An interpretation of the CPM use of SPINE in terms of the ISO 14041 standard

Preface

This report is an adaptation and revision of CPM report 1:1997, which was a project report within the frame of the CPM database project. The original report was an interim solution for handling of data quality when working with the CPM database.

Within the project it was established that requirements for data quality is different depending on among other things users, target groups and purpose of the LCA study. This implies that a given data set at the same time may be considered to be of both high and low quality depending on the different perspective of the user. Quality was considered to be associated with the relevance in a particular application, and data therefore needs to be documented in order allow for users to form an opinion of the relevance and other qualities of data.

In 1996 it was established that the SPINE structure offers means to structure LCI data documentation in an efficient manner. It was also verified that the SPINE structure harmonise with the suggested quality requirements for LCI data in ISO/DIS 14040 (draft international standard).

In this updated report, we have compared SPINE and the CPM LCI data documentation requirements with the final standard ISO 14 041:1998 (E).

In addition to the interpretation on how fields in the SPINE structure is correlated with headlines and wording in the text of the standard, this report begins with a basic description on how the standard is interpreted in this context. This introductory text was missing in the report from 1997, partly due to the fact that the text in the draft standard was noticeably not finished.

The following persons and organisations participated in the development of the original report in 1997:

Peter Arvidsson, Akzo Nobel Surface Chemistry AB, (Project leader)
Jan Bresky, Stora Corporate Research AB
Göran Brohammer, SCA Mölnlycke AB
Ulf Boman, Vattenfall Utveckling AB
Raul Carlson, CPM
Lennart Karlson, ABB Corporate Research
Ann-Christin Pålsson, CPM
Maria Rosell, Vattenfall Utveckling AB
Michael Severinsson, Perstorp AB
Bengt Steen, CPM
Jörgen Wennsten, AB Volvo

This update has been done by:
Peter Arvidsson, Akzo Nobel Surface Chemistry AB
Raul Carlson, CPM
Ann-Christin Pålsson, CPM

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1 Principles for the interpretation of ISO 14041:1998 (E)

The CPM LCI data documentation requirements are based on requirements for data documentation according to ISO 14041:1998 (E). These requirements are interpreted partly from the requirements for data quality formulated in section 5.3.6 (data quality requirements) and partly from the general text in the standard. In this section it is explained how parts of this text is interpreted within the CPM group, and consequently how the standard is applied with the SPINE format.

In the text of the standard it is expressed that unit processes may be modelled correctly in many different ways, e.g. different processes that deliver the same product for different purposes may be modelled differently, with different components included or excluded from the model. In the standard the need for documenting such modelling choices is expressed in different ways. The following example illustrates how different, but correct models may be given for a specific system:

Example:
Consider the production of product A within a production plant. Figure 1 describes the production system for product A viewed from different perspectives, depending on who is studying the system.

In case 1, only the parts within the plant that are directly associated with the production of product is included, i.e. electricity to operate pumps and agitators and steam to run the reaction. The total energy consumption for this is shown in the diagram.

