



BSI Standards Publication

**Automation systems and  
integration — Applications  
integration approach using  
information exchange  
requirements modelling and  
software capability profiling**

**National foreword**

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**Automation systems and  
integration — Applications integration  
approach using information exchange  
requirements modelling and software  
capability profiling**

*Systèmes d'automatisation et intégration — Approche d'intégration  
des applications utilisant des exigences d'échange d'informations de  
modélage et un logiciel de capacité de profilage*





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## Foreword

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The committee responsible for this document is Technical Committee ISO/TC 184, *Automation systems and integration*, Subcommittee SC 5, *Architecture, communication and integration frameworks*.

## Introduction

The motivation for ISO 16100 stems from the industrial and economic environment, in particular:

- a) a growing base of vendor-specific solutions;
- b) user difficulties in applying standards;
- c) the need to move to modular sets of system integration tools;
- d) the recognition that application software and the expertise to apply that software are assets of the enterprise.

ISO 16100 is an International Standard for the computer-interpretable and human readable representation of a capability profile. Its goal is to provide a method to represent the capability of manufacturing application software relative to its role throughout the life cycle of a manufacturing application, independent of a particular system architecture or implementation platform. This can lead to reduced production and information management costs to users and vendors/suppliers of manufacturing applications.

ISO 18435 provides a framework for harmonized use of industry and international standards in order to integrate control, diagnostics, prognostics, capability assessment, and maintenance applications. By using an ISO 15745 application integration modelling approach, key interoperability interfaces can be identified and concisely documented in terms of profiles.

ISO 18435 also provides the elements and the rules to describe the integration requirements of an automation application. The elements include the key aspects when integrating an automation application with other applications and the relationships of these key aspects. The rules include the information exchanges to support interoperability within an application and between applications.

This Technical Report describes a use case of modelling the smart pump application described in [Annex A](#). The detailed manufacturing software unit profiling templates are described in [Annex B](#). The detailed manufacturing software unit profiles are described in [Annex C](#). The information exchanged among manufacturing software units in the smart pump application based on ISO 18435 methodology is described in [Annex D](#).





# Automation systems and integration — Applications integration approach using information exchange requirements modelling and software capability profiling

## 1 Scope

This Technical Report describes an approach for using ISO 16100 and ISO 18435 to specify information exchange requirements between applications. This approach is based on the use of ISO 18435 application interaction matrix element (AIME)/application domain matrix element (ADME) templates in conjunction with ISO 16100 manufacturing software unit (MSU) capability profiles.

This Technical Report also provides an example approach as applied to describing the interoperability requirements of the integrated smart pump application, which comprises the pump control application and the pump diagnostics application.

## 2 Normative references

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

ISO 16100-3:2005, *Industrial automation systems and integration — Manufacturing software capability profiling for interoperability — Part 3: Interface services, protocols and capability templates*

ISO 16100-5:2009, *Industrial automation systems and integration — Manufacturing software capability profiling for interoperability — Part 5: Methodology for profile matching using multiple capability class structures*

ISO 18435-2:2012, *Industrial automation systems and integration — Diagnostics, capability assessment and maintenance applications integration — Part 2: Descriptions and definitions of application domain matrix elements*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16100-3, ISO 16100-5, ISO 18435-2, and the following apply.

### 3.1

#### **application domain matrix element**

##### **ADME**

entry in an application domain matrix to organize information exchange among applications

[SOURCE: ISO 18435-2:2012, 3.2]

### 3.2

#### **application interaction matrix element**

##### **AIME**

entry in application interaction matrix to denote the capabilities of the resource to support information exchange

[SOURCE: ISO 18435-2:2012, 3.4]

### 3.3 application interoperability profile AIP

single specification referencing a group of profiles that reference parts of base specifications which may themselves be profiles

Note 1 to entry: The group of profiles can include process profile(s), information exchange profile(s), resource profile(s) and sometimes other AIPs.

[SOURCE: ISO 18435-2:2012, 3.5]

### 3.4 capability class

element within the capability profiling method that represents manufacturing software unit functionality and behaviour with regard to the software unit's role in a manufacturing activity, as denoted in a capability inheritance structure and as deployed in a capability aggregation structure

Note 1 to entry: The role of a MSU changes when used in different manufacturing activities; however, the MSU's corresponding capability class is positioned uniquely in an inheritance structure, but can assume different positions in an aggregation structure.

Note 2 to entry: In this Technical Report, a capability class template is identical to a capability template (ISO 16100-2:2003, 6.3, gives requirements for capability templates).

