (Loo Hak Jan 1993).

2.2.10.3 Example

Compact Fluorescent Lamps

The technical workgroup that was assembled to develop the criteria for compact fluorescent lamps identified three parameters as most important: energy use per lumen; radioactive isotopes in the starter; and mercury content. Criteria were set for energy use (e.g., 50 lumens per watt for lamps < 10 watts) and mercury content (< 10 mg of mercury), but no criteria were set for radioisotopes after consultation with a radiation specialist in the Ministry of Health who found that the use and disposal of the lamps should not pose an environmental or health hazard (Loo Hak Jan 1993).

2.2.11 Environmental Choice New Zealand

2.2.11.1 General Procedures

The Environmental Choice New Zealand Program is administered by Telarc, which is a government-owned accreditation and certification authority. The Telarc Council, the governing body for Telarc, establishes the criteria for product labelling after receiving recommendations from its Environmental Choice Management Advisory Committee (ECMAC). The ECMAC is a representative body composed of persons with expertise in environmental science, consumer interests, manufacturing, wholesaling, retailing, environmental policy, and environmental improvement (Telarc 1992).

ECMAC selects product categories for evaluation, and Task Groups consisting of experts of different interests in the relevant field are set up to develop product criteria. The Task Groups present a draft of criteria to the ECMAC, which is released to the public, and a public comment period is held. The Task Group then revises the criteria based upon the comments and presents the revised criteria to the ECMAC for approval (Telarc 1992).

2.2.11.2 Procedures for Criteria Development

The procedures used to develop product criteria include an assessment of environmental impacts in the product category throughout the product life cycle, as far as is practicable. The assessment is used to choose those aspects for which a significant environmental gain can be achieved (Telarc 1993).

The ECMAC Guidelines for Task Groups contain the following note about the use of life cycle assessment:

> It may have to be clearly acknowledged that the aspect(s) chosen are considered the best practicable option(s). Other aspects of the product's life cycle which deserve attention may not be considered (at a particular time) because of the unavailability of information, particularly of overseas materials and components, and the inadequacy of the programme's resources to fully investigate the product's life cycle.
>
> Ideally, within a chosen product category the environmental impacts of a product's entire life-cycle should be considered (i.e., a "cradle-to-grave" approach). While this ideal is what the programme should aim for it will often be very difficult to achieve it. When such difficulties occur the criteria document should explain the difficulty and detail any assumptions made.

The guidelines also reflect a concern that certain choices between materials are premature given the state of information on the environmental attributes of materials. The guidelines state that no stance should be taken on the issue of whether plastic or paper is environmentally preferable, for instance, and that such an approach will apply to other similar situations (Telarc 1993).

2.2.11.3 Examples

Examples of product criteria from Environmental Choice New Zealand do not reflect the use of quantitative life cycle assessment in the evaluations performed to develop the criteria. They each contain the preliminary statement that "based upon a review of currently available information, the following product category requirements will produce a net environmental benefit" and that "as information and technology change, product category requirements will be reviewed, updated, and possibly amended."

Paints

The paint criteria focus on the ingredients of the paint and attempt to reduce VOC content and the content of halogenated solvents, hydrocarbon solvents, aromatic hydrocarbon solvents, and toxic compounds. It is assumed that the reduction of these constituents, and in particular, VOCs, will result in a net environmental benefit throughout the product life cycle (Environmental Choice New Zealand 1993).

Carbon Zinc and Zinc Air Batteries

The criteria for both carbon zinc and zinc air batteries focus on reducing levels of mercury in the batteries and do not address any other environmental impacts (Environmental Choice New Zealand 1992a).

Plastic Products Using Recycled Plastics

The criteria for plastic products using recycled plastics assumes that plastics recycling produces a net environmental benefit and focusses only on recycled content (Environmental Choice New Zealand 1992b).

2.3 <u>Comparison of Criteria Among Labelling Programs</u>

Tables 3 and 4, below, compare labelling criteria for two products among labelling programs with different methodologies for developing labelling criteria. From this comparison it can be seen that labelling programs address the same general environmental issues for the same product categories, in spite of differences in methodologies.

Table 3: Paints and Coatings Standards

Country/Program/Products	VOCs	Aromatic Hydrocarbons	Other Organic Compounds	Metals in pigments	Other
Germany/"Blue Angel"/ varnishes and other coatings[1]	Class I substances-- ≤ 0.5% Class II substances--≤ 5.0% All VOCs: < 10 wt % aggregate total in water-dilutable varnishes < 15 wt % aggregate total in varnishes undilutable in water		formaldehyde < 12 mg/kg CFCs 0	no lead, cadmium, chromium VI, other toxic metals and their compounds (except as impurities < 0.1 wt %)	
France/NF-Environnement Mark/paints, varnishes, and related products[2]	Total Losses during manufacture: < 3% of the weight of VOC used Content of paint: < 250 g/l	< 5 wt %	halogenated < 0.1 wt % hazardous organic compounds < 0.5 wt % glycols < 5 wt % no organotin compounds	no copper (except phthalocyamines), lead, cadmium, mercury, chromium VI, arsenic, irradiated pigments	no carcinogens, mutagens, or teratogens; incineration of organic waste during manufacture required; daphnia toxicity < 10% immobilization
USA/Green Seal/paints[3]	Interior: nonflat ≤ 150 g/l flat ≤ 50 g/l Exterior: nonflat ≤ 200 g/l flat ≤ 100 g/l	≤ 1.0 wt %	no methylene chloride, 1,1,1-trichloroethane, vinyl chloride, 1,2-dichlorobenzene, benzene, toluene, ethylbenzene, naphthalene, phthalate esters, isophorone, formaldehyde, MEK, MIBK, acrolein, acrylonitrile	no antimony, cadmium, hexavalent chromium, lead and mercury	packaging: no lead in cans
Canada/Environmental Choice/solvent-based paints[1]	≤ 380 g/l	≤ 10 wt %	no halogenated solvents, formaldehyde	no lead, cadmium, chromium VI or their oxides; no mercury or mercury compounds	flash point ≥ 37.8 C
New Zealand/Environmental Choice/paints[4]	Water-based: ≤ 100 g/l Solvent-based: ≤ 300 g/l	≤ 5 wt %	hydrocarbon solvents ≤ 25 wt % halogenated solvents ≤ 250 mg/l no ethylene glycol	no mercury, arsenic, selenium, lead, cadmium, chromium VI, antimony (except combined total impurity conc. of 0.1 wt% of non-volatile content)	not flammable no human carcinogens or listed toxic compounds

