

Lists of Characteristics for Optimization of the Processes in Automation and Process Control

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ABSTRACT

This paper shows how the use of standardized characteristics and lists of characteristics in electronic data exchange between users and manufacturers of electrical, automation and process control devices and systems can help to optimize various processes. The main processes involved are planning and maintenance on the user side, and design and selection of devices and preparation of quotes on the manufacturer side. Standardization makes it possible to avoid repeated manual input of data and increases the reliability of the data exchanged.

INTRODUCTION

Any tool in the planning and ordering process that is capable of recording all existing information once only and making it available for all further processing gives planners and maintenance staff an opportunity to concentrate on the essentials. A precondition for this is to establish standardized descriptions and procedures for both manufacturers and users of process control equipment. What is required, therefore, is a tool for companies which manage and exchange the data of process control devices in their internal systems and also in their dealings with other companies, e.g. in a supplier-customer relationship.

The commercial and technical tools (B2B, CAE, ERP, etc.) used today already provide all necessary functions for this purpose. What is missing, however, is the unique assignment of the data to be processed. The existing classification systems cover only a small part of the requirements. This lack prompted the establishment of an initiative to develop the required structures.

THE NEED TO EXCHANGE DATA ELECTRONICALLY

The terms “user” or “customer” and “manufacturer” or “supplier” of process control equipment mentioned at the outset will first be defined more closely. A customer is any person involved in the planning, installation and commissioning of processing or production equipment incorporating electrical devices or measuring and control instruments. This person may be employed in a processing or manufacturing company or in a subcontractor company. Maintenance staff who look after processing or manufacturing systems in their company and procure replacement parts for these systems can also be termed customers. In this sense, planners and maintenance staff are also users of electrical devices and measuring and control instruments.

Manufacturers are considered to be the companies and their staff who manufacture and sell electrical and instrumentation and control devices and systems. Suppliers dealing only with the distribution of these devices will be included in the term “manufacturers” for the purposes of this paper.

Electrical devices and measuring and control instruments can be collectively referred to as process control equipment or process control technology (PCT), a term introduced many years ago by the member companies of NAMUR (Normenarbeitsgemeinschaft für Mess- und Regeltechnik).

Up to now, customers have used a wide variety of different terms to describe the requirements on process control equipment (PCT devices) in their inquiries to manufacturers. The manufacturers, on the other hand, describe the devices using the terms contained in their own documentation in various systems (paper, databases, CD, e-catalogs, etc.). This entails enormous effort, both on the customer and the manufacturer side, for each transaction.

If one were to ask a device user (customer) the following questions today

- Do you still manually enter your inquiry data for process control equipment into your purchasing system?
- Do you still send your inquiry to your suppliers by fax?
- Do you still enter the equipment data from the manufacturer’s catalog into your CAE system laboriously by hand?

he would answer “Yes” to all of them. The same applies to manufacturers in response to the questions:

- Do you still receive inquiries by paper (letter or fax) from each customer and in a different form?
- Do you still have to enter the inquiry data into your systems manually for offer generation?
- Do you still send your offers away by fax or letter?

How can this situation be remedied? What tools are required?

There is a need for lists of characteristics (LOC) for both the suppliers/manufacturers and the users/customers, who want to plan, design, maintain and procure electrical and process control equipment and systems using electronic data exchange technology to exchange the needed data

- between any manufacturer and any user or
- between any two systems at the manufacturer’s and user’s site, e.g. between ERP and CAE systems,

while avoiding repeated manual input, paper documents and typing errors.

The following sections will show how lists of characteristics can be used to achieve the desired situation and how they are structured in IT terms.

A SCENARIO FOR UTILIZATION OF DEVICE SPECIFICATIONS

The technical inquiry and technical offer processes, including engineering on the customer side and device selection on the manufacturer side will now be examined. These processes can be accelerated and made more efficient, i.e. optimized, by using modern data exchange techniques and by specifying communication structures for data exchange between customers and manufacturers.