[SOURCE: ISO 16100-5:2009, 3.1, modified]

### 3.5 capability class structure CCS

hierarchy of capability classes

### 3.6 capability profiling template capability template template

schema for a manufacturing software capability profile

Note 1 to entry: It could be partially filled.

[SOURCE: ISO 16100-3:2005, 3.1.14, modified]

### 3.7 manufacturing domain data MDD

unified modelling language (UML) class representing information about manufacturing resources, manufacturing activities, or items exchanged among manufacturing resources within a particular manufacturing domain

[SOURCE: ISO 16100-5:2009, 3.3]

### 3.8 manufacturing domain model MDM

particular view of a manufacturing domain, consisting of manufacturing domain data and relationships among them, corresponding to the domain's applications

[SOURCE: ISO 16100-5:2009, 3.5]

## 4 Abbreviated terms

ADID	Application Domain Integration Diagram
ADME	Application Domain Matrix Element
AIF	Application Integration Framework
AIME	Application Interaction Matrix Element
AIP	Application Interoperability Profile
CCS	Capability Class Structure
IG	Identification Guide
MDD	Manufacturing Domain Data
MDM	Manufacturing Domain Model
MSU	Manufacturing Software Unit
OTD	Open Technical Dictionary
PID	Proportional Integral Derivative
PLC	Programmable Logic Controller
UML	Unified Modelling Language
VFD	Variable Frequency Drive
XML	eXtensible Markup Language

## 5 Applications interoperability requirements modelling

### 5.1 Application integration framework in ISO 15745 and ISO 18435

The application integration framework (AIF) that is explained in ISO 15745-1 provides a basis for integrating an automation and control system architecture within a manufacturing application architecture.

An integrated manufacturing application can be modelled as a combination of a set of manufacturing processes, resources and a set of information exchange among the manufacturing resources, as shown in [Figure 1](#). Manufacturing resources can be further divided as several types of communication networks, devices, software, equipment, material, and personnel necessary to support the processes and information exchanges required by the application.

A set of manufacturing resources that satisfy a set of interoperability and integration requirement is needed to realize a manufacturing application. An integrated manufacturing application is enabled by a manufacturing system consisting of a set of integrated manufacturing resources.

The categories of application domains of interest are enumerated in ISO 18435-1 and represented using an application domain integration diagram (ADID).

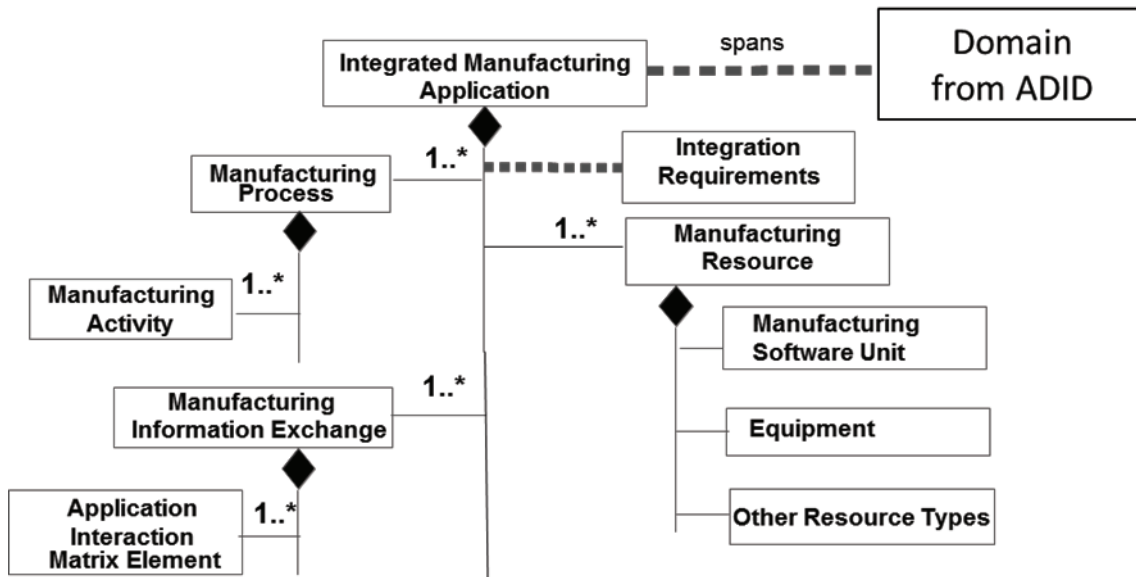


Figure 1 — Application integration model

## 5.2 Elements of information exchanges in ISO 18435

ISO 18435 focuses on integration of applications. ISO 16100 focuses on interoperability of MSUs, including manufacturing information exchange either within one application or within different applications. The information exchange among resources is represented by ISO 18435.