Footnotes:

1 OECD 1991.
2 French NF-Environnement 1992.
3 Green Seal 1993d.
4 Environmental Choice New Zealand 1993.

Table 4: Fluorescent Lamp Standards

Country/Program	Energy Efficiency	Toxic Metal Content	Radioisotopes	Other
UK/Ecolabelling Board[1] (proposed for EC scheme)	40 lumens/watt	$\leq$ 10 mg/lamp mercury 0 cadmium 0 arsenic	$\leq$ 20 kBq ^{3}H $\leq$ 2 kBq ^{85}Kr $\leq$ 12 kBq ^{147}Pm	Packaging: All reusable (except cardboard), or Cardboard--80% recycled material
USA/Green Seal[2]	Compact fluorescent lamps: Wattage — Efficiency < 7 watt — 40 lumens/watt 7-9 — 50 " > 9-13 — 55 " > 13-18 — 60 " > 18 — 62 " Self-ballasted lamps and lamps and ballast supplied together: Wattage — Efficiency < 10 watt — 40 lumens/watt 10-15 — 45 " > 15 — 55 "	$\leq$ 20 mg/lamp mercury (1993) $\leq$ 15 mg/lamp mercury (1994) $\leq$ 10 mg/lamp mercury (1996)	0 radioisotopes by 1997	Packaging: Toxic metal limits Life Span: Self-ballasted and CFLs--8000 hours Ballast adapters-- $\geq$ 8000 hours
Singapore/Green Labelling[3]	Compact fluorescent lamps: $\geq$ 50 lumens/watt Lamps and Ballast: Wattage — Efficiency < 10 watt — 50 lumens/watt 10-30 — 60 " > 30 — 75 "	$\leq$ 10 mg/lamp mercury		

Footnotes:

1 UK Ecolabelling Board 1993b.
2 Green Seal 1992c.
3 Singapore Ministry of the Environment 1993.

3. ALTERNATIVE APPROACHES

3.1 Single-Attribute Claims Certification

Single-attribute labelling programs are distinguished from other seal-of-approval type programs in that they focus on only one product environmental attribute without regard to whether the attribute that is the subject of the label provides overall environmental benefits or is one of the most significant environmental attributes of the product. For instance, a label certifying that a household cleaner is biodegradable says nothing about whether biodegradability is the most significant indicator of the product's overall environmental impacts or whether the product may have other properties that are significantly detrimental to the environment. Almost by definition, single-attribute claims certification does not involve the use of life cycle assessment.

Independent single-attribute claims certification is important in the sense that government agencies have been actively encouraging product environmental improvements for certain single attributes through procurement guidelines and market development programs, such as increased use of recycled material and increased energy efficiency. In addition, the United States Federal Trade Commission (FTC) and certain state agencies have institutionalized criteria for certain specific environmental claims. Finally, consumers have come to believe that certain environmental attributes of products are relatively beneficial to the environment, and manufacturers are making such claims in order to sell products. The independent certification provides the consumer with assurance that the claim has been verified and that the attribute has been measured in some objective fashion by some preset criteria.

Two programs that have been operating for single-attribute claims certification include Scientific Certification Systems, a private environmental labelling organization in the United States, and Environmental Choice Australia (US EPA 1993a).

3.2 Product Environmental Information Profile Approach

The use of a label that represents an environmental information profile of a product represents a significantly different approach than seal-of-approval type programs. Instead of certifying that a product has certain superior environmental attributes as compared to other products in its class based on preset criteria, the environmental information profile approach seeks to simply convey information about the environmental attributes of the product to the consumer in quantitative or qualitative fashion without preset selection criteria or selection of superior products.

3.2.1 Scientific Certification Systems Environmental Report Card

One private environmental labelling organization in the United States, Scientific

Certification Systems (SCS), has launched such a label that it calls an "Environmental Report Card." The purpose of the label is to provide the consumer information concerning the results of a life cycle inventory of the actual product bearing the label in an aggregated format using the concept of "environmental burdens" (SCS 1993a).

SCS uses an LCI model developed by Dr. Ian Boustead of Great Britain to generate quantitative information on inputs and outputs for the product system. Data is collected directly from the manufacturer of the product for the stages of the life cycle that are controlled by the manufacturer. Upstream or downstream data is provided by a database furnished with the Boustead model that is supplemented by data from the literature, government reports, published LCI studies, and other studies conducted by SCS (Rhodes 1993a). SCS staff visit manufacturers' facilities to verify data on inputs and outputs and, in some cases, attempt to verify supplier data through contacts with suppliers (Rhodes 1993a).