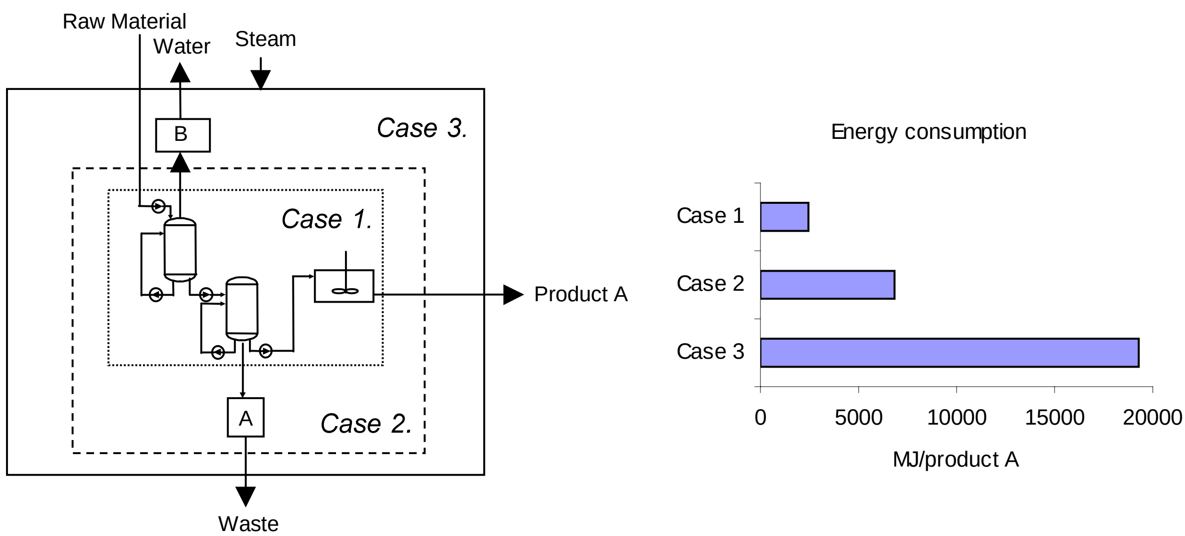

Figure 1.

In case 2, the treatment of waste (A) that is formed in the process has been included, since this takes place at the plant. The total energy consumption is shown in the diagram. Both case 1 and case 2 is equally plausible to answer the question on the amount of energy that is used to produce product A for the company.

In the third case also the water purification (A) and cleansing of pipes and reactor has been included. In the cleansing of pipes and the reactor steam is used and the cleansing is a necessary operation between the production of two products. Both processes take place within the plant.

All three cases are feasible answers to the enquiry on the energy consumption in the production of product A, depending on what view the person answering the question has on what is included in the production.

In section 6.3 of the standard it is stated that “data collection requires thorough knowledge about each unit process”. The example above illustrates the importance of the formulations in the standard, that without such thorough knowledge there is a risk for data gaps and double counting. To avoid these risks it is necessary that the person who is inventorying data also document the choices that have been made and describes the unit process. In section 5.3.3 and 6.3 of the standard it is for instance stated that each unit process should be described with regard to where the unit process begins and ends and the transformations and the operations that occur as part of the unit process.

In section 6.2 a number of steps describes the significance of a “uniform and consistent understanding” of the product system as a whole, which in accordance with the example above presuppose an understanding of each of the constituent unit processes.

The understanding is communicated through the documentation prepared at the data collection, which accompany the data when the data is communicated. This consequently place high requirements on that the work with the documentation is made easy and that it may be done complete, and that support are given to describe widely different processes. Naturally it must be equally easy to interpret this documentation.

SPINE is based on that data documentation is structured efficiently, with the same structure independent on what process that is described, for instance a transport by truck, or a manufacturing plant. The structure is also the same independent on the size or the scope of the process that is described. For instance, it may be an transport by truck or an entire transport route comprising several different means of transportation, or it may be one steam generator or an entire region’s total energy production or distribution.

SPINE enables two different manners to structure documentation of data regarding processes and technical systems:

1. A strongly structured text description of the inflows and outflows of the entire process. The process is described in terms of technical system boundaries, technical functions, geographical location and extension, boundaries towards the environmental system and time-related aspects. The inflows and outflows is described in numerical/statistical terms, by a name (chosen from a predefined nomenclature) and in terms of properties of the receiving system (technosphere or different types of environmental systems). A process or a system documented in this manner is with SPINE terminology called an ‘activity’ or an ‘atomic activity’
2. Processes and technical systems may also be documented in SPINE via flowcharts, constructed by connecting activities together. Such a flow chart can not exist in the SPINE-model without being enclosed in an activity. An activity, which in this manner encloses other activities, is called an ‘aggregated activity’ and its documentation is composed of the total documentation of the enclosed activities. In addition to this, the aggregated activity may be documented in the same fashion as any other activity, i.e. with

