CHALMERS

Industrial applications of future information systems for impact assessment

A procedure for data format mapping and nomenclature issues

Karolina Flemström
Klas Geiron
Markus Erlandsson

IMI - Industrial Environmental Informatics
for
CPM - Centre for Environmental Assessment of Product and Material Systems
CHALMERS UNIVERSITY OF TECHNOLOGY
Göteborg, Sweden 2004

CPM Report 2004:5

Summary

This report describes the work performed in the Center for environmental assessment of Products and Material systems (CPM) project "Industrial applications of future information systems for impact assessment" by Industrial Environmental Informatics (IMI) a unit at Chalmers University of Technology. The goal of the project is a seamless integration between the developed OMNIITOX[1] Information System (IS) and ISO/TS 14048 data documentation format and information system for general LCA environmental impact assessment.

To enable facilitated industrial application of the OMNIITOX project results, the results have been integrated with a software framework which facilitates any type of LCA database development and maintenance, and also with ISO/TS 14048 format in terms of a new prototype LCA tool called LCA@CPM. This new LCA tool which illustrates the practical integration of OMNIITOX impact assessment methods and LCI, is based on earlier results developed within CPM e.g. World Wide LCA Workshop (WWLCAW), ISO/TS 14048, LCI@CPM etc.

Data format mapping has been performed and also a transfer of characterization factors and related information from OMNIITOX IS to LCA@CPM has been successfully tested. Information management work has been concentrated to the substance nomenclature issue and mapping of nomenclatures to find a method of how to handle nomenclatures, and to investigate the scope of the problems when mapping nomenclatures and data formats.

In this project a "cleaning-up" of the substance nomenclatures used in CPM's LCA related applications developed by IMI has been performed resulting in higher computability i.e. result in less inputs and outputs missing characterization and weighting results. For this purpose the new substance nomenclature named CPM2004 has been compiled and is recommended to be used to improve and facilitate industrial application.

---

[1] OMNIITOX (Operational Models aNd Information tools for Industrial applications of eco/TOXicological impact assessments) project web site: www.omniitox.net

1. Introduction

This report describes the results from the CPM project “Industrial applications of future information systems for impact assessment” finalised in September 2004. The aim of the report is to describe the working method used for nomenclature and data format mapping in the project. In addition the report aims at discussing the nomenclature issue and present alternative ways of handling nomenclatures in an LCA tool.

A description of work performed within the project is included as well as proposals for future work and handling of nomenclature issues when building an information system, in terms of a new prototype LCA tool. With this tool a user will be able to perform a complete LCA study from goal and scope definition and inventory to impact assessment and weighting.

Related work performed in the CPM projects “Extension of Database in Networking”, REPID and OMNIITOX have also contributed to this report.

1.1. Related reports

Below is a list of reports related to the ISO/TS 14048 data documentation format and nomenclature issues. These reports are results from earlier work in CPM related projects.

- *ISO/TS 14048:2002(E) Environmental management – Life cycle assessment - Data documentation format*

This document is a technical specification providing the requirements and structure for a data documentation format, to be used for transparent and unambiguous documentation and exchange of Life Cycle Assessment (LCA) and Life Cycle Inventory (LCI) data. By using the format e.g. consistent documentation and reporting of data can be achieved.

- *Facilitating Data Exchange between LCA Software involving the Data Documentation System SPINE, CPM report 2000:2*

This report presents results from the CPM project Data Exchange, which was initiated to facilitate environmental life cycle data communication within the documentation system SPINE and between LCA software. The issues dealt with in the report are the technical specifications of a data documentation file (an XFR-file), nomenclatures and minor technicalities.

- *Information System Supporting a Web Based Screening Life Cycle Assessment Tool, Erixon, M., CPM report 2001:14*

This report describes a procedure for constructing the information content and structure relevant for environmental life cycle inventories and impact assessments for printed circuit boards.

2. Background

The competence center CPM, "Centre for Environmental Assessment of Product and Material Systems" at Chalmers University of Technology, has worked with LCA during several years. There has been a lack of ecotoxicity and toxicity information in terms of commonly used characterization models for LCA and CPM was therefore interested in the knowledge and information build up in the OMNIITOX (Operational Models aNd Information tools for Industrial applications of eco/TOXicological impact assessments) project. To enable facilitated industrial application of the OMNIITOX results in terms of characterisation models for ecotoxicology and human damage, it was decided that the results should be integrated with the ISO/TS 14048 data documentation format for LCI and other types of environmental impact assessment for LCA. This has been performed in the project "Industrial applications of future information systems for impact assessment" described in this report.

2.1. The OMNIITOX project

The EU project OMNIITOX (Operational Models aNd Information tools for Industrial applications of eco/TOXicological impact assessments) started in 2001 and will finish in November 2004. Five main issues are addressed in the project:

- Comparison of life cycle impact assessment (LCIA) and environmental risk assessment (ERA)
- Comparing LCIA methods
- Extending the scope of LCIA methods
- Development of the OMNIITOX Information System
- Use of life cycle assessment (LCA) for regulatory assessment of chemicals

The toxicological consequences have previously been a neglected area in life cycle impact assessment (one of four phases in an LCA), mostly because of lack of knowledge. OMNIITOX addresses this lack of knowledge. In the project impact assessment models for the effects of toxic substances on humans and nature has been developed. Also, the extent to which environmental risk assessment and life cycle assessment overlap and complement each other has been investigated and the knowledge from the area of environmental risk assessment has been used as far as possible in the work with impact assessment models.

An information system called OMNIITOX IS was created in the project together with a database containing physical, chemical and toxicological data on substances and also nature data. The contents are acquired from the IUCLID[2] database and from case studies made in the project. The impact assessment models created in the project are also stored in the database. Characterisation factors for human- and ecotoxicology impacts for a number of chemical substances can be calculated in OMNIITOX IS.

[2] IUCLID is an acronym for International Uniform ChemicaL Information Database and contains information on toxicity of substances.

The ten project partners are: Chalmers University of Technology, Danmarks Tekniske Universitet, Universiteit Leiden P.B., Universitaet Stuttgart, Ecole Polytechnique Fédérale de Lausanne, Volvo Technology Corporation, Procter & Gamble Eurocor, Stora Enso AB, Antonio Puig S.A., Randa Group S.A. and the European Chemicals Bureau, Joint Research Centre.

3. Goal and scope

The goal of the project "Industrial applications of future information systems for impact assessment" is a seamless integration between the currently developed OMNIITOX information system and ISO/TS 14048 and information system for general LCA environmental impact assessment.

The scope of this project is to store and use static characterization data for characterization calculations. The results will be a database with Life Cycle Inventory (LCI) and characterization data and also a characterization tool. The scope of the project is illustrated in the figure below. The focus has been on the interface between LCI and characterization in terms of mapping of nomenclatures and data formats and other issues crucial for integration of LCI and impact assessment.

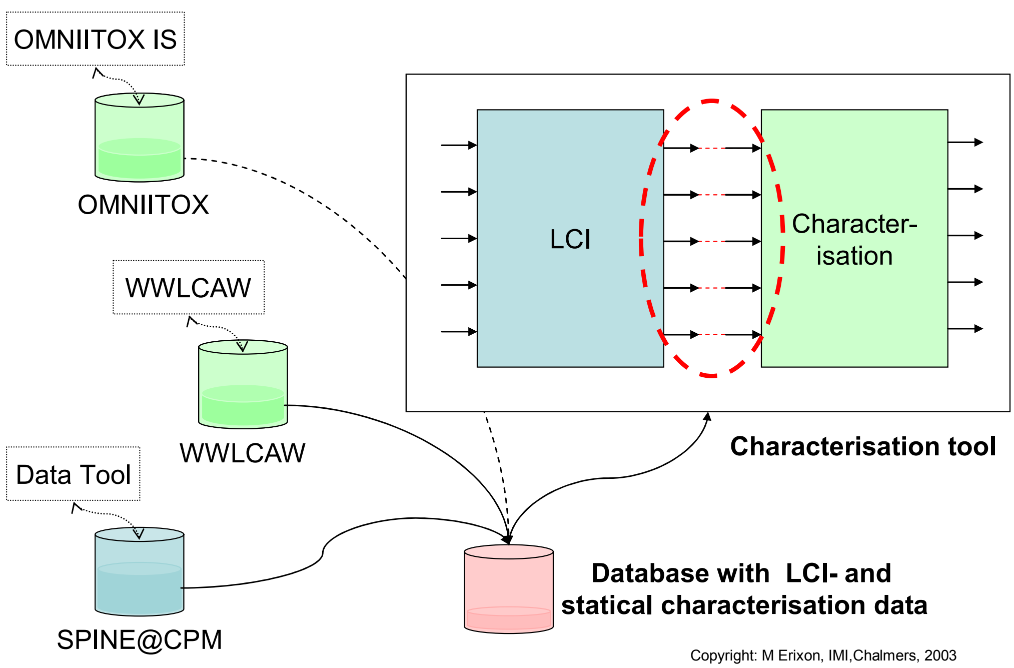


Figure 1: Scope of the project

4. Approach

First, a pre-study was performed to set the framework for integration and to investigate different dimension of an integration including integration of the contents, integration from a system technical perspective, user requirements on the resulting system etc. Secondly, different alternative resulting systems were investigated and finally it was decided that former developed LCA related work should be integrated in an LCA tool. This LCA tool was therefore based on the World Wide LCA Workshop (WWLCAW), a portal for industrial environmental systems analysis, and the environmental management tool developed in the CPM-project "Policy controlled environmental management". The development of the new prototype LCA tool "LCA@CPM" was partly made in the project "Extension of Databases in Networking" due to results from user interviews performed in the project[3].

The methods used to achieve the results has been to conceptually analyse languages developed in *OMNIITOX, ISO/TS 14048, WWLCAW* and other LCA related work within CPM both semantically and technically. In addition, bridge languages and technically integrate the two information systems for impact assessment and life cycle inventory i.e. OMNIITOX and LCI@CPM.

The general approach of the technical integration plan can be summed up by the following steps:

1. Create a database with nomenclatures for the receiving environment, geography location, substance/material name and unit of the aspects, indicators and CFs
2. Create a data format for communication of impact assessment data that allows data from different sources to be stored in a recognizable (for the project's database) way.
3. Create a tool that enables a user to export impact assessment data from the OMNIITOX database to a XML-file according to the data communication format.
4. Create a tool that imports the data from the XML-file into the project's database.
5. Create a tool that applies the CFs to the aspects and calculates the values of the indicators (LCA@CPM).

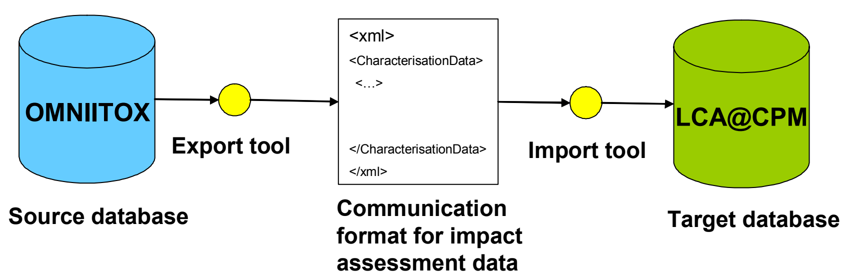


Figure 2: Overview of the steps in the technical integration plan

[3] CPM report 2004:8, Extension of Databases in Networking, Erlandsson, Flemström, Häggström, Tivander, Chalmers University of Technology, 2004

The general approach of the information integration plan can be summed up by the following steps:

1. Analyse the interface between LCI and characterization in terms of mapping of nomenclatures and data formats and other issues crucial for integration of LCI and impact assessment
2. List problems connected to the information integration
3. Prioritize between the problems identified
4. Suggest a solution of the substance nomenclature issue
5. Create mapping table for nomenclatures used in LCA and impact assessment
6. Describe the results from the project in a report

5. Integration of information systems for life cycle impact assessment

5.1. Introduction

When integrating the impact assessment models from the OMNIITOX project and other systems for LCA, a LCA web tool named LCA@CPM where developed. In this section the functionality of LCA@CPM is briefly described. The technical aspects of the integration and data format mapping are described in section 8.

5.2. The LCA@CPM web tool

Integration of industrial environmental information systems practically implies format and software development, reformatting of information, and merging of nomenclatures.
The result of the CPM work at Industrial Environmental Informatics (IMI) at Chalmers with integration of information systems is the LCA@CPM prototype, a user-friendly web based LCA-tool, supporting LCA practitioners at companies and organization to work according to ISO 14040 framework in a transparent way. LCA@CPM is a prototype LCA portal where the user can perform a full LCA study from documenting a technical system (LCI), aggregate it with other systems, choosing an impact assessment method, including choosing indictors and characterization parameters, to finally calculate the environmental impact of the whole LCI system. The result can be presented in different graphical ways depending on the user's choice.

For more information on LCA@CPM see the CPM report 2004:8 Extension of Databases in Networking by Erlandsson, Flemström, Häggström and Tivander, 2004 available at www.cpm.chalmers.se.

6. Substance nomenclature

6.1. Background and problem definition

There exists a huge amount of different substance naming (nomenclatures), used by different companies, organizations, universities etc in different context and for different purposes. One substance can have different names depending on the context e.g. carbon dioxide is the same substance as CO_2, O=C=O and Koldioxid.

In the life cycle inventory area the person performing the inventory study generally has chosen their organization's internal names for the inputs and outputs to the model of the technical system since no substance nomenclature standard exist for LCA purposes. When using specific inventory tools or LCA tools the nomenclature included in the tools are used as far as possible but it is often possible to add new names if a suitable can not be found in the database. To enable efficient calculation of LCA results the substances in the chosen impact assessment methods need to match the substances used in the inventory part. Therefore, it is important to harmonize the use of substance names to improve computability. If several different names are used for the same substance there need to be a connection, a mapping between them informing the system that these names point to the same substance.