In order to present data from the inventory in a format that will fit on a product label, SCS aggregates the inputs and outputs from the model into categories called "environmental burdens". Resource and energy inputs are aggregated based upon chemical or physical properties which can be scientifically identified. Emissions and waste outputs are aggregated based upon government reporting categories under federal environmental regulations in the United States or important international treaties, such as the Montreal Protocol. Emissions of chemicals that have not been so classified are aggregated and reported as "unclassified" for completeness (Rhodes 1993b).

These environmental burdens include the following:

Resources Depleted

- Water
- Wood
- Coal, Natural Gas, Oil (Non-fuel)
- Minerals
- Soil
- Animal Products
- Food/fiber

Energy (total used)

Air Emissions

- Carbon dioxide
- Carbon monoxide
- Sulfur oxides
- Nitrogen oxides

- Ozone depleting chemicals
- Hydrocarbons
- Particulates
- Hazardous air pollutants
- Unclassified emissions

Water Emissions

- Total solids
- Oxygen depleting chemicals
- Toxic pollutants

Solid Waste

- Hazardous waste
- Unclassified waste

(SCS 1993b; Rhodes 1993b).

This aggregation of LCI data into "environmental burdens" is not intended to be a form of life cycle impact assessment. In the EPA and SETAC framework for impact assessment, the first step is classification of inputs and outputs into impact categories. These impact categories represent a step beyond the SCS environmental burden categories in relating the inputs and outputs to some type of environmental impact. For instance, nitrogen oxides are listed as an SCS environmental burden, but in life cycle impact assessment these pollutants would be classified and aggregated with sulfur oxides as acidification emissions or with carbon monoxide and hydrocarbons as smog forming emissions.

The version of the Environmental Report Card that was launched in August 1993 presents the aggregated environmental burdens as bars on a bar chart. The scale is an exponential scale, so that several orders of magnitude for the different burdens can be represented on the same chart. The label "Better: Lower Burdens" is at the left end of the horizontal bar chart and the label "Worse: Heavier Burdens" is on the right end of the bar chart. The aggregated totals for emissions, etc., are presented in numerical form also (SCS 1993c).

The stated goal of SCS for the Environmental Report Card is to function in similar fashion as nutritional labelling and energy efficiency labelling, providing neutral information to consumers that allows them to assess the relative "quality" of the product. SCS claims that the report card approach, as a full disclosure system, also provides consumers an important educational opportunity to learn about how products produce environmental burdens and demonstrates that every product produces environmental burdens and that there are frequently tradeoffs between different types of environmental burdens.

The label recently launched by SCS goes beyond the information-only approach, however, and approaches a seal of approval by including a prominently displayed Green Cross logo in a box on the front of the label titled in bold letters, "Certified Environmental Advantages". The labels for trash bags made with recycled plastic list in this box advantages of the products as compared with trash bags made from virgin plastic, although no virgin plastic products bear the Environmental Report Card (SCS 1993c). The addition of the "Certified Environmental Advantages" box with the Green Cross logo obviously implies environmental superiority and endorsement.

SCS is promoting the report card as preferable to the seal-of-approval approach used by all government-sanctioned environmental labelling programs. SCS claims that the report card approach eliminates the subjective judgment that goes into developing criteria for award of a seal. Another claimed advantage for report cards over seal-of-approval approaches is that report cards recognize incremental improvements in reducing burdens, instead of creating a pass/fail dividing line like most labelling criteria do (Rhodes 1993b).

Criticisms of the report card approach as an environmental labelling system for consumer products include concerns that the presentation of life cycle inventory results without all of the information on assumptions, boundaries, and equivalent use, can be misleading; that the selection of environmental burden categories for the report card and the presentation of widely different environmental burdens on the same scale represents subjective judgment and implies a form of impact assessment that has not been performed; and that having the label appear on one or a few products on the shelf creates the impression of endorsement, even if the burdens may be greater than those for other products that do not carry the label.

3.2.2 Dutch Programs

The Dutch Ministry of Housing, Physical Planning, and Environment is developing two schemes to make use of product life cycle environmental information. In addition to the Dutch Ecolabelling scheme discussed above, the Ministry is developing a system whereby qualitative information on a product's most important environmental attributes would be required by the government to be presented on the label. The product groups and the information to be reported would be specified by the Ministry (Geelen 1993).

The Dutch have also been developing the concept of "integrated chain management", where environmental information concerning the materials and ingredients of a product are shared by producers all along the chain from raw materials to final production. Having this information in usable form would enable producers to assess and reduce their environmental impacts up and down the chain. The "environmental profiles" proposed in this scheme could resemble the Environmental Report Card, discussed above, or something like a Material Safety Data Sheet now used for chemical products (Geelen 1993).

3.3 Expert System Evaluations

Given that the primary use of LCA in most environmental labelling programs is for the identification of the most important stages of the life cycle and the most significant inputs and outputs resulting in potential environmental impacts, it may be possible to perform this identification step without the time and expense required for a quantitative data-based study. The German Blue Angel Program's assessment matrix is a qualitative approach that uses expert judgment to focus in on important life-cycle stages and input/output parameters (Neitzel 1992a).

As in the German experience, such qualitative assessments may be sufficient for setting certain types of criteria for certain product categories. One problem with qualitative approaches such as these, however, is that the expert judgment may come only from one source, with one set of values and experiences, and may be exercised in a non-systematic manner.

