Plus 1116

Canadian Raw Materials Database: Life Cycle Inventory Methodology

Environmental Technology

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July 1996

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Preface

This is the first edition of CSA Information Product Plus 1116, *Canadian Raw Materials Database: Life Cycle Inventory Methodology.* This Information Product provides a methodology for a life cycle inventory (LCI) database for commodities. It is another in the CSA Series of life cycle assessment publications.

The development of this document has been supported by Environment Canada. The participation of the major raw materials manufacturers has also been instrumental. These industries include aluminum, glass, steel, wood, plastic, and pulp and paper.

CSA gratefully acknowledges the support of the major participants in the development of this Information Product.

July 1996

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(1) *Use of the singular in this Information Product does not exclude the plural (and vice versa) when the sense allows.*
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Plus 1116
Canadian Raw Materials Database: Life Cycle Inventory Methodology

1. Purpose

The increased application of Life Cycle Assessment (LCA) techniques to evaluate materials and energy use and emissions from products and processes has led industrial groups and governments to seek to ensure the quality and accessibility of life cycle inventory (LCI) data. The goal is both to help manufacturers, converters, formulators, and users understand the environmental consequences of their activities and to find ways to reduce associated environmental impacts.

1.1 Objectives

Environment Canada, the Canadian Standards Association, and several participating industries wish to develop an LCI database for the commodities produced by these industries. The initial objectives were
(a) To provide LCI data/database for commodities. These data would be used by small- and medium-size companies to support voluntary improvements in the environmental performance of their products, consistent with pollution prevention initiatives issued by the CCME (Canadian Council of Ministers of the Environment). Large businesses may also utilize the database in performing screening LCI studies to make product and process design decisions, and perhaps before undertaking more detailed life cycle studies.
(b) To provide the participating industries with data to benchmark their own industries as a basis for internal improvement, including voluntary actions in line with the CCME pollution prevention initiatives.

1.2 Requirements

An inherent goal is to develop LCIs comprising consistent, representative, and timely data. To accomplish this, the LCI studies shall be
(a) performed using the methodology presented herein, which is based on the CSA Z760, *Life Cycle Assessment,* the Society of Environmental Toxicology and Chemistry (SETAC) document, *A Technical Framework for Life-Cycle Assessment,* SETAC's *Guidelines for Life-Cycle Assessment: A "Code of Practice",* and SETAC's *Life-Cycle Assessment Data Quality: A Conceptual Framework;*
(b) conducted by technical LCA/LCI experts (see Section 3); and
(c) reviewed by an independent Peer Review Panel (see Section 5.2).

This report presents a single methodology so that the proposed studies may be done in the same consistent, uniform manner.

1.3 Role of Consultants

The industries may hire LCI consultants to see that the studies of the subject commodities are efficiently and appropriately conducted. A consultant will work with the materials industries to
(a) manage the collection of LCI data from the client industry;
(b) evaluate the quality of the data;
(c) process and aggregate the data;
(d) calculate the commodity and industry eco-profiles;

(e) interface with the Technical and Steering Committees;
(f) provide assistance, as needed, to the Peer Review Panel; and
(g) compose a final report, consisting of the finalized methodology and eco-profiles for the subject commodities.

At a minimum, a consultant will be engaged to ensure that proprietary information within a material industry will remain confidential.

1.4 Limitations

The sponsors of this study recognize the potential for misuse of the database. It is therefore noted that the results of this study shall not be used
(a) as a basis for regulation or for government to track specific performance of industry;
(b) as a basis for environmental-attributes labelling or as a basis for other marketing claims;
(c) by the purchasers of commodities to choose between manufacturing sites or vendors for their purchases, in an effort to show improvement; or
(d) to support a formal Life Cycle Impact Assessment.

These limitations are incorporated, first, because, as described in Section 3.1, these studies concern only life cycle stages from raw materials extraction through manufacture of the commodities; that is, processes following manufacture, including distribution, use, and disposal of the commodity products, are excluded from the scope of the LCI studies. Second, a generally accepted scientific methodology has not been developed for Impact Assessment (let alone work based upon partial inventory).

Life Cycle Improvement Assessments are also not part of this study, although it is the intent of the sponsors and participating industries to use the LCI as a basis for identifying internal environmental improvements.

2. Definitions

The following definitions apply in this Document:

Allocation — a method of dividing and sharing input and output burdens among coproducts in a single process. Allocation is commonly performed using a mass or energy basis. However, the most appropriate means should be selected.

Ancillary material — a material that is used in any unit process to produce an intermediate or final product. Examples include lubricants used in machinery and chemicals used in treating emissions.

Atmospheric emissions — residual discharges of emissions to the air (usually expressed in pounds or kilograms per unit output) after emission control processes. Includes point sources, such as stacks and vents, as well as fugitive or area sources, such as valve leaks and emissions from storage piles.

Biomass — a quantity of biological material, occasionally used as an energy source. Examples include wood, grasses, and corn.

Burden (load) — values describing any or all of the material resources, energy, and/or releases assigned to an input or output for a given industrial system. (Not to be confused with Overburden.)

Byproduct — (see Coproduct).

Coproduct — a material generated by the same industrial system that produces a given product and that, like the product, is used in or sold into the channels of commerce. Coproducts generally share the environmental burdens of the system or subsystem from which they derive.

Cradle-to-gate — an LCI methodology that focuses on the life cycle stages of a product, service, or activity, from raw materials extraction (the "cradle") through manufacturing (the "gate").

Cradle-to-grave — an LCI methodology that focuses on the life cycle stages of a product, service, or activity, from raw materials extraction (the "cradle") through manufacturing, product fabrication, use and waste management options, and final disposition (the "grave").

CRMD — Canadian Raw Materials Database.

Data category — a group of data of the same form or type.

Data source — data used as input to LCA studies, classified as primary, secondary, or surrogate. Example of sources: industry reports (internal and external), government document, journals, books, patents, trade associations, databases, etc.

Data types — forms of data and the way they are generated. Includes level of aggregation, such as annual, daily, regional average, etc, and generation of the data, such as measured, calculated, and estimated data.

Data quality indicators (DQIs) — DQIs are qualitative and/or quantitative terms defining data characteristics used in assessing the quality of final study results. Examples: consistency, representativeness, completeness, and precision. The number of DQIs selected is determined by the specific purpose of the study.

Distribution — loosely employed. Infers transfer of products from manufacturer to end user, involving both transportation and other activities. Also used to describe delivery of electrical energy to customers (after transmission).

Eco-balance — a description of the environmental performance of industrial systems in terms of the consumption of energy and raw materials and the emission of solid, liquid, and gaseous wastes. May not include all the life cycle stages in an LCI or LCA, such as assembly, use, and disposal.

Eco-profiles — presentation of the results of an eco-balance report.

End user — individual consumers, commercial businesses, and institutions, etc, that actually use (unpackage, consume, operate, store, or prepare, for use) a finished product.

Feedstock value — the rolled-up energy in a product, representing the energy in the input materials from which the product is derived plus materials lost in processing, etc, but not materials or energy consumed in combustion. It is not to be confused with the general term "feedstock" as simply a material fed to a process. Feedstock does not quantify the energy in a material (HHV) that can be recovered by incineration.

Final product — a product in the form in which it will be used.

Function — the purpose for which a product system is designed.

Functional unit — measure of performance of the functional output of the product system.

Goal — the objectives of LCA activities which may be reevaluated or modified at any point, that define study objectives, boundaries, assumptions, limitations, and the intended application or end use of the LCA.

High heat value (HHV) — the gross heat of combustion of a material, only a fraction of which is recoverable.

Impact assessment (Life Cycle) — a process used to identify, characterize, and value the potential impacts to the ecosystem, human health, and natural resources associated with the environmental inputs and outputs of a product system.

Improvement assessment (Life Cycle) — a process that identifies, evaluates, and implements opportunities for environmental improvements, such as reducing environmental releases and resources used. Opportunities may be recognized at any phase of the LCA process.