regard to technical system boundaries, technical functions, geographical location and extension, boundaries towards the environmental system and time-related aspects. The inflows and outflows of an aggregated activity consist of the complete set of inflows and outflows from the internal flow chart. These flows can be explicitly “copied” to the system boundary of the aggregated activity, and can thus be documented in the same manner as an (atomic) activity, i.e. described in numerical/statistical terms, by a name (chosen from a predefined nomenclature) and in terms of properties of the receiving system (technosphere or different types of environmental system). This means that an aggregated activity on the exterior has an identical structure as an atomic activity and that the SPINE model thus enables aggregated activities to contain aggregated activities.

These two different manners to document processes and technical systems in SPINE can give a good technical transparency, i.e. they allow in principle an equally large mass of documentation and depth of the documentation. Which route to chose in the specific case depends on how well one wishes or can structure the documentation. In cases where it is not desirable to have or detailed knowledge is lacking on the internal structure of a technical system or a process it is natural to chose to document the data as an atomic activity. Documentation in the form of an aggregated activity is done when a higher degree of transparency is needed for e.g. review, or if one intends to perform calculations or simulations on the internal activities in order to calculate or to vary the inflows and outflows of the aggregated activity.

We interpret ISO 14041 (E) that a unit process is identical to an (atomic) activity in SPINE and that a study report, that describes the studied product system is an aggregated activity. An aggregated activity does not however need to be a study report, but can be documentation of any technical system. Which situation that is the case is evident from the documentation that constitutes the aggregated activity.

2 LCI data documentation according to CPM

The following is a description on how the CPM data documentation requirements and SPINE is used for data documentation in accordance with ISO 14041:1998(E).

The headlines in italic (table and column in SPINE) refers to the SPINE report[1]

2.1 Data quality requirements

This section describes how SPINE corresponds to the requirements on data quality in section 5.3.6 in ISO 14041:1998(E). The headlines refer to different parameters that should be included or considered.

2.1.1 Time-related coverage

***Table in SPINE:* Inventory; *Column:* DateCompleted**
The date when the study or the data set was completed or final reported. For instance, the major part of data used in the study may be from 1992 or earlier. The final reporting of the study was however not done until 1993-11-14. This is the date that is referred to in DateCompleted.

The following format should be used: YYYY-MM-DD
If only the year is known: YYYY-01-01
If only the year and the month is known: YYYY-MM-01

Example:
1993-11-14

***Table in SPINE:* QMetaData; *Column:* DateConceived**
Timeperiod during which data was collected. The data may represent a study, an activity or an individual value that describes a flow. Through the SPINE model the context is clear.

For instance, the data used to compile a data set may be from 1992 to 1995. The timeperiod that comprises the entire data set should be given.

The following format should be used: YYYY-MM-DD - YYYY-MM-DD
If only the year is known: YYYY-01-01
If only the year and the month is known: YYYY-MM-01

Example:
In a given data set describing a process, the value for the emissions of carbondioxide is a yearly average from 1995-01-01 to 1995-12-31, whereas the value for the emissions of nitrogen is an average from 1995-11-14 to 1995-12-14.
DateConceived for the value for the flow of carbondioxide is then: 1995-01-01 - 1995-12-31.
DateConceived for the value for the flow of nitrogen is then: 1995-11-14 - 1995-12-14.

[1] Carlson R.; Löfgren G. & Steen B. 1995: "Spine A Relation Database Structure for Life Cycle Assessment", IVL report no. 1203, Gothenburg.

Table in SPINE: **Inventory;** ***Column:*** **TimeBoundary**
System boundary in time, i.e. the time period during which the process or the technology can be surveyed. Free text field, no agreed format.

