



Centre for  
Environmental Assessment  
of Product and Material Systems

# An Assessment of the SPOLD-format

with comparisons between SPOLD and SPINE

Maria Erixon & Sara Ågren  
CPM report 1998:5



Includes a mapping table between the SPOLD and the SPINE format



Chalmers University of Technology  
Göteborg, Sweden

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## Foreword

Between the years 1994 and 1997 the SPOLD<sup>1</sup> group developed a data format for LCI data exchange. Chalmers University of Technology had a limited participation in that work, while still developing and further maintaining the SPINE<sup>2</sup> data format. SPINE was developed between the years 1993 and 1995 and has since then been practically and successfully used for many different purposes, such as LCI databases, data exchange, data networking and data publishing. Since the SPOLD format is proposed as a format for different networks, it was considered necessary to perform a practical assessment of the differences between the two formats. What are the strengths and the practical benefits of the SPOLD and the SPINE formats respectively?

Already in 1995 practical and simple LCA software based on SPINE was developed, which soon evolved into full-scale industrial LCA data systems. In 1996 the CPM<sup>3</sup>-group was established. An emphasized goal of this group was to establish a national quality reviewed database. Consequently the term 'data quality' came to be thoroughly analyzed, in regards of actually achievable quality and in regards of quality goals for the future. The result was that currently achievable data quality is to supply data with documentation that makes it possible to identify data sets and to distinguish them from each other. It is only possible to perform numerical data quality assessment for data sets where this requirement is met, and of course this is the data quality goal for the future.

As a result from these data quality insights, the assessment of the SPOLD format has partly focused on how well data may be documented, i.e. how well the format allows for exchanged data to be identified and distinguished.

Since the CPM group has experience of networking between and within different corporations, a number of requirements for the exchange of data documentation have been identified. The most apparent requirement is that data needs to be documented so that it can be understood by people outside the context of where the documentation was created, e.g. by non-LCA experts and by people in other technical and organisational environments. This gives that the documentation should be held in a natural language and that expert terminology should be explained. Simply stated: it should be easy to both document and interpret a data set.

Maria Erixon and Sara Ågren has worked for the CPM group in different smaller projects related to the establishment of the CPM LCA-database. The first was a qualitative and statistical assessment of the usability of Swedish governmental environmental reports in LCA. After that they have worked with reformatting data from LCA reports and other data sources into SPINE@CPM<sup>4</sup>. Due to their experience to interpret and assess LCA documentation, and due to their experience with reformatting data, they were found suitable to perform this assessment of a format. It should be noted, however, that they have no LCA experience and that they therefore are not generally familiar with the LCA terminology and jargon. From the viewpoint of this assessment this of course may be both positive and negative. The negative is mostly due to the fact that the SPOLD format is made for LCA experts and may have been

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<sup>1</sup> Society for Promotion of Life Cycle Development

<sup>2</sup> Sustainable Product Information Network for the Environment

<sup>3</sup> Centre for Environmental Assessment of Product and Material Systems

<sup>4</sup> The Swedish national database and data management at CPM, Chalmers

different to interpret. The positive is that they may somewhat express the same viewpoints and criticism as may be expressed by a general data provider, from outside the LCA-practitioners' world. A truly useful data format not only provides help to exchange data between LCA experts, but is also interpretable by original data suppliers, e.g. people located at production plants.

After having read Maria's and Sara's report, I am convinced of the benefits of both the SPOLD and the SPINE formats. The flexibility and the strong modelling of the SPINE format and the extensive checklist and the nomenclatures of the SPOLD format may both together be used to design feasible and functional data formats.

The experiences with SPINE also show that the theoretical and technical qualities derived from the close relations with computing scientists and software developers was a prerequisite for the success of the format. Due to this several difficulties have been avoided, and many mistakes and problems have been possible to solve. This especially regards compatibility problems between different software and users' interpretations of data fields and concepts. It may be assumed that much have been refunded as avoidance of redesign costs. Due to this and to other benefits associated with technical qualities, a short statement regarding the technical qualities of the SPOLD format has been added and is presented where it belongs: in the introduction to the mapping table between the two formats.

*Raul Carlson*

*Chalmers University of Technology, Göteborg, Sweden, 20:th of November 1998*

## Abstract

By entering data sets in to the SPOLD format, we have learned how to use the format and made an evaluation of it, primarily concerning data quality. Furthermore, we have compared the two formats of SPOLD and SPINE by converting information from one to the other. A mapping has been made of how the information is moved between the two formats. Their differences have also been evaluated.

The SPOLD format is inflexible and non-transparent and can therefore not adequately document different types of data sets. The specific inquiries in SPOLD, together with the great lack of space in the fields where the inquiries are answered, make it impossible to enter all necessary information into the format. However, the specific inquiries in SPOLD help the user to remember valuable detailed information. It is difficult to understand the inquiries and how the format preferably should be used.

The range of use of the SPOLD format seems to be quite narrow, due to the inflexibility. The format clearly aims at documenting branch averages and not separate sites.

In our experience, the SPINE format does not have these weaknesses, why we prefer this format to SPOLD. The flexibility of SPINE ensures that the data quality in the original source is preserved when entering the data.

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# 1 Introduction

This report is commissioned by the Centre for Environmental Assessment of Product and Material Systems (CPM), with purpose to learn how to use and to evaluate the data documentation format from the Society for the Promotion Of Life-Cycle Assessment Development (SPOLD). To make a comparison with the format Sustainable Product Information Network for the Environment (SPINE) and evaluate the differences between the two formats is also a purpose of this report.

We, the authors, have before starting this project, worked for CPM with data documentation related to Life Cycle Assessment (LCA), mainly in the form of LCA-studies, environmental reports<sup>5</sup>, and the SPINE format. The main focus has been to evaluate and emphasise the importance of transparency and data quality in different documentation formats. This has been achieved mainly through practical work, converting information in to the SPINE format.

## 2 Reading the report

The report is divided into three parts. The first includes a description of the documentation-SPOLD format, so that readers, not familiar with the format, can follow and understand the terminology in the rest of the report. This part can preferably be used as a reference text when reading the report. The description is coloured by how we (the authors) see and understand things and may therefore not totally correspond to the way the creators of SPOLD would describe the format. For those interested, the SPOLD format is available on the Internet [Weidema B, 1998, The SPOLD Format for LCI data] to be down loaded.

The main part of this report is the second one, where the SPOLD format is evaluated. The evaluation has been carried out from two different points of view. Firstly just by trying to understand the format as such and then using the format for different data sets. Specific comments about the data sets that were converted to the SPOLD format can be found in section A1.2, while the chapter itself contains more general issues.

Finally, we also were commissioned to compare the SPOLD format with the SPINE format, which is done in the third and last part of the report. The comparison initially was composed to investigate how conversions between the two formats turned out, but was enlarged to also include the formats as such and a few ideas on how the two could be improved. Specific comments about the data sets that were converted from SPOLD format to SPINE format and vice versa, can be found in section A2, while the chapter itself contains general conclusions.

Through out the report, the terms taken directly from the SPOLD format is written in italic text.

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<sup>5</sup> The environmental report is a questionnaire made by the government. The purpose of the environmental report is to be the base for permission trial of industrial activities that are harmful to the environment and further to make sure that the companies comply with the decision, all according to the Swedish environmental protection law.



### 3 Method

The material available about SPOLD is:

- The status report: Introduction into a Common Format for Life-Cycle Inventory Data [Singhofen A, 1996]
- The help function available together with the SPOLD-software
- Personal communication

To understand the SPOLD format we have used the help function, which is available together with the format. We have also had the privilege of corresponding with one of the creators of SPOLD, Bo Weidema [Weidema B, 1998]. Through this contact several questions have been answered, and we are most obliged for all his time and effort. Before starting the evaluation we also studied the status report Introduction into a Common Format for Life-Cycle Inventory Data [Singhofen A, 1996]. The purpose of doing this was to get familiar with the concept behind SPOLD and to get an idea of how the format is built. However, it is worth mentioning that this report is out of date and does not describe the current SPOLD very well. In retrospect, we must say that it would have been preferable not to read the report. The idea of the format that we formed, when reading the report, made it unnecessarily difficult to understand the latest version of the format.

The evaluation has been done through using the SPOLD format to document data sets and evaluating these data sets. The information used in the conversion derives from different kinds of sources already available to us. The purpose was to get as wide range as possible in the study. The sources used are environmental reports, life cycle assessment reports, and environmental declarations. Due to the similarity of these sources and the fact that we have not been able to enter as many data sets as we would prefer, we have also studied the format in a more general way. The evaluation of the entered data sets consisted of looking at which information could and could not be entered into the format. In addition, observations were made regarding which information was stressed in the format.

A comparison with the SPINE format has also been made. To enable the comparison between SPINE and SPOLD, the format for unit processes<sup>6</sup> in SPINE is used, while the format for systems is used for SPOLD, because these are the most compatible. When performing the comparison we used different ways to enter the same information, and then evaluated the results. First one data source was used to create one data set in SPOLD, and then one in SPINE. The advantages and disadvantages were evaluated for three different data sets for each format. In addition, conversions of data were made from SPINE to SPOLD, and vice versa. That is, the information entered in SPINE was used as the data source when a data set was created in SPOLD, and the other way around. Also in this case the results were evaluated and compared, but more importantly we made a mapping over the two formats, so that the different fields in the formats were compared.

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<sup>6</sup> The unit process is called simple or plain process in SPINE.

## 4 A description of the documentation tabs in SPOLD

When entering data into SPOLD, there is a choice to use either a format for unit processes or one for systems. The difference between the format for unit processes and the format for systems is that the former has fewer fields, because some fields are not relevant for unit processes. The unit process and system are further discussed in section 5.1.1.

When the choice is made about what kind of format that should be used, the user can choose a *Reference code*, or one is automatically given. The *Reference code* consists of eight characters and is specific for each data set.

The SPOLD format is built of eight tabs, which are shortly presented here.

### **Graphics**

In *Graphics* one can describe/find a presentation of the processes both in graphs and in text and give information about the flows and the *System Models*.

### **Data Identification**

The *Data Identification* tab consists of two subtabs, where the data set is identified in terms of line of business, the reference product, validity, and representativeness.

### **Data Source**

In the *Data Source* tab the origin of the data and the persons involved with the data set are specified.

### **System Models**

In the *System Model* tab the boundaries, allocations, and structure of the system are addressed.

### **Inputs, Outputs, Other Interventions**

The tabs *Inputs*, *Outputs*, and *Other interventions* list the information about the in- and out-going flows and other interventions in tables.

### **Validation**

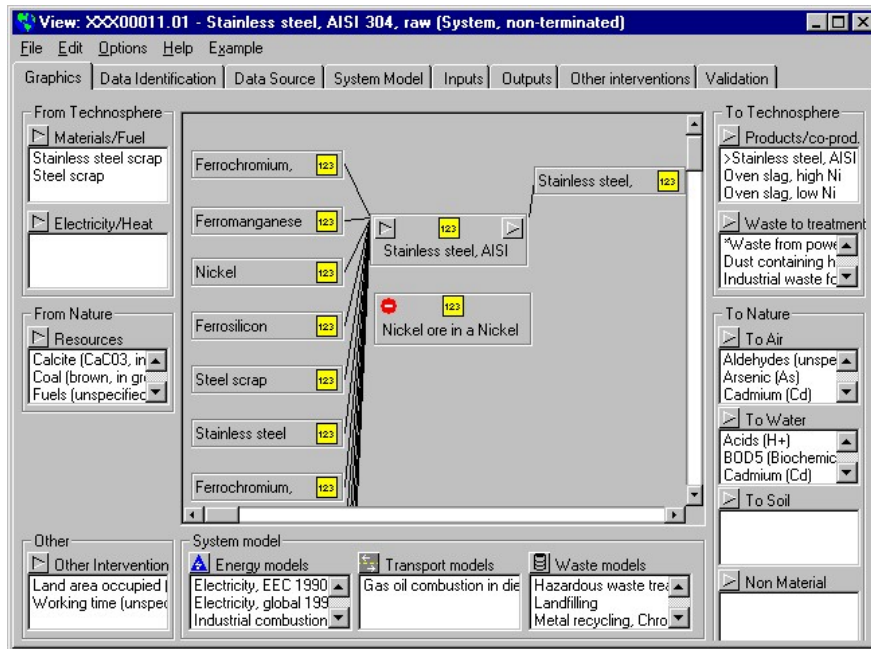
In the *Validation* tab information about the validation in terms of method and the persons involved.

A more detailed description of the different tabs in the format for systems follows below. Comments are made when there are differences between the described format and that for unit processes.

### **4.1 Graphics**

In the *Graphics* tab, one can describe the processes both in graphs and in text and give information about the flows and the *System Models*. The *System Models* are not included in the format for unit processes. Below, figure 1 shows a screen shot of the *Graphics* tab.

**Figure 1** The figure is a screen shot of the initial tab, *Graphics*, in SPOLD. The processes are shown in the flow chart in the centre and the flows are listed on the sides. Beneath the flow chart the *System models* are listed.



#### 4.1.1 The graphical presentation of the processes

In the middle of the tab, as can be seen in figure 1, there is room for the graphical presentation of the processes included in the data set. A flow chart can be constructed by boxes, which are connected by lines.

To each box there is a sheet for information about the processes. The sheet pops up when the box is clicked on. For a unit process the graphical presentation consists of only one box, which can not be described further than with the *Reference code* belonging to the data set.

In the sheet for the central process (where the reference function occurs), there are questions about the *Reference code*, *Name of the process*, and the *Location* of the process. If the central process is available as a separate data set in SPOLD, this is indicated by an icon, which is also chosen in the sheet. There are three different icons to choose between, one that represents that there is no separate data set available, one that there is only qualitative data available in a separate data set, and one that there is quantitative data available in the separate data set. A data set, if any, is referred to by the *Reference code*.

The sheets for the delivering or receiving processes include a field for *Identification*, where a *Reference code* can be given to a separate data set. The *Name of the flow* is asked for, and *Geography*, where there are inquiries about *Location* and *Transport*. At the *Size of flow* inquiry, the *Mean* is asked for, and a *Unit* is chosen, and at the *Uncertainty* inquiry, the *Uncertainty type* (statistical distribution) and the coefficient of variance (*CV*) for the values contributing to the mean value are given. Finally there is also the same choice of icons as for the central process.

#### 4.1.2 The flows

On each side of the flow chart the flows can be listed in different categories, which are:

*From Technosphere: Materials/Fuel, Electricity/Heat*

*From Nature: Resources*

*To Technosphere: Products/Co-products, Waste to treatment*

*To Nature: To Air, To Water, To Soil, Non material.*

For each flow there is a sheet, which pops up when the flow in question is clicked on. The first inquiries are about *Identification*, and the *Name* and an *ID* are addressed. If the substance of the flow is the reference function of a separate data set, the *ID* shall refer to this data set. If there is no such data set, but the substance has a CAS-number, this should be entered instead. The second inquiry covers the *Origin* of the flow if the flow is ingoing and *Destination* of the flow if it is outgoing. In the second inquiry the *Location* and *Type of transport* are asked for. Likewise, *Environmental conditions* are asked for when the flow comes *From nature* or goes *To nature*. The size of the flow is asked for in terms of a *Mean* together with a *Unit*. If the size of the flow is measured in energy content, the amount should be entered in the special *Energy* field, with the same questions about *Mean* and *Unit*. When the first energy related flow is entered into SPOLD, a question about *Net value* or *Gross value* appears. This value is chosen for the whole data set. There is also a field for *Uncertainty* included on the sheet. Here inquiries are made about the *Type* of uncertainty and the *CV* (coefficient of variance). On the bottom of the sheet there are inquiries about the *Collection method*, *Data treatment*, and a *Reference to source*. Finally, there is also an icon for *Adjustments*. If the icon is clicked on, another sheet appears, which is identical to the subtab *Representativeness, Time, Geography and Technology*. *Adjustments* should be made if the specific flow differs from the whole data set regarding the information about *Representativeness, Time, Geography and Technology*. For more information about these inquiries, see section 4.2.