To not use common names in the inventory part of a LCA study can cause problems in terms of usability e.g. misuse of the data and misunderstanding of LCA results, understandability, computability. If impact assessment models uses other naming of substances in the characterization models then there will be no characterization result without some sort of manual mapping of the nomenclature used by the IA-methods and the inventory respectively.

The substance nomenclatures addressed in this report are Natural resources, Emissions, and Residue according to the terms used for *Group* in ISO/TS Data documentation format and the CPM report 2000:2.

The databases from where the substance data origins for LCA@CPM are:

- SPINE@CPM database containing over 500 LCI data sets
- OMNIITOX IS database containing over 100 000 substances named with CAS numbers, IUPAC numbers etc.
- WWLCAW database containing four documented impact assessment methods for characterization and weighting and also LCI data.

All these sources contain a number of different substance nomenclatures as illustrated in the figure below. The naming of the substance nomenclatures sometimes overlapping depends e.g. of the year when the nomenclature was created within CPM.

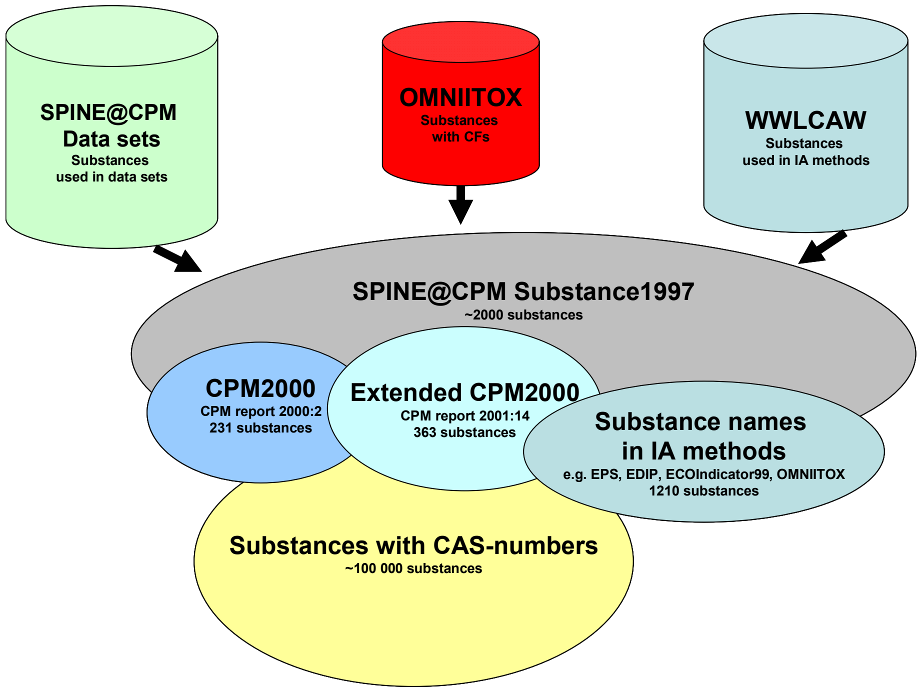


Figure 3: Databases contributing to the substance different nomenclatures

Earlier work in the nomenclature area

Within CPM there has been some work in different project concerning nomenclatures in general e.g. the Database project and the Data exchange project. The goal of the Database project was to make LCA data accessible for LCA analysis. The overall requirement was to establish a national quality reviewed LCA database and project members from Volvo, SCA, Ericsson, STORA, Nordic port, Norsk Hydro, Vattenfall, SAAB, ABB, STFI, Perstorp, Akzo Nobel and Chalmers participated.[4] The Data exchange project, involved CPM, ABB, Akzo Nobel, Assess, Chalmers Industriteknik, Nordic Port and Perstorp. The aim of this project was to identify and compile all current problems related to the data exchange, and to focus on the most important issues to find consensus solutions. In this project the CPM2000 nomenclature was developed and a report describing data exchange between LCA software involving the data documentation system SPINE was produced[5].

In SPINE@CPM and WWLCAW databases the substance nomenclatures are inclusive nomenclatures i.e. optional to use but it has been strongly recommended to use CPM2000 nomenclature. During use new substance names have been added to the nomenclature by the users, e.g. company specific names of products etc, this nomenclature is called SPINE@CPM Substance 1997.

[4] CPM report 1998:3, Project report, Establishment of CPM's LCA database, Carlson, Pålsson, Chalmers University of Technology, 1998

[5] CPM report 2000:2, Facilitating Data Exchange between LCA Software involving the Data Documentation System SPINE, Chalmers University of Technology, 2000

In CPM2000, there are guidelines for how to name a new substance e.g. the substance need to be unambiguously named and it is recommended to name the substance in accordance with a specific nomenclature e.g. CAS numbers, Chemical formula etc.

The work performed in the project "Strategy for Life Cycle Assessment in the electronic industry – inventory" (LCAE) has been useful in this project. The report from that project focused on the life cycle information and structure supporting a web based screening LCA software for printed circuit boards[6]. Knowledge about connecting life cycle inventory and impact assessment systems from this study has been very useful when working with LCA@CPM. For example a mapping table between CPM2000 substances and substances used in different IA methods is presented in appendix 3 in the report.

6.2. Methodology used for the nomenclature work

When trying to investigate the different substance nomenclatures used in WWLCAW, SPINE@CPM and OMNIITOX IS the diverse problem with handling nomenclatures were in focus as described by figure 4. A need for a solution or proposed handling of all nomenclatures to enabling integration of the OMNIITOX results and developing LCA@CPM was highlighted. Compilation of a new substance nomenclature containing CPM2000[7], a mapping to substances used in the IA methods and addition of all substances used in the IA methods was crucial to improve the use of the LCA information system. To remove duplicates, include CAS numbers where possible and harmonize the substance names were main focus. The aim of the new substance nomenclature called "CPM2004" is to include unambiguous names which is crucial in order for the name to be correctly interpreted by the data users. The list of substance names can be found in alphabetic order in Appendix C in this report.

It is not intended to force the user to only use the new nomenclature but these substance names are recommended to obtain a larger amount of LCA results. However, all substances and specific products can not be found in this list of substances and the user then need to define and add a new name of his/her product or substance. The new substances are not stored in the new "CPM2004" nomenclature but in a user specific nomenclature. In addition, substances not present in CPM2004, from new impact assessment methods inserted into the database will be added to CPM2004 manually.

[6] CPM report 2001:14, Information System Supporting a Web Based Screening Life Cycle Assessment Tool, Erixon, E., Chalmers University of Technology, 2000
[7] CPM report 2000:2, Facilitating Data Exchange between LCA Software involving the Data Documentation System SPINE, Chalmers University of Technology, 2000

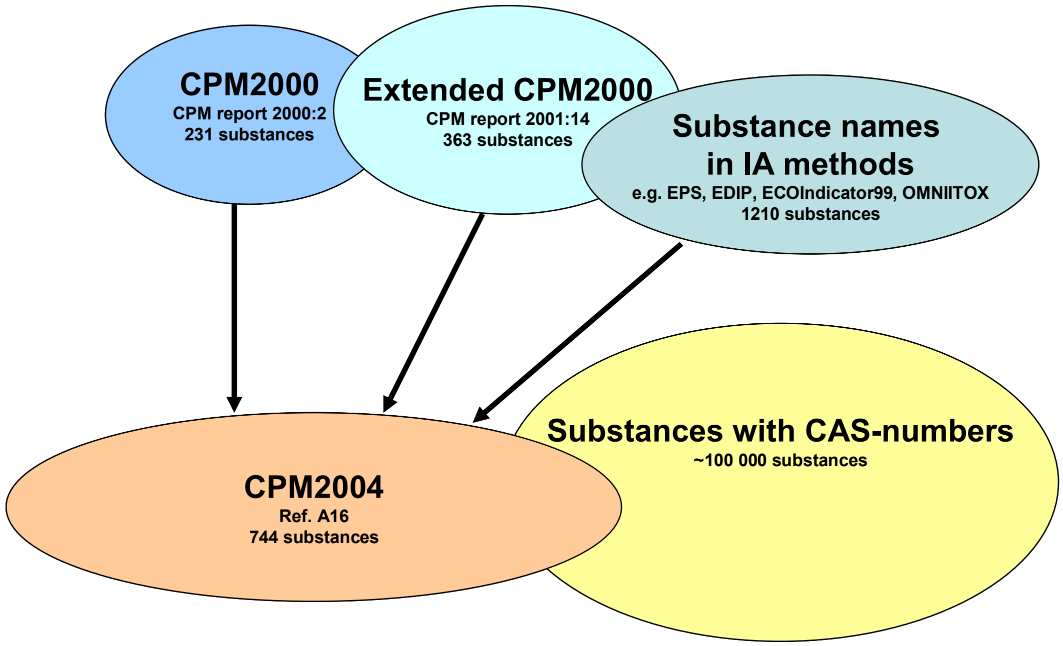


Figure 4: Illustration of different overlapped substance nomenclatures. CPM2004 is the new substance nomenclature.

The mapping between the different nomenclatures is only made when inserting existing SPINE@CPM data sets into the new database. If other data sets will be inserted into the system e.g. when buying LCI sets from other commercial LCI-databases the user is responsible for the matching. For each substance in the imported data set the user will look for a matching substance preferable in the CPM2004 nomenclature to improve the number of LCA results. This may sound as a complicated and resource demanding task. The best solution would be to have a self-learning system saving all mapping made and also have an automatic mapping on name exclusively. However, self-learning systems are very costly and time consuming to develop and this could not be performed in this project. The responsibility of the user would however still be high in terms of inserting a common and unambiguous name of a substance and also understanding the meaning of a specific substance name.

Since many different substance nomenclatures exist there is a need to prioritize between them i.e. create a list of the ones to consider first in mapping procedure and also the substance naming presented in the inventory tables of inputs and outputs.

6.3. Description of work performed

The following is a short description of the work performed when cleaning-up among old nomenclatures and creating a new nomenclature when building the prototype LCA tool LCA@CPM.

The following procedure has been used:

- A check of names of substances in the WWLCAW database was performed. If the same names were used there as in the CPM2000 nomenclature, the substances were replaced by CPM2000 nomenclature. If there were duplicates in the list e.g. due to inconsequent use of capital letters, these were mapped to one single name to reduce the number of duplicates.

- Substances with unknown names and not commonly used abbreviations etc has been analysed and a change to a more correct name has been made in those cases where this was possible. As an example the abbreviations “ind.” and “agr.” were use in the end of the name of 25 substances. These abbreviations stand for “industrial soil” and “agricultural soil” which regards the receiving environment where the particular substance end up in the end of life. This kind of information shall not be included in the name of the substance but in the field “Receiving environment specification” according to ISO/TS 14048 data documentation format.
- A mapping between different substances names used in WWLCAW has been performed based on competence on chemical substance naming.
- General errors in the substance nomenclature used in WWLCAW have been corrected.

Based on this work, a new substance nomenclature called “CPM2004” was created. CPM2004 substance nomenclature consist of 744 substance names from the substances nomenclature CPM2000[8], Extended CPM2000[9], substances used in the IA-methods EPS method[10], Eco-Indicator’99 [11], EDIP[12], LCA-E (ECOI/EPD)[13] and from the OMNIITOX Base model[14].

A mapping between OMNIITOX substance nomenclature i.e. CAS registry numbers, IUPAC name, EINECS number, IUCLID Molecular formula, and IUCLID Long Name and CPM2004 has been performed. Mapping has also been performed of IA98 database model to the new model “IMI Integrated database model”. This was essential to enable transfer of all category indicators, aspects etc from all the impact assessment methods stored in the WWLCAW database.

All data has been transferred to the database “IMI Integrated” and a mapping of the IA data (from WWLCAW) to the existing substance nomenclatures; CPM2000, Alternative names, CAS number, IUPAC Name, Systematic name, IUCLID long name, EINECS Number, Chemical formula, IUCLID Molecular formula and has been performed. The application performing the import of SPINE data sets to the ISO/TS 14048 data model was developed in the project SPINE to ISO/TS 14048. This import has however been improved in this project to also include mapping of substance names to e.g. CPM2000, OMNIITOX nomenclature,

---

[8] CPM report 2000:2, Facilitating Data Exchange between LCA Software involving the Data Documentation System SPINE, Chalmers University of Technology, 2000

[9] CPM report 2001:14

[10] EPS - Environmental Priority Strategies in Product Design described in: Steen B., 1999, A Systematic Approach to Environmental Priority Strategies in Product Development (EPS) Version 2000 - General System Characteristics, CPM-rapport 1999:4, Chalmers University of Technology, Gothenburg, Sweden

[11] Goedkoop and Spriensma, 2000, The Eco-indicator ’99, A damage oriented method for life cycle impact assessment, Product Ecology (Pré) Consultants, Amersfoort, Netherlands

[12] EDIP - Environmental Design of Industrial Products described in: Hauchild and Wenzel, 1998, Environmental Assessment of Products, Scientific Background, Institute for product development, Denmark

[13] Erixon, M., Information System Supporting a Web Based Screening Life Cycle Assessment Tool, CPM report 2001:14, Gothenburg, Sweden

[14] OMNIITOX project public web site : www.omniitox.net

Alternative names, Default names and units to IS-units. As far as possible the substances in imported SPINE@CPM LCI data sets are included in the new checked CPM2004 nomenclature.

For substances in CPM2000 CAS registry numbers were stored in a text field in the database. These have been mapped to CAS-numbers imported from the OMNIITOX substance nomenclature to avoid duplicates.

A list of prioritized substance nomenclatures that the user can choose substance names from staring with the most recommended has been created. This list will be use in the mapping of LCI data sets and when presenting substance naming to the user in the inventory table of inputs and outputs.

List of substance nomenclatures:

1. **CPM2004**, described in this report based on the results in the CPM project Industrial applications of future information systems for impact assessment, reference: CPM report 2004:5, see appendix C.