Industrial system — an operation or group of operations that produces a product and, in many cases, coproducts, together with any packaging. Includes all life cycle steps, from the extraction of raw materials through final use and disposal of the product.

Input — an energy, resource (raw material, ancillary or intermediate), or other requirement or use of the environment in a product system. May include, for example, the amount of timber required to produce 1 ton of paper or the amount of natural gas required per unit of plastic production.

Life cycle assessment (LCA) — compilation and evaluation, according to a systematic set of procedures, of the inputs and outputs and the potential environmental impacts of a product system throughout its life cycle.

Life cycle inventory (LCI) — the identification, compilation, and quantification of the inputs and outputs (energy, resource usage, and environmental emissions) for a particular product system throughout its life cycle.

Load — (see Burden).

Maintenance — includes activities such as onsite (eg, home) repair, offsite repair by a repair company, and preventive maintenance (eg, changing oil in a car or washing laundry). Onsite maintenance may require trips away from the site to obtain supplies. Offsite maintenance includes transport to and from the maintenance facility.

Manufacturing — a process or series of processes using one or more materials to make a product.

National electricity grid — the electricity generated by individual generating stations that are interconnected to form provincial grids and, ultimately, a national grid.

Net water use — in an LCI, surface-water use is calculated on a net consumptive basis. Thus, assuming adequate quality, surface water that is used and discharged back to the surface is not included in the inventory. All groundwater withdrawn for use is included in an LCI, because it is assumed groundwater is not replaced to maintain beneficial purposes.

Output — air emissions, waterborne effluents, solid waste, or other releases to the environment associated with the life cycle of a given product system. Outputs can include, for example, the quantity of CO_2 released per unit of production, the volume of solid waste per unit time, and the level of noise or odour associated with an activity.

Overburden — the material to be removed or displaced that overlies the ore or material being mined.

Partition — a method for splitting or dividing an operation, subsystem, or system into separate portions carrying corresponding allocated burdens.

Product — a material generated by an industrial system that has recognized value and use and is sold into channels of commerce.

Product category — a grouping of products which are intended to be used and which perform in the same way.

Pollutant — generally speaking, any substance introduced into the environment that adversely affects the usefulness of a resource.

Post-consumer material (Solid Waste) — a material that has served its intended use and has been diverted into or become part of the solid-waste stream.

Precombustion energy — energy required to extract, transport, and process fuels used for energy generation. Includes adjustment for generation inefficiencies and for transmission losses in electric power distribution. Also known as energy of fuel acquisition.

Pre-consumer material (Solid Waste) — material (or byproduct) that has not reached a consumer for an intended end use and has been recovered or diverted from solid waste, but is not material returned within an original manufacturing process. Includes, for example, overstock or obsolete inventories of a manufacturer or out-of-spec extruded LDPE film.

Primary data — data for a particular operation or subsystem obtained directly from a site (or sites) related to that operation.

Primary fuels — natural gas, petroleum, coal, nuclear energy, hydro, and so on.

Process — an operation performed on one or more raw materials or intermediates, leading to the formation of another intermediate or product.

Process emissions — waste materials (gaseous, liquid, and solid) generated or produced from raw materials, reactions, processes, or related equipment inherent to a process.

Process energy — energy required for various unit processes within the system to operate the process or equipment within the system. Energy is quantified both in terms of fuel and primary energy units.

Product system — an operation or group of operations associated with the production of a product or service that has clearly delineated input and output boundaries. The product system includes operations associated with each life cycle stage of the product, process, or activity: raw materials acquisition, manufacturing, use/re-use/maintenance, and recycling/waste management. The product system associated with polyethylene production, for instance, includes not only the activities of the company manufacturing the polyethylene but those of all of the companies producing intermediate materials for the system, such as the oil refiner and/or natural gas supplier.

Random error — error that does not have any definite or systemic pattern or bias.

Raw material — material out of the earth without previous human intervention in a natural, unprocessed form (or atmosphere).

Recyclability — possessing properties that enable material to be recycled. Often defined by reference to an actual recycling rate measured in an area set by the region, state, or government.

Recycling — in LCA terms, recycling is an activity that diverts materials from waste management into a manufacturing operation. (In wider chemical engineering service, recycling is any activity that returns material to any part of a process or system.)

Renewable resource — a resource that is being replenished at a rate equal to or greater than its rate of consumption.

Representativeness — the degree to which a data set reflects a population of interest.

Re-use — includes both onsite (eg, home) and offsite re-use. Onsite re-use may include intentional re-use of a product or package for its original purpose (eg, Tupperware) or incidental re-use for a different purpose (eg, storage of paint brushes in an old mayonnaise jar). Offsite re-use includes the return of materials to a retailer or manufacturer to be re-used for their original purpose (eg, a refillable beverage bottle), the use of rental equipment, and donation of used items to charities for re-use.

Scope — the overall purpose and objectives of an LCA/LCI study, including identifying the product, process, or activity under evaluation, the level of analysis, and the end use of the analysis.

Secondary data — published or unpublished data reflecting the results of previous data collection and analysis. The quality of these data depends upon the source and may be good, though questionable.

Secondary raw material — recovered and/or recycled material. See Raw material.

Solid waste — includes wastewater treatment sludges, solids from air pollution control devices, trim or scrap materials that are not recycled, fuel combustion residues (such as the ash generated by burning wood or coal), mineral extraction residues, and other miscellaneous solid wastes.

Subsystem — part of subset of a system.

Surrogate data — substitute data believed to represent the process being investigated. Used in the absence of primary and secondary data.

System — a group of operations which, when acting together, perform a defined function. Defined by boundary conditions.

Ton-mile — a measure of the movement of 1 ton (2,000 lbs) of freight for the distance of 1 mile. For example, 100 ton-miles is the measure for moving 100 tons of freight 1 mile, or moving 1 ton of freight 100 miles. The metric unit is tonne-kilometre.

Transmission line loss — the difference between the amount of electricity entering a transmission line and the amount of electricity delivered.

Transportation — movement of materials, water, or fuels (energy) between operations at different locations.

Transportation energy — energy required to transport material and products throughout a process and final distribution to the consumer. Values are converted from ton-miles by each transport mode (eg, truck, rail, barge, airfreight, pipeline, etc) to energy units using the average efficiency of the given mode.

Unit process — a distinct process or set of processes with a defined boundary (eg, distillation or crystallization).

Use/re-use/maintenance — life cycle activities that begin after the distribution of products or materials and end when these products or materials are discarded and enter a waste management system.

Useful life — the period or duration of time from when the product arrives in the hands of the end user to when it is discarded.

Waste — any output from the product system which is disposed of and which the generator has no further use.

Waste management system — the system used to handle waste prior to or at its release to the environment. Includes landfill operations, for example.

Waterborne wastes — discharges of pollutants to water (usually expressed in kilograms per unit output) after treatment processes.

3. Organization

The organizational structure for this project, illustrated in Figure 1, includes three groups: a steering committee, a technical committee, and a peer review panel.

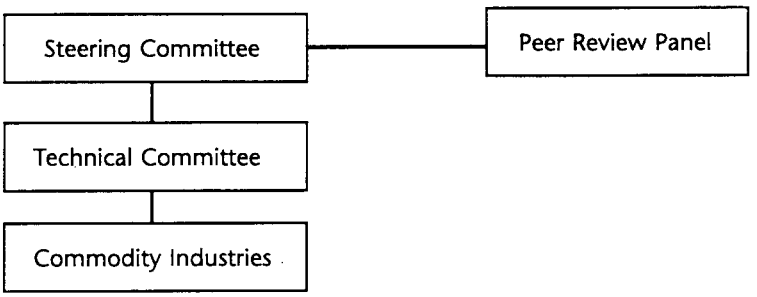

Figure 1
Organization

3.1 Steering Committee

The steering committee (SC) is chaired by a representative from Environment Canada (EC), with the Canadian Standards Association (CSA) acting as the secretary for the committee. Participants on the SC include a representative from academia and one representative from each participating material industry. The mandate of the SC is to provide overall direction for the conduct of this project and to act as the decision-making body.