The sheets for the flows of *Products/Co-products to technosphere* also include a field where the *Type* of product is entered. The different types available are *Reference product*, *Include avoided product system*, and *Allocated by-product*. When the latter two are used it is possible to leave further *Arguments, explanations and references*. The *Allocation method* for the allocated by-product can also be given together with the *Fraction* that is allocated to the by-product.

Other resources, such as land use, are categorised as *Other interventions* in the *Other* field.

The sheet for *Other interventions* is the same as for the flows except for the *Energy* field, which is not included here, and the field for *Origin*, which only has one inquiry about the *Environmental conditions*.

#### 4.1.3 System models

At the bottom of the tab there are inquiries about special models, *System Models* included in the system, which are defined as *Energy model*, *Transport model*, and *Waste model*. The generation of energy, transports, and waste treatment included in the system should be listed here, if any information about these is known. The *System Models* are therefore not included in the format for unit processes. Further *System models* should only be used when these activities are not presented as subsystems with their own data sets.

## Energy model

The sheet, for the *Energy model*, includes the same field for *Identification* as the sheets for the flows. A *System type* description is chosen from one of the following alternatives: *Heat generating subsystem*, *Electricity generating subsystem*, and *Co-generating subsystem*. The size of the flow in the model is required in terms of a *Mean* value, together with a *Unit* and the *Energy efficiency (output/input)*. In addition, a *Reference to source* can be given.

## Transport model

The sheet for *Transport model* has the same fields for *Identification* and *Reference to source* as the one for *Energy model*. The sheet also includes inquiries about *Energy use per Mg and km* and *The total amount of primary energy carrier used*.

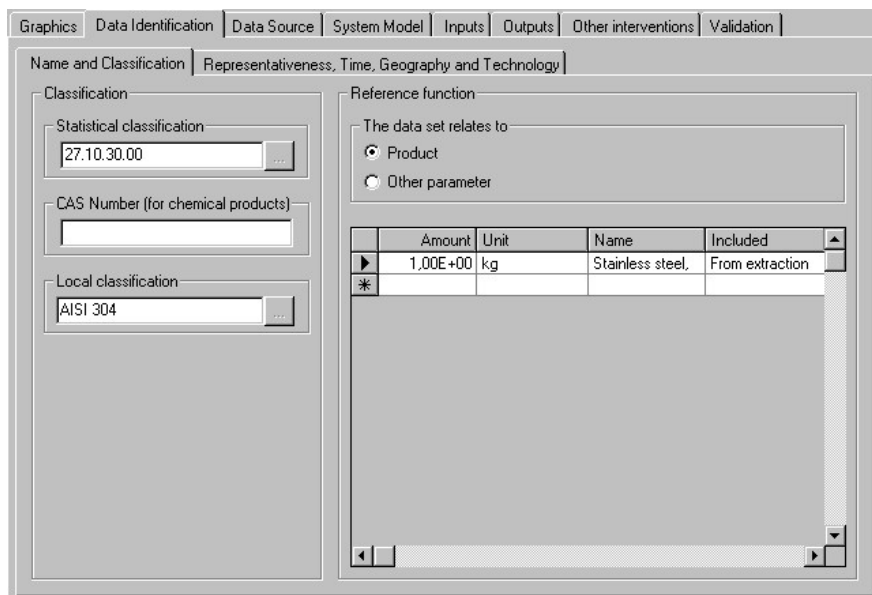
## Waste model

The sheet for *Waste model* also has the same fields for *Identification* and *Reference to source*. Furthermore, it has inquiries about *The total amount of waste entering the system*, *Products output of system*, *Destination*, and the *Allocation method* used. The allocation method can be chosen from the following alternatives: *Expanding system*, *Physical causality*, *Economic causality* or *Other method*. If the last alternative is chosen, a text field, in which a description can be added, appears.

## 4.2 Data Identification

The *Data Identification* tab consists of two subtabs, where the data set is identified in terms of line of business, the reference product, validity, and representativeness. Below, figure 2 shows a screen shot of the *Data Identification* tab.

**Figure 2** The figure shows a screen shot of the *Identification* subtab in the *Data Identification* tab in SPOLD. The other subtab *Representativeness, Time, Geography and Technology* is shown when it is clicked on.



### 4.2.1 Name and Classification

In the *Name and classification* subtab, inquiries about the line of business are made. Here, the user can make a *Classification* of the business both through the *Statistical classification*, which consists of the predefined EU-classification system of branches, and/or a *Local*

*classification*, which enables an internal classification system for the user. A *CAS-number* (for *chemical products*) for the reference function can also be given here if there is one available.

There is also an inquiry about what the data set relates to, where *Product* or *Other parameter* can be chosen. The *Reference function* shall also be described here. This is done in a table, where the reference function can be named, the amount specified, and the included processes listed.

#### 4.2.2 Representativeness, Time, Geography and Technology

The other subtab is *Representativeness, Time, Geography and Technology*. Here, the validity can be specified in terms of the *Time period*, the *Geographical area for which the data set is valid* (specified with the country/countries in question together with additional notes in the *Open text field*), the *Technology for which the data set is valid*, and the *Representativeness*.

The time period is specified with year and date, and can either represent the period during which the data were collected or the period during which all conditions regarding the production are the same.

In the field for Representativeness two questions are asked: 1. *Out of all processes, products or systems (as defined by the "Reference function") using the technology defined above, in the area and time period defined above, what percentage is included in the present data set;* 2. *The actual production volume and number of sites for which the data were collected, the sampling method and possible bias due to lapses.* The sampling method is the way in which the data set has been picked out, and possible bias due to lapses should be entered if the samples are not randomly chosen.

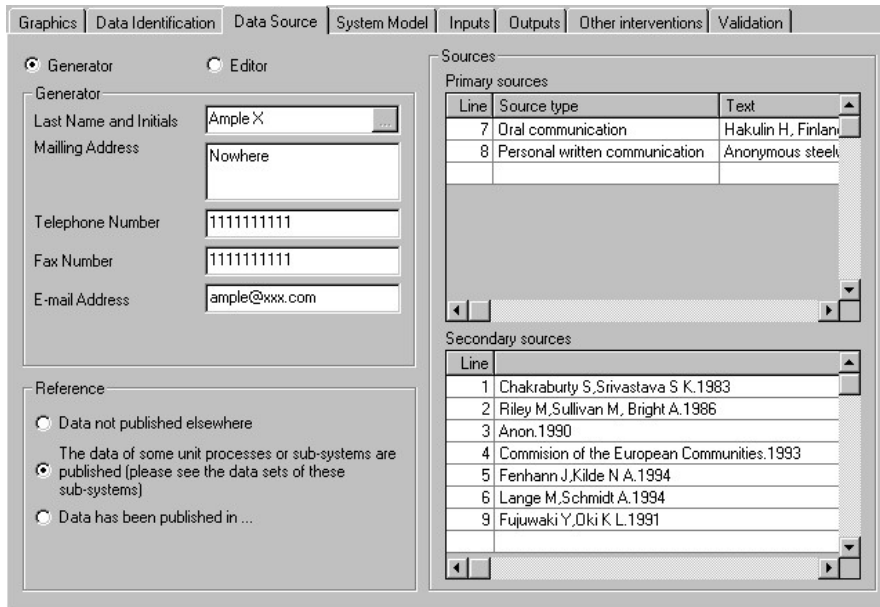
#### 4.3 Data Source

In the *Data Source* tab the origin of the data and the persons involved with the data set are specified. Figure 3 shows a screen shot of the tab below.

The names and addresses of the *Generator* and the *Editor* are asked for. Literature references can be listed as *Primary sources* or *Secondary sources*. The primary sources are categorised as either *Measurement on site*, *Oral communication*, *Personal written communication*, or *Questionnaires*. In the same way secondary sources are categorised as *Article*, *Chapters in anthology*, or *Separate publication*.

Those literature sources that are valid for the whole data set, are asked for in the tab. There is also a possibility to mark that the data has not been published elsewhere, if this is the case, or if the data of some unit processes or subsystems have been published elsewhere.

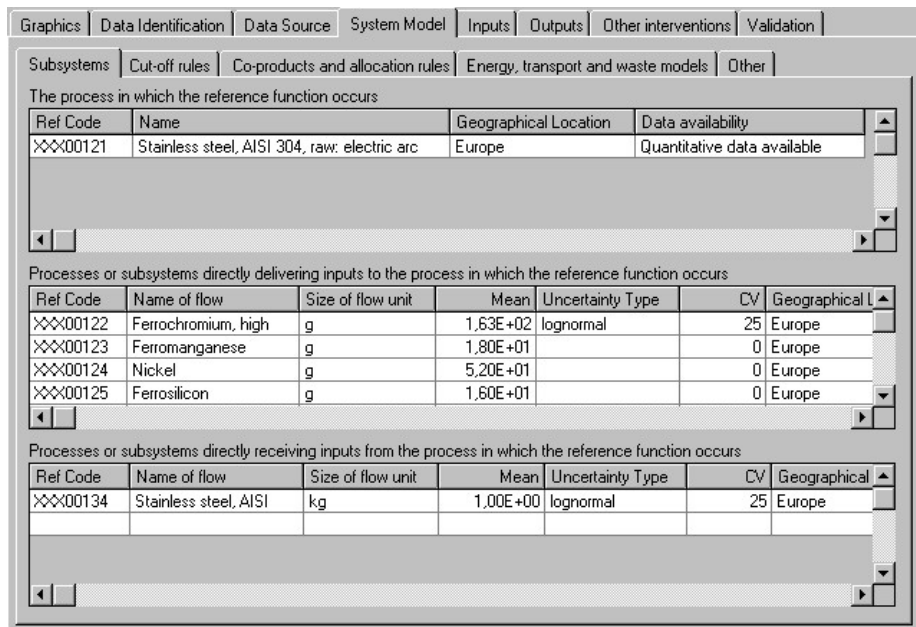
**Figure 3** The figure shows a screen shot of the *Data Source* tab in SPOLD.



#### 4.4 System Model

In the *System Model* tab, the boundaries, allocations, and structure of the system are addressed. Figure 4 shows a screen shot of the *System Model* tab, and the five subtabs are further described below.

**Figure 4** The figure shows a screen shot of the *Subsystem* subtab in *System Model* tab in SPOLD. The other subtabs are shown when they are clicked on.



##### 4.4.1 Subsystem

The *Subsystems* subtab shows tables of information about the processes, which are entered in the flow chart in the first tab *Graphics*.

#### 4.4.2 Cut-off rules

The *Cut-off rules* subtab contains a list of items (such as *Research and Development*, *Personnel Canteen*, and *Waste treatment*) that usually are parts of different industrial activities etc. The cut-offs of these items are to be commented on here in term of *Degree of cut-off*, *Cut-off criteria*, *Threshold*, and *Rational for cut-off criteria*.

The *Degree of cut-off* can be chosen from a list. It can be entered whether the item is included in the system or not, and to what extension it is included. The alternatives are: *Not known*, *All included*, *Not relevant*, *Some excluded by*, and *All excluded by*. When one of the two latter alternatives is chosen the following inquiries also have to be addressed. The *Cut-of criteria* that motivate the degree of cut-off, the *Threshold* value of the criteria determining whether a process is included or excluded, and the *Rational for cut-off criteria*, which describes why the cut-off was made the way it was. The *Rational for cut-off criteria* is chosen from a list, where *Assumption*, *Convention*, *Sensitivity analysis*, and *Experience from similar products* are the alternatives.

If any *Additional screening* has been done, this can be noted on the bottom of the tab. The inquiry aims at finding out if the excluded items in the cut-off list have been checked for toxic or other hazardous substances.

#### 4.4.3 Co-products and allocation rules

The third subtab, *Co-products and allocation rules*, lists both the allocated and avoided by-products, originating from the same process/subsystem as the reference product. The information found here is entered for each product, in the first tab *Graphics*.

#### 4.4.4 Energy, transport and waste models

An overview, of the system models, which are entered in the *Graphics* tab, is given in the next *Energy, transport and waste models* subtab.

#### 4.4.5 Other

The last subtab, *Other*, offers a possibility to leave information that can not be fitted elsewhere. Depending on the character of the information, it is entered in one of the fields *Other assumptions* or *Other information*.

In the subtab there is also a field called *Import overflow data*. This field may contain ASCII text, when there is a mismatch of files when importing data.

### **4.5 Inputs, Outputs, and Other interventions**

The tabs *Inputs*, *Outputs*, and *Other interventions* list the information about the in- and out-going flows, and other interventions in tables. The information shown here is already given in the *Graphics* tab.

### **4.6 Validation**

In the *Validation* tab information about the *Validation procedure which have been applied in general* can be explained both by naming the method used and by giving a detailed description in the *Details for each applied validation procedure* field. The person/company responsible for the validation can be named and a reference to his/her/its address can be made. Below, figure 5 shows the *Validation* tab.



**Figure 5** The figure shows a screen shot of the *Validation* tab in SPOLD.

Graphics | Data Identification | Data Source | System Model | Inputs | Outputs | Other interventions | Validation

Validation procedures which have been applied in general

Validation on site

Recalculation

Mass balance

Cross-check with other source

Proof-reading of database entries

Other

Elements included in mass balance

Total mass

Select verification procedure

Details for each applied validation procedure

For each applied validation procedure, please enter the name, mailing address, telephone and telefax numbers (following the country code in brackets) and e-mail address of the validator

## 5 Evaluation of SPOLD

The SPOLD format aims at giving a complete and detailed presentation of a data set. In our experience, we find it likely that all parts contributing to transparency of a data set are addressed in the format, but not always to a satisfying degree. Our opinion is based on the evaluation of four different data sets converted to the SPOLD format. For detailed notes about each data set, see section A1.2. The following chapter sums up these experiences under the headings Formation of data sets, Language and explanations, Technical flexibility, The range of use of SPOLD, and finally Conclusions.

### 5.1 Formation of data sets

During our work with SPOLD most of our difficulties have been to understand how to structure the information into data sets. The explanations of the definitions of unit process, system, subsystem, and system model are unsatisfying. The restricted way to structure data sets makes it very laborious to enter large data sets, containing other processes than a central process with directly connected delivering and/or receiving processes. Furthermore, the fact that the flow chart contains processes described as flows, makes things even more confusing.

Below we have explained the definitions of unit process, system, subsystem, and system model, as we understand them, and have given general comments about using these definitions to form data sets.

#### 5.1.1 Interpretation of structure related terms

##### Unit process

A unit process is the smallest technical system for which data have been collected. The data can consist of qualitative information, quantitative information or both.

It is worth noticing that if information about energy production, transport, waste treatment, or other included processes is available, the data set is not a unit process, but should be presented as a system.

By leaving identity codes (*ID*), several unit processes can be linked to each other. The *ID* can be given under *Inputs from technosphere* and *Outputs to technosphere*. In this way many unit processes can form a string that constitutes, for example, a production chain. It is important to remember that the SPOLD-software itself can not link the data sets and add the figures. The references are just made so that the user can look up related data sets.

It is possible to make an overview of a string of unit processes as one data set. However, this requires that the string only consists of three (or less) processes, as described below.