ISO 18435-1 provides an overview of the integration requirements of a manufacturing application. The focus is on the production operations and maintenance operations domains, including the capability assessment activities.

ISO 18435-2 provides the detailed definitions of the AIME and ADME structures and their relationships. General procedures for constructing AIMEs and ADMEs are also described.

An AIME represents capabilities provided by a set of resources of an application in order to exchange information with another set of resources associated with another application.

The set of AIMEs that represents the resource capabilities that meet the information exchange requirements to support the interoperability of two applications comprises a key part of an ADME. ADME that qualifies interoperability relationship between two applications is elaborated in [Figure 2](#). Clause A.1 has an example of an integrated application which describes the smart pump application. The capability profiles of MSUs are obtained by filling adequate capability templates. [Annex C](#) shows the examples of capability profiles for the smart pump applications.

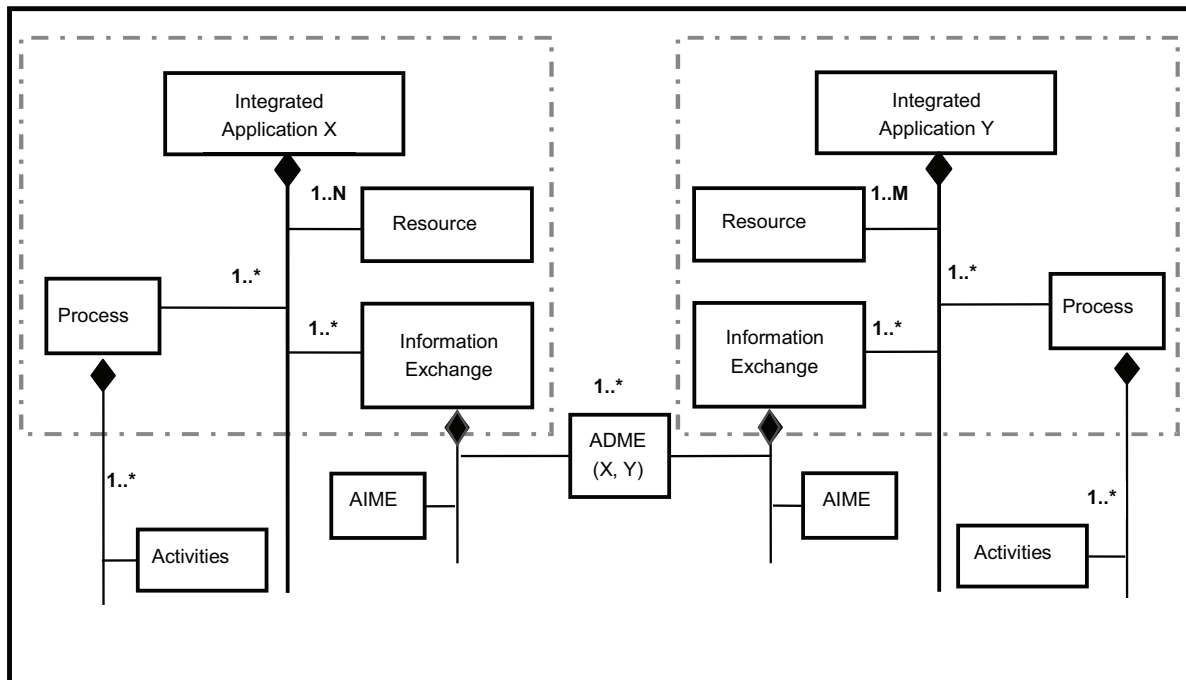


Figure 2 — AIME and ADME

The purpose of the ADME is to describe the interoperability and integration requirements that are required by the applications. The general concept of an ADME is to model the information exchanges between applications using the application interoperability profile (AIP) notation as described in ISO 15745-1. The ADME supports the information exchange between the applications based upon the capabilities identified in the AIMEs. The complete set of AIMEs that represents the information exchange requirements for realizing the interoperability of two applications comprises an ADME.

### 5.3 Context for information exchange requirements

The context for the information should be established using the application domain of interest as described in ISO 18435-1.

A manufacturing process is modelled as a set of activities that follow a specific sequence. Each activity is associated with a set of functions. The functions are implemented by manufacturing resources, such as MSUs shown as the left part of [Figure 3](#). These MSUs enable information exchanges associated with the functions performed.