The scenario begins on the customer side (see fig. 1). Today, many customers already use modern CAE systems consisting of several modules: a module for process engineering, including the P&I diagrams, one for the piping systems and one for the process control equipment. The process control module can import the required data from the processing engineering or the manufacturing engineering module. This relieves the process control equipment planner of many manual input tasks.

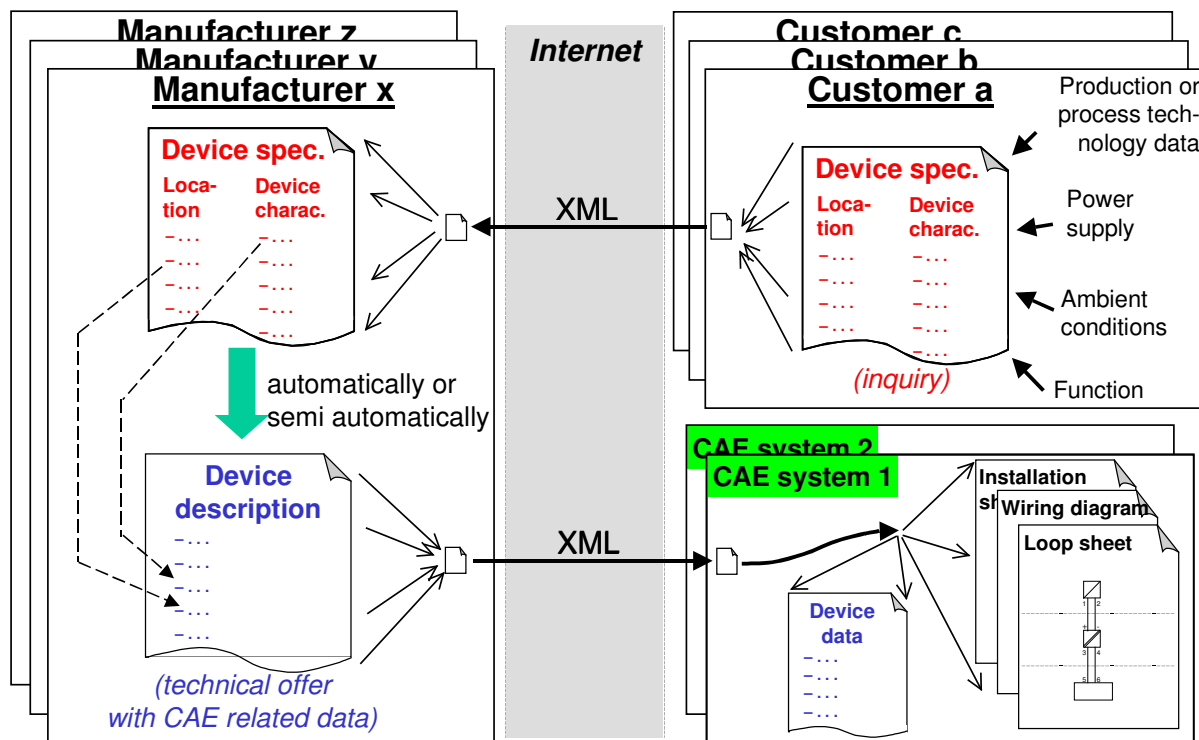


FIG. 1 – DATA EXCHANGE BETWEEN CUSTOMER AND MANUFACTURER USING DEVICE SPECIFICATION AND DEVICE DESCRIPTION

The planner collects further data required for the planning of each process control loop, that is, data concerning the existing or planned power supply, the environmental conditions, and the function to be fulfilled by the entire process control loop and the individual devices and systems which will be

used in this loop. The data imported from other modules and the data collected from other sources are then combined in an electronic document, i.e. a device specification. This document is divided into two sections:

- the requirements list of characteristics, which contains the environmental data and data required for selecting the planned device (“Location” in fig. 1), and
- the device list of characteristics, which contains the desired device characteristics (“Device Characteristics” in fig. 1).

The electronic document can now be sent as a technical inquiry to one or more potential manufacturers via internet using an XML format developed specifically for this purpose. The manufacturer can use this data to prepare an offer.