The SC has agreed to make decisions regarding this project on a consensus basis. A consensus is established when seven out of the eight voting members are in agreement with a recommendation.

3.2 Technical Committee

The technical committee consists of representatives from each of the participating materials industries. The TC is responsible for evaluating various methodological aspects of the project and making recommendations to the SC. Recommendations will be based on the unanimous consensus of the TC members.

A representative from each material industry participating in the TC will also act as the liaison between any consultant engaged to support data collection activities and the corresponding material industry.

3.3 Peer Review Panel

The peer review panel (PRP), composed of three to five members, will review the methodology and the final report and will provide written comments concerning each of these to the SC. The role of the PRP is to provide comment on the technical merits of the methodology used to achieve the purposes of the study and to comment on the consistency of application of the agreed methodology within each of the participating material industries.

4. Scope

4.1 Cradle-to-Gate Analysis

For each commodity in this study, the LCI exercise includes three stages: raw materials acquisition, intermediates processing, and production of the final commodity.

All downstream processes where the subject commodity might be used, including further manufacturing, use, and ultimate disposal, are omitted from the scope. For example, a commodity material is evaluated only through the manufacture of the commodity material as ready for sale. These commodities are processed by numerous converters to make a variety of products.

LCI evaluation through these many channels and eventual disposal is outside the scope of this project. Figure 2 presents a simple diagram of the LCI stages considered:

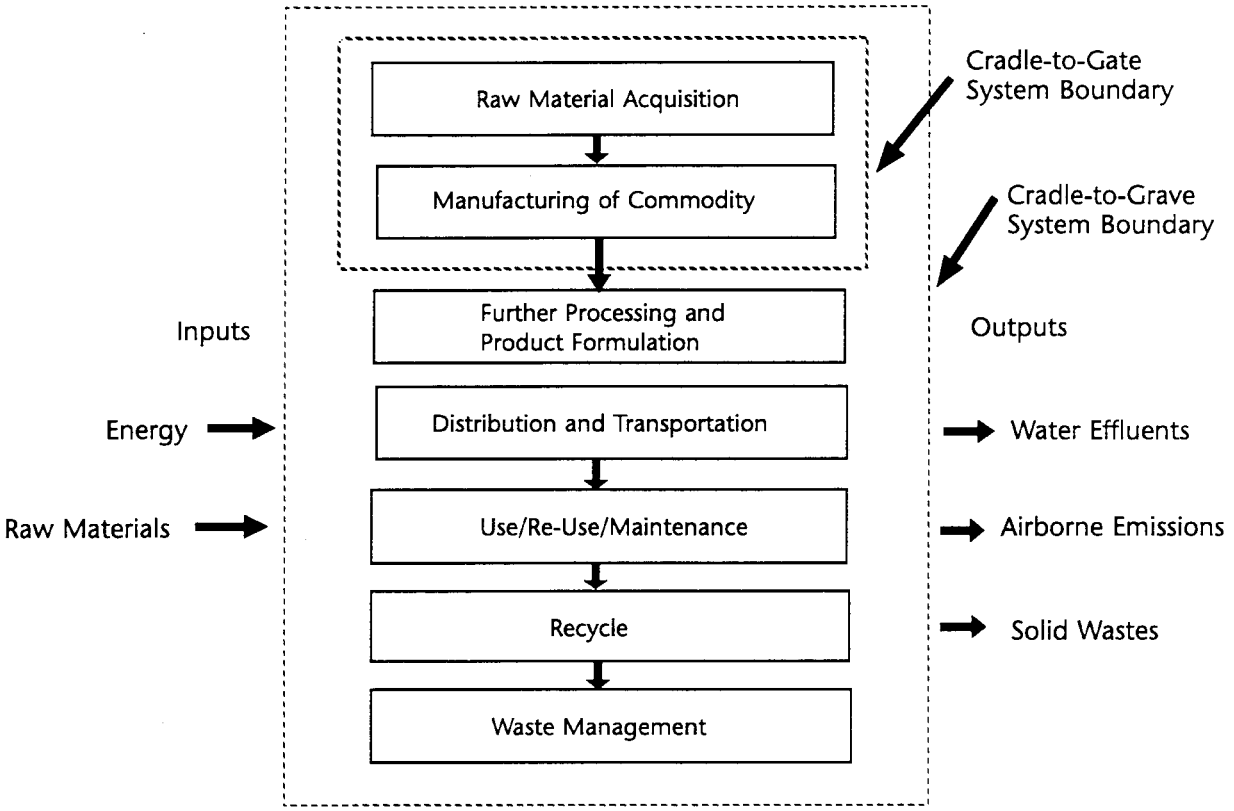

Figure 2
Scope of Cradle-to-Gate LCI

This study, therefore, is only a partial LCI and is more appropriately described as such — as a *cradle-to-gate (LCI) analysis* or an *eco-balance* — and each set of results may be referred to as an *eco-profile*. The location of the "gate" may differ for participants. In general, the gate has been determined to be the commercial commodity that is sold for further processing to make a variety of final products. Each industry will provide a brief rationale for its selection of the gate to the technical committee.

The value of these limited LCIs is that downstream users of the commodity materials can use the data as inputs in modelling their own processes. In each case, further manufacturing, use, and disposal considerations can be added to the partial LCI to produce a corresponding, comprehensive *cradle-to-grave* inventory (a complete LCI).

4.2 Participating Industries (Phase I)

The six industries participating in this study include the
(a) aluminum industry;

(b) glass container industry;
(c) plastics industry;
(d) steel industry;
(e) paper products industry; and
(f) wood products industry.

4.3 Geography

Data will be collected for the production of these materials in Canada, including any chain of supply to Canadian manufacturers.

Data for North American (Canada plus US) production will be used if US production accounts for a significant percentage of the commodity consumed in Canada and/or the US data are needed to prevent publication of proprietary Canadian data.

4.4 Time Period

The latest available data are to be sought by all participants. Primary data will date from no earlier than 1991, and secondary data will date from no earlier than 1985. The relevant time period will be reported for each process.

Each process will reflect actual (not ideal or theoretical) production for a one-year period, including any irregularities in production or emissions. The objective is to collect data that represent real, average, long-term conditions. If the reporting period is less than one year, the full period will be reported, together with a note of any unusual activities.

Requests for exceptions will be reviewed by the technical committee and approved by the steering committee.

All data will be evaluated for quality, following the procedures set out in Section 3.9.

4.5 Technology

Data will be gathered for individual production facilities within each industry, regardless of production technology. Best-available technology is not an issue. In order to provide complete and representative industry-average profiles, a large sample of facilities is required.

In presenting results for a given commodity, the average production-weighted data for all relevant processes will be used in calculating the summary eco-profile. In order to protect company confidentiality for each commodity studied, data from at least three companies shall be averaged.

When fewer companies participate, each of these companies must agree either that its position is safeguarded by the number of its plants involved or the study must be broadened, perhaps by bringing in US companies.

4.6 System Boundary

A product system comprises a number of unit processes forming the main production sequence, plus other processes producing ancillary materials. The production sequence for each commodity in this study is defined by the use of a flow process diagram. These flow process diagrams start from the extraction of raw materials from the earth and end with the production of the subject commodities.

Raw and intermediate materials in the main production sequence that contribute to the final product should be shown on the flowsheet.

Flow process diagrams for each commodity will be finalized by each material industry representative and reviewed by the technical committee. These flow process diagrams will define the initial set of unit processes associated with each of the subject commodities that are to be included in the scope of the study.

A representative from each of the material industries will then catalogue the production sites

associated with each unit process. Where appropriate, the list of production sites by unit process should be classified by the technology employed. The system boundary for each commodity will subsequently be finalized by performing an initial analysis of the production system. The initial analysis is described in the following sections.