2. **CPM2000**, e.g. Carbon dioxide and Cyanide, substance names used by industry and academia when performing life cycle inventory studies, reference: CPM report 2000:2

3. **Alternative name,** e.g. CO2 (renewable), reference CPM report 2000:2

4. **IUPAC Name**, e.g. carbon dioxide
IUPAC (Union of Pure and Applied Chemistry) is an authority on chemical nomenclature, terminology, standardized methods for measurement, atomic weights and many other critically evaluated data, reference: http://www.iupac.org

5. **IUCLID Long name**, a more descriptive and longer name of the substance, e.g. carbon dioxide. IUCLID (International Uniform Chemical Information Database) is developed by the Joint Research Centre, European Commission, European Chemicals Bureau, 2001, reference: http://www.jrc.it

6. **IUCLID Molecule formula** e.g. CO2
IUCLID (International Uniform Chemical Information Database) is developed by the Joint Research Centre, European Commission, European Chemicals Bureau, 2001, reference: http://www.jrc.it

7. **Chemical formula**, reference 2000:2 e.g. CO2 and CN-

8. **CAS registry number** e.g. 124-38-9, 57-12-5
A CAS (Chemical Abstracts Service) Registry Number is a unique identifier of a substance or chemical products, CAS numbers are made up by numbers separated by hyphens. They can contain nine digits, reference: http://www.cas.org/

9. **EINECS Number** e.g. 204-696-9 (for carbon dioxide)
EINECS (European Inventory of Existing Commercial Substances) Number was created by the European Community Commission Decision 81/437/EEC. All of these numbers have the form XXX-XXX-X where X = a digit, reference: http://ecb.jrc.it/existing-chemicals/

10. **Systematic name**, e.g. Cyanide, reference CPM report 2000:2

11. **SPINE@CPM Substance 1997**, has been built up within the CPM network and contains substance names used by industry and academia when performing life cycle inventory (LCI) studies.

12. **WWLCAW name**, used in the LCA tool WWLCAW available at the internet, reference: http://workshop.imi.chalmers.se/

6.4. User interface for selection of substances

In the inventory part of LCA@CPM web tool the user can document a model of a technical system according to the data documentation format ISO/TS 14048. When documenting all inputs and outputs for the system the user can choose from which nomenclature to choose the substance name from. It is recommended to choose from the new CPM2004 nomenclature since this enable maximum calculation of results in this information system due to the mapping made between the names used in the IA methods and CPM2004. The figure below shows how the user interface for selection of substance looks like. The user can search for a substance in specific nomenclature e.g. CAS number, CPM2004 etc. If a substance does not exist the user can add it to a user specific nomenclature.

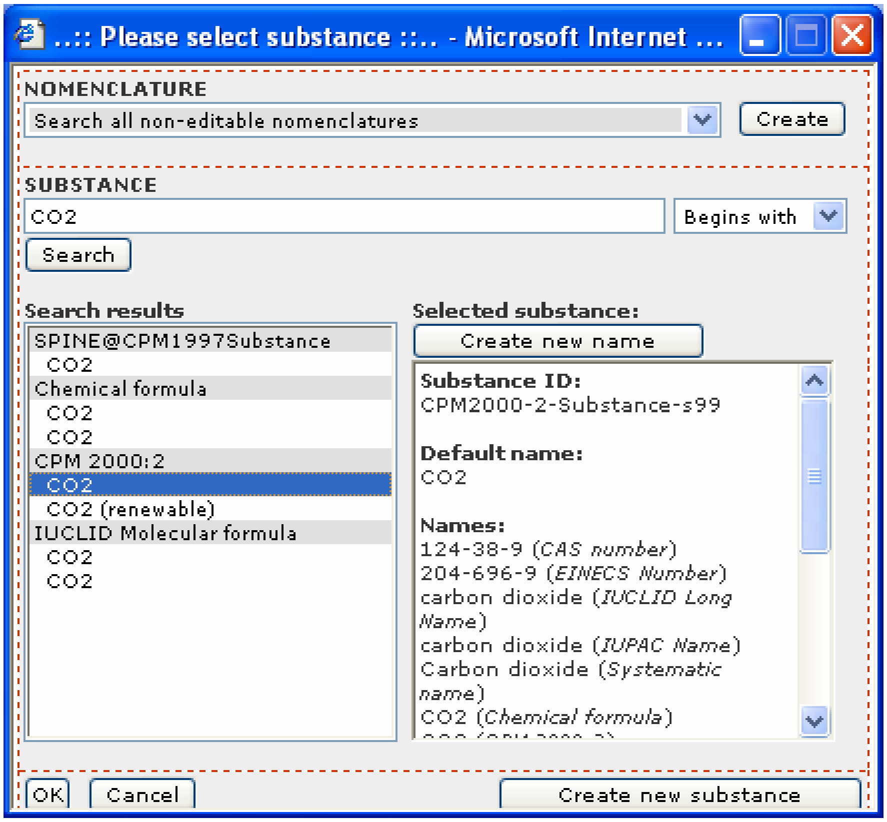


Figure 5: User interface in LCA@CPM web tool for selection of substance.

7. Other nomenclatures

An inventory has been performed regarding the different nomenclatures used in the WWLCAW-database, which has been used a basis for the work with the prototype LCA tool LCA@CPM. This inventory showed that the main problems regard the substance nomenclatures but there are also other important nomenclatures. Nomenclature for geography and receiving environment has been mapped for names used in the impact assessment methods e.g. OMNIITOX and the names used in LCA@CPM i.e. from ISO/TS 14048[15] and CPM report 2000:2[16].

7.1. Receiving environment and geography location nomenclatures

The following tables illustrate the mapping between Media and Geography in OMNIITOX data model and Receiving environment and Geography location in ISO/TS 14048 data documentation format used in LCA@CPM. The definitions of the two concepts are identical and the nomenclatures used are similar. The mapping in terms of these concepts of OMNIITOX characterization models to LCA@CPM are performed based on these tables.

[15] ISO/TS 14048 :2002(E) Environmental management – Life cycle assessment – Data documentation format
[16] Facilitating Data Exchange between LCA software involving the Data Documentation System SPINE, CPM – Center for Environmental Assessment of Products and Material System, Chalmers University of Technology, 2000, CPM report 2000:2

OMNIITOX	ISO/TS 14048	ISO/TS 14048
Media	**Recieving environment**	**Recieving environment specification**
Fresh water	*	Fresh water
water	*	Water
Air	*	Air
Agricultural soil	*	Ground
Geography	**Geography location**	
Europe	Europe	
World	World	
Europe	"All countries in Europe"	
World	"All countries in the world"	

ISO/TS 14048	OMNIITOX
Recieving environment	**Media**
Technosphere	-
Water	Fresh water
Water	water
Air	Air
Ground	Agricultural soil
Geography location	**Geography**
Europe	Europe
World	World
"All countries in Europe"	Europe
"All countries in the world"	World

Table 1: Mapping between OMNIITOX database and ISO/TS 14048

7.2. Unit nomenclatures

A hierarchic structure of units used in the system based on SI units has been performed and improved. There is also a possibility to add new units with symbol and name.
For IA data from the OMNIITOX information system all new units has been added to the system. If the user wants to add a new unit during inventory, this is added to a user specific user nomenclature.

Hierarchical structure for units:

- SI units
  - Mass
  - Volume
  - Area
  - …
- Non-SI units
- Other units
- Impact assessment related units

8. Data format mapping

This section contains a description of the technical aspects of the integration of two information systems for impact assessment and life cycle assessment i.e. OMNIITOX and LCA@CPM, and also a description of the data format mapping performed and assumptions made during export and import of data.

In the project a bridge between the technical system and the impact assessment of a LCA has been created. To make the impact assessment, characterization factors (CFs) are applied to the flows of material and substances, also named Aspects that come out of the technical system. The result is defined as an Indicator and it represents the impact. Figure 6 is an illustration that explains the idea.

To get correct results it is of great importance that the aspects, CFs and indicators are well defined with regards to receiving environment, geography location, substance name and unit. When the aspect is specified you can map it with the correct CF, and apply the CF to get a correct indicator. The process of matching aspects and indicators with CFs is the main technical result of the project.

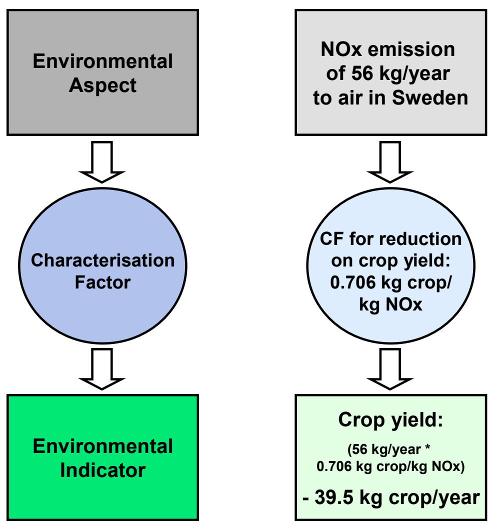


Figure 6: Aspect, Characterisation and Environmental Indicator[17]

8.1. Data communication format for impact assessment data

This data format for communication of impact assessment data is based on the data model IA98[18]. The requirement that resulted in the construction of this format was that characterisation data needed to be transferred from the OMNIITOX information system to the LCA@CPM information system, enabling characterisation data from OMNIITOX to be

[17] CPM report, 2004:10, Policy Controlled Environmental Management Work, Carlson, R., Häggström, S., Pålsson, A-C.
[18] Carlson R., Steen B.; *A Data Model for LCA Impact Assessment*; 8th Annual Meeting of SETAC-Europe 1998 14-18 April; Bordeaux

used when performing LCAs. This communication format is the neutral interface between these two information systems, but the communication format is also developed to be generally applicable for communication of impact assessment between any two systems. A complete version of the data communication format can be found in diagram form in appendix A, and in a very technical and raw text form in appendix B.

The data format does conceptually consist of three main areas:

- **Technical data**
  Aspects are representing inputs and outputs from a technical system. An aspect selection principle is used when selecting a set of aspects.
- **Environmental data**
  An impact indication principle is used to document a viewpoint. Based on this principle category indicators are identified which represents selected environmental protection areas where environmental impact may be observed in quantitative terms. The category indicators may be grouped in different impact categories.
- **Characterisation data**
  A characterisation method describes how an aspect in the technical system affects the defined environmental indicators. The quantitative relation of an aspect to an indicator is stored as a characterisation parameter.

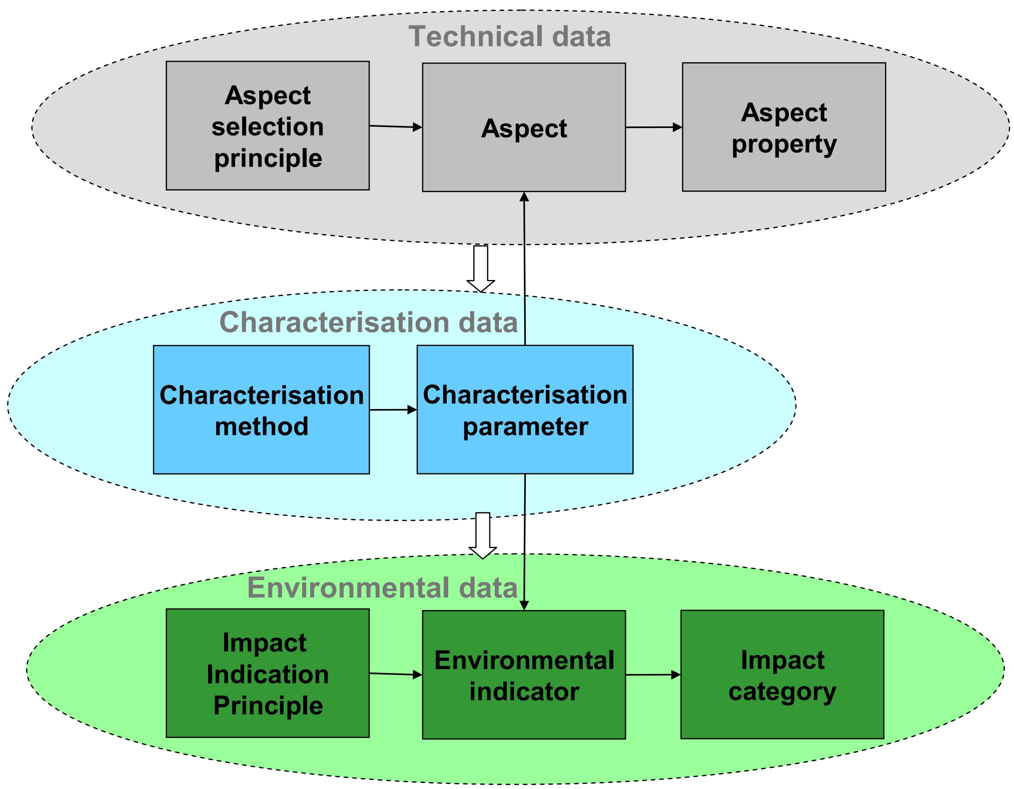


Figure 7: The relation between the most central concepts for technical data, characterisation data and environmental data

The communication format is implemented as an XML Schema[19] [20] which describes a structure that all XML documents need to be compliant with to make the content useful for a receiver. The XML Schema provides grammar that makes the communicated information understandable and interpretable. Since XML Schemas are object-oriented, the relational model IA98 has been transferred into an object-oriented communication format. This has caused that this format and IA98 look quite different at a glance.

The format has a top level object called *CharacterisationData*, representing all the information that is to be communicated with the format. *CharacterisationData* consists of the four objects *CharacterisationMethod, AspectSelectionPrinciple, ImpactIndicationPrinciple* and *ImpactCategory*. The objects *ImpactIndicationPrinciple* and *ImpactCategory* contain all environmental data. For example indicators are hence communicated using this part of the format. The term impact category refers to the ISO 14040 standards and it enables the grouping of indicators into a certain category. The *AspectSelectionPrinciple* contains all information related to which inputs and outputs that can be handled in an impact assessment. Aspects and aspect properties can hence be found here. The *CharacterisationMethod* contains all information related to the characterisation. Characterisation methods and characterisation parameters that define the relation between aspects and category indicators can thus be found here.

