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Data definition and file syntax for ISO/TS 14048 data exchange

with data storage format based on ISO/TS 14048

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Contents

1 Introduction

This report is intended to support computing specialists when implementing electronic data exchange or data storage formats based on the international technical specification ISO/TS 14048 Environmental management — Life cycle assessment — Data documentation format (ISO, 2001). Due to the wide international acceptance of the semi structured data language XML (Extensible Markup Language), this language has been chosen for the implementation of a data exchange format, and due to the wide use of relational databases, the language of relational database models has been used for the database format specification. Other choices could have been made, without losing compatibility with the technical specification.

The report describes a format as specified by the ISO-document ISO/TS 14048, with some exceptions that are explicitly and clearly described. The exceptions are due to practice and requirements specified by the language XML.

This specification can be tested as described over the Internet on a web server hosted at Chalmers University of Technology. We ask you to contact us through http://www.imi.chalmers.se if you have questions, wants to discuss interpretation of issues addressed in the report, or if you find ways for how to improve this report.

2 Scope

The electronic data formats presented in this document is designed to meet the specifications stated in ISO/TS 14048, with specific attention to the requirements in

- section 4, Formatting and reporting
- annex A, Detailed specification of the data documentation format

Additionally, an example of a technical implementation of a database structure that consistently supports the ISO/TS 14048 data documentation format is presented. No mandatory requirements are stated in ISO/TS 14048 regarding the structure of the database, since the design of a database is highly dependant of application. The database structure presented here is a pragmatic implementation based on conscious decisions.

3 Term(s) and definition(s)

Terms used in this document and the definitions of these terms correspond with ISO/TS 14048 section 3 and the following:

Data field title
name of a data field

Data field reference
relation between data fields, including one-to-one or one-to-many relations

4 Data exchange format compatible with ISO/TS 14048

This section describes a technical implementation of an electronic data exchange format for ISO/TS 14048 data exchange. An ISO/TS 14048 compatible data exchange format is described by an unambiguous choice of data definition format and file syntax. Further information including implemented examples can be found at the IMI website http://www.imi.chalmers.se/iso.

4.1 File syntax

The file syntax chosen for this implementation is XML. XML is a subset of SGML (Standard Generalized Markup Language) and is defined according to the specifications by W3C (W3C, 2000; Bryan, 1992). Using XML as the file syntax is motivated by:

- *Informal standard status* – the XML file syntax is well defined and has a broad acceptance. A range of applications and tools exists to aid implementation regarding validation, parsing, and conversion to other formats.
- *Readability* -The appearance of an XML document is understandable even with very limited knowledge of XML
- *Flexibility* – Any number of subsets of any number of processes can be communicated with the same XML document

The standard character set in this data exchange format is set to ISO-8859-1. If characters not supported by this character set are included in the XML the recommendation is to save the XML file in Unicode format and exclude encoding declarations from the file (W3C, 2002a).

4.2 Data definition format

The data definition format in this implementation is formalised in a "Document Type Definition" (DTD) (W3C, 1999; W3C, 2002b).

A DTD can be used to specify the syntax (grammatical structure) of an XML file. The DTD could be replaced by using an XML-Schema, providing the same functionality. However, the choice of using a DTD is motivated by the nature of the task of implementing ISO/TS 14048. ISO/TS 14048 sets a few strict requirements on the publication and exchange of data. No technical requirements is set on the applications generating or consuming the data. Using DTD suffices the need to put a few strict and rigid requirements on the data exchange format. In contrast a variety of XML-Schema “dialects” is in existence, each with their own syntax and platform specific adjustments.

The DTD presented in this document formalises the requirements of the naming and hierarchy of the XML elements and attributes to match the ISO/TS 14048 data field titles and data field references. To allow more than one process to be included in the same XML document, the root element <iso_ts_14048> is one level above <data_documentation_of_process>. The DTD does not specify the data type formatting of data fields. The data type of all data fields in the XML data exchange file is parsed character data (PCDATA). Parsed character data is a unlimited string with no XML reserved characters or combination of characters. Table 1 shows a mapping between XML reserved characters and their respective entity encoding.

Table 1, Reserved XML characters and entity encodings

Reserved character	Special meaning	Entity encoding
>	Begins a tag.	>
<	Ends a tag.	<
"	Quotation mark.	"
'	Apostrophe.	'
&	Ampersand.	&

The protection from violating the ISO/TS 14048 formatting of data types must be handled within the sending and/or receiving application(s) in this implementation. The DTD presented here does not specify any requirements on specific data fields that must be included when communicating ISO/TS 14048 formatted data with XML, which is in line with the freedom of the ISO/TS 14048 specifications.

4.2.1 Data definition

The ISO/TS 14048 DTD Version 1.00 in this implementation is presented in Annex A.

4.2.2 Translation between XML structure and ISO/TS 14048 requirements on naming

The mapping of the hierarchical structure of the XML format and the ISO/TS 14048 requirements on naming is based on three rules. Rule ***i*** applies generally but is overruled by ***ii*** and ***iii*** where they apply respectively.

i: The ISO/TS 14048 referencing naming syntax is represented by the XML tree structure (parent-child relations) I.e. a XML parent-child relation is equivalent to the ISO/TS 14048 data structure syntax represented by a "." (period-sign), see example 1.

Example 1:

XML syntax:

```
<data_documentation_of_process>
  <process>
     <process_description>
      <technical_scope>foo<technical_scope>
```

represents in ISO/TS 14048 naming syntax:

```
data_documentation_of_process.process.process_description.technical_scope =
"foo"
```

ii: Data fields with 1 (one) allowed occurrence that have non-unique data field titles such as "name" and "reference_to_nomenclature" are represented by attributes in the XML syntax. I.e. an XML attribute to an element relation is equivalent to the ISO/TS 14048 naming syntax represented by a "." (period-sign), see example 2.

Example 2:

XML syntax:

```
<data_documentation_of_process>
  <process>
     <process_description>
        <class name="bar"/>
```

represents in ISO/TS 14048 naming syntax:

```
data_documentation_of_process.process.process_description.class.name = "bar"
```

iii: Data fields with unlimited allowed occurrences that have non-unique data field titles namely "formulae", "name_of_variable" and "value_of_variable" are represented in the same XML-element as their parent. The data structure separation is represented by a "__" (double underscore) in the XML syntax. I.e. a "__" within an element is equivalent to the ISO/TS 14048 naming syntax represented by a "." (period-sign), see example 3.

Example 3:

XML syntax:

```
<data_documentation_of_process>
  <process>
    <process_description>
     <technology>
       <mathematical_model__formulae>x+y*z</mathematical_model__formulae>
```

represents in ISO/TS 14048 naming syntax:

```
data_documentation_of_process.process.process_description.technology.mathematica
l_model.formulae = "x+y*z"
```

4.2.3 Parsing the XML exchange file against the data definition in the DTD

By referencing the DTD from the XML file, the XML can be parsed for validity against the data definition in the DTD. The reference can be done in the <!DOCTYPE> tag as illustrated in example 4.

Example 4:

XML document file name: “example.xml”
Content:

```
<?xml version="1.0" encoding="iso-8859-1"?>
<!DOCTYPE iso_ts_14048 SYSTEM "http://www.imi.chalmers.se/iso/14048_v100.dtd">

<iso_ts_14048>
  <data_documentation_of_process>
      <process>
          <process_description name="DTD reference example">
              <technology>
                  <short_technology_descriptors> This example illustrates how the
reference to the DTD can be done within the XML data exchange file by using http
protocol. The DTD is stored on the file 14048v_100.dtd residing on the server
www.imi.chalmers.se/iso. The short_technology_descriptor element is misspelled, why
an error is generated upon parsing against the DTD.
                  </short_technology_descriptors>
              </technology>
          </process_description>
      </process>
  </data_documentation_of_process>
</iso_ts_14048>
```

The “example.xml” file is not automatically parsed by this reference. The parsing of the XML file is done programmatically depending on the platform of the application.