If one now imagines that each manufacturer receives inquiries in one and the same format from each and every customer – i.e. in the form of an electronically transmitted device specification – it becomes evident that this will open up enormous optimization potential for the manufacturer. It allows him to prepare electronic offers automatically or semi-automatically, mirroring the requirements stated in the received device specification. Once he has entered additional CAE-related data, the manufacturer can send this technical offer to the customer via the internet using the mentioned XML format. The customer can input the received device specification directly into his own CAE system. Once he has done so, the customer is in a position to create all the documents necessary for the installation or maintenance of the plant using the data of the inquired device: process control (PCT) loop sheets, wiring diagrams, installation diagrams, etc.

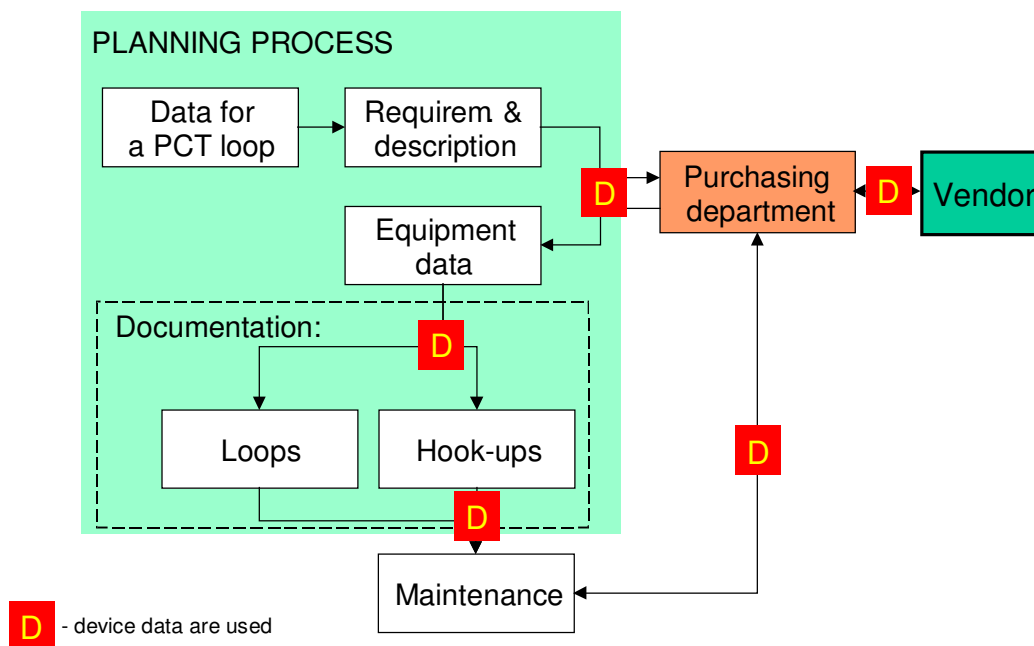


FIG. 2 – DEVICE DATA USED IN THE PLANNING AND MAINTENANCE PROCESSES

This scenario naturally applies to all conceivable CAE systems. It should be noted that both the generation of the inquiry and the processing of the device data received from the manufacturer can

be handled by one and the same CAE system on the customer side. In striving for optimization, the aim is to ensure that a CAE system will be able to handle both tasks.

In the past, NAMUR has already focused on the optimization of planning and maintenance processes. Fig. 2 shows a list from NA 55 (NAMUR Worksheet) [1]. From this list it can be seen that the device data are required at many stages in the planning process, which, of course, includes maintenance operations.

WHAT ARE DEVICE SPECIFICATIONS?

The structural elements used to prepare a device specification have to comply with two international standards relating to characteristics and lists of characteristics: IEC 61360 [2] and ISO 13584 [3].

Identifier: AAC001
Version: 001
Revision: 001
Preferred Name: Flow meter (vortex)
Definition:
 Vortex flow meter.