The University of Tennessee Center for Clean Products and Clean Technologies has tested a more formal expert system approach to qualitative life cycle evaluations. The study was done by selecting an expert system decision-making protocol, called the Analytical Hierarchical Process (AHP), that arrives at decisions by a series of paired comparisons (Saaty 1990). An expert questionnaire was developed for evaluating the life cycle environmental impacts of two competing product systems, kraft paper grocery sacks and polyethylene plastic grocery sacks, and the results were analyzed using Expert Choice®, commercially available software embodying the AHP methodology (Manseill 1993).

The questionnaire broke the life cycle of each product down into four stages: raw materials extraction, production of intermediates, fabrication of final product, and transportation, use and disposal of the product. Basic information was given about each product system, such as functional unit assumptions (4 pounds of paper sack carries same amount as 1 pound of polyethylene sack), raw materials used, and a process flow diagram. The information provided did not quantify or even identify the environmental impacts associated with each stage of the product systems, since the purpose of the questionnaire was to determine if the relative magnitudes of these impacts could be determined through expert judgment without extensive data collection. The experts asked to complete the questionnaire were asked to rely upon their knowledge and experience to determine the relative environmental impacts of the different stages of the life cycles of both product systems, both within each product system and across the product systems.

Thirty-three experts were selected to receive the questionnaire. They were selected based upon their experience in the paper industry or the plastics industry or in general assessment of environmental impacts. The former category included engineers in the paper or plastics industries and university professors. The later category included environmental consultants and government agency scientists. Out of the experts solicited, ten completed and returned the questionnaire, which took most over two hours to complete.

The questionnaire asked the experts to judge the relative importance of each of the following impact categories for each stage of the life cycle of the two products:

Air Pollution:

acidification releases
greenhouse gases
ozone depleting chemicals
smog forming releases
hazardous chemicals
particulates
other

Water Pollution:

toxic chemicals
oxygen depleting discharges
other

Solid Waste

hazardous solid
other solid

Energy Use

For categories like greenhouse gases, ozone depleting chemicals, and hazardous air pollutants, lists of particular chemicals from regulations or scientific journals were provided to the experts as a reference.

For both products, for almost every impact category, the production of intermediates stage of the life cycle was judged by the experts to be the most significant. Table 5 and 6 , below, illustrate the impact categories for the different stages of the life cycle of each product that the experts judged to be most significant ("X" indicates that the categories rated highest). For paper sacks, the three most significant impact categories/life cycle stages were hazardous solid wastes, smog forming air pollutants, and oxygen depleting water pollutants, all in the production of intermediates stage. For polyethylene sacks, the three most significant were energy use, toxic water pollutants, and hazardous air pollutants, all in the production of intermediates stage (Manseill 1993).

These results could be used to focus data collection efforts in a subsequent quantitative life cycle inventory on the production of intermediates stage for each product. They could also be used as grounds for a decision to focus on labelling criteria that would reduce the need for production of intermediates in the life cycle of each product. Recycled content criteria for both types of sacks would be one way of reducing this production. An evaluation would have to be made of the environmental attributes of recycled material versus virgin material before reaching a conclusion that such criteria would reduce environmental impacts.

Table 5: Results of Expert System for Kraft Paper Grocery Sacks

Impact Category/ Life Cycle Stage	Extraction of Raw Materials	Production of Intermediates	Fabrication of Final Product	Transportation, Use, and Disposal
Acidification		X		
Greenhouse				X
Ozone Depleting				X
Smog Forming		X		
Hazardous Air		X		X
Particulate Air				X
Other Air	X	X		X
Water Toxic		X		
Oxygen Depleting		X		
Other Water		X		
Hazardous Solid Waste		X		
Other Solid Waste	X			X
Energy Use	X	X		

Table 6: Results of Expert System for Polyethylene Grocery Sacks

Impact Category/ Life Cycle Stage	Extraction of Raw Materials	Production of Intermediates	Fabrication of Final Product	Transportation, Use, and Disposal
Acidification		X		
Greenhouse		X		X
Ozone Depleting		X		
Smog Forming		X		
Hazardous Air		X		
Particulate Air		X		
Other Air		X		
Water Toxic		X		
Oxygen Depleting		X		
Other Water		X		
Hazardous Solid Waste		X		
Other Solid Waste		X		X
Energy Use		X		

A comparison of the two products for each impact category was also performed by the expert group. The experts ranked kraft paper sacks higher (worse) in every impact category except for hazardous solid waste, which was a tie. The most significant differences for paper versus plastic were in acidification air releases, greenhouse gases, particulate air pollutants, other water pollutants, other solid wastes, and energy use (Manseill 1993).

These results were compared to a quantitative life cycle inventory performed by Franklin Associates for paper and polyethylene grocery sacks (Franklin 1990). In order to make the comparison, the Franklin results for pollutants from the product systems, which were expressed in quantities of particular pollutants, were aggregated into the same impact categories that were used in the expert system. Franklin's results, however, did not include pollutants in some of the impact categories. The Franklin quantitative inventory had similar results, with paper sacks having larger quantities of pollutants in each impact category. In the Franklin study, the amounts of hazardous solid wastes and solid waste in general were significantly higher for paper than for polyethylene (Manseill 1993).

The expert system study shows that the systematic use of expert judgment may produce reasonably accurate results as a first approximation in identifying the most significant impacts in the life cycle of a product for development of labelling criteria and in comparing the life cycle environmental impacts of two product systems. Neither methodology answers the question of which impacts are the most important in an overall sense (e.g., acidification versus water toxics), although the expert system could be used within a company or a diverse group representing different interests to value impact categories as a way of setting priorities or interpreting life cycle assessment results.