Comment:
In addition to allow for handling descriptions of time-related aspects through dates, SPINE also offers a possibility to describe other aspects regarding time in free text. Examples of such descriptions are an estimation of the "best before date" for a data set with a description and motivation.The motivation may be done through a description of the technology level of the process or plans for investments or alterations of the process that will have a significant effect on the process and consequently the data. With such descriptions it is possible to form an opinion on whether the data still is representative or not

2.1.2 Geographical coverage

Table in SPINE: **Geography;** ***Column:*** **AreaType, AreaName**
Descriptions of a geographical area. An interim nomenclature has been developed at CPM within a project "Hierarchies and nomenclatures".

Example 1:
AreaType: City AreaName: Göteborg

Example 2:
AreaType: Continent AreaName: Africa

Table in SPINE: **ObjectOfStudy;** ***Column:*** **Site**
The geographical location where the described process or system is situated, i.e. address or geographical area. If the data describes a specific plant, the name and the address of the plant is given. If the data describes an average or a geographically extended system, the geographical region should be given e.g. Europe (in the sense European average).

Example:
Site: Papper AB
Pappersgatan 5B
123 45 Pappersby
Sweden

Table in SPINE: **Inventory;** ***Column:*** **GeographyBoundary**
The geographical extension or geographical limitations of the studied process or system.

Example:
The plant within the gates
The life cycle within the Swedish borders

2.1.3 Technology coverage

Table in SPINE: **ObjectOfStudy;** ***Column:*** **Category, Sector, Name**
Identification of the studied process or system, e.g. a plant or an average of several processes. The identification is made by the most prevalent name (Name), the type or the scope (Category) and the trade (Sector) of the studied process or system. Interim nomenclatures have been developed for Sector and Category at CPM.

Example:

Category:	The type or the scope of the studied system e.g. "gate to gate" or ”cradle to gate”
Sector:	The sector to which the system belongs, e.g. pulp and paper industry
Name:	The most prevalent name for the system, e.g. tissue production

Table in SPINE: **QMetaData;** ***Column:*** **Represents**
Description of different conditions, e.g. operational that have an influence on entire sets of measurements or individual measurements. This is described through free text.

Example:
The production was 40000 tonnes/year. The available capacity for production in the plant is 75 000 tonnes/year.

A new purification treatment was installed during the year. The installation brought about abnormal high emissions, which is anticipated to be lower next year.

The measurements were performed during the summer half.

Table in SPINE: **ObjectOfStudy;** ***Column:*** **Function**
Description of the technical system as thoroughly as possible. The description should enable an identification of technology that may have a large influence on e.g. emissions, energy consumption etc. All process steps that are included in the system should be described, e.g. administration, internal recycling loops, preparation, sewage treatment, scrubber technology etc.

Table in SPINE: **ObjectOfStudy;** ***Column:*** **Allocations**
Descriptive text on allocations that have been performed, the basis for the allocations and rules and assumptions the have been used to allocate the environmental load to the studied system.

Example:
Allocation of the environmental load between the products produced at the plant is made on the basis of mass.

Table in SPINE: **Inventory;** ***Column:*** **OtherBoundaries**
Description of system boundaries other than towards the surrounding natural environment, geographical extension, extension in time and system expansion. Examples of such

boundaries are boundaries towards other technical systems (e.g. exclusions of technical subsystems, basis for choice of flows to and from other technical systems).

Example:
The system does not include:
- heating of the premises
- erection of the building and infrastructure
- internal transports
- administration

Flows of raw material that are lower than 0,7 % have not been studied

2.1.4 Precision

***Table in SPINE:* Flow; *Column:* QuamtiyMin, QuantityMax, StandardDev**
The size of flow may be given with corresponding minimum value, maximum value and standard deviation.

***Table in SPINE:* ActivityParameter; *Column:* ValueMin, valueMax, ValueStandardDev**
Activity parameters, such as transportation distances or process time may be given with corresponding minimum value, maximum value and standard deviation.