8.1.1. Aspect selection principle

Aspects can be seen as a well-defined interface that the characterisation methods provide for environmental impact assessment of any technical system. Each aspect is together with aspect properties defining a substance and parameters like direction, group, receiving environment, receiving environment specification, and geographical location. When analyzing the environmental impact of a technical system documented as a process in accordance with ISO/TS 14048, each input and output is to be matched with these aspects. Any input or output for which no matching aspect could be found are not taken into account in the characterization, and the environmental impact of those inputs and outputs are hence undefined.

When deciding which aspects that are selected as the interface of the characterisation, an overall selection principle is used. This principle is documented in *AspectSelectionPrinciple*. The Aspect Selection Principle (ASP) consists of several parts and a schema of it can be found below.

[19] http://www.w3.org/XML/Schema - contains the specification of XML schema
[20] http://www.w3schools.com/schema/default.asp - a tutorial on XML schemas

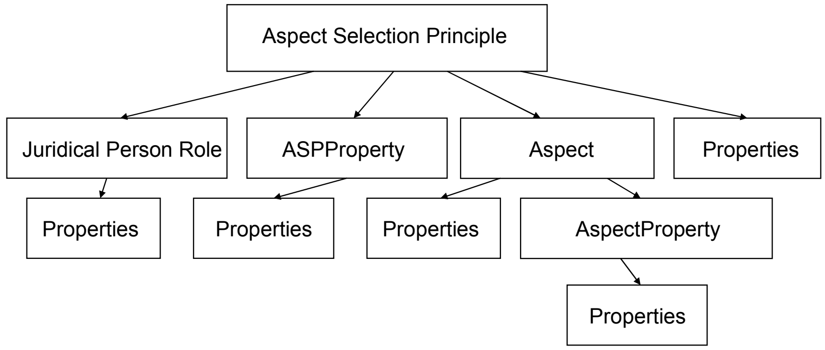


Figure 8: Schema of Aspect Selection Principle

The aspect selection principle can contain an arbitrarily amount of *Aspects*, *ASP Properties*, and *JuridicalPersonRoles*. The aspect selection principle is also described in terms of some well defined properties as for example the name, version, definition and the date it was completed. The ASP Property contains any other property linked to the aspect selection principle, which not are predefined in the communication format. The juridical person role contains information on persons who somehow are related to the principle. An example of a role is creator of the principle. The aspects are the core content of the aspect selection principle. Each aspect contains a name of the aspect, a substance name, a substance nomenclature, a unit, a note, and an arbitrarily amount of *AspectProperties*. The aspect properties provide further specification of the aspect, which are used in the matching with the inputs and outputs of the technical system as described above.

8.1.2. Impact Indication Principle

The choice of how to express or indicate environmental impact is subjective and depends on the viewpoint of an "observer". This viewpoint may be expressed as a "principle", the *Impact indication principle*[21]. With an impact indication principle, different *Category indicators* can be chosen representing selected environmental protection areas where environmental impact may be observed in quantitative terms. The impact indication principle (IIP) consists of several parts and a schema of it can be found below.

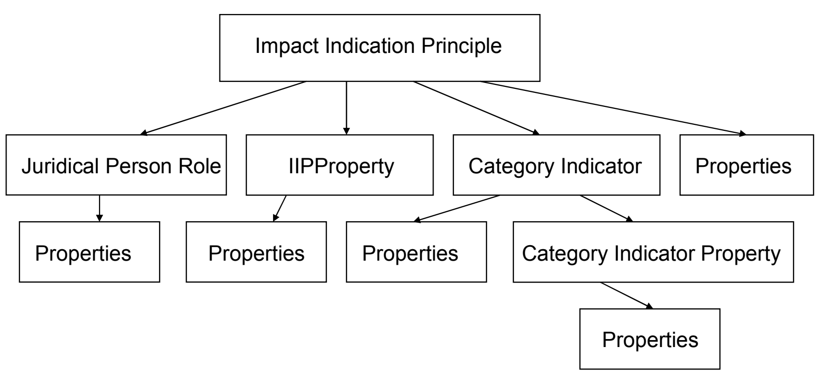


Figure 9: Schema of Impact Indication Principle

[21] Carlson R., Pålsson A-C. "Documentation of environmental impact assessment, compatible with SPINE and ISO/TS 14048" IMI-report 2002:1

As seen in the schema, the impact indication principle consists of any number of *CategoryIndicators*, *IIP Properties*, and *JuridicalPersonRoles*. The impact indication principle is also described in terms of some well defined properties as for example the name, version, definition and the date it was completed. The ASP Property contains any other property linked to the aspect selection principle which not are predefined in the communication format. The juridical person role contains information on persons who somehow are related to the principle e.g. the creator of the principle. The category indicators are the core content of the impact indication principle. In this part the environmental indicators that are used to monitor the impact of a technical system on the environment are documented. Each category indicator contains a name, a description, a unit, a reference to the original impact indication principle, a reference an impact category, a note, and an arbitrarily amount of *CategoryIndicatorProperties*. The category indicatory properties are used to document additional properties of the indicator, which not are part of the set of pre-defined properties in the communication format. The category indicator property contains of the properties name, unit, and value.

8.1.3. Impact Category

The impact category represents the possibility of grouping category indicators into different categories. Impact categories are classes of environmental impacts like for example global warming or eutrophication. The category indicators are as described above quantifiable environmental impact. A schema of the impact category can be found below. Each impact category is described in terms of the properties; name, description and note.

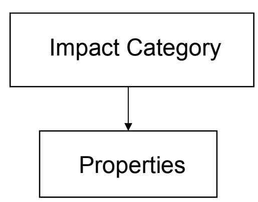


Figure 10: Schema of the impact category

8.1.4. Characterisation method

The characterisation describes in quantitative measures the environmental impact which aspects in the technical system causes on the defined category indicators in the environment. The method used when relating aspects (representing inputs and outputs in the technical system) with a quantification of its environmental impact on a category indicator, is referred to as a *Characterisation method*. The characterization method consists of several parts and a schema of it can be found below.

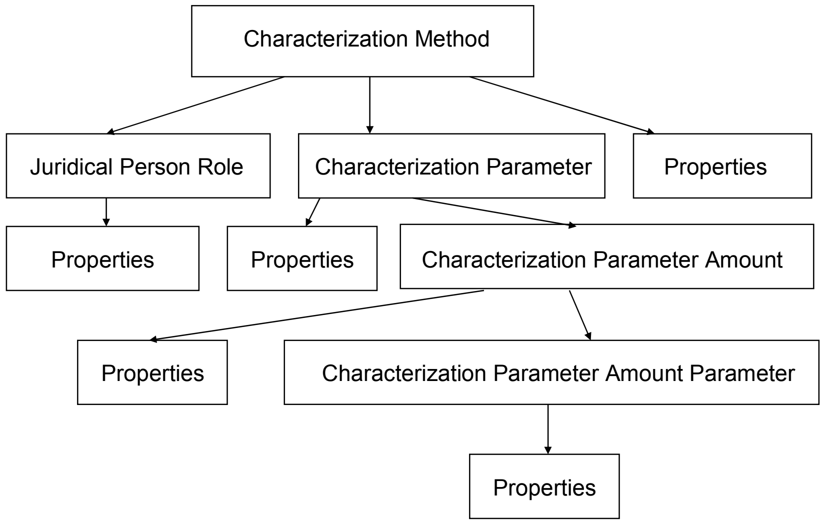


Figure 11: Schema of characterisation method

As seen in the schema, the impact indication principle consists of any number of *CharacterisationParameters*, and *JuridicalPersonRoles*. The impact indication principle is also described in terms of some well defined properties as for example the name, version, definition and the date it was completed. The juridical person role contains information on persons who somehow are related to the characterisation method. An example of a role is creator of the method. The characterisation parameters are the core content of the characterisation method, as they constitute the connection which makes it possible to monitor the impact that inputs and outputs cause on the environment. A characterisation parameter relates an aspect to a category indicator in quantitative terms. Each characterisation parameter contains a name, a relation to an aspect and an aspect selection principle, a relation to a category indicator and an impact indication principle, a unit for the aspect, a unit for the indicator, a note, and a quantitative parameter in terms of a characterisation parameter amount. The *CharacterisationParameterAmount* structure makes it possible to associate any type of numerical values with the parameter, as for example a single value, a min, max, and typical value, or some other kind of distribution. The type of distribution function is specified as a property in characterisation parameter amount, and the values for parameters needed for the distribution function are provided in *CharacterisationParameterAmountParameters*.

8.2. XML – export

The XML export tool was developed to make it possible to export characterisation factors from OMNIITOX to the database used by LCA@CPM utilizing the general communication format described in the previous chapter. To make use of the OMNIITOX data within LCA@CPM, the XML import tool described in next chapter does also has to be used. The target user of this tool is technical administrators of the OMNIITOX database that wants to export characterisation factors.

The export tool can be used to create a correctly formatted XML file from data in the OMNIITOX database. To export data from another database the tool needs to be modified slightly. The implementation of the tool should be regarded as a framework for how data export could be done rather than a generic solution to the data export problems. Below is a snapshot of the graphical user interface of the export tool.

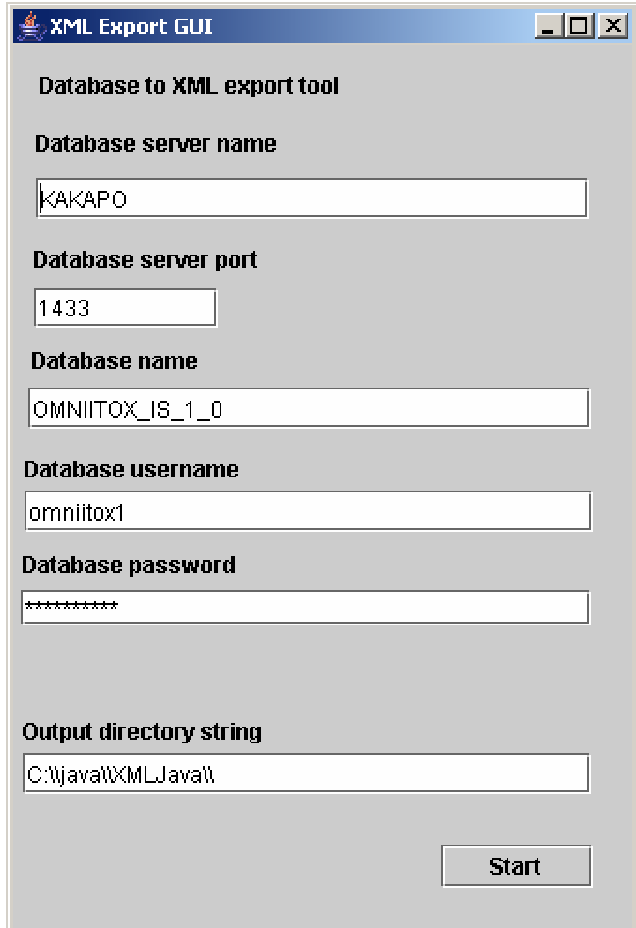


Figure 12: User interface of the export tool

To execute the export, a user gives the name of the database server, the port number, the name of the database and a password. This information is needed for the tool to connect to the database server and execute queries. The XML file is written to the directory specified in the output directory string field. The naming convention of the XML – files is "CharacterisationMethod_Name=XXX_Version=YYY", where XXX is the name of the characterization method and YYY is the version. The Name/Version combination is unique and can only appear once, so there should be no misunderstanding of the name of the file.

8.3. XML – Import

The import tool can be used to import data in an xml file that complies with the format for impact assessment data specified in chapter 8.1, into the LCA@CPM database. The target user of this tool is technical administrators of the LCA@CPM database that wants to import characterisation factors. The import tool has a rather similar graphical user interface as the export tool, and it is pictured below.

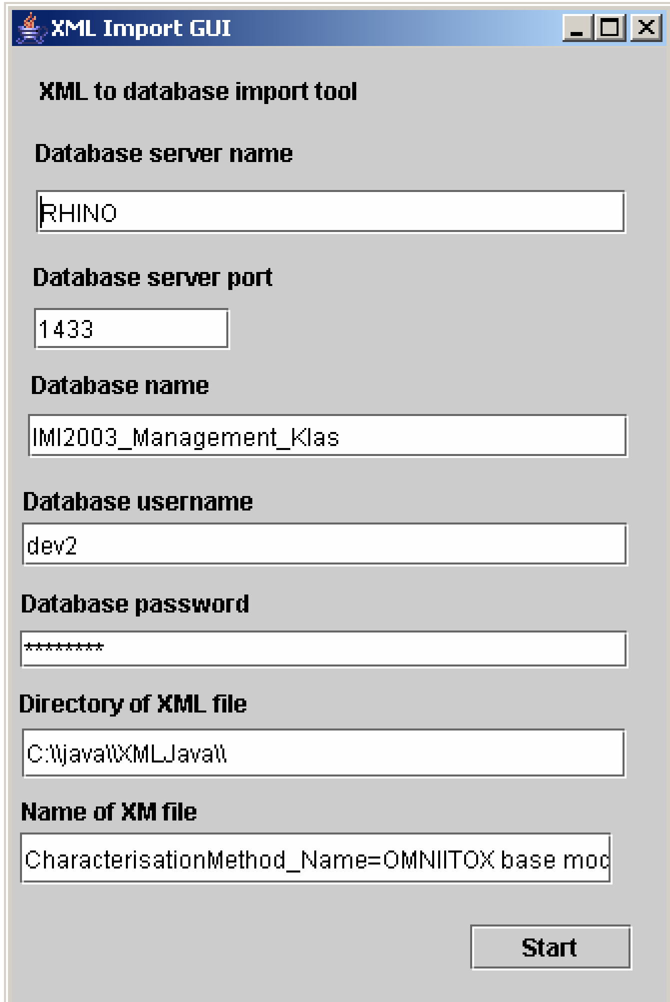


Figure 13: User interface of the import tool

To execute the import, a user gives the name of the database server, the port number, the name of the database and a password. This information is needed for the tool to connect to the database server and execute queries. The XML file is read from the directory specified in the directory of XML file field, and the name of the XML file is specified in the name of the XML file field.

