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Representation of process control engineering requests in P&I diagrams and data exchange between P&ID tools and PCE-CAE tools

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

REPRESENTATION OF PROCESS CONTROL ENGINEERING REQUESTS IN P&I DIAGRAMS AND DATA EXCHANGE BETWEEN P&ID TOOLS AND PCE-CAE TOOLS

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The text of this PAS is based on the following document:

This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document

Draft PAS	Report on voting
65/356/NP	65/361/RVN

Following publication of this PAS, which is a pre-standard publication, the technical committee or subcommittee concerned will transform it into an International Standard.

This PAS shall remain valid for an initial maximum period of three years starting from 2005-06. The validity may be extended for a single three-year period, following which it shall be revised to become another type of normative document or shall be withdrawn.

INTRODUCTION

Efficient process engineering requires highly sophisticated tools for the different needs of the departments involved. These engineering tools are normally specialised in process design (PD), in process control engineering (PCE), etc. Therefore, working interoperability is essential to optimise the engineering process in total. Thus, the definition of a harmonised interface and data management is a core task to ensure a smooth workflow throughout the whole project and to guarantee data consistency in the different tools.

This document defines procedures and specifications for the exchange of PCE relevant data provided by the P&ID module. The requirements for a change management procedure are described. A generally accepted technology for machine information exchange, the Extensible Markup Language (XML) is employed. Hereby, a common basis is given for information integration.

However, a definition is still necessary for uniform semantics. CAEX (**C**omputer **A**ided **E**ngineering e**X**change) as defined in this document is an appropriate data format for this purpose. This concept of data exchange is open for different applications.

The main task of a data exchange is transporting/synchronizing information from the P&ID database to the PCE databases and vice versa. The owner's naming system is the key for a unique identification. For detailed information about representation of PCE loops in P&I diagrams, see Clause 6.

The data exchange system may be a stand-alone, vendor-independent application or a module in an engineering environment. The data between a P&ID tool and a PCE tool and vice versa is exchanged via CAEX.

After the data exchange, there are three places where information about the plant is stored. Both the proprietary databases of the tools considered include private and common information. Both are stored at different places and different divisions that are working on them. Hereby, the intermediate database CAEX only stores common information. In a wider approach, the intermediate database can store both common and private information. This becomes important if a third application is connected to the neutral database. If the intermediate database is used as a temporary data stream only (without storing the information in a file), the information will be lost after processing the data conciliation.

Figure 1 illustrates the information flow for the P&ID and the PCE database reconciliation. The data exchange is carried out via a neutral intermediate CAEX database, not direct from database to database. The intermediate CAEX database can be a file (for file-based data exchange) or a stream (for network-based data exchange). The term "CAEX database“ within this specification has to be understood in this way, it does not denominate a database product such as SQL.