General remark regarding statistical information;
There is space for numerical information in other tables in SPINE, all of which may be supplied with statistical information.
Standard deviation, minimum and maximum values are at present not a requirement within CPM. This type of information should however be reported when available. It is also strongly recommended that an increased focus be put on this issue in data collection.

2.1.5 Completeness

***Table in SPINE:* QMetaData; *Column:* Method**
Description on the basis for and the methods used to acquire the numerical values in a data set. This may both be given for the entire data set and for each flow in the data set. Naturally it should also be described for how well the statistical information has coverage in the basis for the data.

2.1.6 Representativeness

***Table in SPINE:* QMetaData; *Column:* Represents**
Documentation of numerical assumptions of inflows and outflows to the activity regarding values acquired from sources that describes other activities. The documentation should especially contain an argumentation of how well the assumed value may be considered to correspond to the ‘true’ value. A description of relevant aspects of the original conditions for the data i.e. what the data originally represents should also be included.

Table in SPINE: **QMetaData;** ***Column:*** **DataType**
Type of method that has been used in the data collection.

Example:
Unspecified
Monitored, continuous

Table in SPINE: **Inventory;** ***Column:*** **Data**
General description of numerical and other qualities, or quality deficiencies in the overall documentation of an activity.

2.1.7 Consistency

Table in SPINE: **Inventory;** ***Column:*** **Data**
General description of numerical and other qualities, or quality deficiencies in the overall documentation of an activity.

2.1.8 Reproducibility

A data set, thoroughly documented with SPINE is reproducible. If that is not the case or if there are other issues that should be considered for the application of the data set, this should be documented in:

Table in SPINE: **Inventory;** ***Column:*** **Applicability**
Description of an assumed area of application for the data set regarding e.g. geographical, technology or other trade specific applicability. Also, other general cautions and recommendations regarding how data can be used may be given.

Example:
The design of the plant is principally the same all over the world, except for Eastern Europe and the developing countries, where a different technology is used.

2.2 General aspects and requirements

This section describes different general aspects and requirements that should be considered according to ISO 14 041:1998(E).

2.2.1 Input and Output Descriptors (including data categories)

(See also section 2.4 Precision)

Table in SPINE: **SubstanceProperty;** ***Column:*** **Type, Category, Quantity, QuantityMin, QuantityMax, StandardDev, Unit**
Substances may have many different properties that are useful in LCA. Such properties may be described by name, type and quantity.

Example 1:
Category: Physical
Type: Density
Quantity: 30
Unit: kg/m3

Example 2:
Category: Economical
Type: Price
Quantity: 3
Unit: SEK/unit

Table in SPINE: **FlowProperty; *Column:* Type, Category, Quantity, QuantityMin, QuantityMax, StandardDev, Unit**
Flows may have many different properties that are useful in LCA. Some of these properties are not specific for the substance, but are be dependent on the conditions that prevail at e.g. a plant. Such properties may be described by name, type and quantity.

Example:
Category: Physical
Type: Temperature
Quantity: 273
QuantityMin:255
QuantityMax 280
Unit: K

Table in SPINE: **AlternateName; *Column:* Name**
Substance may be known under synonym names, e.g. the trade name and the chemical formula. To allow for a proper and easy identification of the substance, all known synonym names should be given.

Example:
Berol 532
Fattyalcoholethoxylate

Comment:
In appendix 1, a suggestion is given for a minimum set of parameters that should be included in the inventory. However, all substances that are measured and recorded should naturally be given, even if they are not included in this suggestion.

Table in SPINE: **Flow; *Column:* ImpactRegion**
Description of the geographical recipient for the inflows and outflows. An interim nomenclature for this purpose has been developed within CPM.

Table in SPINE: **Flow;** ***Column:*** **ImpactMedia**
Description of the environmental recipient for the inflows and outflows. An interim nomenclature for this purpose has been developed within CPM.