### **System**

The format enables systems consisting of one central process, where the reference function occurs, and delivering and receiving processes, directly connected with the central process. The system format can thus supplement the string of three unit processes, or less, with a direct overview. The data sets containing the unit processes can be referred to with a *Reference code* for each subsystem, so these can be found.

The editor can also choose to present several unit processes as a system, that is, as one data set. An advantage in doing this is that one gets both clear views of the processes and the information about these, in the same place. The drawback is that information could be lost due to lack of space in the documentation format. The system format can be preferable when the user does not want to give detailed information about the system. The reason for this could for example be that some of the data are classified and therefore should not be available to the public.

In addition, systems can be linked together to form larger systems, by leaving *Identification codes* to separate data sets for the inflow or outflow in question. In this way each flow that enters the system can refer to a separate data set, which has the substance of the flow as reference function. In the same way, each outgoing flow can refer to a data set that has the substance of the flow as input, or in the case of waste to treatment, a data set that represents the treatment of the waste in question etc.

### **Subsystem**

A subsystem may be a central process, a delivering or a receiving process. The subsystems can, in the same way as the unit processes, be further described in separate data sets. The references to the data sets are made by a *Reference code* for each subsystem.

### **System models**

Heat generation, electricity generation, transport, and waste treatment should be presented as system models when these are not directly accessible as separate data sets, containing qualitative and/or quantitative information, with their own *Reference codes*. That is, if there is a lot of information available about the heat generation, electricity generation, transport, and/or waste treatment, one should present these processes as separate data sets, so that no information is lost. In the case where there is only a little information available, the system models should be used to make these important parts of the system clear. The definition of unit processes does not include *System Models*, why these fields are not displayed when a data set is represented as a unit process.

### 5.1.2 Comments

When one chooses to form a data set as a unit process there is no possibility to give the process a name or enter the geographical location( as there is if the data set is presented as a system. Only the reference code is shown in the flow chart. The graphical presentation ought to make a contribution to the overall picture, but it loses its purpose when not even the name of the process is shown.

When several unit processes can be connected to form larger systems, the data handling would be made easier if the string of unit processes were presented in some way. Such an overview can not be given/found unless the unit processes can be described as separate subsystems in a system.

The restrictions in the flow chart, which only allow one central process but several receiving and delivering processes directly connected to the central process, can result in a non-transparent structure. When many processes have to be included in one subsystem, no clear view of the system can be given and the specified inquiries and the limited space often make it impossible to enter all relevant qualitative information.

It is, however, possible to make references to data sets, on several different levels, until all processes are described, see figure 6. In this way, one subsystem may contain other smaller subsystems, which in turn can be split to form a new data set. The procedure is repeated until all relevant information can be given. A reference is made by a *Reference code*. This is a time consuming way to enter information and in some cases very inefficient. In the case of the data set Copper, different levels would have to be made, but we would still not be able to enter all information concerning the technical description for each process, because of the restrictions in the format. The example from the data set Copper can be found in section A1.2.4, item 1.

The idea of defining energy generation, transports, and waste treatment as *System Models* confuses the user. It is at first not clear whether these system models are included in the whole system or could/should be added. Furthermore, it is not possible, either from the flow chart or in other ways, to describe/determine how the system models are connected with the rest of the system.

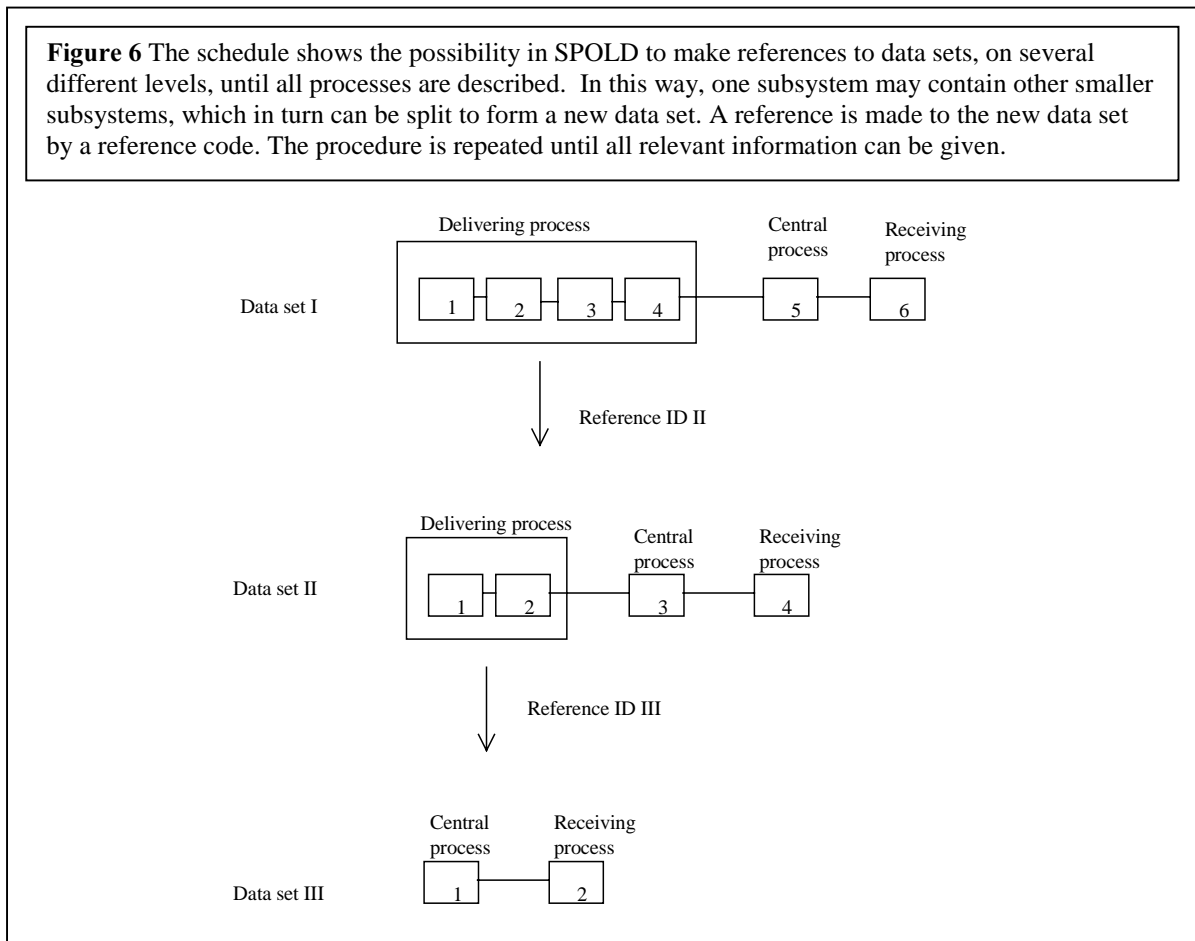
The flow lists on either side of the flow chart is pedagogic and easy to understand, but the sheets where the flows are defined have some weaknesses. There is often a need for a more detailed description of the flows of the data set, for example about the contents and the supplier, see section A1.2.3, item 4 for an example. This should be asked for, or space for general information should be given for each flow. It would also be practical to be able to enter general information that concerns all flows\*.

The flow chart in the *Graphics* tab is confusing, because processes and flows are mixed. The convention when working with LCA is writing processes as squares, and flows of raw material, energy, or waste as arrows [Tillman A-M, 1998]. The sheet in SPOLD, belonging to the delivering and receiving processes/subsystems, does not contain any inquiries about the process/processes in the subsystems. The information shown in the box, in the flow chart, is instead the name of a flow. Inquiries like *Name of flow*, *Size of flow*, and *Uncertainty* are made on the sheet. The fact that the flows are mentioned here is good, but there should be an

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\* For suggestion, see A1.1.1

indication about the direction of the flow (in- or outgoing)\*. The inquiry about transport on the same sheet is also confusing because if the process/subsystem is a transport this information should be given in the process name/description. The insufficient inquiries, together with the confusion in the name conventions, make it very difficult to sort things out.



The same information that is entered in *Graphics* is also presented in the tabs *System Model (Subsystems, Co-products and allocation rules, Energy, transport and waste models), Input (From technosphere, From nature), Output (To technosphere, To nature), and Other interventions*, which give us a clear and comprehensive view of the information in form of tables.

## 5.2 Language and explanations

The format uses some terms that are not clearly defined, and sometimes there are no explanations available in the help function, at least not where you intuitively expect to find them. We think it would be a great help if at least all inquiries can be searched for in the help function, so that it is clear what should be entered in the different fields. An introduction to the format, that can be printed, should also be available.

\* For suggestion, see A1.1.2

Below we present several examples of language related problems that we came across during the work with SPOLD, and the difficulties we experienced finding and understanding the explanations available.

*Unit Process, System, Subsystem, and System Models* are not sufficiently described so that the user clearly understands how to use them. It is of great importance that the user knows how to form the data sets. Without this knowledge no other information can be entered into the format, or the information is entered incorrectly.

Each flow has a field for *ID* and each subsystem (unit process) a field for *Reference code*. At first it is quite difficult to sort out the difference between the two. The explanations are hard to find in the help function and they are separated. It would make it easier if the terms were mentioned at the same place. It is also a bit confusing that the inquiry field is called *ID field* when the *Reference code* is discussed (see *Delivering process or subsystem* in the help function).

The list of references is very practical, but because of the lack of explanation of primary and secondary sources, it is sometimes difficult to decide where to put the sources. For example it was first not clear whether an environmental report was a primary or secondary source. This report is written annually by companies with hazardous activities, and handed in to the government for examination according to the Swedish environmental protection law. We first thought that the environmental report was a primary source because the information comes directly from the company. Tough, Bo Weidema [Weidema, Bo, 1998] could clarify that the environmental report should be classified as a secondary source since the information was not primarily intended for us.

The additional explanations in *Original description*, next to the units in the unit list, are very informative, especially in the cases when SI-units are not used.

*Statistical classification* (under *Name and classification*), which one can choose, is well structured and easy to understand. However, we wonder why the word statistical is used. The fact that the format uses predefined EU-standard is good, because it is used in many similar contexts. The classification system is, however, inconsistent. The list is a mixture of both products and processes, which we find a bit awkward. Finally, it is good that there is a possibility for a local classification system.

In the list of *Cut-off rules* it is not always clear what the inquiries aim at. Some explanations are given in the help function, but the choice of words could initially have been made better. For example it is questionable what the word “by” aims at in the row *Degree of cut-off*. The heading *Additional screening* is not very informative either. Screening is a concept used in LCA but it has no direct definition. The format does not include the context and it is therefore difficult to know what the screening aims at.

It is not clear whether or not the transports, addressed under *Origin* or *Destination* for each flow, are included in the data set. If this is a field for additional information about how the system could be enlarged, this should be stated so that no misunderstandings are made.

In the *Representativeness* field, the user is required to insert information about the production volume and number of sites for which the data were collected, the sampling method, and possible bias due to lapses. This is important information, which preferably could be stressed

by separating these inquiries. It is confusing when information without any direct relation is mixed, why at least the question about the production volume should be moved. The relation between this question and the others is not obvious. There should also be space to describe all sites that are included in the data set, at least so that they can be listed. Furthermore, it is difficult to know what the inquiry about *Possible bias due to lapses* means and what it aims at. At first we thought that it had something to do with overlaps in the documentation of the data set, that may result in errors in the numerical data. We now know that this is not the case, as explained in section 4.2.2.

When the *Energy models* are defined, one alternative is *Co-generating subsystem*. This has no obvious meaning, and no explanation is given.

It is not clear what information should be given in the *Open text field* below the question about *Geographical area for which the data set is valid*, both on the sheet for *Representativeness, Time, Geography and Technology*, and on the sheet for *Adjustments*. We assume that the field should have something to do with geography, but nothing is said about this in the help function.

### **5.3 Technical flexibility**

There are several technical limitations in the format. Some of these have a major impact on the data quality, while others are just annoying. Bugs and errors occurring in the program are listed in section A1.3.

A problem that arises through out the format is the lack of space. The limited fields make it impossible to describe the data sets sufficiently, and the transparency is lost. Below we have listed the fields that in our experience contain too few characters. To each field a reference is given to a data set in section A1.2, where an example can be found.

- *Collection method* (in the *Graphics* tab)  
See Copper section A1.2.4, item 10
- *Data treatment* (*Graphics*)  
See Copper section A1.2.4, item 10
- *Representativeness* (the second question) (*Data Identification*)  
See Copper section A1.2.4, item 7; Sawed construction timber in section A1.2.1, item 7
- *Included processes* (*Data Identification*)  
See Sawed construction timber section A1.2.1, item 4
- *Technology for which the data is valid* (*Data Identification*)  
See Nonylphenol and dinonylphenol section A1.2.3, item 4
- *Place of publication* (*Data Source*)  
See Copper section A1.2.4, item 3
- *Cut-off criteria* (*System Models*)  
See Crude oil section A1.2.2, item 3
- *Other assumptions* (*System Models*)  
See Copper section A1.2.4, item 9
- *Other information* (*System Models*)  
See Sawed construction timber in section A1.2.1, item 5, 6
- *Other* (*Validation*)  
See Nonylphenol and dinonylphenol section A1.2.3, item 8

It is quite difficult to overview the information when the visible part of the fields are so small.

When the mean value of a flow is entered, one has to use a dot, and not a comma, to mark where the decimals begin. The comma represents ten raised to the third power. This is standard in some countries, but not in all. Some users might therefore be confused, when no information is given about what standard that is used. If the user does not notice how the comma is used, severe errors will occur. The program automatically rounds all mean values to three significant numbers, which is not always desirable\*.

On the sheet with *Adjustments* for the different flows, specific information concerning representativeness, time, geography, and technology can be given. This is good as long as the user easily can find this sheet. The more layers there are in the format, the greater the risk of overlooking information. Though, in this format, a red-coloured icon of a pen indicates that information is saved in this sheet. The icon decreases the risk of not finding this sheet.

When the alternative “not known” has been chosen in *Cut-off rules*, this should be shown in the table. Otherwise the user can suspect that the editor has not addressed the item.

The units of the mean values that are added by the user are not shown directly in the list, when it is first opened. Not until a new unit is added, all units are shown. The added items are not assorted in alphabetical order in the lists. These facts make it difficult to find the right unit and know which units that are already defined.

It is good that there is one list of substances for each type of flow. However, sometimes the alternatives for type of flow are not usable, as shown in section A1.2.1, item 2.

When a new data set is created, the *Reference code* and the type of the data set is chosen, and it seems to be unchangeable. This means that the user is not allowed to make any mistakes.

The telephone number to *Generator/Editor* can only be described in numbers, which excludes empty space, +, and -. This makes it difficult to read. When a data set is closed, the editor chooses if the change should be ascribed to the editor or generator. When the original data set is changed, editor should be chosen and the information about the generator is overwritten with the information about the editor. The idea of making the last editor generator when changing the data set is good.

Only one comma can be entered in the field *Data have been published in*, which means only two references can be made. This is of course unacceptable.

The amounts entered for the reference functions are sometime not shown in the list. An example of this can be found in the SPOLD-database at CPM [Erixon M, Ågren M, 1998, SPOLD, CPM00027].

We have not imported data, thus not used the *Import overflow data* field.

#### **5.4 The range of use of SPOLD**

All types of data sets do not fit the SPOLD format, due to the fact that the SPOLD format is quite inflexible. The format lacks in different areas, depending on the source of the information. Because of the limitations in SPOLD, it is interesting to try to find out what kind

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\* For suggestion, see A1.1.3

of data sets that turn out well in the format, and why this is so. In the following chapters this is investigated by looking at the related problems in SPOLD and at the converted data sets, which are based on information from different sources.