4. FINDINGS

Following are the major findings of this report:

4.1 Most government-sanctioned third-party certification environmental labelling programs are seal-of-approval programs that attempt to develop labelling criteria that address the overall environmental attributes of products.

The focus of this evaluation was on so-called seal-of-approval programs, since all of the government-sanctioned third-party certification programs that exist today use this approach. Most of these programs attempt to develop labelling criteria that address the overall environmental attributes of classes of products as opposed to single claim certification, where criteria are developed that address only one environmental attribute (e.g., CFC content). Many of the labelling criteria developed by these seal programs, however, focus on only a few environmental attributes after determining in some fashion that these are the most significant attributes that reflect the overall environmental performance of the class of products and can be used to distinguish environmentally superior products.

4.2 Most environmental labelling programs at least recognize the life cycle concept in development of labelling criteria for classes of products, but only a few programs are using any part of the formal practice of LCA as it has been defined by the U.S. EPA, SETAC, and others.

In evaluating the use of LCA in environmental labelling programs, a distinction must be made between the life cycle concept and the formal practice of quantitative life cycle assessment, as it has been elaborated recently by the U.S. EPA, the Society for Environmental Toxicology and Chemistry, and others. The life cycle concept, in which each stage of the product life cycle is evaluated in some fashion in developing labelling criteria, was embodied in the German Blue Angel Program's matrix approach several years ago, and has been embodied in the recent European Communities' Eco-label regulation. The formal practice of LCA, in which a quantitative inventory is performed, followed by impact analysis and improvement analysis, is still not fully developed, although a consensus has been developed on the inventory component and the framework for impact assessment. Most environmental labelling programs claim to be using the life cycle concept in their evaluation of product categories for the development of labelling criteria, but only a few are using any part of the formal practice of quantitative life cycle assessment.

4.3 Environmental labelling and life cycle assessment have a common goal -- the improvement of the environmental attributes of product systems. Environmental labelling can be viewed as an improvement analysis for a whole class of products.

Life cycle assessment, as it has been conceptually defined, has common goals with environmental labelling. The ultimate goal of LCA, and the yet-to-be-defined portion of the LCA triangle, is the improvement of the environmental attributes of a product system. The quantitative inventory and impact assessment are tools that inform the improvement analysis. Environmental labelling can be viewed as an improvement analysis for a whole class of products, with the labelling criteria being the benchmarks for that improvement. Viewed in this manner, life cycle inventory and impact analysis can be seen as tools for developing the labelling criteria that drive product improvement through environmental labelling.

4.4 LCA is being used as a tool to inform the process of developing labelling criteria for environmental labelling programs, but it has not taken the place of expert judgment and consensus-building in developing those criteria.

Just as the LCA triangle is not complete without improvement analysis, the quantitative life cycle inventory and impact assessment portions of LCA are not being used as the complete basis for environmental labelling in seal-of-approval programs. LCA is being used as a tool to inform the process of developing labelling criteria. All of the third-party certification seal programs that are using some form of formal LCA are using LCA in this fashion. The only environmental labelling program that is attempting to use LCA results directly on a product label, without impact analysis or improvement analysis and criteria development is the Scientific Certification Systems' Environmental Report Card in the United States.

4.5 Most of the labelling programs that are using the formal practice of LCA are using simplified life cycle inventories with elemental impact analysis, at most, and are not performing full quantitative LCA's.

Environmental labelling programs that are using some part of the formal practice of LCA have recognized the expense of fully quantitative LCA and the difficulty of performing an LCA for a class of products. Even those that have gone the farthest in the use of formal LCA practices, such as the French, are using only the inventory component and rely on certain scoping assumptions to reduce the need for collecting data on every stage of the life cycle for every component of the product. Some of the programs are utilizing existing LCAs that have been sponsored by manufacturers or government agencies, and some are using generic LCA databases that have been developed with available data. Where impact analysis is performed to aid in selecting the most significant environmental impacts, only an elementary form of impact assessment is used, such as the aggregation of inventory inputs and outputs into impact categories or the comparison of outputs to pollution standards.

4.6 LCA is being used in seal-of-approval environmental labelling programs to identify the most significant environmental impacts in the various stages of the life cycle in order to guide the development of labelling criteria that address those impacts.

LCA is being used for two primary purposes in seal-of-approval environmental labelling programs: (1) to identify the stages of the life cycle in which the most significant environmental impacts take place, so that labelling criteria can be developed to improve the environmental attributes of these stages; and (2) to identify the most significant types of environmental impacts in those stages and over the life cycle of the product, so that labelling criteria can be developed to address those impacts. As noted below, LCA may also be used when there is an attempt to select between competing product types, competing materials, or competing processes. LCA does not replace the expert judgment and consensus building that takes place in the improvement analysis for developing labelling criteria in the programs using it. During this improvement analysis, a whole range of factors come into play, such as the selection of the most important environmental impacts that drive the criteria, selection of the most effective criteria among several possibilities for improving the overall environmental performance of the product, the technical feasibility of meeting the criteria, the economic feasibility of meeting the criteria, the performance and marketability of products that meet the criteria, and the willingness of manufacturers to redesign their products to meet the criteria.

4.7 Some form of LCA is particularly useful in seal-of-approval environmental labelling programs when the goal is to develop criteria that choose between competing product types (e.g., disposable bottles versus refillable bottles), between competing materials (e.g., plastic versus paper grocery sacks), or between competing processes for making the same product (e.g., chlorine bleaching for white paper products versus non-chlorine bleaching).