Parsing the file “example.xml” on a Microsoft Windows™ platform can be done by putting the code below in a html file located in the same folder as the “example.xml.”. When the html file is opened in a xml compatible web browser, the java script code loads and parses the “example.xml” file into a Microsoft XML Document Object Model and delivers any error messages as output displayed in the browser.

```
<html>
<body>
<script type="text/javascript">
var xmlDoc = new ActiveXObject(‘Microsoft.XMLDOM‘)

xmlDoc.async=‘false‘
xmlDoc.validateOnParse=‘true‘

xmlDoc.load(‘example.xml‘)

document.write(‘Error Code: ‘) document.write(xmlDoc.parseError.errorCode)
document.write(‘Error Reason: ‘)
document.write(xmlDoc.parseError.reason)
document.write(‘Error Line: ‘)
document.write(xmlDoc.parseError.line)

</script>
<body>
<html>
```

Since the “short_technology_descriptors” element is misspelled an error is generated and captured by the parsing function. The below output, including error messages is from the parsing function, is hence displayed in the browser:

```
Error Code: -1072898028
Error Reason: Element content is invalid according to the DTD/Schema. Expecting:
short_technology_descriptor, technical_content_and_functionality,
technology_picture,
process_contents, operating_conditions, mathematical_model__formulae,
mathematical_model__name_of_variable, mathematical_model__value_of_variable.
Error Line: 8
```

5 Data storage format based on ISO/TS 14048

This section presents a technical implementation of a database structure that consistently supports the ISO/TS 14048 data documentation format. No mandatory requirements are stated in ISO/TS 14048 regarding the structure of the database, i.e. it is optional which data fields should be included. In addition, it is quite feasible to add tables and fields to the database, to support the functionality of a specific application. However, only data in data fields defined in the ISO/TS 14048 format can be communicated with a the data exchange format presented in section 4 in this document. Further information including downloadable SQL scripts can be found at the IMI website http://www.imi.chalmers.se/iso.

5.1 Characteristics of this database implementation

There are innumerable possible solutions to structure a database that could be used for the communication of ISO/TS 14048 formatted data. The database structure presented here is a pragmatic implementation based on the following decisions:

- The structure should be easy to implement, one-to-one data field relations and one-to-zero relations are treated equivalently
- The identifying key to an unambiguous process is constituted by the data fields:
  - administrative_information.identification_number
  - administrative_information.registration_authority
  - administrative_information.version_number

  This identifying key often appears in references between tables. For convenience the identifying key is aggregated into one unique implicit key.
- There should be one field in the database for each data field defined in ISO/TS 14048 with the exception of the terms name_of_variable and value_of_variable belonging to the concept mathematical_model and mathematical_relations. The term formulae will be used to store all the necessary data needed within the relating concepts mathematical_model and mathematical_relations.
- The naming of tables and fields should be based on the data field titles and the data field references defined in ISO/TS 14048.
- Where applicable, nomenclature data should be explicitly included in nomenclature tables

5.2 Naming conventions

5.2.1 Database table titles

The aim has been to include only as many tables as necessary to comply with the data field reference specifications in ISO/TS 14048. A consequence of this is that all the data fields with a one-to-one and one-to-zero cardinality will belong to the same table, regardless of their corresponding conceptual hierarchy specified in ISO/TS 14048. The tables in the database in this implementation are given titles corresponding to the topmost concept or term in the hierarchal structure specified in ISO/TS 14048, with a one-to-one mapping to each data fields in the respective table. If this naming convention results in a table name that makes little or no sense by itself, the title is extended with the parent concept. E.g. the title of the table containing data fields with a one-to-one mapping to the concept “property” is extended with the parent concept to “inputs_and_outputs__property” to aid the understanding of the function and data content of the table.

Tables with exclusive and inclusive nomenclature data are given titles based on the corresponding data field title in ISO/TS 14048 including a prefix “iso14048_”. E.g. the exclusive nomenclature table referring to the data field data_documentation_of_process.process.process_description.aggregation_type is given the title iso14048_aggregation_type. This makes it easy to identify the ISO/TS 14048 specified nomenclature tables from other tables in the database, see section 5.3 for details.

5.2.2 Database column titles

The general rule of the naming of columns in the database is that the column is given the same title as the corresponding ISO/TS 14048 term.

The conceptual structure of the ISO/TS 14048 hierarchy of concepts and terms implies a logical structure where terms with the same name may be located at the same hierarchal level. In this technical implementation this means that terms with equal names may be found in the same database table. If this is the case the column name is extended with a prefix corresponding to the parent concept of the term. The same extension rule applies if the name term coincides with a reserved keyword in the language of relational database models SQL (Structured Query Language).

Example:

Consider the data field titles:
`data_documentation_of_process.process.process_description.name`
`data_documentation_of_process.process.process_description.quantitative_reference.name`

They both have a one-to-one relation to the concept data_documentation_of_process. This means they are on the same logical level and hence their corresponding columns are located in the same table in the database.

Since the terms are identical the column names are extended with their corresponding parent concept:
`process_description__name`
`quantitiative_reference__name`

Columns included for technical reasons to make the database consistent with the specifications of data field references in ISO/TS 14048 are given descriptive names to aid the understanding of the function of the field.

5.3 Nomenclature

5.3.1 Exclusive nomenclature

The exclusive nomenclature is stored in the following tables:

iso14048_aggregation_type
referring to the data field:
data_documentation_of_process.process.process_description.aggregation_type

iso14048_direction
referring to the data field:
data_documentation_of_process.process.inputs_and_outputs.direction

iso14048_recieving_environment
referring to the data field:
data_documentation_of_process.process.inputs_and_outputs.receiving_environment

5.3.2 Inclusive nomenclature

The inclusive nomenclature is stored in the following tables:

iso14048_type
referring to the data field:
data_documentation_of_process.process.process_description.quantitative_reference.type

iso14048_technical_scope
referring to the data field:
data_documentation_of_process.process.process_description.technical_scope

iso14048_area_name
referring to the data field:
data_documentation_of_process.process.process_description.area_name

This table has an added column titled “area_description” with no corresponding data field in ISO/TS 14048. This column stores data that gives an understandable description of the corresponding area code.

iso14048_group
referring to the data field:
data_documentation_of_process.process.inputs_and_outputs.group

iso14048_recieving_environment_specification
referring to the data field:
data_documentation_of_process.process.inputs_and_outputs.receiving_environment_specification

iso14048_amount__name
referring to the data field:
data_documentation_of_process.process.inputs_and_outputs.amount.name

iso14048_parameter__name
referring to the data field:
data_documentation_of_process.process.inputs_and_outputs.amount.parameter.name

This tables also have the function to define what parameters are needed to describe an amount distribution.

iso14048_unit
referring to the data fields:
data_documentation_of_process.process.process_description.quantitative_reference.unit
data_documentation_of_process.process.inputs_and_outputs.property.unit
data_documentation_of_process.process.inputs_and_outputs.unit.symbol_or_name

In this implementation the recommended nomenclature for units is the International System of units (SI units) as set out in ISO 31, is used as nomenclature for all data fields who refers to units. The field unit in the table iso14048_unit stores the symbol of the unit. The table iso14048_unit also contains two added fields that is not defined in the ISO/TS 14048 specification. The field unit_name stores the name of the unit and the field physical_quantity stores the physical quantity the unit is representing. For example the physical quantity *length* is measured in the SI unit named *meter* which is represented by the symbol *m*. This is an example of how fields could be added to the database in order to store useful information without hampering the consistency with the ISO/TS 14048 specification.

iso14048_modelling_constants__name
referring to the data field:
data_documentation_of_process.modelling_and_validation.modelling_principles.modelling_constants.name

iso14048_method
referring to the data field:
data_documentation_of_process.modelling_and_validation.validation.method

The data type of this field is specified by ISO/TS 14048 as free text. In most database software a free text typed field cannot have the function of a foreign key, i.e. the reference for consistency with a free text typed nomenclature cannot be an intrinsic part of the database structure. In this implementation the column titled “method” in iso14048_method table is typed as short text. If more than 350 characters are required to store the method data it is truncated to 350 characters and the original method data is stored in the column “method_freetext”.