Context for the information exchange can be derived from the activities and capability class structure (CCS) shown in [Figure 3](#). Clause A.2 has an example of CCS for the smart pump application. According to an ISO 16100 methodology, each capability class has a capability template. Examples of capability templates for the smart pump application are shown in [Annex B](#).

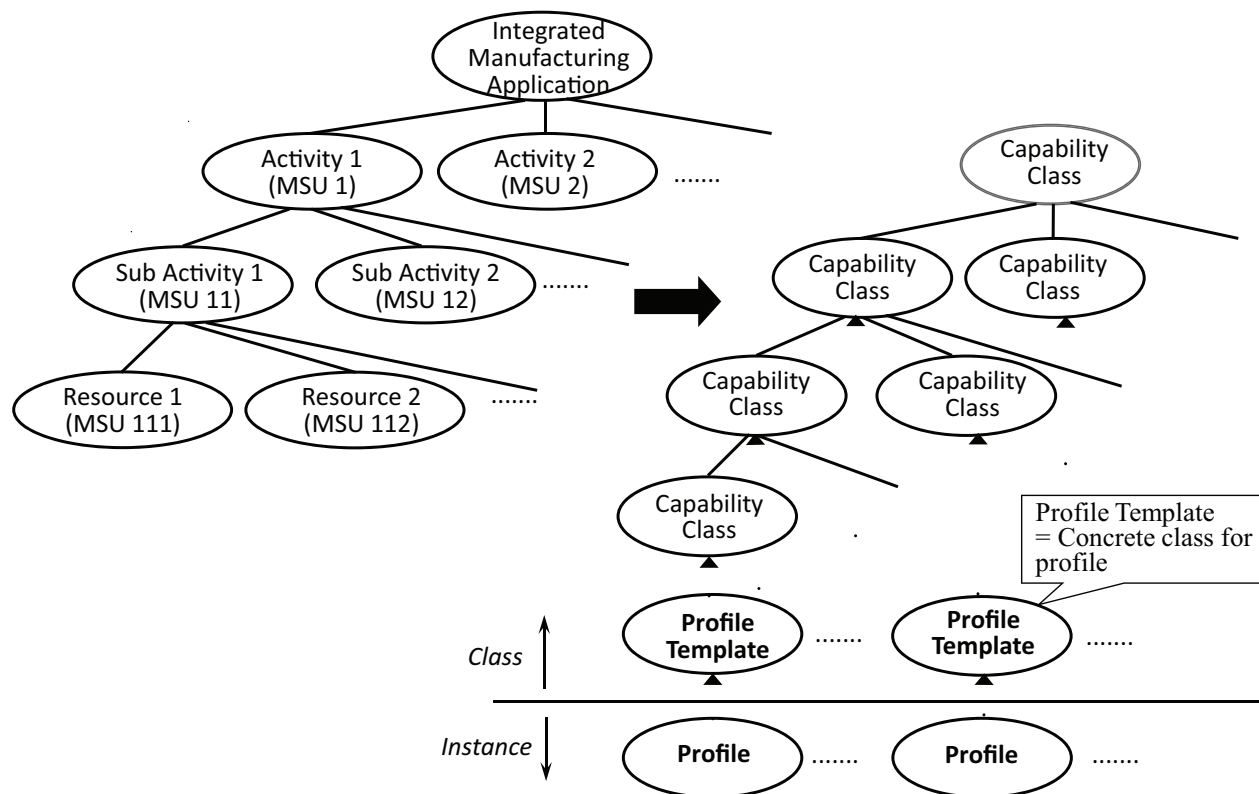


Figure 3 — Activity tree of an application

## 5.4 Content for information exchange requirements

### 5.4.1 Application requirements capability profile

The information exchanged between the MSUs provides the content for the ADME structure as described in the manufacturing domain data (MDD).

Application requirements capability profile in ISO 16100 describes an activity model in [Figure 3](#). The activities also describe information exchange among the resources or MSUs involved in the activity. These information items exchanged typically include, input/output information in a MSU execution (such as recipes, geometric data, schedules, or other activity parameters needed to perform the application), control information (such as commands and requests for service), and status information (such as faults, equipment status reports, alerts, and quality information).

The manufacturing domain model (MDM) is a particular view of a manufacturing domain, consisting of MDDs and relationships among them, corresponding to the domain’s applications as shown in [Figure 4](#). A set of MDDs works like a terminology set in the applicable domain. MDDs represent different types of manufacturing information, including those that are exchanged between the resources within an application and between applications.