Example:
Air
Urban air
Water
Technosphere

Table in SPINE: **Inventory;** ***Column:*** **NatureBoundary**
Description of system boundaries towards the environmental system, primarily though a description of e.g. the choice of parameters that have been included.

Example:
The emissions and resources that are represented in the EPS-system have been included.

Comment
A system boundary is defined by what is communicated between the system and its surroundings, i.e. in LCA by emissions and waste and the resources extracted from the environmental system.

2.2.2 Relating data to unit process

Table in SPINE: **Inventory;** ***Column:*** **FunctionalUnit**
The functional unit addresses the function or product of the studied process or system

Table in SPINE: **Inventory;** ***Column:*** **FUExplanation**
Explanation of the functional unit

2.2.3 Further descriptors

Table in SPINE: **Inventory;** ***Column:*** **Copyright**
A person or an organisation may hold the publishing rights for the data set. This should be identified.

Example:
ETH
APME

Table in SPINE: **Inventory;** ***Column:*** **Availability**
Often the data supplier has certain conditions or agreements on how the data may be distributed. Such restrictions or agreements should be described.

Example:

“The data supplier allows unrestricted use of the data set. This promise was given orally to Sven Svensson at Xerxes Inc. In May 1996”

“The data supplier requires a special agreement when the data is used in a study that will be publicly available”

Table in SPINE: **Inventory;** ***Column:*** **Practitioner**
The person or persons responsible for the data set or the study should be specified with name, organisation and address.

Example:
Sven Svensson Xerxes Inc.

Table in SPINE: **Inventory;** ***Column:*** **Commissioner**
The person or persons or organisation responsible for initiating the data acquisition or the study should be specified with name, organisation and address.

Example:
Xerxes Inc.

Table in SPINE: **Inventory;** ***Column:*** **Reviewer**
The person or persons or organisation responsible for reviewing the data set or the study should be specified with name, organisation and address.

Example:
Inga Andersson, Xerxes Inc.

Table in SPINE: **Inventory;** ***Column:*** **Publication**
Literature reference to where the data set or the study has been published (when applicable), or contact person. Note that this reference refers to the entire data set, with the compilation and interpretation (cf. QMetaData.LiteratureRef)

Table in SPINE: **Inventory;** ***Column:*** **GeneralPurpose**
General purpose or background for the study.

Table in SPINE: **Inventory;** ***Column:*** **DetailedPurpose**
Description of the detailed purpose or the objective for the study.

Table in SPINE: **Inventory;** ***Column:*** **IntendedUser**
Description of the intended target groups and users of the study.

2.3 Documentation of the LCI study (study report)

This section follows the structure in ISO 14 041:1998 (E) section 8 (Study report).

a) Goal of the study
   1) reasons for carrying out the study
      Table in SPINE: **Inventory;** ***Column:*** **GeneralPurpose**
   2) its intended application
      Table in SPINE: **Inventory;** ***Column:*** **DetailedPurpose**
   3) the target audiences
      Table in SPINE: **Inventory;** ***Column:*** **IntendedUser**