#### 5.4.1 Detailed inquiries

We have recognised a problem concerning the documentation, caused by the lack of flexibility in the format. The many detailed inquiries force the user to address important subjects, which is good. However, a problem occurs when this specific information is not available in the source, but related, more general descriptions are available, which often is the case. The problem is that no alternative to the specific inquiry is given. In the bullet-list below this problem is exemplified.

- The *Time period*, for which the data set is valid, is solely defined by year and date. The time period can either represent the period during which the data were collected or the period during which all conditions regarding the production are the same. It is, however, not possible to state which of these alternatives that is valid.

Because of the specific way to answer the inquiry some information is lost in the configuration, when the data source have less specific data concerning the time validity. This can be exemplified with the data set “crude oil, natural gas”, where the field is left empty. The information given in the data source is as follows:

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The development in gas and crude oil extraction is continuously progressing, and the data will therefore in time be out of date. The data are from 1991.

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From this, the user can make his/her own assumption about the validity of the data set. A date is of course easier to use, but this is better than no information at all.

- The *Representativeness* is partly described with the following question:

*Out of all products, processes and systems (as defined by the “reference function”) using the technology, in the area and time period defined, what percentage is included in the present data set?*

To answer this question one has to have knowledge about other sites than the one that is handled in the data set. If this is not the case, it would be preferable if the site specific information could be entered in a field, so that the user can evaluate and decide if the data set ought to be used in that specific case.

- *Cut-off rules* are defined for, among others, *personal heating, lighting, working, transport, canteen, and toilets*. The bases for the cut-offs are inquired, together with the threshold value and the reason for the cut-off\*. The alternatives for *Rationale for cut-off* are too few, see section A1.2.4, item 4 for an example. If there has been any *Additional screening*, for toxic substances or others, this can be described with the method used and the person (for example a toxicologist) responsible for the screening.

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\* For suggestion, see section A1.1.4



The *Cut-off rules* subtab contains very specific inquiries about some cut-offs, but there is no room for other cut-offs, or a more general description of the system boundaries. To exemplify the kind of information that is lost, parts of the description of the system boundaries for “crude oil, natural gas” are shown below.

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The environmental loads taken account for are the substances emitted to air and sea, the resources used, and the waste that is generated, when extracting and transporting the crude oil and gas.

Emissions to air cover the following:

- Combustion gases resulting from fuel gas, diesel and jet fuel based power, and heat production, gas flaring, well test burning, and incineration.
- Cold hydrocarbon vents and fugitive emissions.
- Escape of halon from fire prevention systems.

The emitted gases are comprised of CO<sub>2</sub>, CO, NO<sub>x</sub>, N<sub>2</sub>O, CH<sub>4</sub>, VOC, SO<sub>2</sub>, and halon. The SO<sub>2</sub> emissions result from combustion of marine diesel fuel. The produced natural gas only contains traces of H<sub>2</sub>S. As a result the SO<sub>2</sub> in the fuel gas exhaust is negligible.

Small amounts of hydrocarbon gases are vented directly to the air from parts of the production processing line. There are several sources for these continuous and non-continuous emissions: stripping gas from glycol regeneration, gas turbine start-up gas (on old platforms only), venting, purge and blanket operations, fugitive emissions, and compressor system seal leakage.

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For high data quality, an adequate description of the system boundary is a necessity. If the format does not allow entering of all details about the boundaries, such as the above, no transparency can be achieved, although the inquiries about the cut-off rules are very good reminders of what is and what is not included in the system.

- A basic idea through out the format is not to address fields, when the information in question is missing in the source. The user can misinterpret an empty field. An empty field could mean that the information was not available for the editor, but also that the editor forgot to address the inquiry, and that the information in fact easily could be found in the reference literature. To uphold the data quality, the format should always urge the user to leave as specific information as possible, to avoid misinterpretations. For example when the first electricity or heat flow is defined, one has to choose whether the values are net or gross<sup>7</sup>. This information is seldom at hand, why there should be a third alternative “Unspecified”.

In the case when the inquiries are to be answered with predefined alternatives, the alternatives are not always sufficient. For example, *Rational for cut-off criteria* does not have enough alternatives. What if certain things are excluded without any explanation? In

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<sup>7</sup> The Help function in SPOLD gives the following explanation of net and gross values: Net (or lower) calorific value is the heat released during combustion when H<sub>2</sub>O in the combustion products is in its vapour form. Gross (or higher) calorific value is the heat released during combustion when the H<sub>2</sub>O in the combustion products is in its liquid form.

this case there should be the choice “Unspecified”. Also if “Some excluded” is chosen as *Cut-off rule* it may be incorrect to use only one suggestion under *Rational for cut-off criteria*.

- Inquiries concerning each flow are, among others, the *Mean*, the *Uncertainty Type*, e.g. the statistical distribution, and the *CV* (coefficient of variance of the mean value for the flow).

Firstly, the numerical value is assumed always to be a mean value. This is of course not the case, and there should be other choices available. We also find it quite contradictory that the *CV* is required, but not the number of specimens taken. When the number of specimens is low, the *Uncertainty Type* and the *CV* are statistically irrelevant, and the information about the number of specimens is more informative when examining the accuracy and representativeness of the mean value.

#### 5.4.2 The sources of information

A possible problem with the SPOLD format is that the inquiries cover a wide range of different subjects of knowledge. That is, the knowledge of one person (or profession) is not enough. For example the format addresses such areas as physical conditions, collection method, statistics, and the technology for the included processes. In exceptional cases, in small companies one person may have all of this information, but generally this is not the case. To get coverage of all this, several people therefore has to be involved. As far as this is concerned there is no immediate problem, except that the sampling of all the information may result in misunderstandings and errors that always is a risk when documenting data. The making of a data set can be described, as CPM proposes [Carlson R, Pålsson A-C, 1998], in six steps. These steps address the physical conditions, from which the data originate, the quantification of the reality (for example taking of specimens, and analysis), the aggregation to a mean value (statistics), bringing together the numerical data for the whole system and connecting them with the qualitative data, aggregation of several technical systems, and finally a change of context if there has been any. It is in the communication between these steps the errors may occur.

The problem that so far has been addressed is general for all communication of data, but in SPOLD another difficulty appears. In addition to the knowledge that one expects to find within the company, the format also asks for trade specific information. This requires knowledge not only about ones own company but also the business in general in the surrounding area, locally, regionally, and globally. If the inquiries are to be answered satisfactory, it is also necessary to have information about how the data set is related to the rest of the sector. To satisfy the SPOLD format, the company probably has to turn to external information sources, which may not be possible within the frames of the documentation work.

The purpose of the trade-related information, as we see it, is to inform the user about what the data set represents. If the information about the business in general is not available, there should be an additional way of describing the site in question, so that the user can draw her/his own conclusions about how the data set is related to the rest of the trade. This to ensure that the quality of the data is upheld, despite restricted resources, which does not allow external competence.

### 5.4.3 Different types of data sets

Depending on what kind of source of information the data sets are based on they turn out differently. Generally there is a difference between those data sets that are made to cover one specific site and those that represent a trade average. The former covers the narrow fields for information about physical conditions, collection method, statistics, and the technology for the included processes in a satisfying way, while the latter give sufficient information about the business and more general areas. The different deficiencies result in different problems for the data sets, but in all cases the transparency and high data quality are jeopardised.

When we started to evaluate the SPOLD format we entered three different data sets into SPOLD. It therefore seems to be a good idea to summarise how these data sets turned out. We look at both which information is lost in the conversion due to lack of space in the format, and at which fields are left blank in SPOLD.

#### **LCA-reports**

In the case where data sets are created in SPOLD from information found in LCA-reports, great parts of the description of the technical system is lost. The system boundaries can not be described satisfactory. Neither can the detailed information about data treatment, which is available in the reports, be entered into SPOLD.

System models are sometimes used, but the inquiries do not fit the information that is available. Therefore, many fields are left blank and the information about for example the transports is lost.

Generally, the time period can not be specified as the format requires. No validation of the data sets was addressed in the data source, why the sheet concerning validation is left blank in all cases.

Looking at the data sets, and knowing what information that is lost due to the conversion, it is obvious that the data in the data sets are in no way transparent or of high data quality. One can question if the original data in the LCA-reports are totally transparent to begin with, but there is no question that the documentation is better in these reports. It can be said that the SPOLD format may be more efficient when it comes to time, but the advantage of saving time is weighted out by the disadvantage of losing valuable information. If the data should be used, it is crucial that one at least know in detail what technical system it represents.

In these cases one can not see that anything has been gained by converting the data in to the SPOLD format, except that the data might be easier to find for those that the database is available for. Through the information in the database, the original source can be found, and further investigations can be made.

#### **Environmental reports**

In the conversion of information from environmental reports into the SPOLD format, the same information is lost, due to lack of space, as in the case of converting information from LCA-reports.

When it comes to the system boundaries nothing can be said, because the inquiries at cut-off rules do not fit the information available. One general example that accounts for all environmental reports is that the information about which substances that have to be checked, according to the Swedish environmental protection law, can not be given. Neither can the

threshold values for each substance be given. In addition, a lot of specific information about the flows is lost and site specific information such as environmental conditions can not be entered satisfactory.

The fields for time boundary, validation, and cut-off rules are left empty also in this case.

It must be said, however, that the data in environmental reports are not transparent and of high quality to begin with [Erixon M, Ågren S, 1997]. The fact that the environmental report is a form of questionnaire makes the conversion even more difficult, because there is a mismatch of the inquiries in the environmental report and the ones in the SPOLD format. If information taken from such a specific source, is to be converted to another documentation format, a quite flexible format is required.

### **Environmental declaration for a product**

The trade average that the environmental declaration presents fits the SPOLD format better than the other information sources, which only represent one site. The inquiries in SPOLD are written assuming that the data set represents an average. For example, a *Mean* is required to describe the size of a flow. The information concerning the business in *Representativeness* also fits this type of data set better, although in this specific case, this type of information is not available.

Some information about the system is again lost in the conversion due to lack of space. When it comes to the transport model, certain information can not be entered because it does not fit as answers to the inquiries, see section A1.2.1, item 3 for an example. The fields for *time boundary*, *validation*, and *cut-off rules* are also left empty in this case.

The environmental declaration does not contain all relevant information to achieve high data quality and the restrictions in the SPOLD format make the quality even worse for the entered data set.

### **5.4.4 Data sets fulfilling the requirements of SPOLD**

As previously stated, it is our experience that the format addresses all necessary parts to achieve high data quality. It is, however, not certain, or even likely, that high data quality would be achieved even if all inquiries in SPOLD could be answered.

A great part of the problem lies in the fact that there is so little space in many of the fields. This requires the user to specify the technical system adequately, with just a few words, which we believe often is impossible, particularly for laymen. However, among experts on the subject technical terms could easily be used and understood. Also, when the data sets are used within a limited environment, where the knowledge about the processes in question is high, the SPOLD format can be used.

Furthermore, the only way to describe the system boundaries is through the predefined cut-off rules, which are very inflexible. If neither the technical system nor the boundaries of the system can be described satisfactory, what is then the point of having information about such things as uncertainty type for the measured values? Without the correct context the numerical data are useless.

The technical system is described by the inquiries *Technology for which the data set is valid* and *Included processes*. A detailed function description can not be given here, due to lack of

space. As a complement there is a question about what is represented in the data set. The following discussion will point out that this can not in all cases out-weigh the lack of a description of the technical system.

The inquiry is: *Out of all processes, products or systems (as defined by the “Reference function”) using the technology defined above, in the area and time period defined above, what percentage is included in the present data set?* Depending on the answer to this question a lot or nothing can be said about the data set. For example if the figure is close to 100% and the geographical area is quite large, for example being a whole country, the data set could be used as an branch-average for the country in question. If the figure is small, no conclusions can be made and nothing can be said about the representativeness of the data set. In this case it could be either representative for the branch, or very site specific.

Our conclusion is therefore that it is difficult to uphold the data quality when using the SPOLD format. What must be improved in the format is the flexibility. It must be possible to enter more general information than the inquiries propose, and more space should be available for descriptions.

## **5.5 Conclusions about SPOLD**

The fact that there is no manual to the format and the difficult language in SPOLD makes it unnecessarily hard to get started and use the SPOLD format. The language seems to be that internally used by the creators of SPOLD, and when there are no explanations it is difficult to understand what the inquiries aim at.

The way that the format constructs systems and unit processes is at first difficult to comprehend, and once it is understood, one realises that the documentation format is not transparent. The lack of transparency is, among other things, due to that there is no possibility to document how the flows and system models relate to the processes. That is, it is impossible to check and trace the origin of the numerical data in the format.

Another requirement for transparency and data quality is to be able to fit all necessary information into the format. We have shown that this is not possible in SPOLD.

The range of use of the SPOLD format seems to be quite narrow, due to the inflexibility. The format clearly aims at documenting branch averages and not separate sites. The specific inquiries remind the user to leave detailed information, but at the same time they restrict the ways of documenting the data.

## **6 Comparison between SPOLD and SPINE**

Within the frame of this project, we have chosen not to study the original ideas behind the two formats SPOLD and SPINE. It is, however, obvious that the ideas behind the two formats are not the same and this is reflected in the way the formats are structured and presented. The formats differ in the way the inquiries are made, how specific or general the inquiries are etc.

To enable the comparison between SPINE and SPOLD, the format for unit processes in SPINE is used, while the format for systems is used for SPOLD, because these are the most compatible. The data presented in SPINE as one activity (similar to data set in SPOLD) may

concern individual processes, entire plants or complex composite systems (e.g. a complete cradle to gate system for a certain material) [Carlson R, 1998].

One way of comparing the two formats further, is to convert all information from one format to the other and evaluate the result. In this section we present how this type of mapping turns out and if the converted information has the same data quality as the original.

In the following sections italicized text is used for terms directly taken from the SPOLD format, while terms from the SPINE format are underlined and italicized.

## 6.1 Conversion of information from SPOLD to SPINE

Three of the data sets that were previously entered into SPOLD format are converted into the SPINE format with the purpose of evaluating how the mapping turns out and if the converted information has the same data quality as the original. Each data set is evaluated in detail in section A2.1, and below we give a more general description of the conversion of the information, and summarise some general conclusions that are valid for all the converted data sets.