Characteristics:

<u>Identifier</u>	<u>Vers.</u>	<u>Preferred Name</u>	<u>Format</u>	<u>Unit of Measure</u>	<u>Definition</u>
AAA001	001	Manufacturer	String		...
AAA002	001	Product type	String		...
AAA003	001	Product name	String		...
AAA010	001	Measuring principle	String		...
AAA014	001	Reference conditions air pressure	Real	Pa	...
AAA016	001	Repeatability	Real	%	...
AAA017	001	Hysteresis	Real	%	...
AAA018	001	Settling time	Real		...
AAA019	001	Start-up drift	Real	s	...
AAA020	001	Long-term drift	Real	%/a	...
AAA026	001	Ambient temperature min	Real	K	...
AAA027	001	Ambient temperature max	Real	K	...
AAA028	001	Storage temperature min	Real	K	...
AAA108	001	Nominal width	String		...
AAA030	001	Ingress protection	String		...
...					

FIG. 3 – A PARTIAL LIST OF CHARACTERISTICS FOR THE VORTEX FLOW METER

According to these standards, a list of characteristics can be structured as shown in fig. 3. A list of characteristics can be used to specify an object. The entire list of characteristics is described using the following attributes (header data), among others:

- Identifier,

- Version,
- Revision,
- Preferred name,
- Definition.

The actual list of characteristics is made up of individual characteristics, each characteristic itself being characterized by several attributes, such as:

- Identifier,
- Version,
- Revision,
- Preferred name,
- Definition.
- Format,
- Unit of measure.

The definition is one of the most important attributes of a characteristic. It describes the feature represented by the characteristic.

The structure of a list of characteristics is designed such that the list can be used to describe a type of device or system, but when concrete values are assigned to the individual characteristics, the list of characteristics is capable of describing a specific, individual device. When describing a specific device, concrete values are assigned to the characteristics, e.g.

- Value: “4-20 mA” for the characteristic “Output signal”,
- Value: “40°C” for the characteristic “Ambient temperature”,
- Value: “DN 50” for the characteristic “Nominal diameter”.

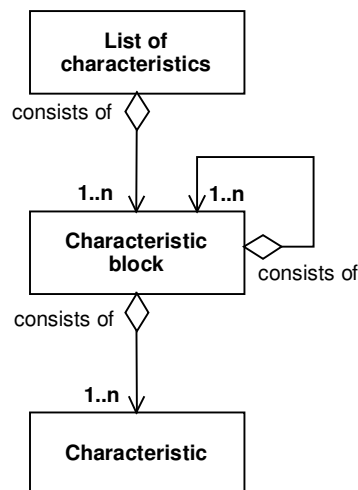


FIG. 4 – STRUCTURE OF A LIST OF CHARACTERISTICS CONSISTING OF CHARACTERISTICS BLOCKS (SIMPLIFIED REPRESENTATION)

Experience has shown that lists of characteristics containing more than 20 or 30 characteristics can be difficult to handle in the field. Consequently, NAMUR hit on the idea of dividing the lists of characteristics into blocks of characteristics. From an IT perspective, each block can then be handled as a sub-list of characteristics. Various criteria can be applied for dividing the list of

characteristics into blocks. One proven criterion can be found in IEC 61987-1 (CD) [4]. The division process can be described using UML, as shown in fig. 4 (simplified representation).

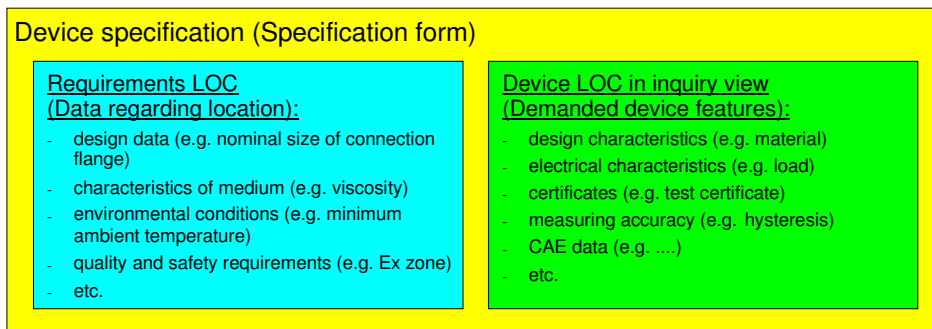
The blocks can be nested in as many levels as needed to satisfy technical requirements. For practical purposes, there should not be more than 4 or 5 levels. The characteristics blocks in the lowest level contain only characteristics.