8.4. Assumptions made for the implementation of the import and export functionality

The following is a list of assumptions for the implementation procedure.

Assumptions made based on scope

1. Some parts of the format which did not contain any data in the OMNIITOX database were neglected in the implementation of the import and export functionality. Since there are no impact categories, ASPProperties or IIPProperties in the OMNIITOX database, the implementation does not support those.

2. If an Aspect or a Category indicator do not have an aspect property or a category indicator does not have a category indicator property, then the aspect and category indicator is disregarded and not imported.

Assumptions made in relation to existence of data

3. To check if an aspect selection principle already exists in the target database, the properties name, version and registration authority are used as a key. If the aspect selection principle already exists, then it is not written.

4. To check if an impact indication principle already exists in the target database, the properties name, version and registration authority are used as a key. If the impact indication principle exists, then it is not written

5. To check if an aspect already exists in the target database, the properties aspectId, name and substance name are used as a key. If the aspect exists, then it is not written

6. To check if a category indicator already exists in the target database, the properties IIPId and name are used as a key. If the a category indicator exists, then it is not written

7. To check if an aspect property already exists in the target database, the properties aspectId, property name, value and unit are used as a key. If the aspect property exists, then it is not written

8. If a specific characterization method already exist in the target database (identified by the name and version of the characterization method), the import for the method is terminated.

9. All the juridical person roles are created with each import. This means that there might be copies of each role in the target database.

Assumptions related to nomenclature

10. The nomenclature “Cas Registry Number” in OMNNITOX is mapped to the nomenclature “Cas Number” in the target database.

11. If a substance is named in a nomenclature that does not exist in the target database, then the substance is referred to by the “OMNIITOX_scrap” nomenclature.

12. If a unit does not exist in the target database, then it is created during the import.

13. The nomenclature mapping of receiving environment and geography location has been performed according to table 1 in section 4.1.

Assumption related to creation of XML-files

14. The exported XML-files contain exactly one characterization method per file. If there are several characterization methods in the OMNIITOX database, there will be as many XML-files after the export.

9. Conclusions

The OMNIITOX results in terms of characterization for LCA have been integrated with the ISO/TS 14048 data documentation format and all steps of a life impact assessment according to LCA methodology described in the ISO 14040 standards. A new prototype LCA tool named LCA@CPM has been developed which demonstrates the practical integration of OMNIITOX impact assessment methods and LCI.

Data format mapping has been performed and also a transfer of characterization factors and related information from OMNIITOX IS to LCA@CPM has been enabled. Successfully testing has been made on transfer of public information from the OMNNITOX database and WWLCAW database. However, even though it is technically possible, LCA@CPM users can not use data from OMNIITOX IS to date. When this report is written the OMNIITOX project is still running and all results are not yet public.

Information management work has been concentrated to the substance nomenclature issue and mapping of nomenclatures. The work with substance nomenclature will continue within the CPM network and other companies to obtain the best and most correct substance naming. However, which nomenclature to use depends very much on the context and user knowledge. A self-learning system would be the best solution. Nevertheless, the responsibility of the user would be high in terms of inserting a common and unambiguous name of a substance and also understanding the meaning of a specific substance name. In this project a “cleaning-up” of the substance nomenclatures used in CPM’s LCA related applications developed by IMI has been performed resulting in higher computability i.e. result in less inputs and outputs missing characterization and weighting results. For this purpose the new substance nomenclature named CPM2004 has been compiled and is recommended to use to improve and facilitate industrial application.

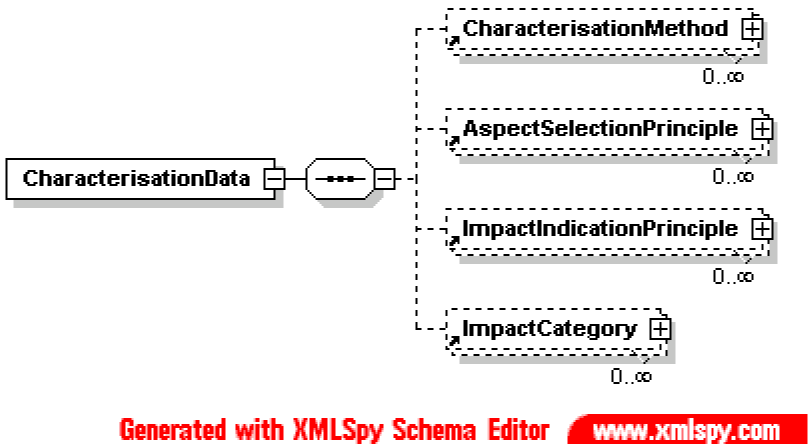
9.1. Future work and next steps

Functionality is needed for substance mapping to be used when importing data sets in ISO/TS 14048 data documentation format from other systems (no CPM system). Manual handling of substances in the LCA@CPM tool should be facilitated and a self learning system would be the best solution.

Appendix A: Diagrams of the communication format for impact assessment data

Appendix A contains diagrams covering the complete data communication format for impact assessment data which was described in chapter 8.1. The communication format is implemented as an XML-schema, which describes a structure that all xml documents need to be compliant with to make the content useful for a receiver. The XML-schema provides grammar that makes the communicated information understandable and interpretable. The diagrams which are provided below have been created using the xml editing tool XML spy.

A.1 Characterisation data

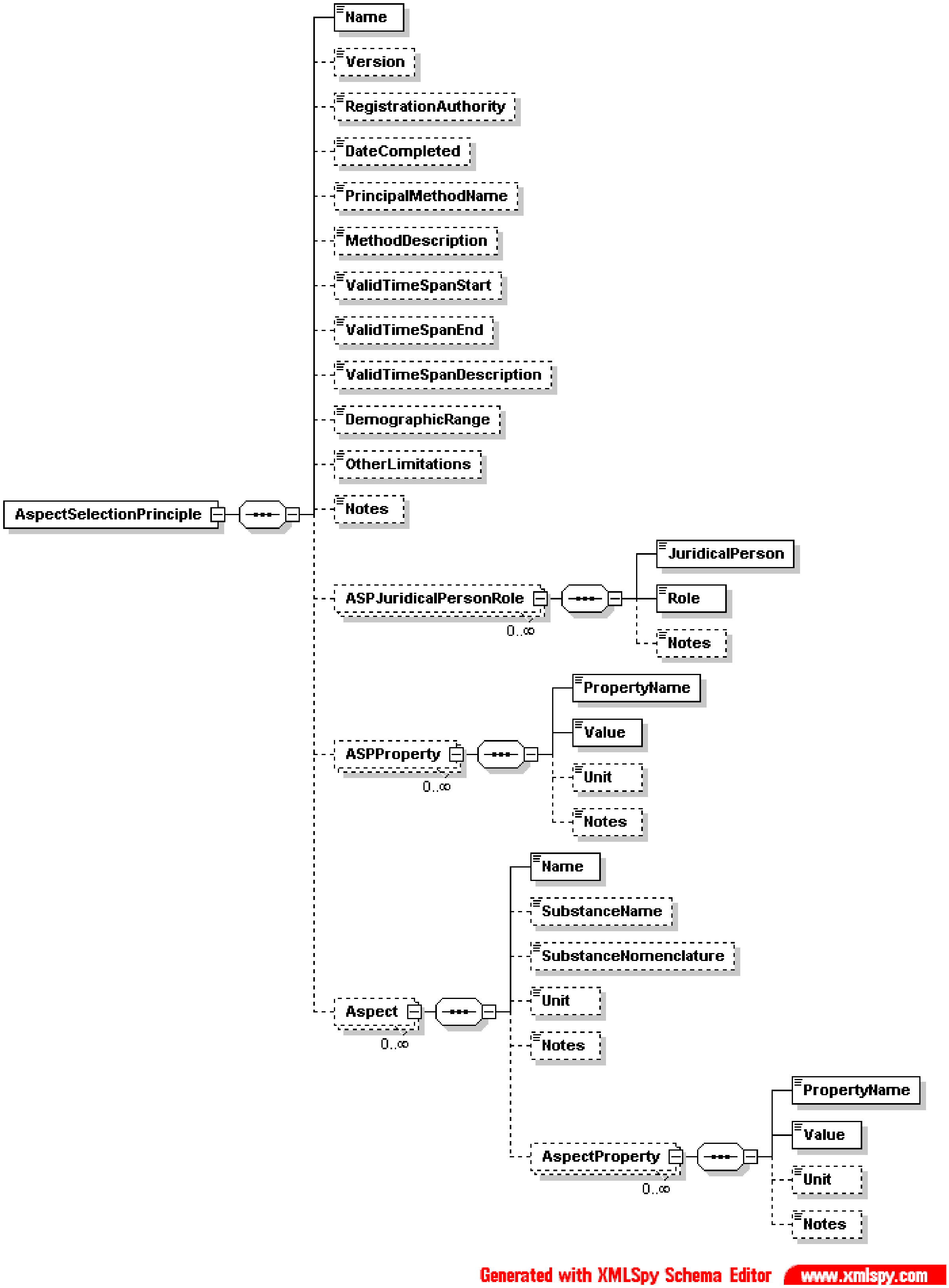


The diagram above illustrates that the CharacterisationData element may consist of any number of CharacterisationMethods, AspectSelectionPrinciples, ImpactIndicationPrincles, and ImpactCategories. The content of these elements are provided in the following pages of this appendix.

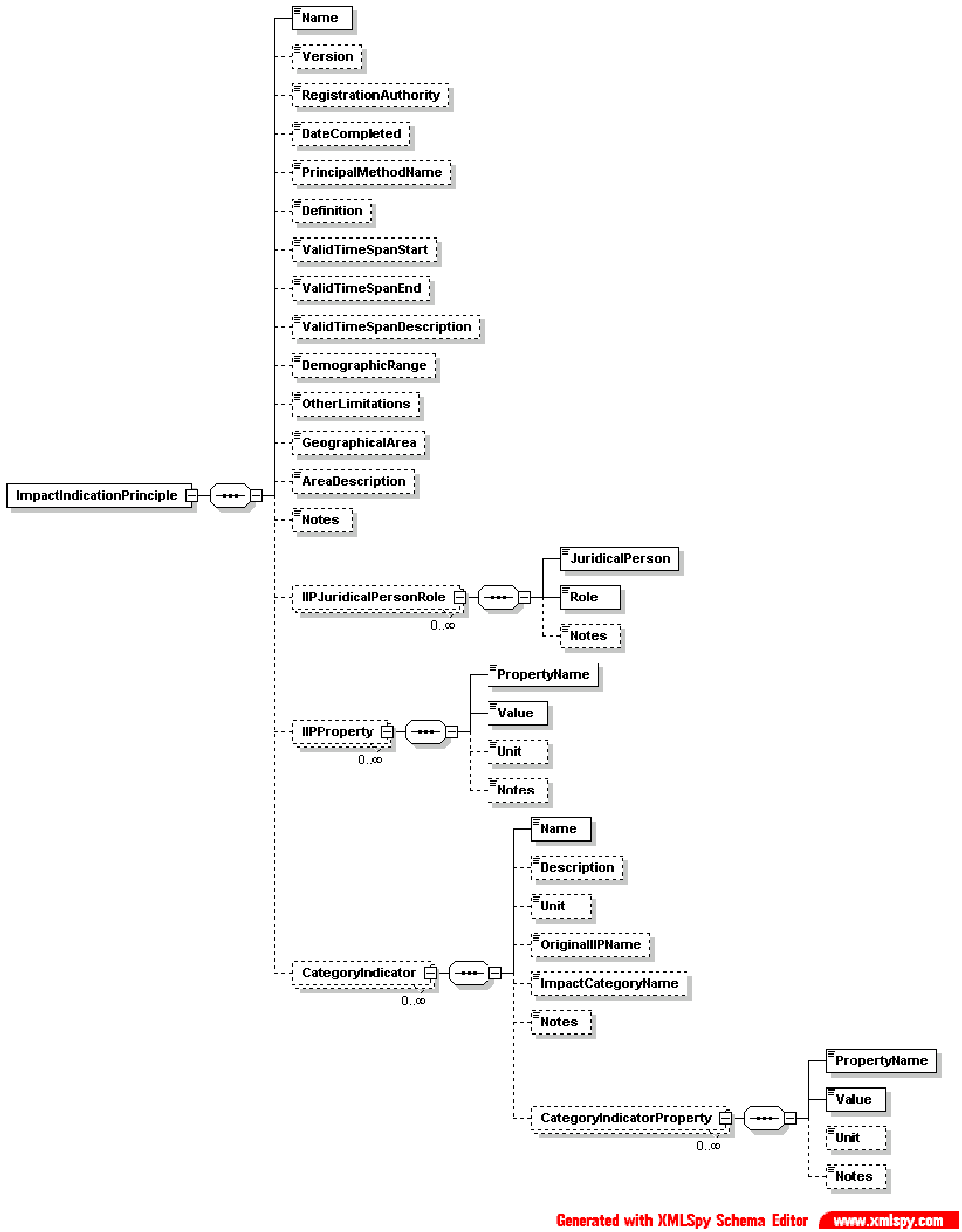
The following information will help you to understand the diagram (for a more detailed description visit www.altova.com).