### 6.1.1 Mapping

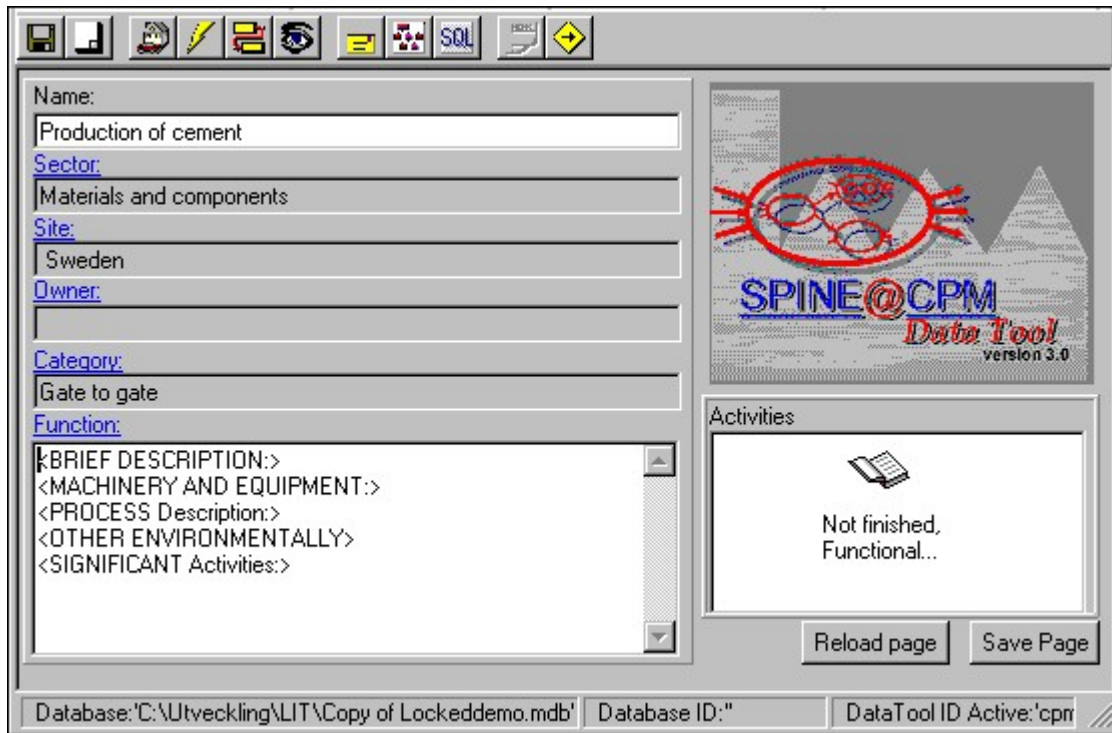
The mapping is done by moving the information in each field in SPOLD, to a corresponding field in SPINE. The result is presented for each tab below.

#### Graphics

From SPOLD	To SPINE
<i>Name of the process</i> (central process)	<u><i>Name</i></u> of object of study
<i>Geographical location</i>	<u><i>GeographicalBoundary</i></u> and possibly <u><i>Site</i></u>
If the activity represents one specific site, the name of the site should be given in <u><i>Site</i></u> and not the geographical area.	
<i>Name of flow</i> (name of delivering and receiving processes)	<u><i>Function</i></u>
<i>Location</i>	<u><i>GeographicalBoundary</i></u> and possibly <u><i>Site</i></u>

The graphical presentation is used to describe the technical system in *Function*. The different processes that are described separately in SPOLD, are described together in *Function*, so that the connections between them are made clear. There are also headings in this text field, helping the editor to sort the information and the user to find it, see figure 7 below.

**Figure 7** The figure shows a screen shot of the *Object of study* in the SPINE@CPM DataTool. In the *Function* field a few headings are given to help the editor to sort the information and the user to find it



### Flows From technosphere

In the table in SPINE entering input or output indicates the *Direction* of the flow. The same accounts for the *Flow Type*. The destination/origin of the flow also has to be indicated under *Environment*, see figure 8.

**Figure 8** The figure shows a screen shot of the *Flow* table in the SPINE@CPM DataTool.

Direction	FlowType	Substance	Quantity	Min	Max	SDev	Unit	Environment	Geography
Input	Resource	Heavy oil (eo5)	XXX				MJ	Not known	
Input	Resource	Iron sulphate	XXX				g	Not known	
Input	Resource	Limestone	XXX				g	Not known	
Input	Resource	Oil	XXX				MJ	Not known	
Input	Resource	Oil	XXX				g	Not known	
Input	Resource	Quartzite	XXX				g	Not known	
Input	Resource	Waste fossil fuel	XXX				MJ	Not known	
Output	Emission	Cd	XXX				g	Air	
Output	Emission	CH4	XXX				g	Air	
Output	Emission	CO	XXX				g	Air	
Output	Emission	CO2	XXX				g	Air	

From SPOLD

To SPINE

<i>ID</i>	<u>Applicability</u> or <u>Note</u> at <u>SpecificQMetaData</u>
References to other activities are made in <u>Applicability</u> , and if the <i>ID</i> is a CAS-number this is put in <u>Note</u> .	
<i>Name</i>	<u>Substance</u> (in the table)
<i>Location</i>	<u>Note</u> in <u>SpecificQMetaData</u>
<i>Type of transport</i>	<u>Note</u> in <u>SpecificQMetaData</u>
<i>Unit</i>	<u>Unit</u> (in the table)
<i>Mean</i>	<u>Quantity</u> (in the table)
<i>Type</i> (uncertainty type)	<u>Method</u> in <u>SpecificQMetaData</u>
<i>CV</i> (coefficient of variance)	<u>SDev</u> (in the table)
The variance can be calculated to standard deviation.	
<i>Collection method</i>	<u>Method</u> in <u>SpecificQMetaData</u> and <u>DataType</u>
<i>Data treatment</i>	<u>Method</u> in <u>SpecificQMetaData</u>
<i>Reference to source</i>	<u>LiteratureRef</u> in <u>SpecificQMetaData</u>
<i>Adjustments</i>	<u>Note</u> in <u>SpecificQMetaData</u>

Flows *From nature* and *To nature*

In addition to the inquiries for flows *From technosphere* there is this following inquiry.

From SPOLD

To SPINE

<i>Environmental conditions</i>	<u>Environment</u> or <u>Note</u> in <u>SpecificQMetaData</u>
---------------------------------	---

### Products/Co-products to technosphere

In addition to the inquiries for flows *From technosphere* there is this following inquiry.

From SPOLD

To SPINE

<i>Type</i> (type of allocation)	<u>Allocations</u> and possibly <u>Note</u> in <u>SpecificQMetaData</u>
The allocation method is described in <u>Allocation</u> and the type of product is mentioned in <u>Note</u> .	

*Other interventions* and *Waste to treatment* include already mapped inquiries.

From SPOLD

To SPINE

<i>System models</i>	<u>Function</u> and possibly <u>Notes</u> in <u>SpecificQMetaData</u>
General information about the included processes is stated in <u>Function</u> . Specific numerical information about the raw material used in the <i>System models</i> is stated in <u>Notes</u> for the concerned flow.	

### Data Identification

From SPOLD

To SPINE

<i>Classification</i>	<u>Sector</u> and possibly <u>Function</u>
If the <i>Classification</i> contribute with new information about the processes this should be added in <u>Function</u> .	
<i>CAS-number</i>	<u>Notes</u> for the substance in question in the nomenclature



<i>Name of Reference function</i>	<u>FUExplanation</u>
<i>Amount of Reference function</i>	<u>FunctionalUnit</u>
<i>Unit of Reference function</i>	<u>FunctionalUnit</u>
<i>Included processes</i>	<u>Function</u>
<i>Time period</i>	<u>TimeBoundary</u>
<i>Geographical area for which the data set is valid</i>	<u>GeographicalBoundary</u> and possibly <u>Site</u>
<i>Technology for which the data set is valid</i>	<u>Function</u>
<i>Representativeness (first question)</i>	<u>Applicability</u>
<i>Production volume (Representativeness, second question)</i>	<u>AboutData</u> and <u>Function</u>
<i>Number of sites (Representativeness, second question)</i>	<u>AboutData</u> and <u>Function</u>
<i>Sampling method (Representativeness, second question)</i>	<u>Method</u> in <u>GeneralQMetaData</u>
<i>Possible bias due to lapses (Representativeness, second question)</i>	<u>Method</u> in <u>GeneralQMetaData</u>

### Data Source

From SPOLD

To SPINE

<i>Generator</i>	<u>Practitioner</u>
<i>Editor</i>	<u>Note</u>
<i>Sources</i>	<u>LiteratureRef</u> and <u>Publication</u>

### System Models

From SPOLD

To SPINE

<i>Cut-off rules</i>	<u>Function</u> , <u>NatureBoundary</u> , <u>OtherBoundaries</u> , and <u>Method</u> in <u>SpecificQMetaData</u>
In <u>Function</u> the technical system is defined. In <u>NatureBoundary</u> and <u>OtherBoundaries</u> information about which parameters that are accounted for etc, while numerical cut-offs concerning the substances are stated in <u>Method</u> .	
<i>Additional screening</i>	<u>AboutData</u>
<i>Other assumptions</i>	<u>Applicability</u> and/or <u>AboutData</u>
<i>Other information</i>	<u>AboutData</u> and/or <u>Note</u> in <u>GeneralQMetaData</u> and/or <u>SpecificQMetaData</u>

### Validation

From SPOLD

To SPINE

<i>Validation procedures which have been applied in general</i>	<u>AboutData</u>
<i>Validator</i>	<u>Reviewer</u>

### 6.1.2 Conclusions

All information in SPOLD can be fitted in to SPINE. Most of the inquiries in SPOLD correspond to one particular field in SPINE, although approximately one third of the inquiries

have two or more corresponding fields. Despite the specific inquiries in SPOLD, the information can differ to some extent, and therefore fit several options in SPINE.

The inquiry in SPOLD, regarding the *Cut-off rules*, involves many options in SPINE. The explanation for this is that there is a substantial difference between how the two formats present the system boundaries. In *Cut-off rules* the processes related to the actual production, and associated flows of material, can be described. The actual production is not addressed here, but the technical system is coarsely defined by the graph in the *Graphics* tab. For each item the cut-off rule deals with technical system, nature boundaries, and other boundaries. The degree of cut-off can also be given here.

In SPINE the structure for cut-offs is different. The boundaries are categorised in technical system, nature boundaries, and other boundaries. The technical system is defined in *Function*, that is, all the included items are stated here. In the same way, there is a field each for *NatureBoundary* and *OtherBoundaries*.

Summarising, the differences between SPOLD and SPINE, when it comes to cut-offs, is a question of what is in focus. In SPOLD, the starting point is the processes and flow of material, while in SPINE it is the characteristics of the boundaries. If SPOLD had had enough space and alternatives in this tab, the system boundaries could be sufficiently described.

Certain information can be given twice in SPINE, either because it is possible, or because it is asked for. For example information about the product can be given both in *SpecificQMetaData* for the product and in *AboutData*, because the opportunity is given and it makes it easy to find the information. Another example is that the geographical area in some cases should be given in *Site* and *GeographicalBoundary*.

SPOLD contains some specific inquiries that have no natural correspondence in SPINE; therefore this information is put in the general fields *AboutData* or *Note*. An example where the converted information is taken from Nonylphenol and dinonylphenol [Erixon M, Ågren S, 1998, SPOLD, npprod], is shown in section A2.1.4. The inquiries in question are *Production volume*, *The number of sites*, *Additional screening*, and *Validation procedure* in *AboutData*, and *Editor* in *Notes*.

In the SPINE format there are certain inquiries that ask for areas that are not at all addressed in the SPOLD format. Hence, the following fields in SPINE are never used when information is converted from SPOLD to SPINE: *Intended user*, *General purpose*, *Detailed purpose*, *Commissioner*, *Availability*, *Copyright*, *System(Lateral)Expansion*, and *Represents (General and SpecificQMetaData)*.

There is no direct equivalence in SPINE to the reference code in SPOLD. The activity is given a code, but when using the SPINE@CPM DataTool, the programme automatically does this. The programme uses this code to identify the activity when storing the data, and the average user neither uses nor sees this code. If references are to be given to other activities, this is done by the name of the activity in *Applicability*, together with an explanation about how they are connected. Since the data set in SPOLD has no name, one should be able to choose the reference code in such way that either the reference function or the central process is indicated. However, the few characters in the code make this almost impossible. Due to this it is better to have automatically given codes.

The original data quality of the data set in SPOLD is preserved in the conversion, in the way that all information can be fitted in to SPINE.

## 6.2 Conversion of information from SPINE to SPOLD

Three of the data sets that were previously entered into SPINE format are converted into the SPOLD format with the purpose of evaluating how the mapping turns out and if the converted information has the same data quality as the original. Each data set is evaluated in detail in section A2.2, and below we give a more general description of the conversion of the information, and summarise some general conclusions that are valid for all the converted data sets.

### 6.2.1 Mapping

The mapping is done by moving the information in each field in SPINE, to a compatible field in SPOLD. The result is presented below.

#### Object of study

From SPINE	To SPOLD
<u>Name</u>	No direct correspondence in SPOLD, possibly <i>Name of process</i> (central)
<u>Sector</u>	No direct correspondence in SPOLD
The type of the information given here corresponds to that in <i>Classification</i> , but this is a more detailed nomenclature.	
<u>Site</u>	<i>Representativeness</i> , <i>Other information</i> , or <i>Geography for which the data set is valid</i>
If the data set represents one <i>Site</i> that is named, the information about that this concerns one site only is entered in <i>Representativeness</i> and the name in <i>Other information</i> . If the data set is not site specific, a geographical site is instead given in <i>Site</i> . In this case the information is entered in <i>Geography for which the data set is valid</i> .	
<u>Owner</u>	<i>Other information</i>
<u>Category</u>	No correspondence in SPOLD, therefore <i>Other information</i>
<u>Function</u>	<i>Classification</i> , <i>Included processes</i> , <i>Technology for which the data set is valid</i> , <i>Representativeness</i> , and/or <i>Other information</i>
Based on the description in <i>Function</i> the <i>Classification</i> is made. More details about the production are put under <i>Other information</i> . In addition, the graphical presentation is based on <i>Function</i> . From the system description <i>Central</i> , <i>Delivering</i> , <i>Receiving processes</i> , and <i>System models</i> are created by separating the information.	

#### Inventory

From SPINE	To SPOLD
<u>IntendedUser</u>	No correspondence in SPOLD, therefore <i>Other information</i>
<u>GeneralPurpose</u>	No correspondence in SPOLD, therefore <i>Other information</i>
<u>DetailedPurpose</u>	No correspondence in SPOLD, therefore <i>Other information</i>
<u>Commissioner</u>	No correspondence in SPOLD, therefore <i>Other information</i>
<u>Practitioner</u>	<i>Sources and Data treatment</i>

<u>Reviewer</u>	<i>Validator</i>
<u>FunctionalUnit</u>	<i>Reference function</i>
<u>FUExplanation</u>	<i>Reference function and possibly Representativeness</i>
When the functional unit is the total production volume, it is also stated in <i>Representativeness</i>	
<u>NatureBoundary</u>	<i>Cut-off rules and/or Other information</i>
When all information can not be fitted in to <i>Cut-off rules</i> , it is stated in <i>Other information</i> .	
<u>TimeBoundary</u>	<i>Time period if numerical value otherwise Other information</i>
<u>GeographicalBoundary</u>	<i>Geographical area for which the data set is valid and possibly Geographical location</i>
<u>OtherBoundaries</u>	<i>Cut-off rules and/or Other information</i>
When all information can not be fitted in to <i>Cut-off rules</i> , it is stated in <i>Other information</i> .	
<u>Allocations</u>	<i>Type (Products/co-products) and/or Other information</i>
When all information can not be fitted in to <i>Type</i> of allocation, with description, it is stated in <i>Other information</i> .	
<u>System(Lateral)Expansion</u>	No correspondence in SPOLD, therefore <i>Other information</i>
<u>Applicability</u>	No correspondence in SPOLD, therefore <i>Other information</i>
<u>About Data</u>	<i>Other information and/or Representativeness</i>
Information about the number of sites included in the data set is entered under <i>Representativeness</i> .	
<u>DateCompleted</u>	<i>Other information</i>
<u>Publication</u>	<i>Sources</i>
<u>Availability</u>	No correspondence in SPOLD, therefore <i>Other information</i>
<u>Copyright</u>	No correspondence in SPOLD, therefore <i>Other information</i>
<u>Notes</u>	-
This field can contain all types of information, why a strict mapping is impossible. Since no information has been moved from this field in our three data sets, we do not even have any suggestions about where to put this information.	