4.7 Data Categories

4.7.1 Measurement Units

Material and water consumption, as well as environmental emissions, shall be reported in metric units (mass in grams, volume in litres, gaseous volume in cubic metres, and energy in joules). The industrys Technical Committee representative is responsible for ensuring that each facility provides accurate metric information.

4.7.2 Data Availability Survey

Each unit process in the commodity system shall be characterized and documented by a list of raw or intermediate input materials, ancillary materials, energy and water consumed, environmental releases, and intermediate output materials of final product. A template that illustrates the information of interest in a unit process is provided in Figure 3.

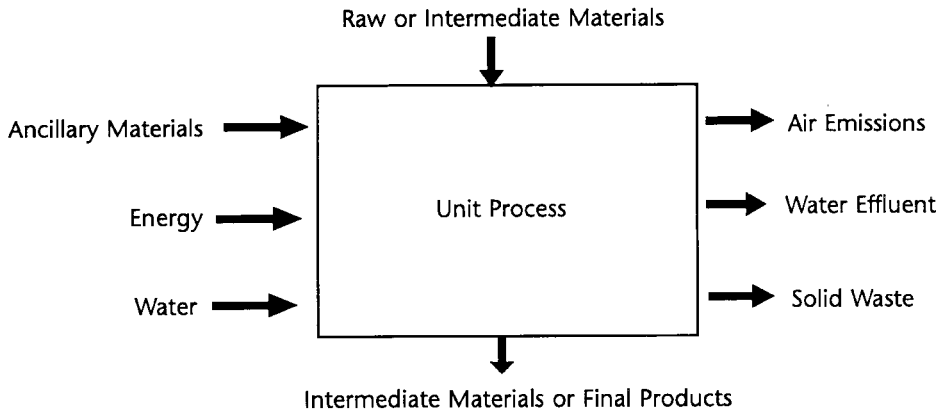

Figure 3
Template for Unit Process

In order to determine the system boundary for each commodity, the inputs and outputs for each initial unit process should be identified and the appropriate data values established. These requirements are achieved by performing a data availability survey (DAS). An example of the format of a DAS is given in CSA Z760, *Life Cycle Assessment.* In general, the DAS should provide a description of the unit process and clear instructions on the nature of the information that is being requested.

The purpose of the DAS is twofold. The initial goal is to identify the available environmental releases associated with each unit process. Each of the sampled production sites will record emissions to air, water effluents, and solid wastes that are normally measured or estimated on the DAS. Average data for each of these data categories are also noted on the DAS.

The second goal of the DAS is to list and estimate the consumption of the materials used in the unit process. This information is used to determine the material flows that should be included in the scope of the study.

The format of the DAS reporting requirements will be formalized by the technical committee.

4.7.3 Environmental Releases

Based on the listings of releases from the DAS, the technical committee will consolidate the various species or compounds into an appropriate set of data categories for each environmental medium (air, water, and land), adding additional categories not identified in the DAS as necessary (eg, CO_2). The specific species or compounds included in each data category will be documented for each commodity.

4.7.4 Energy Consumption

A listing of the type of fossil fuels, biomass, and electrical energy will be defined for each unit process, based on those identified by the DAS.

Canadian-based energy values will be used in this study. Appendix B provides some information on this subject. Requests for exceptions for a commodity group will be presented to the technical committee for consideration.

4.7.4.1 Feedstock Energy

Feedstock energies should be reported for all materials considered sources of energy. Feedstock values will be agreed to by the technical committee once all material inputs for each of the commodity systems have been finalized.

4.7.4.2 Precombustion Energy

Table 1 in Appendix B presents energy values, including precombustion values, to be used in these studies. Exceptions to these values will be reviewed by the technical committee and approved by the steering committee.

4.7.4.3 Electrical Energy

The Canadian national electrical grid will be used for electrical data in this study. The power mix for the Canadian National Grid (1993) is presented in Table 2 in Appendix B.

Conversion of electrical power to primary energy units (joules) must take into account transmission line losses, conversion efficiencies at the generating plants, combustion efficiencies for the fuels involved, and their precombustion energies. Table 3 in Appendix B presents generation efficiency values for Canada.

Exceptions to these grid values will be reviewed by the technical committee and approved by the steering committee.

4.7.4.4 Transportation Energy

The general modes of transportation for materials are ocean vessels, barges, rails, trucks, and pipelines.

The energy involved in moving material varies according to the quantity involved, the size and fuel efficiency of the vehicle, the percentage load, whether or not a back haul is available, and the route (eg, urban versus rural truck routes).

A set of transportation values is provided in Table 4, Appendix B. Some organizations owning transportation vehicles have energy (fuel) and load data which may be used to supplement the data values given in Table 4. In such cases, exceptions will be reviewed by the technical committee and approved by the steering committee.

4.7.4.5 Environmental Emissions from Energy Use

The combustion of primary fuels generates major quantities of air emissions. It is important that the LCI calculations for the commodities in this study use a given set of conversion efficiencies and a common profile of environmental emissions. Tables 5 through 8 in Appendix B summarize the environmental releases associated with the use of various fuels. Exceptions to these values will be reviewed by the technical committee and approved by the steering committee.

4.8 Decision Rules for Materials

Effort need not be spent on developing LCI data for materials of negligible significance. Therefore, a method has been devised to ensure that all process inputs of environmental importance are included. The method is described in the CSA Z760, *Life Cycle Assessment.* Highlights of the method are given below.

First, all material flows that are greater than 1% by mass of the unit process output ("Intermediate Materials or Final Products" in Figure 3) are identified. A mass balance for the subsystems being analyzed is then performed and normalized to the product output from the cradle-to-gate system.

Materials that will be included in the scope of the analysis are then classified as being of primary, secondary, or negligible importance, based on an analysis of their contribution to the total mass of the system, the total energy of the system, and their environmental relevance to the system.

All materials which make a cumulative mass contribution of up to 90% of the system are considered primary and will require primary data sources in the data collection activities. The additional materials that bring the total cumulative mass of the system to at least 95% of the total are considered secondary and require secondary data sources to quantify their life cycle contribution.

A further decision rule is used to classify energy contribution. All materials that make a cumulative contribution of 95% of the total system energy are considered primary. The additional materials that bring the cumulative system energy to at least 99% are considered as secondary.

In addition, any input, regardless of its mass or energy contribution, is considered primary if any of the environmental releases during its extraction, manufacturing, or use contributes more than 15% of an environmental release data category in the summary profile.

All remaining materials are considered negligible and need not be included in the scope of the study.

The analysis for identifying materials for inclusion in the scope of the study will be performed by a consultant, based on the information in the DAS, the supplementary data provided in Appendix B, and secondary data where necessary. The final listing of materials associated with each commodity will be established by the technical committee.

4.9 Data Quality

A comprehensive LCI involves the collection, calculation, and handling of many pieces of data. It is essential, therefore, that data quality be given adequate attention as an integral part of the exercise. Rather briefly stated, data quality may be defined as "the degree of confidence one has in the data."

SETAC has published a comprehensive document concerning data quality, *Life-Cycle Assessment Data Quality: A Conceptual Framework,* and a good review is available in CSA Z760, *Life Cycle Assessment.* Both works discuss a number of data quality indicators (DQIs).

DQIs are specific measures or attributes that describe the level of quality within a data set. There are two types of DQIs, qualitative and quantitative, and certain of these will be touched on below. Useful qualitative descriptors include "high," "medium" and "poor."

The DQIs listed below will be used to assess the quality of the data for each process and each commodity material. The DQI requirements will be defined by the technical committee.

The peer review panel will provide an assessment of the data quality for each commodity, based on input provided by the consultant who tabulates the inventory results.

4.9.1 Qualitative DQIs

4.9.1.1 Consistency

Consistency is elated to how uniformly the methodology is applied. Complete documentation of the assumptions, protocols, and transparency of the process is needed to ensure that the results can be reproduced.

Consistency is assessed by reviewing how tools or procedures including such things as process flow diagrams, boundary descriptions, templates, normalization and/or aggregation methods, calculations, and computer procedures are applied.