5.3.3 Non-intrinsic nomenclature

Non intrinsic nomenclature is not stored in the database. For example, it makes no sense to store every possible GIS coordinate that is valid according to ISO 6709. An explicit formatting rule in the database could be set on the column GIS_reference in the table valid_geography__GIS_reference. This solution is not implemented here, which leaves it up to the application writing, updating or reading the data to check for consistency with the GIS data type format.

5.3.4 User defined nomenclature

No user defined nomenclature tables is specified in this implementation.

5.4 Database structure

For a conceptual understanding of the database presented here please refer to the ISO/TS 14048 document and the specifications stated in section 5.1, 5.2, and 5.3 in this document.

5.4.1 Structure overview

An overview picture of the resulting database structure is presented in Annex C.

5.4.2 Database definition

The structure of the database in this implementation is defined by the SQL statements presented in Annex C[1].

[1] In order for the data definition statements to be compatible with Microsoft Access™ format the ISO/TS 14048 shorttext typed columns must be altered from varchar (350) to varchar (255). This modification implies that excplicit rules must be applied regarding the interpretation of the ISO/TS 14048 shorttext type, if a database is implemented in a Microsoft Access™ format.

Annex A. ISO/TS 14048 DTD Version 1.00

```
<?xml version="1.0"?>

<!DOCTYPE iso_ts_14048 [
<!ELEMENT iso_ts_14048 (data_documentation_of_process*)>
<!ELEMENT data_documentation_of_process (process?,modelling_and_validation?,
administrative_information?)>
    <!ELEMENT process (process_description?,inputs_and_outputs*)>
        <!ELEMENT process_description (class*,quantitative_reference?,technical_scope?,
        aggregation_type?,technology?,valid_time_span?,valid_geography?,
        data_acquisition?)>
        <!ATTLIST process_description name CDATA #IMPLIED>
            <!ELEMENT class EMPTY>
            <!ATTLIST class name CDATA #IMPLIED>
            <!ATTLIST class reference_to_nomenclature CDATA #IMPLIED>
            <!ELEMENT quantitative_reference (type?)>
            <!ATTLIST quantitative_reference name CDATA #IMPLIED>
            <!ATTLIST quantitative_reference unit CDATA #IMPLIED>
            <!ATTLIST quantitative_reference amount CDATA #IMPLIED>
                <!ELEMENT type (#PCDATA)>
            <!ELEMENT technical_scope (#PCDATA)>
            <!ELEMENT aggregation_type (#PCDATA)>
            <!ELEMENT technology (short_technology_descriptor?,
            technical_content_and_functionality?,technology_picture?,process_contents?,
            operating_conditions?,mathematical_model__formulae*,
            mathematical_model__name_of_variable*,mathematical_model__value_of_variable*)>
                <!ELEMENT short_technology_descriptor (#PCDATA)>
                <!ELEMENT technical_content_and_functionality (#PCDATA)>
                <!ELEMENT technology_picture (#PCDATA)>
                <!ELEMENT process_contents (included_processes*,intermediate_product_flows*)>
                    <!ELEMENT included_processes (#PCDATA)>
                    <!ELEMENT intermediate_product_flows (source_process?,input_and_output_source?,
                    input_and_output_destination?,destination_process?)>
                        <!ELEMENT source_process (#PCDATA)>
                        <!ELEMENT input_and_output_source (#PCDATA)>
                        <!ELEMENT input_and_output_destination (#PCDATA)>
                        <!ELEMENT destination_process (#PCDATA)>
                <!ELEMENT operating_conditions (#PCDATA)>
                <!ELEMENT mathematical_model__formulae (#PCDATA)>
                <!ELEMENT mathematical_model__name_of_variable (#PCDATA)>
                <!ELEMENT mathematical_model__value_of_variable (#PCDATA)>
            <!ELEMENT valid_time_span (start_date?,end_date?,time_span_description?)>
                <!ELEMENT start_date (#PCDATA)>
                <!ELEMENT end_date (#PCDATA)>
                <!ELEMENT time_span_description (#PCDATA)>
            <!ELEMENT valid_geography (area_name*,area_description?,sites*,gis_reference*)>
                <!ELEMENT area_name (#PCDATA)>
                <!ELEMENT area_description (#PCDATA)>
                <!ELEMENT sites (#PCDATA)>
                <!ELEMENT gis_reference (#PCDATA)>
            <!ELEMENT data_acquisition (sampling_procedure?,sampling_sites*,number_of_sites?,
            sample_volume?)>
                <!ELEMENT sampling_procedure (#PCDATA)>
                <!ELEMENT sampling_sites (#PCDATA)>
                <!ELEMENT number_of_sites (#PCDATA)>
                <!ELEMENT sample_volume (absolute?,relative? )>
                    <!ELEMENT absolute (#PCDATA)>
                    <!ELEMENT relative (#PCDATA)>
        <!ELEMENT inputs_and_outputs (direction?,group?,recieving_environment?,
        recieving_environment_specification?,environment_condition?,geographical_location?,
        related_external_system?,internal_location?,name?,property*,amount*,
        mathematical_relations__formulae*,mathematical_relations__name_of_variable*,
        mathematical_relations__value_of_variable*,documentation*)>
        <!ATTLIST inputs_and_outputs identification_number CDATA #IMPLIED>
            <!ELEMENT direction (#PCDATA)>
            <!ELEMENT group (#PCDATA)>
            <!ELEMENT recieving_environment (#PCDATA)>
            <!ELEMENT recieving_environment_specification (#PCDATA)>
            <!ELEMENT environment_condition (#PCDATA)>
            <!ELEMENT geographical_location (#PCDATA)>
            <!ELEMENT related_external_system (origin_or_destination?,transport_type?,
            information_reference?)>
                <!ELEMENT origin_or_destination (#PCDATA)>
```

```
            <!ELEMENT transport_type (#PCDATA)>
            <!ELEMENT information_reference (#PCDATA)>
        <!ELEMENT internal_location (#PCDATA)>
        <!ELEMENT name (name_text, specification_of_name)>
        <!ATTLIST name reference_to_nomenclature CDATA #IMPLIED>
            <!ELEMENT name_text (#PCDATA)>
            <!ELEMENT specification_of_name (#PCDATA)>
        <!ELEMENT property EMPTY>
        <!ATTLIST property name CDATA #IMPLIED>
        <!ATTLIST property unit CDATA #IMPLIED>
        <!ATTLIST property amount CDATA #IMPLIED>
        <!ELEMENT amount (unit?,parameter*)>
        <!ATTLIST amount name CDATA #IMPLIED>
            <!ELEMENT unit (symbol_or_name?,explanation?)>
                <!ELEMENT symbol_or_name (#PCDATA)>
                <!ELEMENT explanation (#PCDATA)>
            <!ELEMENT parameter EMPTY>
            <!ATTLIST parameter name CDATA #IMPLIED>
            <!ATTLIST parameter value CDATA #IMPLIED>
        <!ELEMENT mathematical_relations__formulae (#PCDATA)>
        <!ELEMENT mathematical_relations__name_of_variable (#PCDATA)>
        <!ELEMENT mathematical_relations__value_of_variable (#PCDATA)>
        <!ELEMENT documentation (data_collection?,collection_date?,data_treatment?,
        reference_to_data_source*)>
            <!ELEMENT data_collection (#PCDATA)>
            <!ELEMENT collection_date (#PCDATA)>
            <!ELEMENT data_treatment (#PCDATA)>
            <!ELEMENT reference_to_data_source (#PCDATA)>
    <!ELEMENT modelling_and_validation (intended_application?,infomation_sources*,
    modelling_principles?,modelling_choices?,data_quality_statement?,validation*,other_information?)>
        <!ELEMENT intended_application (#PCDATA)>
        <!ELEMENT infomation_sources (#PCDATA)>
        <!ELEMENT modelling_principles (data_selection_principle?,adaptation_principles?,
        modelling_constants*)>
            <!ELEMENT data_selection_principle (#PCDATA)>
            <!ELEMENT adaptation_principles (#PCDATA)>
            <!ELEMENT modelling_constants EMPTY>
            <!ATTLIST modelling_constants name CDATA #IMPLIED>
            <!ATTLIST modelling_constants value CDATA #IMPLIED>
        <!ELEMENT modelling_choices (criteria_for_exluding_elementary_flows?,
        criteria_for_exluding_intermediate_product_flows?,criteria_for_externalising_processes?,
        allocations_performed?,process_expansion?)>
            <!ELEMENT criteria_for_exluding_elementary_flows (#PCDATA)>
            <!ELEMENT criteria_for_exluding_intermediate_product_flows (#PCDATA)>
            <!ELEMENT criteria_for_externalising_processes (#PCDATA)>
            <!ELEMENT allocations_performed (allocated_co_products?,allocation_explanation?)>
                <!ELEMENT allocated_co_products (#PCDATA)>
                <!ELEMENT allocation_explanation (#PCDATA)>
            <!ELEMENT process_expansion (process_included_in_expansion?,
            process_expansion_explanation?)>
                <!ELEMENT process_included_in_expansion (#PCDATA)>
                <!ELEMENT process_expansion_explanation (#PCDATA)>
        <!ELEMENT data_quality_statement (#PCDATA)>
        <!ELEMENT validation (method?,procedure?, result?,validator?)>
            <!ELEMENT method (#PCDATA)>
            <!ELEMENT procedure (#PCDATA)>
            <!ELEMENT result (#PCDATA)>
            <!ELEMENT validator (#PCDATA)>
        <!ELEMENT other_information (#PCDATA)>
    <!ELEMENT administrative_information (registration_authority?,version_number?,data_commissioner?,
    data_generator?,data_documentor?,date_completed?,publication?,copyright?,access_restrictions?)>
    <!ATTLIST administrative_information identification_number CDATA #IMPLIED>
        <!ELEMENT registration_authority (#PCDATA)>
        <!ELEMENT version_number (#PCDATA)>
        <!ELEMENT data_commissioner (#PCDATA)>
        <!ELEMENT data_generator (#PCDATA)>
        <!ELEMENT data_documentor (#PCDATA)>
        <!ELEMENT date_completed (#PCDATA)>
        <!ELEMENT publication (#PCDATA)>
        <!ELEMENT copyright (#PCDATA)>
        <!ELEMENT access_restrictions (#PCDATA)>
]>
```