As shown in the scenario described above and in fig. 1, a device specification is used to prepare an inquiry for a device or system. This device specification actually consists of two lists of characteristics:

- a requirements list of characteristics (RLOC), and
- a device list of characteristics (DLOC) in the inquiry view.

This is illustrated in fig. 5.

The customer sends to his supplier:



The supplier returns to the customer :

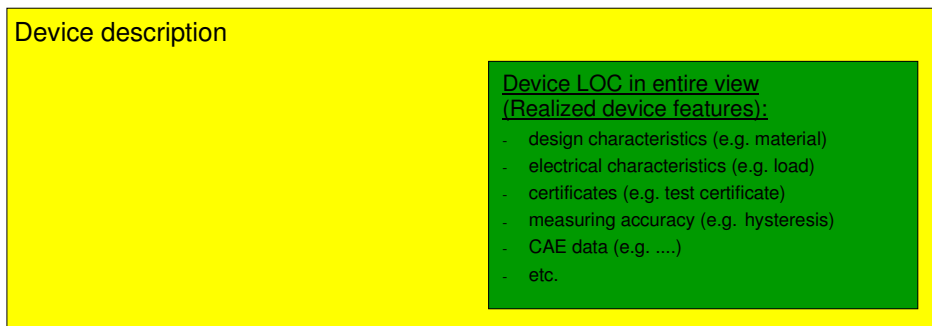


FIG. 5 – A DEVICE SPECIFICATION AND A DEVICE DESCRIPTION

An RLOC serves not just to describe a device but to specify the most important requirements on the device/system, i.e. data characterizing the ambient conditions at the location where the device will ultimately be installed, and data required to select the device. The DLOC always describes only the device or system itself.

The purpose of the device specification is to

- describe the functional requirements on a PCT device,
- enable a device manufacturer to offer a suitable PCT device on the basis of these requirements.

A device description, i.e. a device list of characteristics (DLOC) in the entire view (see fig. 5) is used for technical offers and to describe devices and systems within CAE or ERP systems. In this case, the values assigned to the characteristics are concrete product data, i.e. the data of the device that will be supplied or installed in the plant.

The purpose of the list of characteristics for device descriptions is

- to document the data of a PCT device in a structured manner, and
- to provide the device data for planning using CAE tools or for storage in an ERP system.

The DLOCs in the device specification and the device description differ in terms of the view in which they are displayed. In a DLOC, individual characteristics or individual blocks can be shown or hidden as the circumstances require. This results in different views of the list. The DLOC of the device description contains all of the possible characteristics, i.e. it is displayed in the entire view. By contrast, the DLOC in the device specification is displayed only in the inquiry view. This means that, for inquiry purposes, where only a limited number of required device properties are stated, not all of the characteristics and blocks of a DLOC are needed.

Other views are conceivable:

- CAE view (giving the data required for entering a device in a CAE system),
- company-specific view,
- view for a concrete manufacturer-customer relationship.

PROJECT GROUP “LISTS OF CHARACTERISTICS” (PROLIST)

The first device lists of characteristics and device specifications were drafted by a NAMUR working group in the years 2000 to 2002. However, since this work requires a consensus and collaboration between manufacturers and users (customers), a project group was set up to create further device specifications. This project group, named “Lists of Characteristics” (PROLIST) was founded in Hannover, Germany, on April 10, 2003.

The objectives of the Project Group are:

- to create and maintain characteristics and lists of characteristics for process control devices and systems,
- to make the lists of characteristics immediately available to manufacturers and users through NAMUR Recommendation NE 100 (see below),
- to promote internationalization of the lists of characteristics through IEC standards.