It may be noted that although consistent techniques are used, diverse results may still be obtained, for a variety of reasons, including the use of different raw materials or different processes. It is easy to misplace or misinterpret the position of process boundaries, an error which directly affects perceived quality.

4.9.1.2 Representativeness

Representativeness refers to the degree to which data values and results truly reflect the processes that the LCI is pledged to study. The degree of representativeness may be judged by comparing data sets for similar processes within the study, and perhaps comparing them with published sets of data.

Where published studies are not readily available, an examination of the technological mix of the processes in the study is conducted to ensure that the production-weighted inputs of the various technologies are fairly represented.

4.9.1.3 Anomalies and Missing Data

Anomalies are extreme data values within a data set. These values will be identified by the project consultant through inspection, statistical analysis, and/or as a result of expert review, and will be reported to the technical committee for review.

Where a data value is suspect, more information should be obtained, if possible, to determine if the datum is within the expected range of the average value.

Treatment of anomalies and missing data is discussed in Section 4.2.

4.9.2 Quantitative DQIs

4.9.2.1 Completeness

Completeness is assessed by comparing the number of sets of primary data obtained and the number of data sets that might possibly be obtained. A measure of the completeness of a primary data category for each unit process is provided by dividing the number of reporting locations providing data by the number of locations solicited for data.

4.9.2.2 Precision

Precision is a measure of the spread or variability of values within a data set, expressed as a statistical mean and variance.

Where more than three data points exist, a mean and an estimate of variability may be obtained. Such calculations are performed for each primary data category.

4.10 Deliberate Exclusion of Data

As discussed earlier, the further use, distribution, and ultimate disposal life cycle stages of the commodities are excluded from the study.

In addition, the environmental burdens associated with the production, delivery, and/or construction of capital equipment are excluded. Other studies have shown these burdens to be very small, given the long life span of most capital equipment. A clear distinction, however, should be observed for some items which might rightly be termed "maintenance" materials.

While transportation of personnel to and from a production site should be excluded, personnel-related on-site burdens including space heating, lighting, water, and solid wastes, should be included as part of the associated process(es).

5. Data Collection and Modelling

5.1 Data Input Sheet

After the DAS responses and the analysis of material flows have been reviewed, the technical committee will develop a generic data input sheet and questionnaire, which can be customized for the finalized set of unit processes for each commodity. An example of such a data input sheet is presented in Appendix A. The data input sheet is then distributed to the reporting locations selected for inclusion in the study. The completed questionnaires are then returned to the consultant selected to consolidate the data.

5.2 Treatment of Anomalies and Missing Data

Anomalies are extreme data values within a data set. These data values may exist as a result of misinterpreted requests for data input, misreported values, or improper analysis, or data not available from a reporting location (missing data). The project consultant should identify anomalies and missing data for each reporting location.

When an anomaly can be traced to a process upset or accidental release, it is included in the data set. If an explanation cannot be found, the anomaly will be removed from the data set.

With respect to missing data, a recommended guideline is that each data category for each reporting location must have either

(a) an acceptable reported data value;
(b) a zero value, where applicable; or
(c) a calculated value based on the average of reported values from a unit process with similar technology.

Where primary and secondary data are not available, surrogate unit processes may be constructed. Surrogate unit processes will be itemized and reviewed by the technical committee. All surrogate unit processes will be fully documented.

5.3 Allocation Rules

Allocation is the procedure used to distribute environmental burdens fairly among coproducts formed in the same process.

Partitioning is a related procedure used to divide process values.

Allocations may be made in a number of ways. In this study, it is recommended that allocations be made on a weight-proportional (mass) basis, unless some other clearly defined physical relationship reigns (eg, environmental releases are tied directly to a particular material, or a volume, or an area, relationship is involved).

All cases where allocation methods are contemplated must be described to the technical committee for review and approval.

The description should include the rationale for allocation, as well as the method to be used.

5.4 Data Processing and Normalization

The data on the data input sheets returned to the consultant will reflect the production quantity of the subject process. This quantity may bear no relation to those for the other processes making up the system to be studied. The consultant must, therefore, normalize the data obtained to a calculated production quantity, normally 1000 kg. Each unit process is then scaled proportionally to the associated unit process in the product system in order to produce the functional unit defined for each commodity.

5.5 Recycled Materials

Recycling is involved in the production of some of the commodities to be evaluated in this study. In LCI work, there are three recycled materials to be considered.

5.5.1 Scrap

Internal, Home, or Process Scrap is scrap generated by a process and returned to the same process. It may be referred to as "run around," which describes a circulating flow of material within the process boundary. The word "scrap" is reserved for this kind of material. This scrap is not recognized by the US EPA and other bodies as a recycled material for LCI purposes. Scrap will not be recognized as recycled material in this exercise.

5.5.2 Pre-Consumer Material

Pre-consumer material (also referred to as "manufacturing scrap") is material incidentally and unintentionally produced in a production process and released for use in a manufacturing process.

Pre-consumer material is generally single-sourced; relatively clean and predictable in terms of properties, it generally enjoys a high recycling rate.

5.5.3 Post-Consumer Material

Post-consumer material is material which has served its intended product use and has been diverted from the solid-waste stream to be recycled. Because post-consumer material can be contaminated and dirty, it often requires sorting and cleaning before it can be used again. In spite of this, technologies have been developed in certain areas capable of achieving efficient and high recycling rates. In some cases, however, the recycling rates tend to be low.

Of these materials, only pre- and post-consumer materials will be modelled as secondary materials in recycled materials. These materials will be modelled as having zero burdens associated with the virgin (past) life cycle. Burdens associated with transportation and beneficiation processes shall be assigned to these materials; the nature and magnitude of the burdens will be established by the technical committee and approved by the steering committee.

6. Peer Review

The use of a peer review process plays an important part in conducting and completing an LCI. This review ensures that the quality of the LCI is commensurate with the intended use of the study.

The peer review process varies with the intended use of the study:

(a) A study for internal use involves data collection and integration sufficient to support decision-making within the company that undertakes the study. Peer review by an independent panel is not a requirement.

(b) A study for external use (for public or outside organizations) requires much more attention to the integrity and quality of the data, and independent peer review of the study will be conducted.

6.1 Peer Review Panel

Members serving on the peer review panel (PRP) should have a reputation for independent study; experience with technical design and/or the conduct of LCA/LCI studies; no conflict of interest; and a willingness to interact positively as part of the PRP. Members might also be drawn from a wider audience of stakeholders, including, for example, environmental activists and government personnel.

Selection of the PRP, numbering perhaps 3 to 5 persons, will be made by the Chair, Mr. Murray Haight, selected by Environment Canada and CSA. While the Chair will receive suggestions for possible candidates for the panel, the final choice will be the responsibility of the Chair.

The Chair must operate within a prescribed budget and may change the composition of the panel to accommodate particular needs. No person from participating industries, or from organizations assisting in conducting the LCIs, will be nominated to the PRP. It is anticipated that the consultant(s) performing the data integration will have a close working relationship with the Chair.

Because of the confidentiality of some of the data, confidentiality agreements will be required of the PRP Chair before he receives confidential LCI information.

In conducting their various tasks,

(a) The PRP Chair will at all times drive towards consensus within the panel and between the panel, each commodity group, and the associated consultant.

(b) The steering committee, the review panel, and the consultant should work together to understand the methodology and assumptions and to answer questions as they arise.

(c) Recommendations from the review panel will be evaluated by the commodity groups and appropriate actions will be implemented.

6.2 Peer Review Methodology

Two peer review steps are proposed:

(a) initial review of the study's purpose, system boundaries, and data categories, at the beginning of the LCI project; and

(b) mid-project review, after data have been collected and integrated.

The review schedule and methodology are presented below.

6.2.1 Stage 1: Initial Review

The objectives of Stage 1 are to review the purpose of the study:

(a) what is to be analyzed;

(b) what is included and what is excluded from the boundary;

(c) how will the results be structured; and

(d) how will the results be documented and distributed?