Annex B. Example of ISO/TS 14048 formatted XML document

The following example shows the ISO/TS 14048 formatted XML document containing the same data as the documented example in ISO/TS 14048 section B2. Note that only two flows are included in this example.

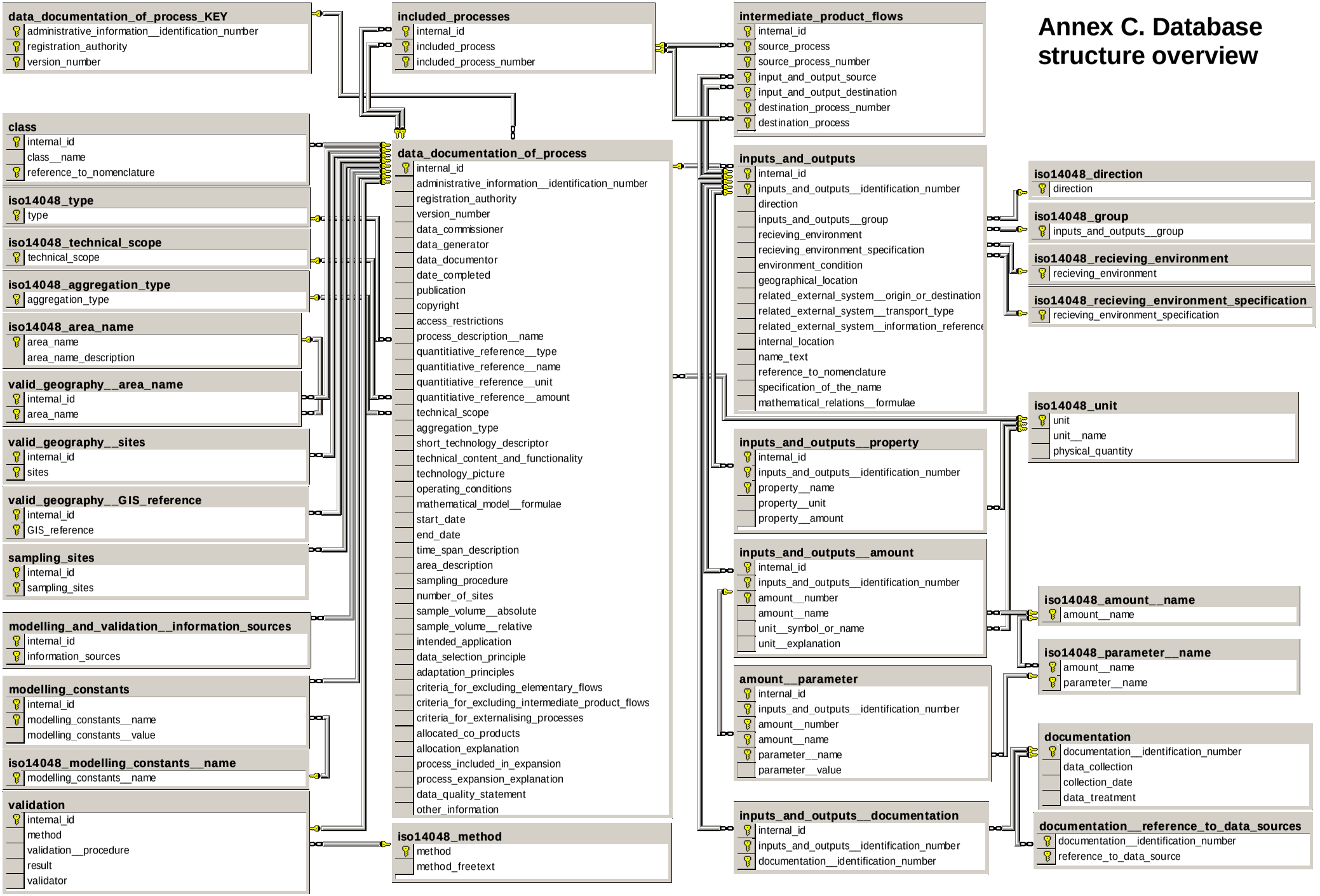
```
<?xml version="1.0" encoding="iso-8859-1"?>
<!DOCTYPE iso_ts_14048 SYSTEM "http://www.imi.chalmers.se/iso/14048_v100.dtd">
<iso_ts_14048>
        <data_documentation_of_process>
              <process>
                       <process_description name="Coal Fired Electricity Production Plant with co-
                       generation of steam">
                              <class name="Electricity Supply (3601)"
                              reference_to_nomenclature="Australian Industry Classification Scheme
                              (AICS)"/>
                              <quantitative_reference name="Net production of electricity" unit="kWh"
                              amount="1">
                               <type>Functional unit</type>
                         </quantitative_reference>
                         <technical_scope>Gate to gate</technical_scope>
                         <aggregation_type>Other</aggregation_type>
                         <technology>
                                     <short_technology_descriptor>CFB coal based power
                                     plants</short_technology_descriptor>
                                     <technical_content_and_functionality>The studied system includes
                                     all processes from washed coal delivery through to power
                                     generation, including treatment of cooling water, of a combined
                                     heat and power plant with
                                     conventional steam cycle within a circulating fluidisation bed.
                                     The fuel is 100 % washed black
                              coal extracted from mines located within 200 km of the plant.
                              Technical assumptions data for the studied plant:
                              Annual time of operation (hours): 4000
                              Normal annual electricity production (GWh): 40
                              Steam production – 30 TJ per annum
                              Assumed life-time (years): 40
                                     Electricity production, net during 40 years (TWh):
                                     1.6</technical_content_and_functionality>
                              <technology_picture/>
                              <process_contents>
                                    <included_processes/>
                                    <intermediate_product_flows>
                                          <source_process/>
                                          <input_and_output_source/>
                                          <input_and_output_destination/>
                                          <destination_process/>
                                    </intermediate_product_flows>
                              </process_contents>
                                     <operating_conditions>Normal (see data field Technical content
                                     and functionality)</operating_conditions>
                              <mathematical_model__formulae/>
                              <mathematical_model__name_of_variable/>
                              <mathematical_model__value_of_variable/>
                         </technology>
                         <valid_time_span>
                              <start_date>1995-01-01</start_date>
                              <end_date>2015-01-01</end_date>
                                     <time_span_description>The combined heat and power plant is
                                     assumed to have an operation time of 40 years, starting
                              20 years before above start date.</time_span_description>
                         </valid_time_span>
                         <valid_geography>
                              <area_name>Au</area_name>
                                     <area_description>The plant resides in Australia and all its
                                     support systems are calculated in relation to
                                     Queensland.</area_description>
                              <sites>Maidstone</sites>
                              <gis_reference>Easting_301230 Northing_6263230</gis_reference>
                         </valid_geography>
                         <data_acquisition>
                                     <sampling_procedure>The inventory relates to a single site so no
                                     sampling procedure was necessary.</sampling_procedure>
```

```
            <sampling_sites>[No sampling undertaken]</sampling_sites>
            <number_of_sites>[No sampling undertaken]</number_of_sites>
            <sample_volume>
                  <absolute/>
                  <relative/>
            </sample_volume>
      </data_acquisition>
</process_description>
<inputs_and_outputs identification_number="1">
      <direction>input</direction>
      <group>Raw Material</group>
      <recieving_environment>Technosphere</recieving_environment>
      <recieving_environment_specification>...
          </recieving_environment_specification>
      <environment_condition>...</environment_condition>
      <geographical_location>Queensland</geographical_location>
      <related_external_system>
            <origin_or_destination>Coal Washery Plant</origin_or_destination>
            <transport_type>Truck, long distance</transport_type>
                  <information_reference>Company internal
                  report</information_reference>
      </related_external_system>
          <internal_location>Coal is delivered to crushing unit on power plant
          site</internal_location>
      <name reference_to_nomenclature="Company specific">
            <name_text>Washed Coal</name_text>
                  <specification_of_name>Raw coal with low grade material
                  removed</specification_of_name>
      </name>
      <property name="Energy Content" unit="MJ/kg" amount="22.3"/>
      <amount name="Range">
            <unit>
                  <symbol_or_name>g</symbol_or_name>
                  <explanation>SI-unit</explanation>
            </unit>
            <parameter name="max" value="450"/>
            <parameter name="min" value="420"/>
      </amount>
      <mathematical_relations__formulae/>
      <mathematical_relations__name_of_variable/>
      <mathematical_relations__value_of_variable/>
      <documentation>
            <data_collection>Coal purchase data</data_collection>
            <collection_date>1995-1996</collection_date>
                  <data_treatment>Annual coal purchases were divided by annual
                  electricity generation</data_treatment>
                  <reference_to_data_source>CIR 1995:4 Company internal
                  report</reference_to_data_source>
      </documentation>
</inputs_and_outputs>
<inputs_and_outputs identification_number="2">
      <direction>Input</direction>
      <group>Ancillary</group>
      <recieving_environment>Technosphere</recieving_environment>
      <recieving_environment_specification>...
          </recieving_environment_specification>
      <environment_condition>...</environment_condition>
      <geographical_location>Queensland</geographical_location>
      <related_external_system>
            <origin_or_destination>Ammonia producer</origin_or_destination>
            <transport_type>Truck, long distance</transport_type>
                  <information_reference>Company internal
                  report</information_reference>
      </related_external_system>
          <internal_location>Ammonia is used for reduction of NOx in the flue
          gas.</internal_location>
      <name reference_to_nomenclature="">
            <name_text>Ammonia</name_text>
            <specification_of_name>Company specific</specification_of_name>
      </name>
      <property name="Density" unit="kg/m3" amount="0.85"/>
      <amount name="Point Value">
            <unit>
                  <symbol_or_name>g</symbol_or_name>
                  <explanation>SI-unit</explanation>
            </unit>
            <parameter name="single point" value="3"/>
```

```
            </amount>
            <mathematical_relations__formulae/>
            <mathematical_relations__name_of_variable/>
            <mathematical_relations__value_of_variable/>
            <documentation>
                  <data_collection>Measured, discrete</data_collection>
                  <collection_date>1995-1996</collection_date>