The Project Group is a nonprofit organization. The annual subscription serves exclusively to cover costs. The Project Group reports to the NAMUR Executive Board and the participating companies on the progress of its work. It will have completed the various tasks within a maximum of 5 years, after which it will be dissolved. Membership of the project group is open to manufacturing companies, corporate users, trade associations, and universities or colleges operating in the field of process control technology. The current list of members can be found on the internet at

<http://www.namur.de/de/projektgruppe6/mitglieder.htm>

Fig. 6 shows the structure of the Project Group and its logo.

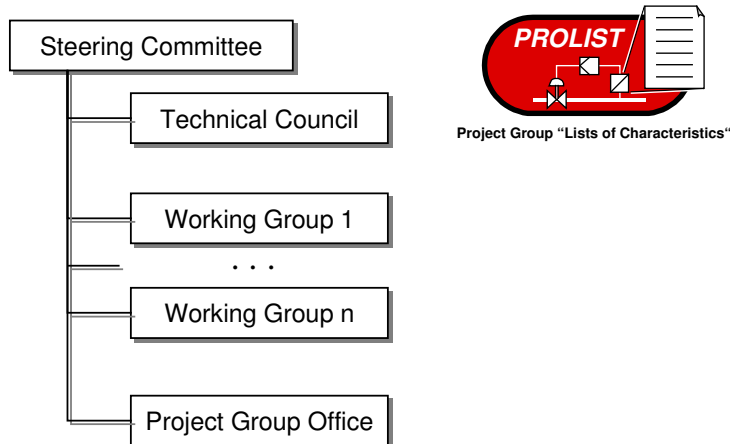


FIG. 6 – STRUCTURE OF PROLIST

The Steering Committee is composed of authorized representatives with voting rights of the member companies, associations and universities/colleges forming the Project Group. It deals mainly with management matters. The central, technical functions are covered by the Technical Council. Working groups are set up temporarily by the Steering Committee to focus on specific areas of electrical engineering and process control technology. Once the work has been completed, the working groups are dissolved. The results are made available to the member companies in the form of device specifications.

The Project Group focuses on characteristics and lists of characteristics (device specifications) for devices and systems in the field of electrical, automation and instrumentation and control technology.

The working groups (WG) include two with overarching functions:

- WG Data Model, and
 - WG CAE Applications,
- and, currently, the following WGs devoted to creating device specifications for specific technical areas:

- WG LV Switchgear
- WG Sensors (temperature/pressure/level/flow/density)
- WG Control Valves
- WG Signal Adjustment
- WG Electric Drives

Other working groups, such as for field buses and weighing equipment are planned.

The Project Group also has its own website, which can be accessed via the NAMUR homepage.

The link to the English version of the PROLIST website is:

<http://www.namur.de/en/projektgruppe6/ziele.php>

NE 100 AND INTERNATIONAL STANDARDIZATION OF ITS CONTENTS

Once they have been finalized, the device specifications are incorporated in NAMUR Recommendation NE 100. Each NAMUR recommendation is published in two languages, German and English. Provisions have been made to channel the contents of NE 100 into international IEC standards.

The various versions of NE 100 are published in keeping with the progress made in creating the device specifications.

NE 100 Version 1.0, which was published in 2003, contains device specifications for 41 equipment types in the category

- measuring instruments: pressure, flow, level and temperature.

The next version of the NE 100, Version 2.0, has been prepared. It will be published in 2004 and will contain device specifications for 63 equipment types of

- measuring instruments (51): pressure, flow, level, temperature and density,
- electric motors (2) and
- actuators (10).

Besides a description of the data model, the text of NE 100 provides fundamental information about characteristics and lists of characteristics, as well as a description of applications of device specifications for inquiry and offer, planning (e.g. using a CAE system), and maintenance purposes, and for incorporation of the data in ERP systems. The data specifications provided by NE 100 can also be used as a tool for definition of data transfer between any two systems with the aid of characteristics.