b) Scope of the study
   1) modifications together with their justification
      Table in SPINE: **Inventory;** ***Column:*** **Notes**
   2) function
      - i) statement of performance characterisitcs
        Table in SPINE: **ObjectOfStudy;** ***Column:*** **Function**
      - ii) any omission of additional functions in comparisons
        Table in SPINE: **Inventory;** ***Column:*** **OtherBoundaries**
   3) functional unit
      - i) consistency with goal and scope
        Table in SPINE: **Inventory;** ***Column:*** **FUExplanation**
      - ii) definition
        Table in SPINE: **Inventory;** ***Column:*** **FunctionalUnit**
      - iii) result of performance measurements
        Table in SPINE: **Inventory;** ***Column:*** **FUExplanation**
   4) system boundaries
      - i) inputs and outputs of the system as elementary flows
        Table in SPINE: **Flow;** ***Column:*** **Quantity, QuantityMin, QuantityMax, StandardDev, Unit, ImpactMedia, ImpactRegion**
      - ii) decision criteria
        Table in SPINE: **Inventory;** ***Column:*** **NatureBoundary, OtherBoundaries**
      - iii) omissions of life cycle stages, processes or data needs
        Table in SPINE: **Inventory;** ***Column:*** **NatureBoundary, OtherBoundaries**
      - iv) initial description of the unit processes
        Table in SPINE: **ObjectOfStudy;** ***Column:*** **Function (also the flow chart in an aggregated activity)**
      - v) decision about allocation
        Table in SPINE: **Inventory;** ***Column:*** **Allocation**
   5) data categories
      - i) decision about data categories
        Table in SPINE: **Inventory;** ***Column:*** **NatureBoundary**
      - ii) details about individual data categories
        Table in SPINE: **Flow;** ***Column:*** **Substanceid**
      - iii) quantification of energy inputs and outputs
        Table in SPINE: **Flow;** ***Column:*** **Quantity, QuantityMin, QuantityMax, StandardDev, Unit**

iv) assumptions about electricity production
Table in SPINE: **ObjectOfStudy;** ***Column:*** **Function**

v) combustion heat
Table in SPINE: **ObjectOfStudy;** ***Column:*** **Function**
Table in SPINE: **QMetaData;** ***Column:*** **Method**
Table in SPINE: **SubstanceProperty**

vi) inclusion about fugitive emissions
Table in SPINE: **QMetaData;** ***Column:*** **Method**
Table in SPINE: **Inventory;** ***Column:*** **OtherBoundaries**

6) criteria for initial inclusion of inputs and outputs

i) description of criteria and assumption
Table in SPINE: **Inventory;** ***Column:*** **NatureBoundary, OtherBoundaries**

ii) effect of selection on results
Table in SPINE: **Inventory;** ***Column:*** **AboutData**

iii) inclusion of mass, energy and environmental criteria (comparisons)
Table in SPINE: **Inventory;** ***Column:*** **NatureBoundary, OtherBoundaries**

7) data quality requirements
See the descriptions in section 2.1

c) inventory analysis

1) procedures for data collection
Table in SPINE: **QMetaData;** ***Column*:** **Method**
Table in SPINE: **Inventory;** ***Column:*** **NatureBoundary, OtherBoundaries**

2) qualitative and quantitative description of unit processes
Table in SPINE: **Flow**
(also documentation of the enclosed activities in an aggregated activity)

3) source of published literature
Table in SPINE: **QMetaData;** ***Column:*** **LiteratureReference**

4) calculation procedure
Table in SPINE: **QMetaData;** ***Column:*** **Method**

5) validation of data

i) data quality assessment
Table in SPINE: **QMetaData;** ***Column:*** **Notes**
Table in SPINE: **Inventory;** ***Column:*** **AboutData**

ii) treatment of missing data
Table in SPINE: **QMetaData;** ***Column:*** **Represents**
Table in SPINE: **Inventory;** ***Column:*** **AboutData**

6) sensitivity analysis for refining system boundaries
Table in SPINE: **Flow;** ***Column:*** **QuantityMin, QuantityMax, StandardDev**

7) allocation principles and procedures

i) documentation and justification of allocation procedure
Table in SPINE: **Inventory;** ***Column:*** **Allocation**

ii) uniform application of allocation procedure
Table in SPINE: **Inventory;** ***Column:*** **Allocation**

d) limitations of LCI

1) data quality assessment and sensitivity analysis
Table in SPINE: **Flow;** ***Column:*** **QuantityMin, QuantityMax, StandardDev**
Table in SPINE: **Inventory;** ***Column:*** **Applicability, Notes**