                        <data_treatment>The value is derived from the use of ammonia in
                        the CFBKVV plant (CPR 1995:4)</data_treatment>
                        <reference_to_data_source>
                        CPR 1995:4 Company internal report</reference_to_data_source>
            </documentation>
      </inputs_and_outputs>
</process>
<modelling_and_validation>
         <intended_application>The purpose was to obtain a reliable basis to be able to
         perform life-cycle assessment of different local power supply plant, taking
         account of additional steam utilisation, and ash treatment.
         The work with life-cycle assessment is also expected to contribute to
         reinforcement and structuring of the environmental work within the Company, and
         provide a deeper knowledge on the use of resources and emissions to the
         environment.
      This inventory is part of large set of inventories covering upstream and downstream
         processes. See Clean Coal Technologies LCA profile report 234, 2000.
         </intended_application>
         <infomation_sources>The information used in the assessment is largely based on
         Company internal reports.
      Regarding methodology for life cycle assessment, the ISO 14040 standards(1) and the
      SETAC guidelines(2) were used.
      1. ISO 14040:1997, Environmental management - Life cycle assessment – Principles and
      framework.
         2. SETAC, Guidelines for Life-Cycle Assessment A Code of Practice,
         </infomation_sources>
      <modelling_principles>
            <data_selection_principle>The following priorities have been followed:
                  1) Site data has been used only when continuous measurement data has been
                  found.
                  2) Modelling from similarity has been used whenever site data has not
                  been found.</data_selection_principle>
            <adaptation_principles>No numerical adaptations is made:
                  both numerical data and process information used for modelling of the
                  included processes are referred to in the original report.
            Other adaptations are addressed as allocations.
            No numerical adaptations are made.</adaptation_principles>
            <modelling_constants name="Reinvestments and
            reconstruction, as percentage of
            the of the use of resources and
            emissions at the building phase." value="1 % per year"/>
      </modelling_principles>
      <modelling_choices>
                  <criteria_for_exluding_elementary_flows>The parameters that are presented
                  are chosen because they have a general interest and because the basis for
                  these parameters is relatively good.
            The following aspects have been excluded:
                  -The risk of major accidents and rare breakdowns and environmental
                  consequences from these
            - Work environment
                  Trace metal and hydrocarbons have been excluded due to a lack of data and
                  will be investigated as part of National Pollutant Inventory over the
                  next 2 years.
                  </criteria_for_exluding_elementary_flows>
                  <criteria_for_exluding_intermediate_product_flows>
                  Known use of chemicals is accounted for. In the cases where it was
                  possible to obtain data,
                  resource use and emissions for the production of these chemicals are
                  included. Fuels and materials used in site landscaping and ponding are
                  not included in the study.
                  </criteria_for_exluding_intermediate_product_flows>
                  <criteria_for_externalising_processes>
                  The following processes have been externalised from this documented
                  process:
            - Transmission and distribution losses
            -Coal extraction, washing and delivery
            -Ammonia production
            -Limestone production
            -Boiler service impacts
            -Stream supply and corresponding credit for energy from natural gas
```

```
                        -Ash treatment in concrete manufacture
                        </criteria_for_externalising_processes>
                  <allocations_performed>
                              <allocated_co_products>No allocations performed [for examples of
                              how to use the allocation section of the data documentation
                              format see CPM report 2001:8]</allocated_co_products>
                        <allocation_explanation></allocation_explanation>
                  </allocations_performed>
                  <process_expansion>
                        <process_included_in_expansion>Not applied in the study
                              </process_included_in_expansion>
                        <process_expansion_explanation/>
            </process_expansion>
                  </modelling_choices>
                     <data_quality_statement>Data concerning the power plant are based on data for
                     one specific power plant owned by     Company.
                     The parameters that are presented are chosen because they have a general
                     interest and because the bases for these parameters are relatively good. All
                     values are reported with 3 figures. The data are however seldom that accurate.
                     </data_quality_statement>
                  <validation>
                        <method>Inventory method reviewed</method>
                        <procedure>Critical review</procedure>
                        <result>No significant discrepancies
                              with ISO 14040 or
                              ISO 14041
                        </result>
                        <validator>Jim Stynes CIM</validator>
                  </validation>
                  <validation>
                        <method>Data Checks</method>
                        <procedure>Client review</procedure>
                        <result>Corrections made to ash
                              generation values</result>
                        <validator>Clean Coal Power Company
                              P/L</validator>
                  </validation>
                     <other_information>The fuel chain and combustion of coal based electricity
                     production in a CFB-boiler should be  applicable on current coal-fired plants.
                     Transmission and distribution losses are not included. When the result is used
                     to study different types of electricity use, these losses should be included. A
                     rough estimate is that the distribution losses for a large industry customer are
                     approximately 5 % of the bought electricity, i.e., to obtain data for the use of
                     electricity the data should be multiplied with 1.05.
                     For an average household customer the transmission losses are approximately 10 %
                     of the bought electricity, i.e., the data should be multiplied with 1.10.
                  Throughout the calculations, the CFB-boiler is assumed to be equipped with flue gas
                     condensing equipment. If the results are applied to a existing combined heat and
                     power plant without flue gas condensing equipment, the use of resources and
                     emissions per produced    kWh electricity will be higher. This because a plant
                     without flue gas condensing equipment has a lower total degree of efficiency.
                     </other_information>
            </modelling_and_validation>
            <administrative_information identification_number="CIM-AUSDATA0000234">
                     <registration_authority>CIM International P/L-
                     Http://www.cimint.com</registration_authority>
                  <version_number>1</version_number>
                  <data_commissioner>Clean Coal Power Company P/L
                  35 Station Road
                  Maidstone 8452,
                  Queensland, Australia</data_commissioner>
                  <data_generator>Clean Coal Power Company P/L</data_generator>
                  <data_documentor>Alex Jamison
                  Energy LC Consultants P/L</data_documentor>
                  <date_completed>22 February 2000</date_completed>
                  <publication>Not published</publication>
                  <copyright>Public</copyright>
                  <access_restrictions>None</access_restrictions>
            </administrative_information>
      </data_documentation_of_process>
</iso_ts_14048>
```