6.2.1.1

Guideline questions for Stage 1 are as follows:

(a) Are study objectives, purpose, and scope clearly identified?

(b) Was methodology clearly identified? Was it of sufficient detail for someone to repeat the study?

(c) Are boundary conditions clearly stated?

(d) Are the initial assumptions clearly stated, reasonable, and justified?

(e) Are the data quality characterization procedures appropriate and reasonable?

(f) Are the sources and data categories adequately identified?

Written results of this review will be forwarded to the CRMD technical committee for evaluation and action. The steering committee will prepare a written response.

6.2.2 Stage 2: Mid-Project Review

This step will occur after data have been collected, normalized, and summarized. The objective is to confirm that data category identification, data collection procedures, and data processing and integration have been conducted in accordance with the methodology.

6.2.2.1

Guideline questions include the following:

(a) Are the data sources clearly identified?

(b) Has data quality been evaluated, and have targets been met?

(c) Is the methodology for data calculations sound?

(d) Are data assumptions clear, reasonable, and justified?

(e) How were the data aggregated, summarized, and presented?

(f) Has the methodology been consistently applied?

(g) Has the purpose of the study been met?

Written comments will be summarized by the Chair and submitted to the steering committee. Recommendations from the steering and technical committees will be carefully addressed by the commodity materials groups and the consultant, and appropriate actions and/or revisions to the modelling of commodities will be considered.

7. Final Report

The final report will comprise the following:
(a) description of the methodology, data collection, handling, calculations, etc, employed for the study. Any exception to the methodology outlined in the foregoing will be highlighted within the section dealing with the subject matter;
(b) the calculated average eco-profile for each commodity;
(c) the Stage 1 peer review and steering committee response; and
(d) the Stage 2 peer review and steering committee response.

The individual results for each commodity and related details on the normalized unit process will be made available to the corresponding material industry to support benchmarking activities and the identification of improvement opportunities.

8. Plan of Action

This project will follow the fifteen steps described below:
(a) **The industry representatives will organize the technical committee.** Each participating industry group will select a representative for the TC. The TC will operate in a transparent manner and will strive to achieve consensus. The TC brings recommendations and rationales for decisions back to the steering committee.
(b) **The industry representatives and Environment Canada select the consultant(s) for this project.**
(c) **The peer review Chair will assemble the complete peer review panel (PRP).** The Chair will ensure that the proper confidentiality agreements are in place and will orient the panel.
(d) **The technical committee conducts its first phase of work.** The TC will meet to finalize process flowsheets, determine the number and location of facilities in each industry which must be surveyed, establish target DQIs, prepare the draft allocation rules, resolve any issues identified by the SC, and finalize the data availability survey (DAS).
(e) **The industry will sample facilities using the DAS.** Industry representatives will distribute the DAS and collect sample data from a representative list of industry facilities to obtain input-output profiles for each process identified on the commodity flowsheet. This information will be used to finalize the data input sheets and the material flows to be included in the study.
(f) **The consultant will analyze the DAS information.** Using the information received from the DAS, the consultant will determine classifications of materials, energy, and outputs that must be modelled. The consultant will recommend a finalized format for the data input sheet.
(g) **The technical committee reviews the recommendations from the consultant.** The TC will review in detail the findings from the DAS and the recommendations from the consultant. A finalized data input sheet and an agreed approach to data rollups will be the outcome of this step.
(h) **The peer review panel will conduct its Stage 1 review.** The PRP will meet to review the work of the TC and consultant and will report back to the SC.
(i) **The steering committee meets to review the report of the PRP.** The SC will meet to review the report of the PRP, as well as other information provided by the TC. A written response to the PRP will be prepared by the SC.

(j) **The industry will disseminate data input sheets and collect data.** Each industry group will be responsible for disseminating data input sheets and ensuring that the facilities understand these sheets and how to complete them. The industry groups will also ensure a timely completion of the data gathering.

(k) **The consultant will collect and summarize/analyze data from the data input sheets.** The consultant will receive the completed data input sheets from the industry participants, test for anomalies and missing data, conduct data quality assessment, construct and document any secondary/surrogate process profiles necessary to complete each commodity profile, and construct data rollups and the presentation of results.

(l) **The technical committee will develop the final results.** The TC will review the work of the consultant and will finalize the data rollups and presentation of results.

(m) **The peer review panel will conduct its Stage 2 review.** The PRP will conduct its mid-project review. A report will be written and submitted to the SC.

(n) **The steering committee will review the final results and the report of the PRP.** The SC will meet to review the results of the data rollups and presentation of results, as well as the report from the PRP. A written response to the PRP will be prepared by the SC.

(o) **The final report will be prepared and disseminated.** The SC will have the final report prepared and disseminated.

Appendix A
Example of Data Input Sheets and Instructions

Data categories for each unit process associated with each commodity has been established by the technical committee.

Life Cycle Inventory Data Input Sheets

Scope:

Process and boundary description of operation corresponding to following data (list exceptions):

Operation	
Year	199__
Start Month	
End Month	

Inventory Basis:

-All data supplied on this sheet should refer to the period stated.

-Data should be in physical measures and not monetary values.

-Ensure that units in which quantities are recorded are stated.

Production Outputs	Quantity	Units	Avg Dist	Avg Load	Transport Mode	1- or 2-way

Material Inputs*	Quantity	Units	Avg Dist	Avg Load	Transport Mode	1- or 2-way

*Please include materials for abatement and water treatment, etc.

Leadoff Boxes

1. A brief description of the scope of the study and the part of the system to which the data correspond.
2. * The name of the process and the boundaries, in terms of the nature of the inputs and outputs, where these inputs were obtained, and where the outputs go — which, for the commodity products in this study, is the gate.
* The time period to which the given data correspond.
3. The annual production of the intermediate/product for the named process. Note that actual production figures are required, in order that production weight-averaged LCI values can eventually be calculated for each commodity product.
4. The production quantity (inventory basis) corresponding to the period identified. (If this period is 1 year, the inventory basis is the same as the annual production.)
5. Notes — *including the request to highlight any data which are not tied to primary information (secondary data, data derived from emission factors, or regulatory values).*

Production Outputs

Names and quantities of coproducts made in the process, together with outgoing transportation details. For the final process, where the commodity product is made, there is no transportation (beyond the gate).

Material Inputs

As for coproducts above, names and quantities of material inputs, along with incoming transportation data.

To prevent double entry of transportation data, when the subject process uses material (intermediate product) from another process for which outgoing transportation data have already been provided, it suffices to reference the previous process.

If the material is a mixture, the weights of the defined components must be given. This comment applies also to solutions: the solid (or liquid) content and solvent (water or other material) content must be given and defined.

Water

Information on water is handled in connection with water emissions on page 3 of the data input sheet.

Operation	

ENERGY INPUTS	Quantity	Units	Avg Dist	Avg Load	Transport Mode	1- or 2-way
Electricity	Quantity	Units				
Purchased						
Onsite Generation						
Sale						
Steam	Quantity	Units	Pressure	Heat Content		
Purchased						
Onsite Generation						
Sale						

Onsite Gen. Energy*	Quantity	Units	Avg Dist	Avg Load	Transport Mode	1- or 2-way
**Please include heating value and show portion of energy used in generation.*						

SOLID WASTES	Quantity	Units	Avg Dist	Avg Load	Transport Mode	1- or 2-way

Energy Inputs

The nature and quantities of energy inputs and the nature and quantity of any energy "sold" to another process are identified, along with transportation details. Only the energy actually used by the process will be used in the LCI calculations.

If steam or electricity are deliberately generated onsite, the primary fuels consumed should be given (after adjusting for any energy that is exported). If steam or electricity are purchased, the metered quantities should be given.

The sulphur contents of oils, coals, and cokes should be annotated, along with higher heating values (HHV), if known.

The nature, moisture content , and HHV (if known) of biomass should be annotated.

Where a chemical reaction (usually oxidation) generates heat which is partially recovered and used in some "foreign" process, the amount of material which is oxidized must be calculated and partitioned away from the material input to the subject process.