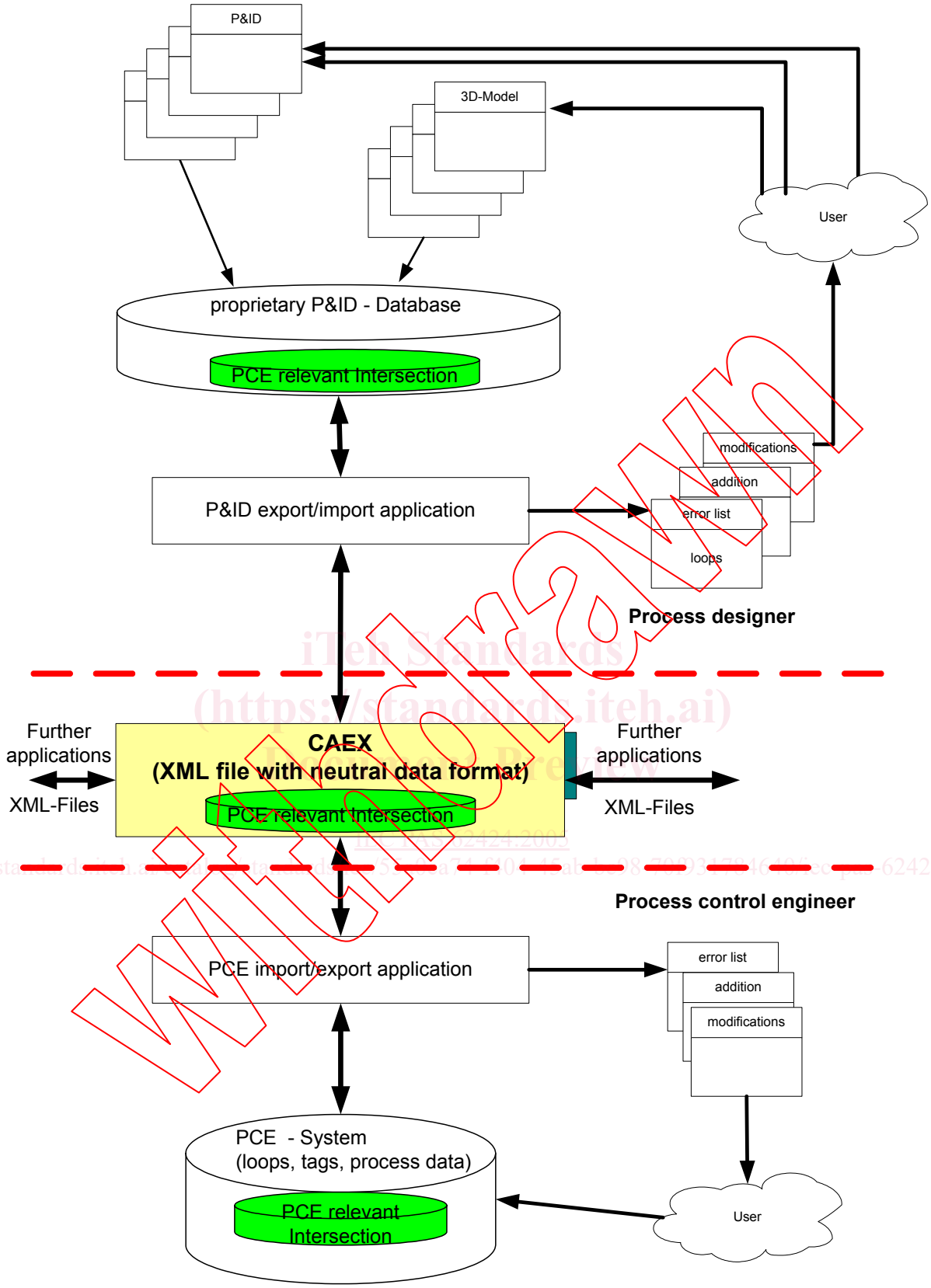

Figure 1 – Information flow of P&ID and PCE tools

REPRESENTATION OF PROCESS CONTROL ENGINEERING REQUESTS IN P&I DIAGRAMS AND DATA EXCHANGE BETWEEN P&ID TOOLS AND PCE-CAE TOOLS

1 Scope

This specification describes how process control engineering requests are represented in a P&I diagram.

It also defines the exchange of process control engineering request relevant data between a process control engineering tool and a P&I tool by means of a data transfer language (called CAEX). These provisions apply to the export/import applications of such tools.

The representation of the PCE functionality in P&I diagrams is defined by a minimum number of rules to clearly indicate their category and processing function, independent from the technique of realization (see Clause 6). The definition of graphical symbols for process equipment (for example vessels, valves, columns, etc.), their implementation and rules for the numbering system are not the scope of this standard. These rules are independent from this standard and can be found, for example, within DIN EN ISO 10628 or ISO 14617.

Clause 7 specifies the data flow between the different tools and the data model CAEX.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-826, *International Electrotechnical Vocabulary – Part 826: Electrical installations of buildings*

IEC 61346-1 (all parts), *Industrial systems, installations and equipment and industrial products – Structuring principles and reference designation*

IEC 61511-1 (all parts) , *Functional safety – Safety Instrumented Systems for the process industry sector*

ISO 10628, *Flow diagrams for process plants – General rules*

ISO 14617 (all parts), *Graphical symbols for diagrams*

EN 13480-1, *Metallic industrial piping – Part 1: General*

EN 1594, *Gas supply systems – Pipelines for maximum operating pressure over 16 bar – Functional requirements*

EN 982, *Safety of machinery – Safety requirements for fluid power systems and their components – Hydraulics*

Extensible Markup Language (XML) 1.0 (Third Edition), W3C Recommendation 04 February 2004 (available at <http://www.w3.org/TR/2004/REC-xml-20040204/>)

3 Terms and definitions

For the purpose of this document, the following terms and definitions, as well as those given in 60050-826, apply

3.1
process control equipment
equipment, having a process control function

3.2
process control function
function to work on process variables, which is composed of basic functions of process control, specific to units of the plant

NOTE In addition to process control functions associated with single sensors and actuators, there can also be process control functions that link input and output variables across several sensors and actuators. For instance, a process control function in the feedback path with the controlled variable as input variable and the manipulated variable as output variable, describes the action path from the sensor via the controller to the final controlling element.