Annex C. Database structure overview



Annex D. Database definition

The following SQL (Structured Query Language) statements define the database structure in this implementation.

```
CREATE TABLE amount__parameter (
internal_id varchar (150) NOT NULL ,
inputs_and_outputs__identification_number int NOT NULL ,
amount__number int NOT NULL ,
amount__name varchar (150) NOT NULL ,
parameter__name varchar (150) NOT NULL ,
parameter__value real NULL
)


CREATE TABLE class (
internal_id varchar (150) NOT NULL ,
class__name varchar (150) NULL ,
reference_to_nomenclature varchar (350) NOT NULL
)


CREATE TABLE data_documentation_of_process (
internal_id varchar (150) NOT NULL ,
administrative_information__identification_number varchar (150) NOT NULL ,
registration_authority varchar (150) NOT NULL ,
version_number int NOT NULL ,
data_commissioner varchar (350) NULL ,
data_generator varchar (350) NULL ,
data_documentor varchar (350) NULL ,
date_completed datetime NULL ,
publication varchar (350) NULL ,
copyright varchar (350) NULL ,
access_restrictions varchar (350) NULL ,
process_description__name varchar (150) NULL ,
quantitiative_reference__type varchar (350) NULL ,
quantitiative_reference__name varchar (350) NULL ,
quantitiative_reference__unit varchar (150) NULL ,
quantitiative_reference__amount real NULL ,
technical_scope varchar (350) NULL ,
aggregation_type varchar (150) NULL ,
short_technology_descriptor varchar (350) NULL ,
technical_content_and_functionality text NULL ,
technology_picture varchar (350) NULL ,
operating_conditions text NULL ,
mathematical_model__formulae text NULL ,
start_date datetime NULL ,
end_date datetime NULL ,
time_span_description text NULL ,
area_description text NULL ,
sampling_procedure text NULL ,
number_of_sites real NULL ,
sample_volume__absolute varchar (350) NULL ,
sample_volume__relative real NULL ,
intended_application text NULL ,
data_selection_principle text NULL ,
adaptation_principles text NULL ,
criteria_for_excluding_elementary_flows text NULL ,
criteria_for_excluding_intermediate_product_flows text NULL ,
criteria_for_externalising_processes text NULL ,
allocated_co_products varchar (350) NULL ,
allocation_explanation text NULL ,
process_included_in_expansion varchar (350) NULL ,
process_expansion_explanation text NULL ,
data_quality_statement text NULL ,
other_information text NULL
)
```

```
CREATE TABLE data_documentation_of_process_KEY (
administrative_information__identification_number varchar (150) NOT NULL ,
registration_authority varchar (150) NOT NULL ,
version_number int NOT NULL
)


CREATE TABLE documentation (
documentation__identification_number varchar (150) NOT NULL ,
data_collection varchar (150) NULL ,
collection_date datetime NULL ,
data_treatment text NULL
)


CREATE TABLE documentation__reference_to_data_sources (
documentation__identification_number varchar (150) NOT NULL ,
reference_to_data_source varchar (350) NOT NULL
)


CREATE TABLE included_processes (
internal_id varchar (150) NOT NULL ,
included_process varchar (150) NOT NULL ,
included_process_number int NOT NULL
)


CREATE TABLE inputs_and_outputs (
internal_id varchar (150) NOT NULL ,
inputs_and_outputs__identification_number int NOT NULL ,
direction varchar (150) NULL ,
inputs_and_outputs__group varchar (150) NULL ,
recieving_environment varchar (150) NULL ,
recieving_environment_specification varchar (150) NULL ,
environment_condition text NULL ,
geographical_location varchar (350) NULL ,
related_external_system__origin_or_destination varchar (350) NULL ,
related_external_system__transport_type varchar (350) NULL ,
related_external_system__information_reference varchar (350) NULL ,
internal_location text NULL ,
name_text varchar (150) NULL ,
reference_to_nomenclature varchar (350) NULL ,
specification_of_the_name varchar (350) NULL ,
mathematical_relations__formulae text NULL
)


CREATE TABLE inputs_and_outputs__amount (
internal_id varchar (150) NOT NULL ,
inputs_and_outputs__identification_number int NOT NULL ,
amount__number int NOT NULL ,
amount__name varchar (150) NOT NULL ,
unit__symbol_or_name varchar (150) NOT NULL ,
unit__explanation varchar (350) NULL
)


CREATE TABLE inputs_and_outputs__documentation (
internal_id varchar (150) NOT NULL ,
inputs_and_outputs__identification_number int NOT NULL ,
documentation__identification_number varchar (150) NOT NULL
)


CREATE TABLE inputs_and_outputs__property (
internal_id varchar (150) NOT NULL ,
inputs_and_outputs__identification_number int NOT NULL ,
property__name char (150) NOT NULL ,
property__unit varchar (150) NULL ,
property__amount real NULL
)
```

```
CREATE TABLE intermediate_product_flows (
internal_id varchar (150) NOT NULL ,
source_process varchar (150) NOT NULL ,
source_process_number int NOT NULL ,
input_and_output_source int NOT NULL ,
input_and_output_destination int NOT NULL ,
destination_process_number int NOT NULL ,
destination_process varchar (150) NOT NULL
)


CREATE TABLE iso14048_aggregation_type (
aggregation_type varchar (150) NOT NULL
)


CREATE TABLE iso14048_amount__name (
amount__name varchar (150) NOT NULL
)


CREATE TABLE iso14048_area_name (
area_name char (2) NOT NULL ,
area_name_description varchar (150) NULL
)


CREATE TABLE iso14048_direction (
direction varchar (150) NOT NULL
)


CREATE TABLE iso14048_group (
inputs_and_outputs__group varchar (150) NOT NULL
)


CREATE TABLE iso14048_method (
method varchar (350) NOT NULL ,
method_freetext text NULL
)


CREATE TABLE iso14048_modelling_constants__name (
modelling_constants__name varchar (350) NOT NULL
)


CREATE TABLE iso14048_parameter__name (
amount__name varchar (150) NOT NULL ,
parameter__name varchar (150) NOT NULL