It is difficult in many cases to make choices between competing product types, competing materials, and between competing processes for making the same product without the rigorous quantitative process of LCA. If an environmental labelling program intends to make these choices, then some form of LCA is useful unless the differences between product types, materials, and processes are well-documented and readily apparent. For instance, many programs have concluded without a full quantitative LCA that paper products containing recycle content are environmentally superior to paper products made from virgin pulp.

4.8 Full quantitative LCA may not be necessary in developing criteria that would improve the environmental attributes of the product without choosing between competing product types, materials, or manufacturing processes.

Where the life cycle stages and environmental impacts that are the most significant in the product life cycle can be identified without LCA, labelling criteria can sometimes be developed that improve the environmental attributes of the product without choosing between competing product types, materials, or manufacturing processes. An example is the biodegradability criteria and aquatic toxicity criteria for laundry detergents and household cleaners, that will insure that any ingredients, whether petrochemical or "natural" in origin, have a minimal impact on receiving streams.

4.9 The use of formal LCA may not make a big difference in the type of criteria that are ultimately developed for a product class, particularly where the significant environmental impacts of the product system are already known.

The comparison of the paint standards and fluorescent lamp standards showed that the use of formal LCA may not make a big difference in the type of criteria developed for a product class. Each of the paint standards compared focussed on similar environmental impacts and components of the product, even if they had different levels of stringency. This is because the environmental impacts of these product systems are already known and it is widely recognized that some stages of the life cycle and some particularly types of impacts are the most significant.

4.10 Although the formal methodology for full LCA has received attention from national and international organizations, insufficient attention has been paid to the development of a consensus methodology for a "streamlined" LCA , such as is being used by some seal-of-approval environmental labelling programs.

The efforts of the United States EPA, SETAC, and other organizations have been focussed on the development of a consensus methodology for a full quantitative LCA. This time-consuming and expensive methodology is beyond the reach of most seal-of-approval environmental labelling programs and may not be necessary for the purpose of developing labelling criteria. Some of the programs are already using forms of "streamlined" LCA, recognizing that the identification of the most significant environmental impacts throughout the product life cycle for development of criteria does not necessarily require finding data for every input and output for every component of the product for every stage of the life cycle. Little attention has been paid, however, to the development of a consensus methodology for a "streamlined" LCA for environmental labelling, and the approaches being used by different labelling programs vary significantly.

REFERENCES

Assarsson, Bo, Standards Institute of Sweden. Letter to Gary Davis, March 19, 1993 (1993a).

Assarsson, Bo, Standards Institute of Sweden. Comments on Draft Report, August 16, 1993 (1993b).

Association Française de Normalisation (AFNOR). *NF-Environmental Label: Technical Rules Applicable to Paints, Varnishes and Related Products*, Paris, September 3, 1992.

Centrum voor Milieukunde Leiden (CML) (Center for Environmental Science at Leiden University). *Environmental Life Cycle Assessment of Products*, Leiden, The Netherlands, October 1992.

Council of the European Communities (EC), Council Regulation of March 23, 1992, on a Community Eco-Label Award Scheme, Brussels, Belgium, 1992.

Danish Environmental Protection Agency (Danish EPA). *Eco-labelling of Paper Products*, Miljøprojekt nr. 179, Copenhagen, Denmark, 1991.

Danish Technological Institute (DTI). *Eco-Products: Proposal for a European Community Environmental Label*, prepared for the Commission of the European Communities, Copenhagen, Denmark, January 1990.

dk-Teknik. *Background and General Principles*, Søborg, Denmark, December 15, 1992.

dk-Teknik. *Wall Insulation Products: Impact Assessment and Criteria for Eco-Labelling (Draft)*, Søborg, Denmark, June 1993.

Douglas, Valerie. Environmental Choice Canada. Personal communication with Gary Davis, May 27, 1993.

Duffy, Bernadette. "Detergents: Environmental Choice Program Options", Prepared for Environmental Choice Program, Ottawa, Canada, January 24, 1992.

Environmental Choice Canada. "Laundry Detergents (ECP-24-90)", Ottawa, Canada, April 28, 1993.

Environmental Choice Canada. "Briefing Note: Laundry Detergents", Ottawa, Canada, 1991.

Environmental Choice New Zealand. "Paints: Requirements Specification EC-12-93", Telarc New Zealand, Auckland, New Zealand, March 1993.

Environmental Choice New Zealand. "Batteries: Carbon Zinc: Requirements Specification EC-10-92"; "Batteries: Zinc Air: Requirements Specification EC-01-92", Telarc New Zealand, Auckland, New Zealand, April 1992 (1992a).

Environmental Choice New Zealand. "Plastic Products Using Recycled Plastics: Requirements Specification EC-09-92", Telarc New Zealand, Auckland, New Zealand, April 1992 (1992b).

Ecobilan Company. *European Eco-Label: Project for Application to Paints and Varnishes, General Methodology*, Paris, May 21, 1992.

Franklin Associates Ltd. *Resource and Environmental Profile Analysis of Polyethylene and Unbleached Paper Grocery Sacks*, Prairie Village, Kansas, 1990.

Environmental Data Services Ltd. *Eco-Labels: Product Management in a Greener Europe*, London 1989.

French NF-Environnement, AFNOR. "Technical Rules Applicable to Paints, Varnishes and Related Products," Paris, France, 1992.