The “List of Characteristics” Project Group has set up a database to manage the completed device specifications. This database, named the PROLIST database, can be viewed and accessed via the internet. Only the members of PROLIST have unrestricted access to the database. The data model used in the database conforms to the relevant international standards: IEC 61360 and ISO 13584.

Device specifications from the current version of NE 100 can be downloaded from the PROLIST database in three formats:

- as a specification sheet (PDF file),
- as an Excel worksheet, and
- as a file in XML format.

Since the characteristics stored in the PROLIST database conform to the relevant international standards, an application will be made for their integration in the IEC Component Data Dictionary. The contents of the PROLIST database are entered in at least two languages, English and German. It is therefore also possible to prepare the PROLIST characteristics for integration in the characteristics database on the DIN server.

SUMMARY AND OUTLOOK

The device specifications of NE 100 enable both users and manufacturers of PCT devices to optimize processes within their own companies and in their dealings with other companies. In the simplest case, NE 100 provides specification sheets with defined characteristics for PCT devices or collections of characteristics with which PCT devices for various purposes can be described. When utilized to its full extent, NE 100 constitutes a basis for structures and interfaces in ERP, maintenance and CAE systems, as well as for user and supplier marketplaces.

Overall, the NE 100 device specifications and the XML format provided constitute a modern tool for use in the electronic exchange of device data in all of the above-mentioned application cases. It has also been demonstrated that the use of standardized characteristics and device specifications based on these characteristics promotes efficient electronic data exchange between users and manufacturers of electrical, automation, and instrumentation and control devices and systems. This opens up new opportunities for optimization of internal and external processes, such as planning and maintenance processes on the device user side and selection and offer preparation processes on the device manufacturer side. Manual input can be reduced to the necessary minimum, which increases the reliability of the data transferred.

In addition, the NE 100 device specifications offer the potential to store device descriptions in process control systems and field devices, thereby creating the preconditions for exchanging device data via different communication systems.

REFERENCES

- [1] - NAMUR (ed.), NA 55 “Specifications for planning, installation and maintenance of PCT loops” (in German)
- [2] - IEC (ed.), IEC 61360 “Standard data element types with associated classification scheme for electric components”
- [3] - ISO (ed.), ISO 13584 “Industrial automation systems and integration – Parts library”
- [4] - IEC (ed.), IEC 61987-1 (CD) “Industrial-process measurement and control – Data structures and elements in process equipment catalogues - Part 1: Measuring equipment with analogue and digital output”

NOMENCLATURE

NAMUR -

An association of users of process control technology. Its member companies come from the chemical, pharmaceutical and petrochemical industries in the German speaking region. Contractor companies working for the named industries are also eligible for membership. Two thirds of the members are based in Germany. The rest are located in Spain, Austria, Hungary, Switzerland, Belgium and the Netherlands. Manufacturers of process control technology, hardware and software are not eligible as members.

NAMUR Recommendations (NE) and Worksheets (NA) -

These are experience reports and working documents prepared by NAMUR for its members among process control users. Their use is optional.

Process Control Technology (PCT) –

An expression used by the NAMUR members for describing the electrical, process control and automation technology as a common technology.

Characteristic (or Property) –

A defined parameter suitable for the description and differentiation of objects. A Characteristic describes one detail of a given object.

List of characteristics (LOC) –

Describes by means of characteristics one set of similar products, i.e. one equipment type. An LOC is also used for collecting the requirements a planned device should fulfill.

ABBREVIATIONS

B2B	Business to Business
CAE	Computer Aided Engineering
DLOC	Device List of Characteristics
ERP	Enterprise Resource Planning
IEC	International Electrotechnical Commission
ISO	International Standards Organisation
IT	Information Technology
LOC	Lists of Characteristics
LV	Low Voltage
NAMUR	Normenarbeitsgemeinschaft für Mess- und Regeltechnik
NE	NAMUR Recommendation
PCT	Process Control Technology
RLOC	Requirements List of Characteristics
UML	Universal Markup Language
WG	Working Group
XML	eXtensible Markup Language