)


CREATE TABLE iso14048_recieving_environment (
recieving_environment varchar (150) NOT NULL
)


CREATE TABLE iso14048_recieving_environment_specification (
recieving_environment_specification varchar (150) NOT NULL
)


CREATE TABLE iso14048_technical_scope (
technical_scope varchar (350) NOT NULL
)


CREATE TABLE iso14048_type (
type varchar (350) NOT NULL
)
```

```
CREATE TABLE iso14048_unit (
unit varchar (150) NOT NULL ,
unit__name varchar (150) NOT NULL ,
physical_quantity varchar (150) NULL
)


CREATE TABLE modelling_and_validation__information_sources (
internal_id varchar (150) NOT NULL ,
information_sources varchar (350) NOT NULL
)


CREATE TABLE modelling_constants (
internal_id varchar (150) NOT NULL ,
modelling_constants__name varchar (350) NOT NULL ,
modelling_constants__value real NULL
)


CREATE TABLE sampling_sites (
internal_id varchar (150) NOT NULL ,
sampling_sites varchar (350) NOT NULL
)


CREATE TABLE valid_geography__GIS_reference (
internal_id varchar (150) NOT NULL ,
GIS_reference varchar (150) NOT NULL
)


CREATE TABLE valid_geography__area_name (
internal_id varchar (150) NOT NULL ,
area_name char (2) NOT NULL
)


CREATE TABLE valid_geography__sites (
internal_id varchar (150) NOT NULL ,
sites varchar (350) NOT NULL
)


CREATE TABLE validation (
internal_id varchar (150) NOT NULL ,
method varchar (350) NULL ,
validation__procedure text NULL ,
result text NULL ,
validator varchar (350) NULL
)


ALTER TABLE amount__parameter ADD
CONSTRAINT PK_amount__parameter PRIMARY KEY
(
internal_id,
inputs_and_outputs__identification_number,
amount__number,
amount__name,
parameter__name
)


ALTER TABLE class ADD
CONSTRAINT PK_class PRIMARY KEY
(
internal_id,
reference_to_nomenclature
)


ALTER TABLE data_documentation_of_process ADD
CONSTRAINT PK_data_documentation_of_process PRIMARY KEY
(
internal_id
)
```

```
ALTER TABLE data_documentation_of_process_KEY ADD
CONSTRAINT PK_data_documentation_of_process_KEY PRIMARY KEY
(
administrative_information__identification_number,
registration_authority,
version_number
)


ALTER TABLE documentation ADD
CONSTRAINT PK_documentati KEY
(
documentation__identification_number
)


ALTER TABLE documentation__reference_to_data_sources ADD
CONSTRAINT PK_documentation__references_to_data_sources PRIMARY KEY
(
documentation__identification_number,
reference_to_data_source
)


ALTER TABLE included_processes ADD
CONSTRAINT PK_included_processes PRIMARY KEY
(
internal_id,
included_process,
included_process_number
)


ALTER TABLE inputs_and_outputs ADD
CONSTRAINT PK_inputs_and_outputs PRIMARY KEY
(
internal_id,
inputs_and_outputs__identification_number
)


ALTER TABLE inputs_and_outputs__amount ADD
CONSTRAINT PK_inputs_and_outputs__amount PRIMARY KEY
(
internal_id,
inputs_and_outputs__identification_number,
amount__number
)


ALTER TABLE inputs_and_outputs__documentation ADD
CONSTRAINT PK_inputs_and_outputs__documentati KEY
(
internal_id,
inputs_and_outputs__identification_number,
documentation__identification_number
)


ALTER TABLE inputs_and_outputs__property ADD
CONSTRAINT PK_inputs_and_outputs__property PRIMARY KEY
(
internal_id,
inputs_and_outputs__identification_number,
property__name
)
```

```
ALTER TABLE intermediate_product_flows ADD
CONSTRAINT PK_intemediate_product_flows PRIMARY KEY
(
internal_id,
source_process,
source_process_number,
input_and_output_source,
input_and_output_destination,
destination_process_number,
destination_process
)


ALTER TABLE iso14048_aggregation_type ADD
CONSTRAINT PK_iso14048_aggregation_type PRIMARY KEY
(
aggregation_type
)


ALTER TABLE iso14048_amount__name ADD
CONSTRAINT PK_iso14048_amount__name PRIMARY KEY
(
amount__name
)


ALTER TABLE iso14048_area_name ADD
CONSTRAINT PK_iso14048_area_name PRIMARY KEY
(
area_name
)


ALTER TABLE iso14048_direction ADD
CONSTRAINT PK_iso14048_direction PRIMARY KEY
(
direction
)


ALTER TABLE iso14048_group ADD
CONSTRAINT PK_iso14048_group PRIMARY KEY
(
inputs_and_outputs__group
)


ALTER TABLE iso14048_method ADD
CONSTRAINT PK_iso14048_method PRIMARY KEY
(
method
)
ALTER TABLE iso14048_modelling_constants__name ADD
CONSTRAINT PK_iso14048_modelling_constants__name PRIMARY KEY
(
modelling_constants__name
)


ALTER TABLE iso14048_parameter__name ADD
CONSTRAINT PK_iso14048_parameter__name PRIMARY KEY
(
amount__name,
parameter__name
)


ALTER TABLE iso14048_recieving_environment ADD
CONSTRAINT PK_iso14048_recieving_environment PRIMARY KEY
(
recieving_environment
)
```

```
ALTER TABLE iso14048_recieving_environment_specification ADD
CONSTRAINT PK_iso14048_recieving_environment_specification PRIMARY KEY
(
recieving_environment_specification
)


ALTER TABLE iso14048_technical_scope ADD
CONSTRAINT PK_iso14048_technical_scope PRIMARY KEY
(
technical_scope
)


ALTER TABLE iso14048_type ADD
CONSTRAINT PK_iso14048_type PRIMARY KEY
(
type
)


ALTER TABLE iso14048_unit ADD
CONSTRAINT PK_iso14048_unit PRIMARY KEY
(
unit
)


ALTER TABLE modelling_and_validation__information_sources ADD
CONSTRAINT PK_modelling_and_validation__information_sources PRIMARY KEY
(
internal_id,
information_sources
)


ALTER TABLE modelling_constants ADD
CONSTRAINT PK_modelling_constants PRIMARY KEY
(
internal_id,
modelling_constants__name
)


ALTER TABLE sampling_sites ADD
CONSTRAINT PK_sampling_sites PRIMARY KEY
(
internal_id,
sampling_sites
)


ALTER TABLE valid_geography__GIS_reference ADD
CONSTRAINT PK_valid_geography__GIS_reference PRIMARY KEY
(
internal_id,
GIS_reference
)


ALTER TABLE valid_geography__area_name ADD
CONSTRAINT PK_valid_geography__area_name PRIMARY KEY
(
internal_id,
area_name
)


ALTER TABLE valid_geography__sites ADD
CONSTRAINT PK_valid_geography__sites PRIMARY KEY
(
internal_id,