## Flow

From SPINE

To SPOLD

<u>Direction</u>	-
This is defined by entering the information in the correct field in SPOLD.	
<u>FlowType</u>	-
This is defined by entering the information in the correct field in SPOLD.	
<u>Substance</u>	<i>Name</i>
<u>Quantity</u>	<i>Mean</i>
<u>Min</u>	No correspondence in SPOLD, possibly <i>Data treatment</i>
<u>Max</u>	No correspondence in SPOLD, possibly <i>Data treatment</i>
<u>SDev</u>	<i>CV (coefficient of variance)</i>
<u>Unit</u>	<i>Unit</i>

<u>Environment</u>	-
This is defined by writing the information in the correct place in SPOLD.	
<u>Geography</u>	<i>Location</i>

### GeneralQmetaData

From SPINE

To SPOLD

<u>DataConcieved</u>	<i>Time period</i>
<u>DataType</u>	<i>Collection method</i> and possibly <i>Data treatment</i>
<u>Method</u>	<i>Collection method</i> and <i>Data treatment</i>
<u>Represents</u>	<i>Other information</i>
<u>LiteratureRef</u>	<i>Sources</i>
<u>Notes</u>	<i>Other information</i>

### SpecificQmetaData

From SPINE

To SPOLD

<u>DataConcieved</u>	<i>Time period (Adjustments)</i>
<u>DataType</u>	<i>Collection method</i> and possibly <i>Data treatment</i> (for each flow)
<u>Method</u>	<i>Collection method</i> and <i>Data treatment</i> (for each flow)
<u>Represents</u>	<i>Collection method</i>
<u>LiteratureRef</u>	<i>Sources</i>
<u>Notes</u>	<i>Other information</i>

## 6.2.2 Conclusions

Not all information can be converted from SPINE to SPOLD, due to lack of space. Most of the inquiries in SPINE correspond to one particular field in SPOLD, though approximately one third of the inquiries have two or more corresponding fields.

SPINE uses the *Function* field to define and describe the technical system. In SPOLD this is done in several smaller, more specified fields, which are *Classification*, *Included processes*, *Technology for which the data set is valid*, *Representativeness*, and *Other information*. Thus, the information in *Function* is split between these, but due to lack of space all information can not be entered. It is not clear whether or not the SPOLD format requires all information given in *Function*, that is, if the creators of SPOLD at all value this information. The advantage of having all information regarding the technical system in one place is that a clear view can be given and difficult technical terms can be explained so that laymen too can assimilate the information. The disadvantage is that it might be time-consuming to look for specific information in a long description. For example it is much easier to find the production volume in SPOLD, because of the specific inquiry about this. As mentioned, headings could be used in SPINE to structure the description in *Function* and make it easier to find specific information.

A lot of information from SPINE can not be put elsewhere than in *Other information*. This is either due to lack of space in the correspondent field or that there is no such field. The result of this is that the *Other information* field contains a great range of different types of information and it becomes very disordered. It is confusing when information is not found in

the intended text field, but in *Other information*, due to lack of space. The user can draw the incorrect conclusion that no further information concerning the subject is available.

One example of which information that would be given in *Other information* if there would be enough space can be found in section A2.2.4. The type of information given here is taken from SPINE at Site, Category, Function, IntendedUser, GeneralPurpose, DetailedPurpose, Commissioner, NatureBoundary, TimeBoundary, AboutData, Availability, and SpecificQMetaData concerning several flows [Erixon M, Ågren S, 1998, SPINE, Production of nonylphenol and dinonylphenol]. Note that most of this information in fact is lost due to lack of space in *Other information*.

In the SPOLD format there are certain inquiries that ask for areas that are not directly addressed in the SPINE format. This is the case for the following inquiries: *Type (Uncertainty)*, *Transport*, and *Environmental conditions*, concerning the flows, *System models*, *Representativeness*, *Editor*, *Additional screening*, and *Validation procedures which have been applied in general*.

The SPOLD software has an efficient way of describing Direction, Flow Type, and Environment, by entering the flow in the correct pre-defined field. Compared to SPINE@CPM.Datatool, where this information has to be given for each flow in the table, time and effort is saved.

Since all information can not be converted to the SPOLD format, the original data quality of the activity in SPINE is not preserved. The conversion essentially lowers the data quality of the information.

### **6.3 Concluding comparison**

When we started working with SPOLD, the lack of both an introduction to the current format and a user guide on how to efficiently use the format, really made our job harder. The contact with Bo Weidema was therefore crucial to understand basic terminology and the structure of the formation of data sets. A lot of what he explained could have easily been presented in a document, but some kind of personal contact should remain available.

As a help to understand and start working with SPINE, the following information is available<sup>8</sup>.

- SPINE – A Relation Database structure for Life Cycle Assessments [Carlson R et al, 1995]
- Handbok vid arbete med datakvalitet och SPINE (Handbook when working with data quality and SPINE) [Pålsson A-C, 1997]
- SPINE website [Carlson R, 1998]
- Help file [SPINE@CPM Data Tool](#) [CPM, 1998]
- Personal communication [Carlson R, 1997-98][Pålsson A-C, 1997-98]

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<sup>8</sup> Other related material is Krav på datakvalitet CPM:s databas 1997 [Arvidsson P, 1997], LCI Data Modelling and a Database Design [Carlson R et al, 1998], Handling GIS Information in Life Cycle Assessment Using a Relational Database [Bengtsson M, 1997] and Help-system and documentation of Ecolab software [Nordic Port, 1998].

When we have used SPINE to document data, the opportunity to communicate with the creators has been a great help. In fact, part of the concept of SPINE is that CPM works as a reference group, responsible for the quality of the documentation, which also teaches how the format should be used. This is also a good way of upholding the data quality without controlling each data set/activity.

It is made clear, when working with SPINE, that the documentation of the technical function and the system boundaries is essential to achieve a good data quality. The essence of SPOLD is not possible to make out from the format.

The two formats differ in the way the inquiries are formed. SPINE has more flexible and general fields, while SPOLD has detailed fields. Our experience is that the detailed way of asking for data results in inflexibility, although it can be a helpful remainder and show where specific information can be found. SPINE can be improved by using headings in the text fields to point out, in detail, what information the text field addresses.

If it should be possible to enter different kinds of information sources in a documentation format, flexibility is required. Looking at the entered data sets in SPOLD, the conclusion can be made that the format is insufficient. In all cases there is a loss of information, due to the conversion, which results in a low data quality. In SPINE however, all information can be entered.

In both formats there are fields for information not already addressed. In the case of SPOLD, the *Other information* field gets overfilled with mixed information, due to lack of space in the other fields. Except for this kind of information, for example the purpose of the original data collection, the commissioner, what site the data represents and which part of the life cycle the data represents are stated here. In the case of SPINE, the information in *AboutData* concerns the production volume, operating hours, validation procedures, and information about the environmental policy<sup>9</sup>. In *Notes* the person responsible for the documentation is stated.

It is necessary to have these kinds of fields since it is not possible to anticipate, or even relevant to make specified fields for, all types of information. However, it should be noted that the format becomes less transparent when there is too much information, of various kinds, in these fields.

## 7 Final words

When summarising the concluding sections, in chapter 5 and 6 in this report, it is obvious that there are too many severe weaknesses in the present SPOLD format to achieve good data quality when using it. The SPOLD format is inflexible and non-transparent and can therefore not adequately document different types of data sets. Furthermore, the lack of space is unacceptable.

When the SPOLD format is used adequately, as intended, the best data quality possible, allowed by the format, is achieved. To find this optimal way of using the format, great effort has to be made. Without personal guidance this can even be impossible. The risk is that the

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<sup>9</sup> Depending on how the technical system is described, the production volume and the operating hours can be given in *Function*.

importance of understanding the format is neglected, which results in large errors in the documentation.

In our experience, the SPINE format does not have these weaknesses, why we prefer this format to SPOLD. The flexibility of SPINE insures that the data quality in the original source is preserved when entering data.



## 8 References

### 8.1 Literature

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- Sunér M, 1996, Life Cycle Assessment of Aluminium, Copper and Steel, Report 1996:6, TEP, Chalmers University of Technology, Göteborg, Sweden

## **8.2 Electronic databases**

Erixon M, Ågren Å, 1998, SPOLD-database at CPM, Chalmers University of Technology, Göteborg, Sweden

*Reference function:* Copper *Reference code:* coppro

*Reference function:* Crude oil; Naturalgas *Reference code:* CPM00027

*Reference function:* Crude oil; Naturalgas *Reference code:* #crudoil

*Reference function:* Nonylphenol and dinonylphenol *Reference code:* CPM00025

*Reference function:* Nonylphenol and dinonylphenol *Reference code:* npprod

*Reference function:* Sawed construction timber *Reference code:* CPM00011

*Reference function:* Sawed construction timber *Reference code:* CPM00026

Erixon M, Ågren Å, 1998, SPINE-database at CPM, Chalmers University of Technology, Göteborg, Sweden

Name: Extraction of crude oil and natural gas

Name: Production of nonylphenol and dinonylphenol

Name: Production of sawed construction timber

Name: Spold Extraction of crude oil and natural gas

Name: Spold Production of nonylphenol and dinonylphenol

Name: Spold Production of sawed construction timber

## **8.3 Personal communication**

Carlson R, 1997-98, CPM, Chalmers University of Technology, Göteborg, Sweden, Tel: +46 31 772 21 73, E-mail: raul@vsect.chalmers.se

Pålsson A-C, 1997-98, CPM, Chalmers University of Technology, Göteborg, Sweden, Tel: +46 31 772 21 73, E-mail: acp@vsect.chalmers.se

Tillman, Ann-Marie, 1998, CPM, TEP, Chalmers University of Technology, Göteborg, Sweden, Tel: +46 31 772 21 22, E-mail: amt@vsect.chalmers.se

Weidema Bo, 1998, IPU, DTU, Lyngby, Denmark, Tel: +45 4525 4662, E-mail: [bow@ipt.dtu.dk](mailto:bow@ipt.dtu.dk)

## **8.4 Web sites**

Carlson R, 1998, SPINE, <http://www.cpm.chalmers.se/spine>

Weidema B, 1998, The SPOLD Format for LCI data, <http://ipt.dtu.dk/~bow/>

## APPENDIX

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## **A1 EVALUATION OF SPOLD**

This section in Appendix contains further comments and more detailed descriptions regarding the evaluation of SPOLD, which is presented in section 5 in the report.

### **A1.1 Suggestions**

*When working with SPOLD, we have sometimes been able to see simple adjustments that could be made to improve the format. However, no time has been put aside for suggestions in general.*

To find the reference to the suggestion in question in the text, see footnotes (\*). In the text you can find the right context to each suggestion.

#### **A1.1.1 Suggestion 1**

Often the data management and sometimes also the collection method are the same for all of the flows in the system. In such cases it would be practical to have general fields, that are valid for all of the flows in the data set. Other general information regarding the flows could also be given here.

#### **A1.1.2 Suggestion 2**

We suggest that the sheets for the different boxes in the flow chart, also include fields where a description of the processes/subsystems can be given. Information about the flows in and out of the subsystem or process could also be entered here. An alternative to or a further complement to this suggestion would be to enlarge the sheets for the flows so that information about which processes the flow goes to and from could be given here. The last proposal would in practice mean an expansion of the inquiry about *Origin*.

#### **A1.1.3 Suggestion 3**

As it is now the program itself rounds the numerical values to have three numbers of significance. To avoid an unwanted loss of information, we propose that the generator/editor should be able to choose the number of significance, specifically for each data set.

#### **A1.1.4 Suggestion 4**

When the degree of cut-off is chosen, the ways to answer are limited by the alternatives available. For example “Some excluded” is not the same as “Some included”, why we think the latter also should be an alternative such as a *Cut-off rule*, or there should be a more flexible field that can handle other alternatives.

### **A1.2 Evaluation of data sets converted into SPOLD**

Below, the converted data sets that the general evaluation is based on, are separately commented in detail. For each data set there is a reference to the database where the data set was created, and the following references are to the original publications.

#### **A1.2.1 Sawed construction timber**

[Erixon M, Ågren S, 1998, SPOLD, CPM00011], [Andersson B-I, 1996], [Björklund T, Tillman A-M, 1997]

1. We are not able to set the new group emission to air “Ashes”.
2. What shall irrigation water be described as? It does not fit in to emission *To water*, or to *Waste to treatment*. The only alternatives available for emission *To water* are *Chemical*

*substance, Group emission, and Indicator*. The irrigation water is not treated, but let out directly to nature why *Waste to treatment* is not suitable.

3. The transports “Transport from forest to sawmill and internal transports” are described with both qualitative and quantitative information, but this can not be entered as a delivering or receiving subsection because the transports concerns many different parts of the system, as the name indicates. The transports have been described as a system model.
4. The processes included in the reference function can not all be listed in the table due to lack of space.
5. A lot of information about how the timber is produced is lost due to the fact that there is no space for a function description. For example the irrigation procedure can not be described.
6. There are a lot of information concerning related activities, such as recycling of the used product, packaging, how the product is used etc. Some of this information could be written in *Other information*, but everything can not be fitted into this field due to lack of space.
7. The sites that are included in the data set can not be listed, only numbered in *Representativeness*.

#### A1.2.2 Crude oil

[Erixon M, Ågren S, 1998, SPOLD, #crudoil], [Keiserås Bakkane K, 1994]

1. We can not add:
  - Halon, as an emission to air, to *Group emission* on the sheet *Graphics*.
  - Drilling chemicals, Production chemicals, Pipeline chemicals and Weighting material, as emissions to water, to *Group emission* on the sheet *Graphics*.
2. All included processes do not fit into the *Included processes* field under *Data identification/name and classification/reference function*.
3. There is no accurate alternative for *Rational for cut-off rules* in *System model/Cut-off rules* for *Ancillary materials*. There is also not enough space for *Cut-off criteria*.
4. The formulation *Other material inputs* in the table in *System model/Cut-off rules* is quite vague and because there is no possibility to specify this further we see no use of this inquiry.
5. Information about the representativeness of the sewage can not be given since the adjustment field can not be saved.
6. There is no room for a proper function description and a lot of information is lost.
7. Because of lack of space in *Included processes*, and the fact that no general technology is valid for the whole data set, all processes have been entered in *Technology for which the data set is valid*.

#### A1.2.3 Nonylphenol and dinolylphenol

[Erixon M, Ågren S, 1998, SPOLD, npprod], [Akzo Nobel, 1996]

1. We are not able to set the new *Group emission* “dust” *To air*.
2. The text field for *Included processes* is too small.
3. We want to make a description of the function of the system regarding the production of alkylphenols, the internal energy extraction, the location of the plant, recipient conditions, the purification plant and the internal waste treatment etc, but there is no space for this.
4. There is also no space for a description of every flow (in and out) regarding for example where in the production they are used and what media they are emitted to. For the waste we want to add information about the forwarding agent and how it is treated.
5. Heated cooling water is let out, what kind of flow is this?

6. The *Other* field under *Validation methods that have been applied in general*, in the *Validation* tab, is too small to contain the method used.
7. There is no space to describe the information about which substances that have to be checked, according to the Swedish environmental protection law.