3.3
PCE request
a PCE request describes requirements for process control equipment. Each PCE request is graphically represented by a bubble which collects all information on the functional requirements

3.4
sensor
functional unit that senses the effect of a measured variable at its input and places a corresponding measurement signal at its output

NOTE Examples of sensors are:

a) Thermocouple; b) Foil strain gauge; c) pH electrode.

3.5
Actuator
functional unit that generates from the controller output variable the manipulated variable required to drive the final controlling element

NOTE If the final controlling element is mechanically actuated, it is controlled via an actuating drive. The actuator drives the actuating drive in this case.

EXAMPLE A practical example of an actuator acting directly on the final controlling element is a d.c. drive. The control unit takes the function of an actuator. The final controlling element is formed by the thyristor assembly that delivers a variable d.c. voltage as an output variable. The control unit and the thyristor assembly together form the final controlling equipment.

3.6
CE loop
collection of PCE requests and PCE control functions depicting their functional coherence

3.7
Bubble
symbol used to denote and identify a process function. It contains an identification

3.8
process function
function in a process
[IEC 61512-1]

3.9
PCE control function
function in a PCE control
[IEC 61512-1]

3.10
process category
letter that designates the kind of process control request

4 Abbreviations

Table 1 shows the abbreviations used in this specification.

Table 1 – Abbreviations

CAD	Computer Aided Design
CAE	Computer Aided Engineering
CAEX	Computer Aided Engineering eXchange
CCR	Central Control Room
E&I	Electrical and Instrumentation
ERP	Enterprise Resource Planning
GMP	Good Manufacturing Practice
N.A.	Not applicable
PCE	Process Control Engineering
PCS	Process Control System
P&ID	Piping and Instrumentation Diagram
PD	Process design
PU	Package Unit
SIL	Safety Integrety Level
XML	Extensible Markup Language

5 Conformity

To claim conformity to this specification with respect to the graphical representation of PCE requests in P&ID, the requirements of Clause 6 shall be fulfilled.

To claim conformity to this specification with respect to the PCE relevant data exchange, the requirements of Clause 7 and the following requirements shall be fulfilled.

The data exchange shall be performed by a separate or integrated **import/export application** that provides for the data exchange between the related tool and CAEX.

NOTE The goal of the import/export application is to provide for a data reconciliation for the intersection of the source and target databases. It is able to read the proprietary database of the considered tool and to reconcile the data with the neutral CAEX database.

The export/import application shall check, report and provide the intersection data of both databases. The neutral database shall be open for additional applications.

The data import function shall enforce a configurable checking step (for example,. rule-based) during the import process; it shall not allow unguided automatic changes. The configurable

checking step shall include functionality for automatic or manual acceptance of data changes, allowing single decisions up to bulk data management.

All changes in the proprietary database and all data inconsistencies discovered shall be reported by the import application. The generation of the report shall be configurable. The import/export application shall assure that the intersection of the different databases holds the same information and that additional division specific data is handled in a consistent way. Data manipulation by a project division is an ongoing process during the whole project and beyond it. Thus, the creation, changing and deletion of data shall be possible during the life-cycle of the plant.

CAEX databases shall be consistent. This requires a consistency check before exporting the data. This procedure shall be followed after a successful data manipulation in a P&ID-tool or PCE-tool in order to bring the new information into the neutral database or vice versa. Before any data changing action is carried out, the user shall be informed and asked for confirmation. The consistency check shall encompass at least the following steps and fulfil the following requirements.

a) Data export from source database to neutral database

   1) Check P&ID and PCE database for at least

      i) duplicate PCE requests or loop designations;

      ii) mandatory fields being filled in;

      iii) correct use of numbering system of the PCE requests;

   Inconsistent data shall not be exported

   2) Generate PCE relevant information.

   3) Check for changed information in comparison with previously stored data in the neutral database.

   4) Renaming of PCE request shall be supported by the export functionality.

   5) Perform data export from proprietary into neutral database

      i) e. g. if the PCE request has been changed, the old PCE request within the neutral database shall be deleted and the new one can be exported from the proprietary database into the neutral database. The old PCE request information may be stored in a backup.

      ii) Other changes shall be performed with the existing object.

   6) Generate reports after each data exchange

      i) new PCE requests list, missing PCE requests list, changed PCE requests list, deleted PCE requests list, problems and error list.

b) Data import from neutral database into the target database

   1) Generate PCE relevant information from neutral database.

   2) Check for changed information by comparing the neutral database with the target database.

   3 Perform data import from the neutral into the proprietary database.

   4 Renaming of PCE request shall be supported by the import functionality.

   5 Generate reports after each data exchange.

      i) error lists:

      ii) inconsistencies due to imported data can be detected by the target application during the import process and are not considered within this specification.