sites
)
```

```
ALTER TABLE validation ADD
CONSTRAINT PK_validation PRIMARY KEY
(
internal_id
)


ALTER TABLE amount__parameter ADD
CONSTRAINT FK_amount__parameter_inputs_and_outputs__amount FOREIGN KEY
(
internal_id,
inputs_and_outputs__identification_number,
amount__number
) REFERENCES inputs_and_outputs__amount (
internal_id,
inputs_and_outputs__identification_number,
amount__number
),
CONSTRAINT FK_amount__parameter_iso14048_parameter__name FOREIGN KEY
(
amount__name,
parameter__name
) REFERENCES iso14048_parameter__name (
amount__name,
parameter__name
)


ALTER TABLE class ADD
CONSTRAINT FK_class_data_documentation_of_process FOREIGN KEY
(
internal_id
) REFERENCES data_documentation_of_process (
internal_id
)


ALTER TABLE data_documentation_of_process ADD
CONSTRAINT FK_data_documentation_of_process_data_documentation_of_process_key FOREIGN
KEY
(
administrative_information__identification_number,
registration_authority,
version_number
) REFERENCES data_documentation_of_process_KEY (
administrative_information__identification_number,
registration_authority,
version_number
),
CONSTRAINT FK_data_documentation_of_process_iso14048_aggregation_type FOREIGN KEY
(
aggregation_type
) REFERENCES iso14048_aggregation_type (
aggregation_type
),
CONSTRAINT FK_data_documentation_of_process_iso14048_technical_scope FOREIGN KEY
(
technical_scope
) REFERENCES iso14048_technical_scope (
technical_scope
),
CONSTRAINT FK_data_documentation_of_process_iso14048_type FOREIGN KEY
(
quantitiative_reference__type
) REFERENCES iso14048_type (
type
),
CONSTRAINT FK_data_documentation_of_process_iso14048_unit FOREIGN KEY
(
quantitiative_reference__unit
) REFERENCES iso14048_unit (
unit
)
```

```
ALTER TABLE documentation__reference_to_data_sources ADD
CONSTRAINT FK_documentation__reference_to_data_sources_documentation FOREIGN KEY
(
documentation__identification_number
) REFERENCES documentation (
documentation__identification_number
)


ALTER TABLE included_processes ADD
CONSTRAINT FK_included_processes_data_documentation_of_process FOREIGN KEY
(
internal_id
) REFERENCES data_documentation_of_process (
internal_id
),
CONSTRAINT FK_included_processes_data_documentation_of_process1 FOREIGN KEY
(
included_process
) REFERENCES data_documentation_of_process (
internal_id
)


ALTER TABLE inputs_and_outputs ADD
CONSTRAINT FK_inputs_and_outputs_data_documentation_of_process FOREIGN KEY
(
internal_id
) REFERENCES data_documentation_of_process (
internal_id
),
CONSTRAINT FK_inputs_and_outputs_iso14048_direction FOREIGN KEY
(
direction
) REFERENCES iso14048_direction (
direction
),
CONSTRAINT FK_inputs_and_outputs_iso14048_group FOREIGN KEY
(
inputs_and_outputs__group
) REFERENCES iso14048_group (
inputs_and_outputs__group
),
CONSTRAINT FK_inputs_and_outputs_iso14048_recieving_environment FOREIGN KEY
(
recieving_environment
) REFERENCES iso14048_recieving_environment (
recieving_environment
),
CONSTRAINT FK_inputs_and_outputs_iso14048_recieving_environment_specification FOREIGN
KEY
(
recieving_environment_specification
) REFERENCES iso14048_recieving_environment_specification (
recieving_environment_specification
)


ALTER TABLE inputs_and_outputs__amount ADD
CONSTRAINT FK_inputs_and_outputs__amount_inputs_and_outputs FOREIGN KEY
(
internal_id,
inputs_and_outputs__identification_number
) REFERENCES inputs_and_outputs (
internal_id,
inputs_and_outputs__identification_number
),
CONSTRAINT FK_inputs_and_outputs__amount_iso14048_amount__name FOREIGN KEY
(
amount__name
) REFERENCES iso14048_amount__name (
amount__name
),
CONSTRAINT FK_inputs_and_outputs__amount_iso14048_unit FOREIGN KEY
(
unit__symbol_or_name
) REFERENCES iso14048_unit (unit)
```

```
ALTER TABLE inputs_and_outputs__documentation ADD
CONSTRAINT FK_inputs_and_outputs__documentation_documentation FOREIGN KEY
(
documentation__identification_number
) REFERENCES documentation (
documentation__identification_number
),
CONSTRAINT FK_inputs_and_outputs__documentation_inputs_and_outputs FOREIGN KEY
(
internal_id,
inputs_and_outputs__identification_number
) REFERENCES inputs_and_outputs (
internal_id,
inputs_and_outputs__identification_number
)
ALTER TABLE inputs_and_outputs__property ADD
CONSTRAINT FK_inputs_and_outputs__property_inputs_and_outputs FOREIGN KEY
(
internal_id,
inputs_and_outputs__identification_number
) REFERENCES inputs_and_outputs (
internal_id,
inputs_and_outputs__identification_number
),
CONSTRAINT FK_inputs_and_outputs__property_iso14048_unit FOREIGN KEY
(
property__unit
) REFERENCES iso14048_unit (
unit
)


ALTER TABLE intermediate_product_flows ADD
CONSTRAINT FK_intemediate_product_flows_inputs_and_outputs FOREIGN KEY
(
destination_process,
input_and_output_destination
) REFERENCES inputs_and_outputs (
internal_id,
inputs_and_outputs__identification_number
),
CONSTRAINT FK_intermediate_product_flow_included_processes1 FOREIGN KEY
(
internal_id,
destination_process,
destination_process_number
) REFERENCES included_processes (
internal_id,
included_process,
included_process_number
),
CONSTRAINT FK_intermediate_product_flows_included_processes FOREIGN KEY
(
internal_id,
source_process,
source_process_number
) REFERENCES included_processes (
internal_id,
included_process,
included_process_number
),
CONSTRAINT FK_intermediate_product_flows_inputs_and_outputs1 FOREIGN KEY
(
source_process,
input_and_output_source
) REFERENCES inputs_and_outputs (
internal_id,
inputs_and_outputs__identification_number
)


ALTER TABLE iso14048_parameter__name ADD
CONSTRAINT FK_iso14048_parameter__name_iso14048_amount__name FOREIGN KEY
(
amount__name
) REFERENCES iso14048_amount__name (amount__name)
```

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