French Ministry of the Environment, Directorate for Prevention of Pollution and Risk, Division of Clean Technologies and Waste. "Information Bulletin: Ecolabelling and Life Cycle Analysis in France," Paris, France, August 24, 1993.

Giezeman, H.G.M. and G. Verhees, Stichting Milieukeur. *Ecolabelling: Practical Use of Cradle-to-Grave*, The Hague, The Netherlands 1993.

Geelen, Paul, Dutch Ministry for Housing, Physical Planning and Environment. Personal communication with Gary Davis, Cincinnati, Ohio, June 1, 1993.

German Federal Ministry for Environment, Nature Conservation, and Nuclear Safety. *Documentation, International Conference on Environmental Labelling--State of Affairs and Future Perspectives for Environment Related Product Labelling, July 5-6, 1990, Berlin, Germany*. Berlin, Germany, 1990.

Green Seal. "Green Seal Call for Comments: Proposed Criteria and Standard for Toilet and Facial Tissue", Washington, D.C., June 17, 1991.

Green Seal. "Environmental Standard for Tissue Paper", Standard GS-1, Second Edition, Washington, D.C., February 12, 1992 (1992a)

Green Seal. "Proposed Environmental Standard for General Purpose Household Cleaners", Washington, D.C., June 30, 1992 (1992b).

Green Seal. "Environmental Standard for Energy Efficient Lighting-Compact Fluorescent Products", Standard GS-5, Washington, D.C., July 22, 1992 (1992c).

Green Seal. "Green Seal Call for Comments: Proposed Environmental Standards for Windows (GS-13) and Retrofittable Window Films (GS-14)", Washington, D.C., January 28, 1993 (1993a).

Green Seal. "Green Seal Call for Comments: Proposed Environmental Standards for Major Household Appliances (GS-20 to GS-25)", Washington, D.C., March 9, 1993 (1993b).

Green Seal. "Proposed Environmental Standard for General Purpose Household Cleaners", Washington, D.C., May 1993 (1993c).

Green Seal. "Proposed Environmental Standard for Paints," Washington, D.C., 1993 (1993d).

Habicht II, F. Henry, U.S. Environmental Protection Agency. "Opening Remarks Before the Federal Trade Commission Hearings on Environmental Labeling", July 17, 1991.

Hashimoto, Michio. "The Ecomark System in Japan", in German Federal Ministry for Environment, Nature Conservation, and Nuclear Safety. *Documentation, International Conference on Environmental Labelling--State of Affairs and Future Perspectives for Environment Related Product Labelling, July 5-6, 1990, Berlin, Germany.* Berlin 1990.

Heintz, Bruno, Ecobilan. Personal communication, Paris, France, October 26, 1992.

International Standards Organization, Strategic Advisory Group on the Environment, Subgroup on Environmental Labelling. "Recommendations to be Submitted to SAGE on June 1, 1993, Toronto, Canada," Canadian Standards Association, Rexdale, Ontario, Canada, May 28, 1993.

Jensen, Allan, dK-Teknik. Letter to Gary Davis, August 20, 1993.

Loo Hak Jan, Singapore Green Labelling Scheme. Letter to Gary Davis, March 20, 1993.

Manseill, James R., University of Tennessee Department of Chemical Engineering and Center for Clean Products and Clean Technologies. *A Qualitative Approach to Life Cycle Inventory Analysis,* Masters Thesis, May 1993.

Marbek Resource Consultants. "Briefing Note: Household All Purpose Cleaners", prepared for Environment Canada and the Environmental Choice Board, Toronto, Canada 1991.

Neitzel, Harald, German Federal Environmental Agency. "Experiences With the Blue Angel Scheme (Environmental Labelling in Germany) Working Methods, Problems, Balance, and Perspectives," Presented at the Annual Conference of the Environmental Law Network International, Athens, Greece, October 9-10, 1992 (1992a).

Neitzel, Harald, German Federal Environmental Agency. Personal communication, Geneva, Switzerland, October 13, 1992 (1992b).

Neitzel, Harald, German Federal Environmental Agency. Personal communication, Toronto, Canada, May 28, 1993.

Nordic Council of Ministers. *Environmental Labelling in the Nordic Countries-Position Report*, Copenhagen, Denmark, November 1991.

Norwegian Foundation for Environmental Product Labeling. *Environmental Labeling of Fine Paper (With and Without Wood Pulp) for Printing, Writing, and Copying*. Oslo, Norway, November 4, 1991.

Norwegian Foundation for Environmental Product Labeling. *Environmental Labelling of Marine Engines*, Oslo, Norway, September 18, 1992.

Novak, Margo, Canadian Environmental Choice Program. Comments on Draft Report, August 23, 1993.

Organization for Economic Cooperation and Development (OECD). *Environmental Labeling in OECD Countries*, Paris 1991.

PA Consulting Group. *Proposals: Eco-Label Criteria for Washing Machines*, Prepared for the UK Ecolabelling Board, London, U.K., November 1992.

Pidoux, Michel, French Agency for the Environment and Conservation of Energy (Ademe). Personal communication, Paris, October 28, 1992.

Poremski, H.J. et al., German Federal Environmental Agency. *Detergents in Western Europe: Environmental Labelling*, prepared for the Commission of the European Communities, General Directorate XI, Berlin, Germany, October 1991.

Proia, Patricia, AFNOR. Letter to Gary Davis, February 26, 1993.

Reuter, Max, Austrian Consumer Organization. Personal communication, Geneva, Switzerland, October 14, 1992.