Solid Wastes

The nature and quantities of solid wastes (including liquid, non-aqueous wastes), along with their transportation, are listed according to whether they are destined for beneficial use, incineration, or landfill. Quantities are given in weight units.

If necessary later, these data can be converted to equivalent volumes.

Solid wastes may be deposited in landfills before or after composting, incineration, or recovery for treatment or recycling.

Operation	

AIR EMISSIONS	Quantity	Unit	AIR EMISSIONS	Quantity	Unit

WATER EMISSIONS	Quantity	Unit	WATER EMISSIONS	Quantity	Unit

Process Water:	Quantity	Please describe relative quality:
Source		
Discharge		

Cooling Water:	Quantity	Please describe relative quality:
Source		
Discharge		

Air Emissions

Air emissions are listed by species. The data should be provided on a weight-production basis, not in concentration terms.

Measured data for all individual species should be provided to the consultant for his or her attention. Some of these values may be combined into aggregated categories.

Water Emissions

All water emissions are also listed by species and on a weight-production basis, not in concentration terms. The consultant will justify any aggregation of data species.

Water Flow/Quantities

A distinction will be made between groundwater and surface water. All groundwater pumped will be included, whereas only the net amount of surface water used (water incorporated into product and/or evaporated) should be included. Brief descriptions are required concerning the qualities of incoming and outgoing water streams.

Appendix B
Example of LCI Data for Fuels, Electricity, and Transportation

The attached data were abstracted from the WESTON database. Specific references can be obtained from WESTON for those data sources which are not of a proprietary nature.

This Appendix contains tables of LCI energy data, mainly for average Canadian conditions, for reference purposes.

Table B1
Total and Precombustion Energies for Fuels (MJ)

Fuel	Unit	Delivered	Precombustion	Total
Heavy Fuel Oil	1 kg	36.4	6.1	42.6
Diesel	1 litre	38.7	6.5	45.2
Gasoline	1 litre	34.9	5.9	40.80
Natural Gas	1 m3	38.4	3.2	41.6
Propane	1 litre	25.5	4.3	29.8
Coal	1 kg	19.9	0.8	20.7
Wood	1 kg	8.5	0.81	9.66

Table B2
Electrical Power Mix: Canadian Grid

Fuel	Gwh	%
Fuel Oil	9,293	2.2
Natural Gas	3,030	0.7
Coal	82,728	19.8
Hydroelectric	242,660	58
Nuclear	80,413	19.2
Total	418,124	99.9

Table B3
Canadian Grid Electrical Generation Efficiency (%) and Energy Contributions (J)

Fuel	Efficiency %	Precombustion	
		Excl.	Incl.
Fuel Oil	33	261.9	305.8
Natural Gas	33	85.4	92.5
Coal	33	2331.1	2424.3
Hydroelectric	95	2375.2	2375.2
Nuclear	35	2336.7	2336.7
	Total	7390.2	7534.6

Note: *The energy data include 8% transmission line loss.*

Table B4
Transportation Energy Data

Mode	Fuel	Gal/Ton-mile
Ocean Vessel	Heavy Fuel Oil	0.00106
Barge	Heavy Fuel Oil	0.00241
Rail	Diesel	0.00313
Truck (bulk)	Diesel	0.00943

Table B5
Emissions Data for Primary Fuels

Precombustion Factors (Per Fuel Unit)

	Heavy fuel oil barrels	Diesel barrels	Gasoline barrels	Natural gas MSCF	Propane Mgals	Coal tons
Air emissions (lb)						
Particulates	1.04E-01	9.64E-02	8.69E-02	1.22E-02	1.51E+00	3.98E+00
SO_x	1.29E+00	1.20E+00	1.08E+00	1.22E-02	1.88E+01	1.28E+00
NO_x	8.61E-01	7.99E-01	7.20E-01	8.78E-02	1.25E+01	6.88E-01
CO	7.42E-02	6.89E-02	6.21E-02	0.00E+00	1.30E+00	2.46E-01
CO_2	1.56E+02	1.45E+02	1.30E+02	5.62E+00	2.27E+03	1.20E+02
Organics	8.76E-01	8.12E-01	7.32E-01	4.44E-01	2.16E+01	2.95E-01
Solid Waste (lb)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.44E-01
Net Water Use (Mgal)	7.14E-02	6.63E-02	5.97E-02	0.00E+00	1.04E+00	4.85E-01
Water Effluent (lb)						
TSS	1.48E-02	1.38E-02	1.24E-02	0.00E+00	2.16E-01	1.08E+00
Oils/Grease	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dissolved Metals	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Organics	1.93E-01	1.79E-01	1.61E-01	0.00E+00	2.59E+00	0.00E+00
BOD	1.48E-02	1.38E-02	1.24E-02	0.00E+00	2.16E-01	0.00E+00

Precombustion Factors (Per MMBtu)

	Heavy fuel oil	Diesel	Gasoline	Natural gas	Propane	Coal
Air Emmissions (lb)						
Particulates	1.65E-02	1.65E-02	1.65E-02	1.18E-02	1.65E-02	1.91E-01
SO_x	2.05E-01	2.06E-01	2.06E-01	1.18E-02	2.05E-01	6.14E-02
NO_x	1.37E-01	1.37E-01	1.37E-01	1.42E-01	1.37E-01	3.30E-02
CO	1.18E-01	1.18E-02	1.18E-01	1.42E-02	1.42E-02	1.18E-02
CO_2	2.48+01	2.48E+01	2.48E+01	9.56E+00	2.49E+01	5.78E+00
Organics	1.39E-01	1.39E-01	1.39E-01	4.55E-01	2.36E-01	1.42E-02
Solid Waste (lb)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.65E-02
Net Water Use (Mgal)	1.14E-02	1.14E-02	1.14E-02	0.00E+00	1.14E-02	2.33E-02
Water Effluent (lb)						
TSS	2.36E-03	2.36E-03	2.36E-03	0.00E+00	2.36E-03	5.19E-02
Oils/Grease	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dissolved Metals	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Organics	3.07E-02	3.07E-02	3.07E-02	0.00E+00	2.83E-02	0.00E+00
BOD	2.36E-03	2.36E-03	2.36E-03	0.00E+00	2.36E-03	0.00E+00

Table B6
Emissions Data for Power Plants

	Fuel oil	Natural gas	Coal	Nuclear
	Factors without Fuel Precombustion Burden (Per MMBtu Heat Input)			
Air Emissions (lb)				
Particulates	7.87E-02	3.48E-03	4.89E-02	
SO_x	8.89E-01	7.67E-04	1.84E+00	
NO_x	3.67E-01	4.49E-01	8.87E-01	
CO	3.93E-02	4.60E-02	3.17E-02	
CO_2	1.69E+02	1.09E+02	2.53E+02	
Organics	6.56E-03	2.30E-03	5.24E-03	
Solid Waste (lb)	0.00E+00	0.00E+00	1.15E+01	
Net Water Use (Mgal)	1.14E+00	1.14E+00	1.14E+00	1.08E+00
Water Effluent (lb)				
TSS	9.13E+00	9.13E+00	9.13E+00	8.70E+00
Oils/Grease	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dissolved Metals	9.61E-02	9.61E-02	9.61E-02	9.15E-02
Organics	4.80E-02	4.80E-02	4.80E-02	4.58E-02
BOD	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Factors with Fuel Precombustion Burden (Per MMBtu Heat Input)			
Air Emissions (lb)				
Particulates	9.52E-02	1.57E-02	2.40E-01	
SO_x	1.09E+00	1.26E-02	1.90E+00	
NO_x	5.04E-01	5.91E-01	9.20E-01	
CO	5.11E-02	4.60E-02	4.35E-02	
CO_2	1.94E+02	1.18+02	2.59E+02	
Organics	1.46E-01	4.57E-01	1.94E-02	
Solid Waste (lb)	0.00E+00	0.00E+00	1.15E+01	
Net Water Use (Mgal)	1.15E+00	1.14E+00	1.16E+00	1.08E+00
Water Effluent (lb)				
TSS	9.13E+00	9.13E+00	9.18E+00	8.70E+00
Oils/Grease	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dissolved Metals	9.61E-02	9.61E-02	9.61E-02	9.15E-02
Organics	7.87E-02	4.80E-02	4.80E-02	4.58E-02
BOD	2.36E+00	0.00E+00	0.00E+00	0.00E+00