#### A1.2.4 Copper

[Erixon M, Ågren S, 1998, SPOLD, copprod], [Sunér M, 1996]

1. This system consists of many subsystems with qualitative data available. These can not be shown separately in the flow chart. The electrolysis is the central process in which the reference product occurs. The previous processes (production of explosives, mining, concentration, calcination, melting in electric furnace and conversion) will have to be aggregated into one subsystem, "Mining and processing", which makes the system less transparent. Furthermore, there is no space for information about what is included in this subsystems. This means that space for a more detailed description about the different processes is also missing. For example production of explosives includes six other processes, in which the material used in the production of explosives is manufactured. Correspondingly for the processes: melting in electric furnace and conversion. As explained in section 5.1.2, the subsystem with aggregated information could be described further in many, smaller data sets, though within the frames of this project this would be too time consuming.
2. There is not enough space in the field for *Included processes in Data identification/Name and Identification*.
3. On the sheet *Data source*, under *Secondary source*, the field for *Place of publication* is too small.
4. Waste treatment is not included in this system, but no reason is given for this in the literature. We can not find the correct alternative for *Rationale for cut-off* in the table for cut-off rules.
5. There is no space where the method of the waste treatment can be described when it is not included in the system. In this case the sand is used as landfill.
6. Some parameters, for example rich scrap, are not traced back to the cradle in this study, but this system boundary can not be given in the *Cut-off rules* subtab.
7. The substances that are accounted for can not be specified in the format.
8. We can not find space to give special information about the companies concerned.
9. We could not find any special place for information regarding allocations in the system, so some of this information was put in the fields *Other information* and *Other assumptions* on the sheet *System model/Other*. All information could not be given because the sheets are too small. There is a whole sheet intended for information regarding allocations, but this page can not be used when there are no co-products defined. Furthermore, this sheet does not include the possibility to describe the intentions or explanations for the chosen allocations.
10. The methods to decide the size of the flows, for example the emissions, are impossible to state, because the value shown as the output is a sum of different flows (for example emissions of one substance is caused by both combustion for heat generation and production), which have different collection methods. The field where collection method for the flows is to be described, is too small for such an explanation. For example the CO<sub>2</sub> emissions are both measured and calculated from the consumption.

#### A1.3 Bugs and errors

When using SPOLD one sometimes get notes saying that an error has been made. This has happened in the following situations:

- A problem occurs when one wants to give information about the flow on the sheet *Adjustment*. The message “type mismatch” is given, when one exits the sheet with specific information about the flow and the information given in *Adjustments* is not saved.

At other times the message about the error is followed by a program shutdown. This has happened in the following situations:

- When one wants to add a substance name to group emission for *To Air* and *To Water*, the message “Runtime error 3265: item not found in this collection” appears. The same thing happens when one changes ones mind from choosing a flow in *Chemical substances* to choosing it in *Group emission*. For examples see section A1.2.1 item 1 and section A1.2.2 item 1.

Another problem is that the information given in *Other* in *System model* sometimes is not saved correctly. At first it seems to be saved but at another time when opening the data set the information has disappeared. We have not been able to figure out exactly what happens, but we do not think that this is due to mistakes on our part.

- When a date is entered without a dot between the date and month, in *Time period*, the message “The Date value must be entered as ‘mm.dd’. A dot (.) is missing.” appears. Although the OK-button is pressed the message does not disappear and the program is locked.

## A2 Comparison between the two formats SPOLD and SPINE

We compare the two formats by converting all information from one format to the other and evaluating the result. In this section we present how this type of mapping turns out for each example.

In the following sections italicized text is used for terms directly taken from the SPOLD format, while terms from the SPINE format are underlined and italicized.

### **A2.1 Conversion of information from SPOLD to SPINE**

Three of the data sets that were previously entered into the SPOLD format are converted into the SPINE format with the purpose of evaluating how the mapping turns out and if the converted information has the same data quality as the original. Each data set is evaluated in detail below.

#### A2.1.1 Production of sawed construction timber

[Erixon M, Ågren Å, 1998, SPOLD, CPM00011], [Erixon M, Ågren S, 1998, SPINE, Spold Production of sawed construction timber]

#### **Graphics (except flows which are addressed under Inputs and Outputs)**

The name of the unit process also becomes the name of the activity in SPINE.

The name and location of the system models is put in *Function*, where the function of the system is described. Information about *Total amount of primary energy carriers used* is put in *Specific QmetaData* for the flow concerned.

#### **Data Identification**

*Classification* corresponds to *Sector*, but the latter is not as specified. In this case the classification does not contribute to any information not already given.

The unit and name of the *Reference function* is equivalent to Functional Unit and FUExplanation. The *Included processes* fits in under Function.

The *Time Period* is unspecified and this can be noted under Time Boundary.

The *Geographical area for which the data set is valid*, together with the information written in the *Open text field*, are stated under Geographical Boundary and Site. It is also given under Represents in General QmetaData (since the data represents the mean value for 15 sites in this area, see *Representativeness* below).

*Technology for which the data set is valid* is presented in Function.

The number of sites for which data were collected (*The actual production volume and number of sites for which data were collected, the sampling method and possible bias due to lapses*), under *Representativeness*, is put under Represents in General QMetaData.

### **Data Source**

There is no specific inquiry about the person/company responsible for the entering of data into SPINE, why the *Editor* is given in Note. The *Generator* is analogous to Practitioner.

The information in *Data has been published in...*, in *Reference*, is equivalent to Publication.

### **System Model**

*Cut-off rules for Packaging* is put under Other Boundary.

The information under *Other assumptions* is separated and put in Function and About Data.

The information under *Other information* is separated and put in About Data and Specific QmetaData for the flows in question.

### **Inputs and Outputs**

All information concerning the flows can be given in the table in SPINE together with Specific QMetaData:

*Name - Substance*

*(Energy) Unit - Unit*

*(Energy) Mean Value - Quantity*

*Data Treatment - Method*

*Reference to source - LiteratureRef*

In the table in SPINE, entering input or output indicates the Direction of the flow. The same accounts for the Flow Type, which, in this case, is indicated by Resource, Product, Residue, and Emission. The destination/origin of the flow also has to be indicated under Environment. This is done with terms like Technosphere, Air, Forestral ground.

#### **A2.1.2 Extraction of crude oil and natural gas**

[Erixon M, Ågren Å, 1998, SPOLD, #crudoil], [Erixon M, Ågren S, 1998, SPINE, Spold Extraction of crude oil and natural gas]

### **Graphics (except flows which are addressed under Inputs and Outputs)**

The name of the unit process also becomes the name of the activity in SPINE.



The name and location of the system models is put in Function, where the function of the system is described. Information about the *Transport Models* is also put in Function.

### **Data Identification**

*Classification* corresponds to Sector, but the latter is not as specified. In this case the classification does not contribute to any information not already given.

The unit and name of the *Reference function* is equivalent to Functional Unit and FUExplanation. The *Included processes* fits in under Function.

The *Time Period* is unspecified and this can be noted under Time Boundary.

The *Geographical area for which the data set is valid* is stated under Geographical Boundary.

*Technology for which the data set is valid* is presented in Function.

*The actual production volume and possible bias due to lapses* are put under About data and *the sampling method* is put under General QMetaData.

### **Data Source**

There is no specific inquiry about the person/company responsible for the entering of data into SPINE, why the *Editor* is given in Note. The *Generator* is analogous to Practitioner.

The information in *Data has been published in...*, in *Reference*, is equivalent to Publication. The literature references that refer to specific flows are put under Specific QMetaData in LiteratureRef for the flow in question.

### **System Model**

*Cut-off rules for Administration, Personal canteen, Maintenance, Ancillary materials and Transports* are put under Other Boundary.

### **Inputs and Outputs**

All information concerning the flows can be given in the table in SPINE together with Specific QMetaData:

*Name* - Substance

*(Energy) Unit* - Unit

*(Energy) Mean Value* - Quantity

*Origin Location* - Geography

*Collection method* - Method

*Data Treatment* - Method

*Reference to source* - LiteratureRef

In the table in SPINE entering input or output indicates the Direction of the flow. The same accounts for the Flow Type, which, in this case, is indicated by Resource, Product, Residue, and Emission. The destination/origin of the flow also has to be indicated under Environment. This is done with terms like Technosphere, Air, Forestral ground.

The information about area use in *Other Interventions*, is put under About Data. There is also a possibility to enter this information in the flow table in SPINE, but because of the difficulties handling this type of flow, we have chosen not to.

### A2.1.3 Production of nonylphenol and dinonylphenol

[Erixon M, Ågren Å, 1998, SPOLD, npprod], [Erixon M, Ågren S, 1998, SPINE, Spold Production of nonylphenol and dinonylphenol]

#### **Graphics (except flows which are addressed under Inputs and Outputs)**

The name of the unit process also becomes the name of the activity in SPINE.

The *Geographical location* of the process is put in Geographical Boundary. Information about the *Energy Models* is put in Function too.

#### **Data Identification**

*Classification* corresponds to Sector, but the latter is not as specified. In this case the classification does not contribute to any information not already given.

The unit and name of the *Reference function* is equivalent to Functional Unit and FUExplanation. The *Included processes* fits in under Function.

The *Time Period* is unspecified and this can be noted under Time Boundary.

The *Geographical area for which the data set is valid* has already been stated under Geographical Boundary.

*Technology for which the data set is valid* is presented in Function.

*The actual production volume and possible bias due to lapses* is put under About data and the *sampling method* is put under General QMetaData.

#### **Data Source**

There is no specific inquiry about the person/company responsible for the entering of data into SPINE, why the *Editor* is given in Note. The *Generator* is analogous to Practitioner.

The information in *Data has been published in...*, in *Reference*, is equivalent to Publication and also put under LiteratureRef in General QMetaData.

#### **System Model**

The information under *Other information* is put under About Data and Site.

#### **Inputs and Outputs**

All information concerning the flows can be given in the table in SPINE together with Specific QMetaData:

*Name - Substance*

*(Energy/Mass) Unit - Unit*

*(Energy) Mean Value - Quantity*

*Destination Location - Note*

In the table in SPINE entering input or output indicates the Direction of the flow. The same accounts for the Flow Type, which, in this case, is indicated by Resource, Product, Residue, and Emission. The destination/origin of the flow also has to be indicated under Environment. This is done with terms like Technosphere, Air, Forestral ground.

## Validation

The information about the *Validation procedures which have been applied in general* is put under *About Data*. The reason why this is not put under *Reviewer* is that only an address can be given here and there is no room for an explanation about the validation procedure.

### A2.1.4 Example of the information given in About Data and Notes

The following section shows what the fields *AboutData* and *Note* include, when the information in the data set Nonylphenol and dinonylphenol [Erixon M, Ågren Å, 1998, SPOLD, npprod] is converted from SPOLD to SPINE [Erixon M, Ågren Å, 1998, SPINE, Production of nonylphenol and dinonylphenol]. The information is characterised by short answers to a few specific inquiries in SPOLD.

## About Data

The system represents the annual production at Akzo Nobel, Surface Chemistry AB for 1996. During this year the plant was in operation for 8100 hours.

The production volume is 8128 ton/year. No bias due to lapses known.

The products handled in the system are not restricted according to National Agreements or the North Sea Conference.

The environmental reporting is handled and controlled by the board of county in Gothenburg, Sweden, which follows Swedish environmental protection law.

## Notes

The data set has been entered by

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## A2.2 Conversion of information from SPINE to SPOLD

### A2.2.1 Production of sawed construction timber

[Erixon M, Ågren Å, 1998, SPINE, Production of sawed construction timber],[Erixon M, Ågren S, 1998, SPOLD, CPM00026]

## Object of study

*Name* directly corresponds to *Name of process* for the central process.

The information in *Sector* is not compatible to any field in SPOLD. However, a similar inquiry is *Classification* but the information here is more specific and therefore the function description is used to define/choose this. *Site* does in this case correspond to *Geographical Location* of the processes and *Geographical area for which the data set is valid*. *Category* is put under *Other information*.

The text found in *Function* is written below. The text that we can find space for in SPOLD, is the text written in a different text style below. A comment about where the text is put in SPOLD, is given within parentheses.

-----  
The study comprises forestry, production of wooden material at the sawmill, transports from forest to sawmill and internal transports at the sawmill. (*Included processes and Technology for which the data set is valid*) The average transport distance between the forest and the sawmill is about 55 km. (*Other information*)  
-----

### **Inventory**

*IntendedUser* and *GeneralPurpose*, have no direct similarity in SPOLD, but the information is given in *Other Information*. The *Practitioner* is mentioned in *Data treatment*, together with an explanation about how the practitioner is related to the data set. The information about *FunctionalUnit* and *FUExplanation* is given under *Reference function* and *Representativeness*.

Information about the *NatureBoundary* can not be given in any other place than the field for *Other information*, which is filled when some of the information is entered. All information can therefore not be entered into SPOLD. *GeographicalBoundary* directly corresponds to the *Geographical area for which the data set is valid* and the information can in this case also be entered at *Geographical location* of the process, though the same information already has been stated in *Site*.

All of the text in *Applicability* and some of the information in *About Data* should be put in the *Other Information* field, but this can not be done due to lack of space. The fact that the data set represents 16 sawmills is taken from *About Data* and entered under *Representativeness*.

*DateCompleted* has no specific field in SPOLD, but in this case this date is the same as the year of publication of the environmental declaration, which is given at *Sources*. The *Publication* directly fits into the list under *Sources*. *Availability* and *Copyright* could have been put under *Other information*, if this field was not already full.

### **Flow**

By entering the different flows in predefined fields, where Direction, Flow Type, and Environment are specified, the information about these things are automatically entered.

### **QMetaData**

The use of waste bark, is given in *Other Information*.

The *General QMetaData* about *Method* is in this case compatible to *Data treatment* for each flow. *DateConceived* has no equality in SPOLD, but the information given here does not in this case contribute with any new facts. The *DataType* is unspecified.

#### **A2.2.2 Extraction of crude oil and natural gas**

[Erixon M, Ågren Å, 1998, SPINE, Extraction of crude oil and natural gas], [Erixon M, Ågren S, 1998, SPOLD, CPM00025]

### **Object of study**

*Name* directly corresponds to *Name of process* for the central process.

The information in *Sector* is not compatible to any field in SPOLD. However, a similar inquiry is *Classification* but the information here is more specific and therefore the function description is used to define/choose this.

Site does in this case correspond to *Geographical location* of the process and *Geographical area for which the data set is valid*. Category is put under *Other information*.

The text found in Function is written below. The text that we can find space for in SPOLD, is the text written in a different text style below. A comment about where the text is put in SPOLD, is given within parentheses.

The part of the text in Function that is left out includes a more detailed description of the function of the system. In all, the original text was six pages. This information could be fitted into the text *Other information* field, but this field is already filled.

-----

The system involves extraction of offshore crude oil and natural gas in Norway and all Norwegian sites are included (*Representativeness*). The production therefore follows Norwegian standards concerning legislation and environmental policy.

In the system the following operations are included:

Production drilling, Well steam processing, Produced water removal, Pressure maintenance, Oil and gas metering, Flaring and venting, Power supply systems, Support and safety systems, and Transportation of the crude oil and natural gas to the main land. (*Technology for which the data set is valid*, the field for *Included processes* is not big enough to contain all processes)

## PRODUCTION DRILLING

Drilling and casting of production wells

Production wells can be drilled either from the production platform, requiring the platform to be equipped with full drilling facilities or from a mobile production unit, which predrills platform wells and... (All of the detailed information should be put in *Other information*, but this is the only part that can be fitted into the field)... subsea completed wells. Current drilling technique enables the wells to be drilled with exact deviation any direction, even horizontally, from the drilling installation. This enables several wells to be drilled from the same platform.

...and so on.

-----

Four transport models and two energy models have been made from the function description, but no other information than the name could be given.

## Inventory

DetailedPurpose has no direct similarity in SPOLD, but the information could be given in *Other Information* if this field was not full. The Practitioner is referred to in the reference list *Sources* in SPOLD and mentioned in the field for *Data treatment* for each flow. The information about FunctionalUnit and FUExplanation is given under *Reference function*.