2) the system functions and functional unit(s)
   Table in SPINE: **Flow;** ***Column:*** **QuantityMin, QuantityMax, StandardDev**
   Table in SPINE: **Inventory;** ***Column:*** **Applicability, Notes**
3) the system boundaries
   Table in SPINE: **Inventory;** ***Column:*** **Applicability, GeographicalBoundary, OtherBoundaries, TimeBounary, Notes**
4) uncertainty analysis
   Table in SPINE: **Flow;** ***Column:*** **QuantityMin, QuantityMax, StandardDev**
   Table in SPINE: **Inventory;** ***Column:*** **Applicability, Notes**
5) limitations identified by the data quality assessment and sensitivity analysis
   Table in SPINE: **Flow;** ***Column:*** **QuantityMin, QuantityMax, StandardDev**
   Table in SPINE: **Inventory;** ***Column:*** **Applicability, Notes**
6) conclusions and recommendations
   Table in SPINE: **Inventory;** ***Column:*** **Applicability, Notes**

3 Final words

This report is a draft, please comment on any suggestions to add or change in the report before 30:th of June, 1999 to:

Raul Carlson or Ann-Christin Pålsson
CPM
Chalmers University of Technology
412 96 Gothenburg

Tel: 031-772 21 73
Fax: 031-772 21 72
e-mail:
raul@vsect.chalmers.se
acp@vsect.chalmers.se

Appendix 1

SUGGESTION OF PARAMETERS TO BE REQUESTED FROM INVENTORIES FOR IMPACT ASSESSMENT.

As decided at the last WG4 meeting in Berlin, a list of inventory parameter requested by WG4 from WG2 and 3 should be established. In the suggestion below parameters are grouped in three categories. The list of parameters is strongly influenced by what is present praxis and only in the case of water depletion and land use it is suggested that less common parameters are used. In this way inventories will have to focus to an increasing extent on two of the most severe environmental problems we have today: lack of clean water and land areas.

Category I: obligatory or strongly requested. Parameters in category I are such that are frequently present in technical systems and contribute to major global and regional environmental problems.

Category II: should be considered and included when emitted or used in significant amounts. Inventory parameters in Category II contribute to major global and regional environmental problems but are only occasionally present in technical systems.

Category III: included when emitted in sufficient amounts to suspect an impact, that cannot be neglected. Parameters in Category III have typically specific and limited effects on the environment.

Values may be given as best estimates or less than values. The reporting of a range or standard deviation is encouraged, as it is of great help when comparing the results from two inventories.

Category I

Emission to air of CO2, CH4, NMVOC, NOx, SOx.

Emissions to water of BOD, Ptot and Ntot.

Depletion of resources of natural gas, fossil oil, coal. Depletion of resources of water in arid areas. Land use (UN classification, used in the Swiss energy system study).

Note: by NMVOC is meant what is measured by a FID-detector calibrated with propane where methane is excluded. BOD refers to ISO standard 1997-03-27, Ptot to ISOxxy and Ntot to ISO xyy By arid areas are meant areas where the average annual evaporation exceed the precipitation.

Category II

Emission to air of CO, PAH, ethene, butadiene, freons, Cr, Hg, Pb, Cd, H_2S, organic sulphides, pesticides, organochlorine compounds, radioisotopes,

Emissions to water of suspended matter, phenol, pesticides, organochlorine compounds, radioisotopes, Hg, Pb, Cd and microorganisms.

Scarce metal resources such as Ag, Al, Au, Cd, Co, Cr, Cu, Eu, Fe, Ga, Mn, Mo, Ni, Pb, Pt, Rh, Sn, Ti, V, W, Zn.

P-mineral resources.

Depletion of water resources in non arid areas.

Adding new species into ecosystems.

Harvesting from renewable but limited resources: wood, crop, fish

Category III

If the main process streams consists of substances that are toxic to humans or to the environment or may be considered as scarce resources, they should be included into the inventory and their emissions and flows specified.

Trace substances that are highly toxic should also be included unless their emissions are neglectable in relation to the levels where they are toxic.

1995 06 04 Bengt Steen