Table B7
Emissions Data for Industrial Facilities

Factors without Fuel Precombustion Burden (Per MMBtu Heat Input)

	Fuel oil ind. boiler	Diesel ind. boiler	Diesel ind. eng.	Gasoline ind. eng.	Natural gas ind. boiler	Propane ind. boiler	Coal ind. boiler
Air Emissions (lb)							
Particulates	7.87E-02	1.44E-02	2.42E-01	5.17E-02	4.87E-03	5.52E-03	1.09E-01
SO_x	8.89E-01	8.89E-01	2.25E-01	4.25E-02	5.41E-04	6.13E-04	2.05E+00
NO_x	3.67E-01	1.44E-01	3.38E+00	8.16E-01	6.18E-01	7.01E-01	7.32-E01
CO	3.34E-02	3.61E-02	7.35E-01	3.15E+01	9.47E-02	1.07E-01	9.72E-02
CO_2	1.70E+02	1.63+02	1.63E+02	1.78E+02	1.09E+02	1.23E+02	2.53E+02
Organics	8.55E-03	1.80E-03	2.70E-01	1.06E+00	1.49E-02	1.69E-02	3.89E-03
Solid Waste (lb)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.15E+01
Net Water Use (Mgal)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Water Effluent (lb)							
TSS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Oils/Grease	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dissolved Metals	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Organics	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BOD	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Factors with Fuel Precombustion Burden (Per MMBtu Heat Input)						
Air Emissions (lb)							
Particulates	9.52E-02	3.10E-02	2.58E-01	6.83E-02	1.67E-02	2.20E-02	3.00E-01
SO_x	1.09E+00	1.09E+00	4.31E-01	2.48E-01	1.24E-02	2.06E-01	2.12E+00
NO_x	5.04E-01	2.81E-01	3.52E+00	9.53E-01	7.61E-01	8.38E-01	7.65E-01
CO	4.52E-01	4.79E-02	7.47E-01	3.15E+01	9.47E-02	1.21E-01	1.09E-01
CO_2	1.94E+02	1.88E+02	1.88E+02	2.03E+02	1.18E+02	1.48E+02	2.59E+02
Organics	1.48E-01	1.41E-01	4.10E-01	1.19E+00	4.69E-01	2.53E-01	1.80E-02
Solid Waste (lb)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.15E+01
Net Water Use (Mgal)	1.14E-02	1.14E-02	1.14E+00	1.14E+00	0.00E+00	1.14E-02	2.33E-02
Water Effluent (lb)							
TSS	2.36E-03	2.36E-03	2.36E-03	2.36E-03	0.00E+00	2.36E-03	5.19E-02
Oils/Grease	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dissolved Metals	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Organics	3.07E-02	3.07E-02	3.07E-02	3.07E-02	0.00E+00	2.83E-02	0.00E+00
BOD	2.36E-03	2.36E-03	2.36E-03	2.36E-03	0.00E+00	2.36E-03	0.00E+00

Table B8
Emissions Data for Transportation

Factors without Fuel Precombustion Burden (Per MMBtu Heat Input)

	Ocean vessel heavy fuel oil	Barge heavy fuel oil	Rail diesel	Truck diesel
Air Emissions (lb)				
Particulates	1.34E-01	0.00E+00	1.80E-01	4.54E-01
SO_x	1.27E+00	2.14E-02	4.11E-01	3.24E-01
NO_x	3.73E-01	1.87E+00	2.67E+00	9.63E-01
CO	2.30E-02	6.68E-01	9.37E-01	7.30E-01
CO_2	1.70E+02	1.70E+02	1.63E+02	1.63E+02
Organics	4.56E-03	3.34E-01	6.78E-01	2.13E-01
Solid Waste (lb)	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Net Water Use (Mgal)	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Water Effluent (lb)				
TSS	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Oils/Grease	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dissolved Metals	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Organics	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BOD	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Factors with Fuel Precombustion Burden (Per MMBtu Heat Input)				
Air Emissions (lb)				
Particulates	1.50E-01	1.65E-02	1.97E-01	4.71E-01
SO_x	1.48E+00	2.27E-01	6.17E-01	5.30E-01
NO_x	5.10E-01	2.01E+00	2.80E+00	1.10E+00
CO	3.48E-02	6.80E-01	9.49E-01	7.42E-01
CO_2	1.94E+02	1.94E+02	1.88E+02	1.88E+02
Organics	1.44E-01	4.73E-01	8.17E-01	3.52E-01
Solid Waste (lb)	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Net Water Use (Mgal)	1.14E-02	1.14E-02	1.14E-02	1.14E-02
Water Effluent (lb)				
TSS	2.36E-03	2.36E-03	2.36E-03	2.36E-03
Oils/Grease	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dissolved Metals	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Organics	3.07E-02	3.07E-02	3.07E-02	3.07E-02
BOD	2.36E-03	2.36E-03	2.36E-03	2.36E-03

Proposal for Change

To help our volunteer members to assess proposals to change requirements we recommend that each proposal for change be submitted in writing and identify the
(a) Standard number;
(b) Clause number;
(c) proposed wording of the Clause (requirement, test, or pass/fail criterion) using mandatory language and underlining those words changed from the existing Clause (if applicable); and
(d) rationale for the change, including all supporting data necessary to be considered.

The proposal should be submitted to the Standards Administrator at least one month prior to the next meeting of the Committee. It is CSA Committee practice that only those proposals sent out to members prior to a meeting can be the subject of discussion and action. This is to allow the members time to consider the proposal and to do any research they may feel necessary.

Date: ____ - ____ - ____
YY MM DD

To: The Standards Administrator of CSA Standard _____

From: _____

Affiliation: _____

Address: _____

_____

Phone: _____ **Fax:** _____

Re: Request for an Amendment, Deletion, or Addition to Clause(s) _____

Proposed change:

(Use reverse and additional pages as required.)

Product Description Produit	Quantity Nombre	Price Prix	Sub-Total Total	Shipping (see chart) Frais de port (voir grille)	Sub-Total Total	GST* TPS*	PST** TVP**	Sub-Total Total	QST*** TVQ***	Sub-Total Total
	x	=	+	=	+	+	=	+	=	
	x	=	+	=	+	+	=	+	=	
	x	=	+	=	+	+	=	+	=	
	x	=	+	=	+	+	=	+	=	
	x	=	+	=	+	+	=	+	=	
								Grand Total/Total global :		

* Add GST to all Canadian Orders. (NOTE: The CE Code Handbook and all PLUS products are GST exempt.) / Ajouter la TPS à toute commande passée au Canada. (NOTE. Le Guide explicatif du CCE et les répertoires sont exempts de TPS.)
** Add PST on all orders for electronic products placed in Alberta, British Columbia, Manitoba, New Brunswick or Ontario. / Ajouter la TVP à toute commande de produits électroniques passée en Alberta, en Colombie-Britannique, au Manitoba, au Nouveau Brunswick et en Ontario.
*** Add QST to all Quebec orders. (NOTE: The CE Code Handbook and all PLUS products are QST exempt.) / Ajouter la TVQ à toute commande passée au Québec. (NOTE. Le Guide explicatif du CCE et les répertoires sont exempts de TVQ.)

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The more than 1000 standards published by CSA are written, reviewed, and revised by over 7000 committee members, who represent users, producers, and regulatory authorities in all regions of Canada. In addition to these volunteers, some 2000 representatives from industry, labour, governments, and the public participate in the work of the Association through sustaining memberships. Approximately one-third of CSA's standards have been referenced into law by provincial and federal authorities.

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