Rhodes, Stanley, Ian Boustead, et al., Scientific Certification Systems. Personal communication with Gary Davis, February 26, 1993 (1993a).

Rhodes, Stanley, Scientific Certification Systems. Comments on Draft Report, August 24, 1993 (1993b).

Saaty, Thomas L. *Multicriteria Decision Making: The Analytical Hierarchy Process*, RWS Publications, 1990.

Scientific Certification Systems (SCS). *Life-Cycle Assessment & the Environmental Report Card*, Oakland, California, 1993 (1993a).

Scientific Certification Systems (SCS). Environmental Report Card Mock-up, Oakland, California, 1993 (1993b).

Scientific Certification Systems (SCS). Press Release, Oakland, California, August 17, 1993 (1993c).

Singapore Ministry of the Environment, Waste Minimization Department. *Resource Conservation Bulletin*, No. 1, Singapore, May 1992.

Society for Environmental Toxicology and Chemistry (SETAC). *A Technical Framework for Life-Cycle Assessments*, Washington, D.C. 1991.

Society for Environmental Toxicology and Chemistry (SETAC). *A Conceptual Framework for Life-Cycle Impact Analysis (Draft)*, Pensacola, Florida 1992.

Society for Environmental Toxicology and Chemistry (SETAC). *Guidelines for Life-Cycle Assessment: A 'Code of Practice'*, from the workshop held at Sesimbra, Portugal, March 31-April 3, 1993, Pensacola, Florida, 1993.

Stichting Milieukeur. *The Dutch Ecolabel: Added Value for Your Product and the Environment*, The Hague, The Netherlands, 1993.

Standards Institute of Sweden (SIS) - Environmental Labeling. *Environmental Labelling of Dishwashers*, Stockholm, Sweden, September 6, 1991.

Telarc New Zealand. "Environmental Choice New Zealand: Environmental Labeling in New Zealand, Telarc Profile", Auckland, New Zealand, July 1992.

Telarc New Zealand. "Environmental Choice New Zealand: ECMAC Guidelines for Task Groups", Auckland, New Zealand, January 1993.

Udo de Haes, Helias, Center for Environmental Science, Leiden University, Personal communication, Leiden, The Netherlands, June 18, 1993 (1993a).

Udo de Haes, Helias, Center for Environmental Science, Leiden University, Letter to the participants of the UNEP Seminar "LCA and its Applications", June 16, 1993 (1993b).

United Kingdom Ecolabelling Board. *Newsletter*, London, U.K., February 1993 (1993a).

United Kingdom Ecolabelling Board. *Ecolabelling Criteria for Lightbulbs*, London, U.K., February 1993 (1993b).

United Kingdom Ecolabelling Board. *Criteria for Hairspray Ecolabels: A Proposal by the UK Ecolabelling Board*, London, U.K., March 1993 (1993c).

United Nations Environment Programme (UNEP), Industry and Environment Office, *Expert Seminar: Global Environmental Labelling, September 24-25, 1991, Lesvos, Greece*. Paris, France, 1991.

U.S. Environmental Protection Agency (US EPA), Office of Pollution Prevention. *Environmental Labeling in the United States: Background Research, Issues, and Recommendations (Draft)*, prepared Applied Decisions Analysis, Inc., Washington, D.C., February 2, 1990.

U.S. Environmental Protection Agency (US EPA), Office of Pollution Prevention and Toxics, Pollution Prevention Division. *Status Report on Environmental Labeling Programs Worldwide (Draft)*, prepared by Abt Associates, Inc., Washington, D.C., April 2, 1993 (1993a).

U.S. Environmental Protection Agency (US EPA), Office of Research and Development, Risk Reduction Engineering Laboratory. *Life-Cycle Assessment: Inventory Guidelines and Principles*, prepared by Battelle and Franklin Associates, Cincinnati, Ohio (EPA/600/R-92/245) February 1993 (1993b).

U.S. Environmental Protection Agency (US EPA), Office of Air Quality Planning and Standards, Pollutant Assessment Branch. *Life Cycle Impact Assessment: Framework Issues*, prepared by Research Triangle Institute, Center for Economics Research, Environmental Management Systems, Research Triangle Park, North Carolina February 1993 (1993c).

University of Tennessee Center for Clean Products and Clean Technologies. *Household Cleaners: Environmental Evaluation and Recommended Standards for General Purpose Household Cleaners*, prepared for Green Seal, Knoxville, Tennessee, June 1992.

Ventère, Jean-Paul, French Ministry of the Environment, Directorate for Prevention of Pollution and Risk, Division of Clean Technologies and Waste. Telephone conversation, August 31, 1993.

Verhees, G., Dutch Stichting Miliekeur (Ecolabelling Organization). Personal communication, The Hague, The Netherlands, June 18, 1993 (1993a).

Verhees, G., Dutch Stichting Miliekeur (Ecolabelling Organization). Comments on Draft Report, August 23, 1993 (1993b).

Weissman, Arthur, Green Seal. Comments on Draft Report, August 18, 1993.

Wendler, Susanna, "The Austrian Eco Label: Discussion Paper", Vienna, Austria, 1993.

Whitehead, Kathy. "Situation Report, EC Ecolabelling Scheme," UK Ecolabelling Board, London, U.K., April 16, 1993.

Wijnen, J.M., Dutch Ministry for Housing, Physical Planning, and the Environment. Personal communication, The Hague, The Netherlands, June 18, 1993.

United States
Environmental Protection Agency
(7409)
Washington, DC 20460