Some information about the NatureBoundary and OtherBoundaries can be given at *Cut-off rules*. The remaining information together with that from TimeBoundary can not be given in any other place than the field for *Other Information*, which is full. This information can therefore not be entered into SPOLD. GeographicalBoundary directly corresponds to the *Geographical area for which the data set is valid*, the information can in this case also be entered in *Geographical location* of the process.

The text in *About Data* and *Applicability* can not be fitted into the *Other Information* field, due to lack of space.

*DateCompleted* has no specific correspondence in SPOLD, but in this case this date is the same as the year of publication of the environmental report, which is given at *Sources*. The *Publication* directly corresponds to *Sources*. *Availability* could have been put under *Other Information*, if this field was not already full.

### **Flow**

By entering the different flows in predefined fields, where the *Direction*, *Flow Type*, and *Environment* are specified, the information about these things are automatically entered.

### **QMetaData**

*Specific QMetaData* about Diesel, mineral, and oil extraction area, Hazardous waste, and Industrial waste can not be given together with other information concerning the flow. Because the *Other Information* field is full this information is lost in the conversion from SPINE to SPOLD.

The *Specific QMetaData* and *General QMetaData* about *Method* is in this case compatible to *Data treatment* for each flow but all information can not be given due to lack of space. Information about Steel, Hazardous waste, Household waste, Industrial waste, Sewage, all discharges to sea and all emissions to air are therefore lost. *DateConceived* has no equality in SPOLD, but the information given here does not in this case contribute with any new facts.

#### **A2.2.3 Production of nonylphenol and dinonylphenol**

[Erixon M, Ågren Å, 1998, SPINE, Production of nonylphenol and dinonylphenol], [Erixon M, Ågren S, 1998, SPOLD, CPM00025]

### **Object of study**

*Name* directly corresponds to *Name of process*.

The information in *Sector* is not compatible to any field in SPOLD. However, a similar inquiry is *Classification* but the information here is more specific and therefore the function description is used to define/choose this.

*Site* has no direct correspondent in SPOLD, why this information is put under *Other information* and under *Representativeness*. It can be noted that the data set represents only one site.

The *Owner* of the system is in this case the same as the *Site* and the *Practitioner*. *Category* is put under *Other information*.

The text found in *Function* is written below. The text that we can find space for in SPOLD, is the text written in a different text style below. A comment about where the text is put in SPOLD, is given within parentheses.

-----  
Production of nonylphenol and dinonylphenol (This information has already been entered)

Alkylphenols are produced with a chemical reaction between the substances nonen and phenol. (*Technology for which the data set is valid and Included processes*) The reaction is accelerated

by the catalyst borontrifluoride. The production is done batch by batch in a reactor, (*Other information*, this field is now full) in which the slightly exothermal reaction leaves the substances mono- and dinonylphenol together with the non-reacted phenol and nonen. The phenol and nonen are then cupeled to be recycled in an oil-heated boiler. (*Technology for which the data set is valid*)

The gases contain small amounts of different kinds of hydrocarbons, which are taken up by the pack water of the vacuum pump or are cupeled to be destroyed in a combustion heat exchanger. (*Technology for which the data set is valid*) Dissolved phenol in the pack water is separated and neutralised with potassium lye. Water containing potassium phenolate and non reacted nonen is treated (destroyed) in Stenungsund or by SAKAB.

Through distillation nonylphenol and dinonylphenol is produced. The higher alkylphenols that are rest products from the distillation are mixed with the fuel oil to be combusted in a steam boiler or an oil-heated boiler. (*Technology for which the data set is valid*)

The nonylphenol and the dinonylphenol are stored to be put on barrel or to be delivered by tank lorry.

*Emission to the air is caused by the energy production in the process of making nonylphenol. Diffuse emissions are also made from the stock of tanks. Hydrocarbons, from the cupel column and the distillation columns of the process that are not condensed are led to a combustion exchanger. The exchanger consists of bedding of gravel in a segregated holder. Electrical heating spirals are situated in the centre, and they keep the contamination burning. The air is cleansed to at least 90%. The gas is cupeled to the atmosphere by a smokestack.*

Substances are not normally emitted to water.

-----

Most of the text can not be fitted into SPOLD, due to the lack of space in the field for *Other information*.

### **Inventory**

*IntendedUser*, *GeneralPurpose*, *DetailedPurpose*, and *Commissioner*, have no direct similarity in SPOLD, but the information could be given in *Other Information* if this field was not full. *Practitioner* has no correspondence, but *Reviewer* corresponds, to some extent, to the *Validator*. The information about *FunctionalUnit* and *FUExplanation* is given under *Reference function* and *Representativeness*.

Information about the *NatureBoundary* and *TimeBoundary* can not be given in any other place than the field for *Other Information*, which is full. This information can therefore not be entered into SPOLD. *GeographicalBoundary* directly corresponds to the *Geographical area for which the data set is valid*, the information can in this case also be entered at *Geographical location* of the process.

Some of the text in *About Data* can not be fitted into the *Other Information* field due to lack of space. How the figures are rounded off in the literature source is no longer relevant because SPOLD always rounds off the figures to three numbers of significance.

*DateCompleted* has no specific field in SPOLD, but in this case this date is the same as the year of publication of the environmental report, which is given at *Sources*. The *Publication* directly corresponds to *Sources*. *Availability* could have been put under *Other Information*, if this field was not already full.

## Flow

By entering the different flows in predefined fields, where the *Direction*, *Flow Type*, and *Environment* are specified, the information about these things are automatically entered.

The emission to air of dust can not be entered into SPOLD, because of a bug, see section A1.3.

## QMetaData

*SpecificQMetaData*, about Borontrifluoride, Lubricating oil, Mitco LB 2050, Mitco R-10, Potashlye, Solvay salt tablets, Water, Sox, Nonen, Waste of plastic, wood, glass, and waste from the garden, Waste water containing alkylphenols and oil, and Flush, process, and rain water can not be given together with other information concerning the flow. Because the *Other Information* field is full this information is lost in the conversion from SPINE to SPOLD. The exception is the final disposal site for the waste, which is given in *Destination at Location*.

The *General QMetaData* about *Method* is in this case compatible to *Data treatment* for each flow. *DateConceived* has no equality in SPOLD, but the information given here does not in this case contribute with any new facts. The *DataType* is unspecified.

### A2.2.4 Example of the information given in the Other information field

The following section shows what the *Other information* field would include, if it was large enough, when the information in the activity Production of nonylphenol and dinonylphenol [Erixon M, Ågren Å, 1998, SPINE, Production of nonylphenol and dinonylphenol] is converted from SPINE to SPOLD. In this case a large amount of information is put in this field and there is a great mixture of different kinds of information.

The text written in a different text style is that, which currently can be fitted into the *Other information* field for the data set Nonylphenol and dinonylphenol [Erixon M, Ågren Å, 1998, SPOLD, CPM00025].

-----

## Other information

The site represented in the gate to gate data set is Akzo Nobel, Surface Chemistry AB, Ågatan 44, 431 37 Möndal, Sweden (Tele +46 -31 873760 Fax +46 -31 877681).

The reaction, in which the nonylphenol and dinonylphenol is produced, is accelerated by the catalyst borontrifluoride. The production is done batch by batch in a reactor, in which the slightly exothermal reaction leaves the substances mono- and dinonylphenol together with the non-reacted phenol and nonen.

Dissolved phenol in the pack water is separated and neutralised with potassium lye. Water containing potassium phenolate and non reacted nonen is treated (destroyed) in Stenungsund or by SAKAB.

Through distillation nonylphenol and dinonylphenol is produced. The higher alkylphenols that are rest products from the distillation are mixed with the fuel oil to be combusted in a steam boiler or an oil-heated boiler. The nonylphenol and the dinonylphenol are stored to be put on barrel or to be delivered by tank lorry.



Emission to the air is caused by the energy production in the process of making nonylphenol. Diffuse emissions are also made from the stock of tanks. Hydrocarbons, from the cupel column and the distillation columns of the process that are not condensed, are led to a combustion exchanger. The exchanger consists of bedding of gravel in a segregated holder. Electrical heating spirals are situated in the centre, and they keep the contamination burning. The air is cleansed to at least 90%. The gas is cupeled to the atmosphere by a smokestack.

Substances are not normally emitted to water.

The intended use of the information was to show the environmental load from the company according to Swedish law. This is done in an annual Environmental Report. The purpose of the environmental report is to be the base for permission trial of activities that is harmful to the environment and further to make sure that the company complies with the decision.

The detailed purpose of the information was to control that the legislated limits are not exceeded.

The environmental report is commissioned by The Environmental Administration in the municipality of Göteborg, Box 360, 401 25 Göteborg, Sweden. The company is not obligated to state other emission- or waste substances than the Swedish Environmental Protection law requires. The company is obligated to write an Environmental report once every year. However, the legislated limits can be changed only if the activity is changed.

No margin of error is found in the original source (the environmental report), and one can assume that a lot of values have been rounded.

The plant has during 1996 been in operation 8100 h.

Information about the flows:

- Lubricating oil (SAE 40) for the vacuum pump.
- Solvay salt tablets, Mitco LB 2050 and Mitco R-10 are added in the feed water.
- Potashlye is a solvent.
- 99,4% of the water is used for cooling, and is taken from Mölndalsån The used water is led back to the stream. The temperature difference between outgoing and incoming water is 25°C. The rest of the water comes from the water purification plant. After use, if it is not contaminated, it is led to Mölndalsån through an oil seperater.
- Emission of SO<sub>x</sub> to air occurs from the combustion exchanger and the steam boiler.
- The liquid nonen is transported by ADR.
- The wastewater that contains flush-, process- and rainwater, nonylphenol, dinonylphenol, oil, products and raw material is transported by RECI (Skaraborgs miljötransporter).
- The wastewater consists of nonylphenol, dinonylphenol, and oil and is transported by ADR.

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## A3 The SPOLD to SPINE mapping

*Mapping performed by R. Carlson and A-C Pålsson, Chalmers University of Technology, 1998*

### 8.4.2 A3.1 Summary

SPINE is capable of mapping all data from a SPOLD data source. The opposite is possible only by an extensive use of the field TextOverflow in the SPOLD format.

The SPOLD format may work as a well-structured checklist for the LCI-process, but it needs to be improved in order for it to be a reliable and useful data exchange format. This because the SPOLD format has a number of technical weaknesses, such as:

- It is intended that the SPOLD format should recursively handle connected data sets. But since the format does not include a description of how this should be done with preservation of consistence it can only be used under very special conditions. Import of data sets needs to be done in a specific order, into a new system, or the system needs to be designed so that inconsistency is disallowed. CPM does not recommend that SPINE systems should make use of recursive SPOLD data sets unless the SPOLD group proclaims a better handling of the consistency issue.
- The SPOLD data format does also lack consistency handling for references to many literature sources, which gives that it cannot be distinguished which literature source is referred to in a specific case. This is a minor technical weakness of the format, which implies that relational information is lost.
- The SPOLD format has weak models, both in regards of a weakly defined conceptual model, which should work as an aid when interpreting a SPOLD data set, as well as in regards of the data format itself. There is a risk that the lack of an unambiguous conceptual model will foment development of 'local dialects' and thereby support deficient communication. The data format itself is based on a non-normalised model. An example of this, is the different flow 'tables' of the data format; 'Inputs from Technosphere, materials/fuels', 'Inputs from Technosphere, electricity/heat', etc. There are 10 almost equal data structures, and they definitely should have been expressed as one or maybe two structures. Consequences of non-normalised models are that mappings between formats become complex (The SPOLD-SPINE mapping could have been the third of its current size) and that maintenance or further development of the format will be difficult and prone to errors.

### 8.4.3 A3.2 Syntax of mapping

The SPOLD to SPINE mapping is expressed by the use of syntax described in the following. The syntax has been developed in parallel with the mapping and should not be considered a full mapping syntax, but it has been found sufficient for this specific task.

A specific field in a format is generally expressed as:

```
<Data format><Entity><Field><Section><Type>[<Domain of values>][<Algorithmic statement>]
```

- Brackets []  
Brackets around a syntax term means that the statement is optional.
- Data format  
The format in which the field exists, e.g. SPINE@CPM : 0 which means SPINE as interpreted by the CPM group, base version 0, or SPOLD : 0 which means the SPOLD format version 0.

- **Entity**  
A high level entity of the format, such as a table in the SPINE format or a subsection in the SPOLD format.
- **Field**  
A specific field in the format, such as a text field or a numerical value. In SPINE, the columns of the tables and in SPOLD the text fields of the software.
- **Section**  
A specific field in the SPOLD format and a specific subsection in a field of the SPINE format. A SPOLD subsection in the SPINE format should have a subsection header as described in the mapping table, and it should be denoted as <Field name> within the field.
- **Type**  
The data type of the Field, e.g. String 60, Text 60 for 60 characters long strings or Numerical 30:6 for 30 figures long numerical values having 6 decimals.
- **Domain of values**  
Optional if the field allows only a specific set of values, e.g. 'Input' or 'Output' or an integer that is either 0 or 1.
- **Algorithmic statement**  
A number of algorithmic statements has been included with the mapping syntax
  - **INDISTINGUISHABLE, INDISTINGUISHABLE** means that it cannot be distinguished which value to import. For example, it cannot be distinguished which source is referenced in the SPOLD format in the field:  
<CutOffRules><EnergyInputsReferenceToSource>.
  - **CREATE NEW <Entity>.<Field>; LOGICAL STATEMENT**  
Before inserting a value of an occurrence of an entity in the SPOLD format an ID needs to be inserted in the SPINE format.
  - **SELECT CASE CASE n = value...**  
The SPOLD format in many cases stores numerical values instead of text, while addressing a text value. The SELECT CASE statement describes which text to expand the number code to in the SPINE format, when it appears in the SPOLD format.

In addition there are two other syntax statements:

- **FOR EACH <Data format><Entity>... END FOR EACH**  
Some data structures may occur many times in a single data set. The FOR EACH statement means that everything between the FOR EACH and END FOR EACH statements should be repeated for each entity in the data source.
- **<"ImportantNote: + text>**  
In some cases it has been considered important to insert a note on how to interpret a value inserted from a SPOLD data source in a SPINE data source. The full text of this statement should be added to the SPINE field where the value of the SPOLD field is inserted.

It should be noted that, in order for data to be moved from a SPINE data source to a SPOLD formatted data source, without loss of data or structural information, some fields (or columns) in the SPINE source should be sectioned, as described in the mapping table. Be careful to create rules so that the sections have the correct format and length, as described in the SPOLD format.

An electronic version of the mapping table may be ordered from the authors. Possible errors will continuously be corrected and included with the electronic version.

Visit <http://www.cpm.chalmers.se> for a correct address.

*Raul Carlson, Chalmers University of Technology, 1998*

### A3.3 Mapping table

Data destination	Data source
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<SPINE@CPM : 0><QMetaData Type><Notes>	<SPOLD : 0>
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<SPINE@CPM : 0><Substance><DefaultUnit>	<SPOLD : 0>
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<SPINE@CPM : 0><JuridicalPerson><Telephone>	<SPOLD : 0><DataGeneratorAndpublication><Telephone><String; 12>
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<SPINE@CPM : 0><Sector><Superior>	<SPOLD : 0>
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<SPINE@CPM : 0><ProcessName><Id>	<SPOLD : 0> No names are used in the SPOLD-format to identify the names of processes
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FOR EACH <SPOLD : 0><TransportModels>	<SPOLD : 0><TransportModels>
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