- Border: solid= mandatory element, dotted= non-mandatory element
- Plus sign = element has a complex content consisting of many other elements
- Number range 1..infinity = the element must occur at least once in the document and may occur infinitely many times

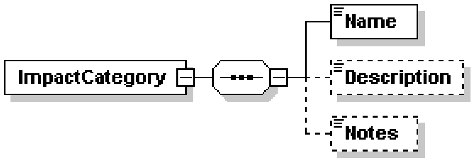
A.2 AspectSelectionPrinciple



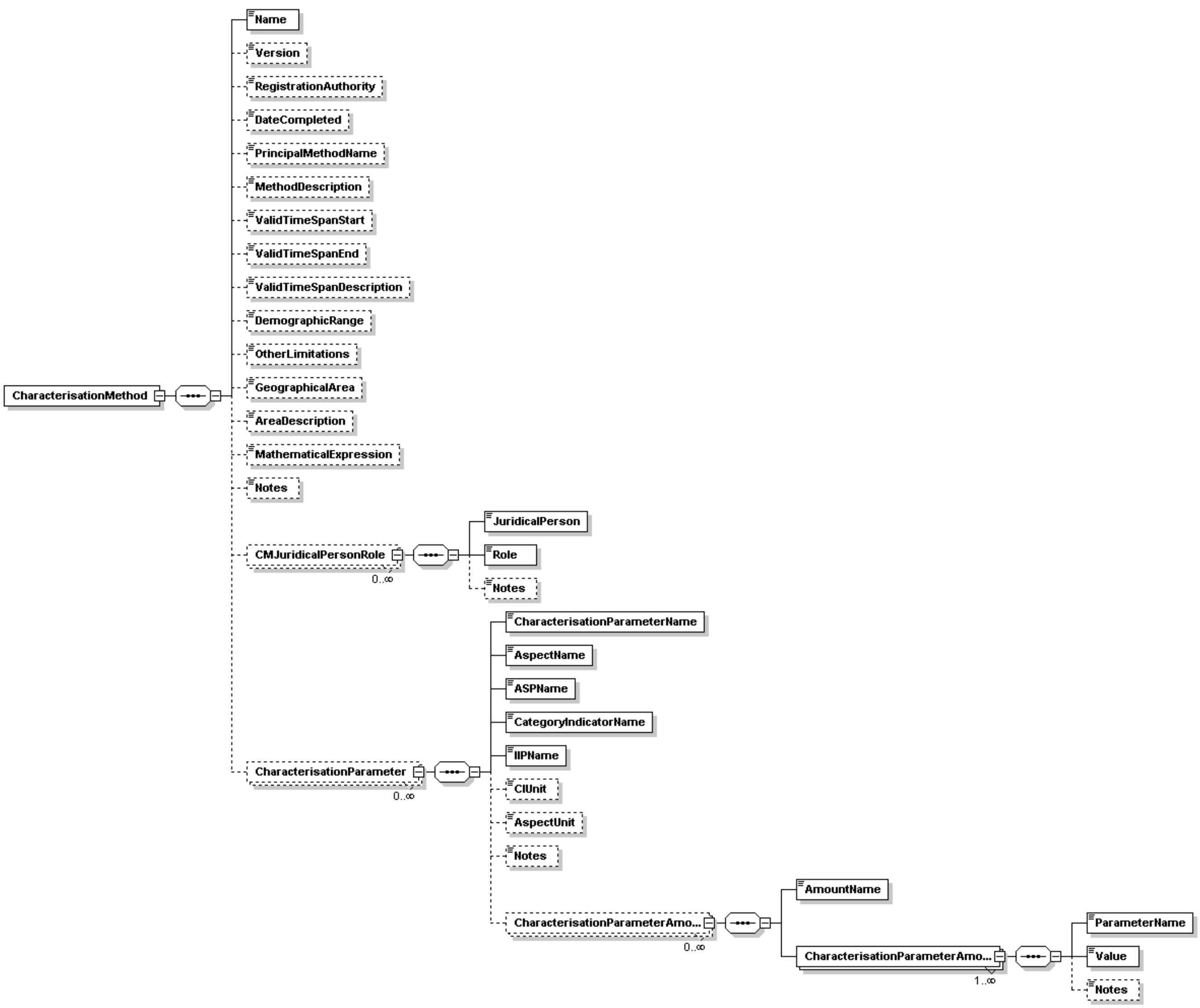
A.3 Impact indication principle



A.4 Impact category



A.5 Characterisation method



Appendix B: Data communication format for impact assessment data

Appendix B contains the full technical version of the data communication format which was described in chapter 8.1 and provided in diagram form in appendix A. The communication format is implemented as an XML-schema. The restrictions specified in an XML-schema are regarding structure and content:

- structure
  - which elements are allowed
  - in what order shall the elements come
- content
  - how many instances of each element are allowed
  - is there a minimum number of occurrences specified
  - data types
    - numerical values
    - free text and in that case how many characters
    - date format

```xml
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified" attributeFormDefault="unqualified">
  <xs:element name="CharacterisationData">
    <xs:complexType>
      <xs:sequence>
        <xs:element ref="CharacterisationMethod" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element ref="AspectSelectionPrinciple" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element ref="ImpactIndicationPrinciple" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element ref="ImpactCategory" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="CharacterisationMethod">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="Name">
          <xs:simpleType>
            <xs:restriction base="xs:string">
              <xs:maxLength value="150"/>
            </xs:restriction>
          </xs:simpleType>
        </xs:element>
        <xs:element name="Version" nillable="true" minOccurs="0">
          <xs:simpleType>
            <xs:restriction base="xs:string">
              <xs:maxLength value="25"/>
            </xs:restriction>
          </xs:simpleType>
        </xs:element>
        <xs:element name="RegistrationAuthority" nillable="true" minOccurs="0">
          <xs:simpleType>
            <xs:restriction base="xs:string">
              <xs:maxLength value="150"/>
            </xs:restriction>
          </xs:simpleType>
        </xs:element>
        <xs:element name="DateCompleted" type="xs:date" nillable="true" minOccurs="0"/>
        <xs:element name="PrincipalMethodName" nillable="true" minOccurs="0">
          <xs:simpleType>
            <xs:restriction base="xs:string">
              <xs:maxLength value="255"/>
            </xs:restriction>
          </xs:simpleType>
```

```xml
</xs:element>
<xs:element name="MethodDescription" nillable="true" minOccurs="0">
	<xs:simpleType>
		<xs:restriction base="xs:string">
			<xs:maxLength value="2147483647"/>
		</xs:restriction>
	</xs:simpleType>
</xs:element>
<xs:element name="ValidTimeSpanStart" type="xs:date" nillable="true" minOccurs="0"/>
<xs:element name="ValidTimeSpanEnd" type="xs:date" nillable="true" minOccurs="0"/>
<xs:element name="ValidTimeSpanDescription" nillable="true" minOccurs="0">
	<xs:simpleType>
		<xs:restriction base="xs:string">
			<xs:maxLength value="2147483647"/>
		</xs:restriction>
	</xs:simpleType>
</xs:element>
<xs:element name="DemographicRange" nillable="true" minOccurs="0">
	<xs:simpleType>
		<xs:restriction base="xs:string">
			<xs:maxLength value="2147483647"/>
		</xs:restriction>
	</xs:simpleType>
</xs:element>
<xs:element name="OtherLimitations" nillable="true" minOccurs="0">
	<xs:simpleType>
		<xs:restriction base="xs:string">
			<xs:maxLength value="2147483647"/>
		</xs:restriction>
	</xs:simpleType>
</xs:element>
<xs:element name="GeographicalArea" nillable="true" minOccurs="0">
	<xs:simpleType>
		<xs:restriction base="xs:string">
			<xs:maxLength value="50"/>
		</xs:restriction>
	</xs:simpleType>
</xs:element>
<xs:element name="AreaDescription" nillable="true" minOccurs="0">
	<xs:simpleType>
		<xs:restriction base="xs:string">
			<xs:maxLength value="2147483647"/>
		</xs:restriction>
	</xs:simpleType>
</xs:element>
<xs:element name="MathematicalExpression" nillable="true" minOccurs="0">
	<xs:simpleType>
		<xs:restriction base="xs:string">
			<xs:maxLength value="2048"/>
		</xs:restriction>
	</xs:simpleType>
</xs:element>
<xs:element name="Notes" nillable="true" minOccurs="0">
	<xs:simpleType>
		<xs:restriction base="xs:string">
			<xs:maxLength value="2048"/>
		</xs:restriction>
	</xs:simpleType>
</xs:element>
<xs:element name="CMJuridicalPersonRole" minOccurs="0" maxOccurs="unbounded">
	<xs:complexType>
		<xs:sequence>
			<xs:element name="JuridicalPerson">
				<xs:simpleType>
					<xs:restriction base="xs:string">
						<xs:maxLength value="255"/>
					</xs:restriction>
				</xs:simpleType>
			</xs:element>
			<xs:element name="Role">
				<xs:simpleType>
```

```
                    <xs:restriction base="xs:string">
                        <xs:maxLength value="100"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="Notes" nillable="true" minOccurs="0">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:maxLength value="2048"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
        </xs:sequence>
    </xs:complexType>
</xs:element>
<xs:element name="CharacterisationParameter" minOccurs="0" maxOccurs="unbounded">
    <xs:complexType>
        <xs:sequence>
            <xs:element name="CharacterisationParameterName">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:maxLength value="100"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="AspectName">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:maxLength value="100"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="ASPName">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:maxLength value="100"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="CategoryIndicatorName">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:maxLength value="100"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="IIPName">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:maxLength value="100"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="CIUnit" nillable="true" minOccurs="0">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:maxLength value="100"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="AspectUnit" nillable="true" minOccurs="0">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:maxLength value="100"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="Notes" nillable="true" minOccurs="0">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:maxLength value="2048"/>
```

```xml
                                        </xs:restriction>
                                    </xs:simpleType>
                                </xs:element>
                                <xs:element name="CharacterisationParameterAmount" minOccurs="0" maxOccurs="unbounded">
                                    <xs:complexType>
                                        <xs:sequence>
                                            <xs:element name="AmountName">
                                                <xs:simpleType>
                                                    <xs:restriction base="xs:string">
                                                        <xs:maxLength value="100"/>
                                                    </xs:restriction>
                                                </xs:simpleType>
                                            </xs:element>
                                            <xs:element name="CharacterisationParameterAmountParameter" maxOccurs="unbounded">
                                                <xs:complexType>
                                                    <xs:sequence>
                                                        <xs:element name="ParameterName">
                                                            <xs:simpleType>
                                                                <xs:restriction base="xs:string">
                                                                    <xs:maxLength value="100"/>
                                                                </xs:restriction>
                                                            </xs:simpleType>
                                                        </xs:element>
                                                        <xs:element name="Value">
                                                            <xs:simpleType>
                                                                <xs:restriction base="xs:string">
                                                                    <xs:maxLength value="50"/>
                                                                </xs:restriction>
                                                            </xs:simpleType>
                                                        </xs:element>
                                                        <xs:element name="Notes" nillable="true" minOccurs="0">
                                                            <xs:simpleType>
                                                                <xs:restriction base="xs:string">
                                                                    <xs:maxLength value="2048"/>
                                                                </xs:restriction>
                                                            </xs:simpleType>
                                                        </xs:element>
                                                    </xs:sequence>
                                                </xs:complexType>
                                            </xs:element>
                                        </xs:sequence>
                                    </xs:complexType>
                                </xs:element>
                            </xs:sequence>
                        </xs:complexType>
                    </xs:element>
                </xs:sequence>
            </xs:complexType>
        </xs:element>
        <xs:element name="AspectSelectionPrinciple">
            <xs:complexType>
                <xs:sequence>
                    <xs:element name="Name">
                        <xs:simpleType>
                            <xs:restriction base="xs:string">
                                <xs:maxLength value="100"/>
                            </xs:restriction>
                        </xs:simpleType>
                    </xs:element>
                    <xs:element name="Version" nillable="true" minOccurs="0">
                        <xs:simpleType>
                            <xs:restriction base="xs:string">
                                <xs:maxLength value="25"/>
                            </xs:restriction>
                        </xs:simpleType>
                    </xs:element>
                    <xs:element name="RegistrationAuthority" nillable="true" minOccurs="0">
                        <xs:simpleType>
                            <xs:restriction base="xs:string">
                                <xs:maxLength value="150"/>
                            </xs:restriction>
```

```xml
        </xs:simpleType>
    </xs:element>
    <xs:element name="DateCompleted" type="xs:date" nillable="true" minOccurs="0"/>
    <xs:element name="PrincipalMethodName" nillable="true" minOccurs="0">
        <xs:simpleType>
            <xs:restriction base="xs:string">
                <xs:maxLength value="1073741823"/>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
    <xs:element name="MethodDescription" nillable="true" minOccurs="0">
        <xs:simpleType>
            <xs:restriction base="xs:string">
                <xs:maxLength value="1073741823"/>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
    <xs:element name="ValidTimeSpanStart" type="xs:date" nillable="true" minOccurs="0"/>
    <xs:element name="ValidTimeSpanEnd" type="xs:date" nillable="true" minOccurs="0"/>
    <xs:element name="ValidTimeSpanDescription" nillable="true" minOccurs="0">
        <xs:simpleType>
            <xs:restriction base="xs:string">
                <xs:maxLength value="2147483647"/>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
    <xs:element name="DemographicRange" nillable="true" minOccurs="0">
        <xs:simpleType>
            <xs:restriction base="xs:string">
                <xs:maxLength value="2147483647"/>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
    <xs:element name="OtherLimitations" nillable="true" minOccurs="0">
        <xs:simpleType>
            <xs:restriction base="xs:string">
                <xs:maxLength value="2147483647"/>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
    <xs:element name="Notes" nillable="true" minOccurs="0">
        <xs:simpleType>
            <xs:restriction base="xs:string">
                <xs:maxLength value="1073741823"/>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
    <xs:element name="ASPJuridicalPersonRole" minOccurs="0" maxOccurs="unbounded">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="JuridicalPerson">
                    <xs:simpleType>
                        <xs:restriction base="xs:string">
                            <xs:maxLength value="255"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
                <xs:element name="Role">
                    <xs:simpleType>
                        <xs:restriction base="xs:string">
                            <xs:maxLength value="100"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
                <xs:element name="Notes" nillable="true" minOccurs="0">
                    <xs:simpleType>
                        <xs:restriction base="xs:string">
                            <xs:maxLength value="2048"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
```

```xml
        </xs:sequence>
      </xs:complexType>
    </xs:element>
    <xs:element name="ASPProperty" minOccurs="0" maxOccurs="unbounded">
      <xs:complexType>
        <xs:sequence>
          <xs:element name="PropertyName">
            <xs:simpleType>
              <xs:restriction base="xs:string">
                <xs:maxLength value="100"/>
              </xs:restriction>
            </xs:simpleType>
          </xs:element>
          <xs:element name="Value">
            <xs:simpleType>
              <xs:restriction base="xs:string">
                <xs:maxLength value="255"/>
              </xs:restriction>
            </xs:simpleType>
          </xs:element>
          <xs:element name="Unit" nillable="true" minOccurs="0">
            <xs:simpleType>
              <xs:restriction base="xs:string">
                <xs:maxLength value="100"/>
              </xs:restriction>
            </xs:simpleType>
          </xs:element>
          <xs:element name="Notes" nillable="true" minOccurs="0">
            <xs:simpleType>
              <xs:restriction base="xs:string">
                <xs:maxLength value="2048"/>
              </xs:restriction>
            </xs:simpleType>
          </xs:element>
        </xs:sequence>
      </xs:complexType>
    </xs:element>
    <xs:element name="Aspect" minOccurs="0" maxOccurs="unbounded">
      <xs:complexType>
        <xs:sequence>
          <xs:element name="Name">
            <xs:simpleType>
              <xs:restriction base="xs:string">
                <xs:maxLength value="100"/>
              </xs:restriction>
            </xs:simpleType>
          </xs:element>
          <xs:element name="SubstanceName" nillable="true" minOccurs="0">
            <xs:simpleType>
              <xs:restriction base="xs:string">
                <xs:maxLength value="100"/>
              </xs:restriction>
            </xs:simpleType>
          </xs:element>
          <xs:element name="SubstanceNomenclature" nillable="true" minOccurs="0">
            <xs:simpleType>
              <xs:restriction base="xs:string">
                <xs:maxLength value="100"/>
              </xs:restriction>
            </xs:simpleType>
          </xs:element>
          <xs:element name="Unit" nillable="true" minOccurs="0">
            <xs:simpleType>
              <xs:restriction base="xs:string">
                <xs:maxLength value="100"/>
              </xs:restriction>
            </xs:simpleType>
          </xs:element>
          <xs:element name="Notes" nillable="true" minOccurs="0">
            <xs:simpleType>
              <xs:restriction base="xs:string">
```

```xml
                                                  &lt;xs:maxLength value="2048"/&gt;
                                             &lt;/xs:restriction&gt;
                                        &lt;/xs:simpleType&gt;
                                   &lt;/xs:element&gt;
                                   &lt;xs:element name="AspectProperty" minOccurs="0" maxOccurs="unbounded"&gt;
                                        &lt;xs:complexType&gt;
                                             &lt;xs:sequence&gt;
                                                  &lt;xs:element name="PropertyName"&gt;
                                                       &lt;xs:simpleType&gt;
                                                            &lt;xs:restriction base="xs:string"&gt;
                                                                 &lt;xs:maxLength value="100"/&gt;
                                                            &lt;/xs:restriction&gt;
                                                       &lt;/xs:simpleType&gt;
                                                  &lt;/xs:element&gt;
                                                  &lt;xs:element name="Value"&gt;
                                                       &lt;xs:simpleType&gt;
                                                            &lt;xs:restriction base="xs:string"&gt;
                                                                 &lt;xs:maxLength value="255"/&gt;
                                                            &lt;/xs:restriction&gt;
                                                       &lt;/xs:simpleType&gt;
                                                  &lt;/xs:element&gt;
                                                  &lt;xs:element name="Unit" nillable="true" minOccurs="0"&gt;
                                                       &lt;xs:simpleType&gt;
                                                            &lt;xs:restriction base="xs:string"&gt;
                                                                 &lt;xs:maxLength value="100"/&gt;
                                                            &lt;/xs:restriction&gt;
                                                       &lt;/xs:simpleType&gt;
                                                  &lt;/xs:element&gt;
                                                  &lt;xs:element name="Notes" nillable="true" minOccurs="0"&gt;
                                                       &lt;xs:simpleType&gt;
                                                            &lt;xs:restriction base="xs:string"&gt;
                                                                 &lt;xs:maxLength value="2048"/&gt;
                                                            &lt;/xs:restriction&gt;
                                                       &lt;/xs:simpleType&gt;
                                                  &lt;/xs:element&gt;
                                             &lt;/xs:sequence&gt;
                                        &lt;/xs:complexType&gt;
                                   &lt;/xs:element&gt;
                              &lt;/xs:sequence&gt;
                         &lt;/xs:complexType&gt;
                    &lt;/xs:element&gt;
               &lt;/xs:sequence&gt;
          &lt;/xs:complexType&gt;
     &lt;/xs:element&gt;
     &lt;xs:element name="ImpactIndicationPrinciple"&gt;
          &lt;xs:complexType&gt;
               &lt;xs:sequence&gt;
                    &lt;xs:element name="Name"&gt;
                         &lt;xs:simpleType&gt;
                              &lt;xs:restriction base="xs:string"&gt;
                                   &lt;xs:maxLength value="100"/&gt;
                              &lt;/xs:restriction&gt;
                         &lt;/xs:simpleType&gt;
                    &lt;/xs:element&gt;
                    &lt;xs:element name="Version" nillable="true" minOccurs="0"&gt;
                         &lt;xs:simpleType&gt;
                              &lt;xs:restriction base="xs:string"&gt;
                                   &lt;xs:maxLength value="25"/&gt;
                              &lt;/xs:restriction&gt;
                         &lt;/xs:simpleType&gt;
                    &lt;/xs:element&gt;
                    &lt;xs:element name="RegistrationAuthority" nillable="true" minOccurs="0"&gt;
                         &lt;xs:simpleType&gt;
                              &lt;xs:restriction base="xs:string"&gt;
                                   &lt;xs:maxLength value="150"/&gt;
                              &lt;/xs:restriction&gt;
                         &lt;/xs:simpleType&gt;
                    &lt;/xs:element&gt;
                    &lt;xs:element name="DateCompleted" type="xs:date" nillable="true" minOccurs="0"/&gt;
                    &lt;xs:element name="PrincipalMethodName" nillable="true" minOccurs="0"&gt;
                         &lt;xs:simpleType&gt;
```

```xml
            <xs:restriction base="xs:string">
                <xs:maxLength value="255"/>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
    <xs:element name="Definition" nillable="true" minOccurs="0">
        <xs:simpleType>
            <xs:restriction base="xs:string">
                <xs:maxLength value="2147483647"/>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
    <xs:element name="ValidTimeSpanStart" type="xs:date" nillable="true" minOccurs="0"/>
    <xs:element name="ValidTimeSpanEnd" type="xs:date" nillable="true" minOccurs="0"/>
    <xs:element name="ValidTimeSpanDescription" nillable="true" minOccurs="0">
        <xs:simpleType>
            <xs:restriction base="xs:string">
                <xs:maxLength value="2147483647"/>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
    <xs:element name="DemographicRange" nillable="true" minOccurs="0">
        <xs:simpleType>
            <xs:restriction base="xs:string">
                <xs:maxLength value="2147483647"/>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
    <xs:element name="OtherLimitations" nillable="true" minOccurs="0">
        <xs:simpleType>
            <xs:restriction base="xs:string">
                <xs:maxLength value="2147483647"/>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
    <xs:element name="GeographicalArea" nillable="true" minOccurs="0">
        <xs:simpleType>
            <xs:restriction base="xs:string">
                <xs:maxLength value="50"/>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
    <xs:element name="AreaDescription" nillable="true" minOccurs="0">
        <xs:simpleType>
            <xs:restriction base="xs:string">
                <xs:maxLength value="2147483647"/>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
    <xs:element name="Notes" nillable="true" minOccurs="0">
        <xs:simpleType>
            <xs:restriction base="xs:string">
                <xs:maxLength value="2048"/>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
    <xs:element name="IIPJuridicalPersonRole" minOccurs="0" maxOccurs="unbounded">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="JuridicalPerson">
                    <xs:simpleType>
                        <xs:restriction base="xs:string">
                            <xs:maxLength value="255"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
                <xs:element name="Role">
                    <xs:simpleType>
                        <xs:restriction base="xs:string">
                            <xs:maxLength value="100"/>
                        </xs:restriction>
```

```
                    </xs:simpleType>
                </xs:element>
                <xs:element name="Notes" nillable="true" minOccurs="0">
                    <xs:simpleType>
                        <xs:restriction base="xs:string">
                            <xs:maxLength value="2048"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
    <xs:element name="IIPProperty" minOccurs="0" maxOccurs="unbounded">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="PropertyName">
                    <xs:simpleType>
                        <xs:restriction base="xs:string">
                            <xs:maxLength value="100"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
                <xs:element name="Value">
                    <xs:simpleType>
                        <xs:restriction base="xs:string">
                            <xs:maxLength value="255"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
                <xs:element name="Unit" nillable="true" minOccurs="0">
                    <xs:simpleType>
                        <xs:restriction base="xs:string">
                            <xs:maxLength value="100"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
                <xs:element name="Notes" nillable="true" minOccurs="0">
                    <xs:simpleType>
                        <xs:restriction base="xs:string">
                            <xs:maxLength value="2048"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
    <xs:element name="CategoryIndicator" minOccurs="0" maxOccurs="unbounded">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="Name">
                    <xs:simpleType>
                        <xs:restriction base="xs:string">
                            <xs:maxLength value="100"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
                <xs:element name="Description" nillable="true" minOccurs="0">
                    <xs:simpleType>
                        <xs:restriction base="xs:string">
                            <xs:maxLength value="2147483647"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
                <xs:element name="Unit" nillable="true" minOccurs="0">
                    <xs:simpleType>
                        <xs:restriction base="xs:string">
                            <xs:maxLength value="50"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
                <xs:element name="OriginalIIPName" minOccurs="0">
```

```xml
                        <xs:simpleType>
                            <xs:restriction base="xs:string">
                                <xs:maxLength value="100"/>
                            </xs:restriction>
                        </xs:simpleType>
                    </xs:element>
                    <xs:element name="ImpactCategoryName" nillable="true" minOccurs="0">
                        <xs:simpleType>
                            <xs:restriction base="xs:string">
                                <xs:maxLength value="100"/>
                            </xs:restriction>
                        </xs:simpleType>
                    </xs:element>
                    <xs:element name="Notes" nillable="true" minOccurs="0">
                        <xs:simpleType>
                            <xs:restriction base="xs:string">
                                <xs:maxLength value="2048"/>
                            </xs:restriction>
                        </xs:simpleType>
                    </xs:element>
                    <xs:element name="CategoryIndicatorProperty" minOccurs="0" maxOccurs="unbounded">
                        <xs:complexType>
                            <xs:sequence>
                                <xs:element name="PropertyName">
                                    <xs:simpleType>
                                        <xs:restriction base="xs:string">
                                            <xs:maxLength value="100"/>
                                        </xs:restriction>
                                    </xs:simpleType>
                                </xs:element>
                                <xs:element name="Value">
                                    <xs:simpleType>
                                        <xs:restriction base="xs:string">
                                            <xs:maxLength value="4000"/>
                                        </xs:restriction>
                                    </xs:simpleType>
                                </xs:element>
                                <xs:element name="Unit" nillable="true" minOccurs="0">
                                    <xs:simpleType>
                                        <xs:restriction base="xs:string">
                                            <xs:maxLength value="100"/>
                                        </xs:restriction>
                                    </xs:simpleType>
                                </xs:element>
                                <xs:element name="Notes" nillable="true" minOccurs="0">
                                    <xs:simpleType>
                                        <xs:restriction base="xs:string">
                                            <xs:maxLength value="2048"/>
                                        </xs:restriction>
                                    </xs:simpleType>
                                </xs:element>
                            </xs:sequence>
                        </xs:complexType>
                    </xs:element>
                </xs:sequence>
            </xs:complexType>
        </xs:element>
    </xs:sequence>
    </xs:complexType>
</xs:element>
<xs:element name="ImpactCategory">
    <xs:complexType>
        <xs:sequence>
            <xs:element name="Name">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:maxLength value="100"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="Description" nillable="true" minOccurs="0">
```

```
                        <xs:simpleType>
                            <xs:restriction base="xs:string">
                                <xs:maxLength value="2147483647"/>
                            </xs:restriction>
                        </xs:simpleType>
                    </xs:element>
                    <xs:element name="Notes" nillable="true" minOccurs="0">
                        <xs:simpleType>
                            <xs:restriction base="xs:string">
                                <xs:maxLength value="2048"/>
                            </xs:restriction>
                        </xs:simpleType>
                    </xs:element>
                </xs:sequence>
            </xs:complexType>
        </xs:element>
    </xs:schema>
```

Appendix C: CPM 2004 nomenclature in alphabetic order

1,1,1-Trichloroethane	2-Chlorotoluene	Acephate
1,1,2,2-Tetrachloroethane	2-Ethoxy-2-methylpropane	Acetaldehyde
1,1-Dimethylethyl acetate	2-Ethoxyethanol	Acetic acid
1,2,3-trichlorobenzene	2-Ethyl hexanol	Acetone
1,2,3-Trimethylbenzene	2-Ethylhexyl acetate	Acetylene
1,2,4-trichlorobenzene	2-Hexanone	Acid as H+
1,2,4-Trimethylbenzene	2-m-1-butene	Acrylic acid
1,2,5-trimethylbenzene	2-m-2-butene	Acrylic acid. 2-hydroxyethyl ester
1,2-Benzoisothiazolin-3-one	2-Methoxyethanol	Acrylonitrile
1,2-dibromoethane	2-Methyl-1-butanol	Ag
1,2-Dichlorobenzene	2-Methyl-1-butene	Ag-110m
1,2-Dichloroethane	2-Methyl-2-butanol	Al
1,2-Propylene oxide	2-Methyl-2-butene	Alachlor
1,3,5-trichlorobenzene	2-Methylbutane	Alcohols
1,3,5-Trimethylbenzene	2-methylheptane	Aldehydes
1,3-butadiene	2-Methylhexane	Aldicarb
1,3-Diethyl-5-methylbenzene	2-methylnonane	Aldrin
1,4-dioxane	2-Methylpentane	Alkanes
1-butanol	2-Methylpropanal	Alkenes
1-Butene	2-Methylpropane	Allyl chloride
1-Butoxypropanol	2-Methylpropene	Alpha-hexachlorocyclohexan
1-Ethyl-2-methylbenzene	2-metylokane	Aluminium in ore
1-Ethyl-3-methylbenzene	2-Pentanone	Aluminium ore
1-Ethyl-4-methylbenzene	2-pentene	Anglesite
1-Hexene	2-Propanol	Anionic detergent (worst case)
1H-Isoindole-1,3(2H)-dione, 2-(trichloromethyl)thio-	2-Propenal	Anthracene
1-Methoxy-2-propanol	3,3-Dimethyl-2-butanone	Antimony
1-Methylethyl acetate	3,5-diethyl toluene	AOX
1-Methylpropyl acetate	3,5-Dimethylethylbenzene	Ar
1-Pentene	3-Chlorotoluene	Arable land use EPS/2000
2,2-Dimethylbutane	3-Hexanone	Aromatics
2,2-Dimethylpropane	3-Methyl-1-butanol	As
2,3-Dimethylbutane	3-Methyl-1-butene	As(III)
2,4,5-Trichloropheno xyacetic acid	3-Methyl-2-butanol	Atrazine
2,4,6-trichlorophenol	3-Methyl-2-butanone	Au
2,4-Dichloropheno xyacetic acid	3-Methylhexane	Azinphos-methyl
2,4-Dinitrotoluene	3-Methylpentane	B
2-butene	3-Pentanol	Ba
2-butene(trans)	3-Pentanone	Bauxite
2-Butoxyethanol	4-Chlorotoluene	Be

Benomyl	Cd	ClO-
Bentazon	Ce	ClO2
Bentonite	Cerussite	CN-
Benzaldehyde	CFC-11	Co
Benzene	CFC-111	CO2
Benzene, hexabromo-	CFC-112	CO2 (renewable)
Benzo(a)anthracene	CFC-113	Co-58
Benzo(a)pyrene	CFC-114	Co-60
Benzotriazole	CFC-115	Coal
Benzotrichloride	CFC-12	Coal ETH
Benzyl alcohol	CFC-13	COD
Benzylchloride	CFC-211	Construction waste
Beta-chlorocyclohexan	CFC-212	Conv. to Continuous urban land ECO/99
Bi	CFC-213	Conv. to Convent. arable land ECO/99
Biomass	CFC-214	Conv. to Discontinuous urban ECO/99
Biphenyl	CFC-215	Conv. to Green urban ECO/99
Bis(chloromethyl)ether	CFC-216	Conv. to Industrial area ECO/99
BOD	CFC-217	Conv. to Integr. arable land ECO/99
Br	CFCs	Conv. to Intensive meadow ECO/99
Bromodichloromethane	Chalcocite	Conv. to Less intensive meadow ECO/99
Bromomethane	Chalcopyrite	Conv. to Organic arable land ECO/99
But-2-iol	Chalk	Conv. to Organic meadow ECO/99
Butadiene	Chlordane	Conv. to rail/ road area ECO/99
Butanal	Chlorinated VOC	Copper in ore
Butane	Chlorobenzenes	Copper ore
Butanol	Chloromethane	Cr
Butene	Chloroorganics	Cr(VI)
Butyl acetate	Chlorophenols	Cr3+
Butyl diglycol acetate	Chlorpyrifos	CrO3
C-14	Chromite	CrO42-
C6F14	Chromium in ore	Crude oil
Ca	Chromium ore	Crude oil (feedstock)
Calcium fluoride	cis-1,2-Dichloroethene	Crude oil (resource)
Calcium sulphate	cis-2-Butene	Crude oil ETH
Captan	cis-2-Hexene	Crude oil IDEMAT
Carbaryl	cis-2-Pentene	Cs-134
Carbendazim	Cl	Cs-137
Carbofuran	Cl-	CS2
Carnotite	Cl2	Cu
C-C4F8	Clay	Cumene

Cuprite	Dissolved organics	Fenamiphos
CxHy aromatic	Dissolved solids	Fentin acetate
CxHy chloro	Disulfoton	Fluoranthene
CxHy halogenated	Diuron	Fluorides
Cyclohexane	DNOC	Forestry EPS/2000
Cyclohexanol	Dodecafluoropentane	Formaldehyde
Cyclohexanone	Dodecane	Formic acid
Cyclohexanone waste	Dolomite	Ga
Cypermethrin	Drinking water	Galena
Decafluorobutane	Dust	Gamma-HCH
Decane	Dy	Gas
Demeton	Electricity	Gd
Detergents	Emulsifier	Ge
Di-(2-ethylhexyl) phthalate	Endosulfan	Geothermal energy
Di(n-octyl) phthalate	Endrin	Glycerol
Diacetone alcohol	Energy from coal	Glyphosate
Dibenz(a)anthracene	Energy from natural gas	Gold in ore
Dibutylphthalate	Energy from oil	Gravel
Dibutyltinoxide	Epichlorohydrin	Ground water
Dichloromethane	Er	H2
Dichlorvos	Esters	H2S
Dicofol	Ethane	H2SO4
Dieldrin	Ethane diol	H3
Diesel	Ethanol	H3PO4
Diethanolamine	Ethene	Haematite
Diethyl ether	Ethers	Halon-1201
Diethylaminoethanol	Ethyl acetate	Halon-1202
Diethylene glycol	Ethylbenzene	Halon-1211
Diethylene glycol mono-n-butyl ether	Ethylene glycol	Halon-130
Diflubenzuron	Ethylene glycol acetate	Halon-1301
Diisopropyl ether	Ethylene glycol mono-n-butyl ether	Halon-1303
Dimethoate	Ethylene oxide	Halon-2311
Dimethyl ether	Ethylenediamine tetraacetic acid	Halon-2401
Dimethyl phthalate	Ethylenediamine. 1,2-ethanediamine	Halon-2402
Dimethylester	Eu	Hard coal
Dioxin	F	Hardmaking of forest land EPS/2000
Dioxin (TCDD)	F-	Hazardous waste
Diquat	F2	HCFC-123
Diquat-dibromide	Fe	HCFC-124
Dissolved organic carbon	Feldspar	HCFC-125

HCFC-134a	Ho	Lindane
HCFC-141b	Hydro energy	Littering EPS/2000
HCFC-142b	Hydrocarbons	Lu
HCFC-143a	I	Magnetite
HCFC-152a	I-129	Malachite
HCFC-22	I-131	Malathion
HCFC-225ca	I-133	Maleic acid. Dibutyl ester
HCFC-225cb	I-butane	Maneb
HCFCs	i-Butanol	Manganese in ore
HCl	I-butylacetate	Manganese ore
HCN	I-butyraldehyde	Mecoprop
He	In	Mercury in ore
Heptachlor	Inert chemical waste	Metabenzthiazuron
Heptachlor epoxide	i-Propanol	Metals
Heptane	I-propyl acetate	Metals refuse
Hexachlorobenzene	I-propylbenzene	Metamitron
Hexachlorobutadiene	Ir	Methacrylic acid
Hexachlorocyclopentadiene	Iron in ore	Methane
Hexafluoroethane	Iron ore	Methanol
Hexamethylene diisocyanate	Irrigation water	Methomyl
Hexane	Isobutane	Methoxychlor
HF	Isobutyl acetate	Methyl acetate
HFC-123	Isobutyraldehyde	Methyl chloroform
HFC-124	Isopentane	Methyl ethyl ketone
HFC-125	Isoprene	Methyl formate
HFC-134	Isopropyl acetate	Methyl i-butyl ketone
HFC-134a	K	Methyl i-propyl ketone
HFC-143	Ketones	Methyl methacrylate
HFC-143a	Kr-85	Methyl propene
HFC-152a	La	Methyl t-butyl ether
HFC-227ea	Land use II-III ECO/99	Methyl t-butyl ketone
HFC-23	Land use III-IV ECO/99	Methylcyclohexane
HFC-236fa	Land use II-IV ECO/99	Methylene chloride
HFC-245ca	Lead in ore	Methylenebis(4-phenylisocyanate)
HFC-32	Lead ore	M-ethyltoluene
HFC-41	Li	Metribuzin
HFC-43-10mee	Lignite	Metylcyclohexane
Hg	Lime	Mevinphos
Highly radioactive waste	Limestone	Mg
HNO3	Limonite	Mineral waste

Mirex	N-Nitrosodiethylamine	PAC
Mixed industrial waste	N-nonane	PAH
Mn	NO	Paper & board refuse
Mo	NO2	Paraquat
Molybdene in ore	NO2-	Parathion
Molybdenum ore	NO3-	Particles
Monoethanolamine	NO3- as N	Particles diesel soot
Monolinuron	Noise	Pb
Morpholine	N-oktane	Pb2+
m-Xylene	Non hazardous waste	Pb-210
N total	Nonane	PCB
N2O	NOx	PCBS
Na	N-pentane	Pd
Naled	N-propyl acetate	p-Dichlorobenzene
Natural gas	N-propylbenzene	Peat
Natural gas (feedstock)	Nuclear energy	Pentachlorophenol
Natural gas (vol)	N-undecane	Pentanal
Natural gas ETH	O2	Pentane
Nb	Occup. As Contin. urban land ECO/99	Perfluorhexane
N-butane	Occup. as Convent. arable land ECO/99	Permethrin
N-butanol	Occup. as Discont. urban land ECO/99	P-ethyltoluene
N-butylacetate	Occup. as Forest land ECO/99	Petrol
N-butyraldehyde	Occup. as Green urban land ECO/99	PH3
Nd	Occup. as Industrial area ECO/99	Phenol
N-decane	Occup. as Integrated arable land ECO/99	Pirimifosmethyl
N-dodecane	Occup. as less intens.meadow land ECO/99	Pitchblende
Ne	Occup. as Organic arable land ECO/99	Plastics refuse
NH3	Occup. as organic meadow land ECO/99	Po-210
NH4+	Occup. as rail/ road area ECO/99	PO43-
NH4+ as N	Octafluorocyclobutane	PO43- as P
Ni	Octafluoropropane	Polychlorobiphenyls
Nickel in ore	Octane	Pr
Nickel ore	O-ethyltoluene	Pronamide
Nickel-refinery-dust	Oil	Propachlor
Nickel-subsulfide	Olivine	Propanal
Nitrilotriacetate	Os	Propane
Nitrobenzenesulphonic acid	Oxamyl	Propane diol
Nitrobenzenesulphonic acid. Sodium salt	Oxide ore	Propanoic acid
NMHC	o-Xylene	Propanoic acide
NMVOC	P total	Propanol

Propene	Slags and ash	Tin in ore
Propeneoxide	Sm	Tin ore
Propionaldehyde	Sn	Tl
Propoxur	SO2	Tm
Propyl acetate	SO3	Toluene
Propylbenzene	SO32-	Toluene diisocyanate 2.4/2.6 mixture
Propylene glycol	SO42-	Toluene-2.4-diamine
Propylene glycol 1,2-propanediol	Sodium benzoate	Total organic carbon
Propylene glycol methylether	Sodium chloride	trans-1,2-Dichloroethene
Propylene glycol methylether acetate	Sodium fluoracetate	trans-2-Butene
Propyleneoxide	Sodium hypochlorite	trans-2-Hexene
Pt	Sodium sulphate	trans-2-Pentene
Pu alpha	Solar energy	Tribromomethane
Pu-238	Solvey soda	Trichloroethene
p-Xylene	Soot	Trichloromethane
Pyrophosphate	SOx	Triethanolamine
Ra-226	Sr	Triethylamine
Raw rubber	Styrene	Trifluoroiodomethane
Rb	Sulphamic acid	Trifluralin
Re	Sulphide ore	Tungsten ore
Regulated chemical waste	Sulphur in ore	U-234
Renewable energy source	Surface water	U-235
Resmethrin	Suspended solids	U-238
Rh	Ta	Undecane
Rn-222	Tb	Uraninite
Ru	t-Butanol	Uranium in ore
S	T-butyl acetate	Uranium ore
S2-	Te	V
Sand	Tetrachloroethene	W
Sb	Tetrachloromethane	Valeraldehyde
Sb-124	Tetradecafluorohexane	Warfarin
s-Butanol	Tetrafluoromethane	Waste to incineration
S-butyl acetate	Th	Waste to recycling
Sc	Th-230	Water
Se	Thallium	Wind energy
Sea water	Thallium sulfate	Vinyl chloride
SF6	Thiols	VOC
Siderite	Thioperoxydicarbonic diamide, tetramethyl-	VOC from chemical cleaning of clothes
Silver in ore	Thiram	VOC from coal mining
Simazine	Ti	VOC from combustion of wood or twigs

VOC from controlled landfilling
VOC from Diesel powered car, exhaust
VOC from farming
VOC from food industry
VOC from natural gas leakage
VOC from oil refining and distribution
VOC from petrol powered car, exhaust
VOC from petrol powered car, vapour
VOC from power plant
VOC from surface coating
Wood
Xe-133
Xylene