Information items pertaining to control of the actions of the equipment and device, e.g. the pump and the variable frequency drive (VFD) in [Figure A.1](#), are usually handled by MSUs but are not included in this example.

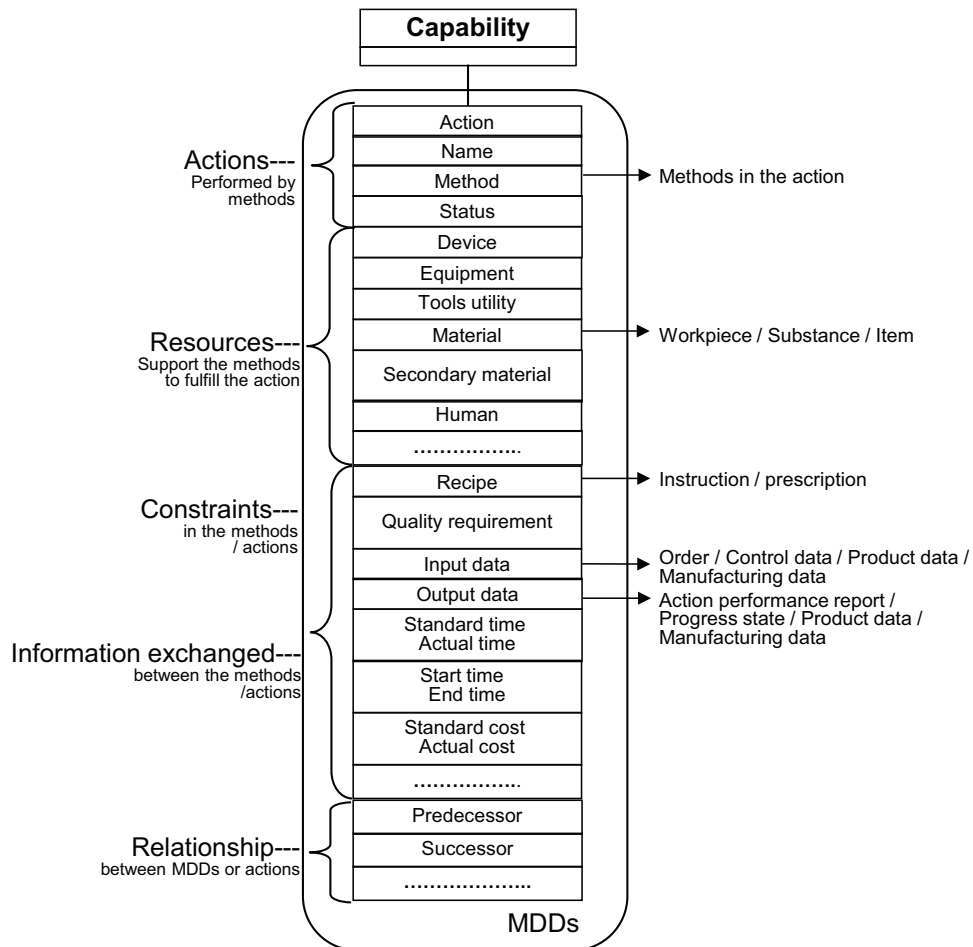


Figure 4 — Partial activity model represented by MDDs

#### 5.4.2 MDDs used in ADME Content

Within a specific manufacturing domain, a manufacturing application can be represented as a set of MDDs. MDDs provide information about various aspects within a specific manufacturing domain. MDDs that represent information exchange between applications in the domain are used to enumerate the content section in the ADME. MDDs in [Annex C](#) are examples of ADME contents for the integrated smart pump application information exchange requirements.

#### 5.5 Conveyance for information exchange

The ADME conveyance section captures resource types and specific configuration required to support information exchanges enumerated in the content section of the same ADME. Interoperability requirements expressed in the context section present the constraints to be addressed by the resource configurations. Clause D.4 shows one possible example of the conveyance section to support integration of the pump control and the pump diagnostics applications. The channel in the conveyance section is configured to support information exchange to meet the requirements of the integrated smart pump application.

#### 5.6 ADME for the smart pump application

The context, content and conveyance section noted in [5.3](#), [5.4](#) and [5.5](#) form the ADME for expressing the information exchange requirements that support interoperability of the pump control and the pump diagnostics applications within the integrated application of the smart pump application.

## 6 Approach for smart pump application interoperability

### 6.1 Smart pump system information model

The asset design environment provides a wealth of information operating and managing the manufacturing assets, e.g. a pump in certain manufacturing processes. ISO 15926 facilitates integration of asset information to support the life-cycle activities and processes of production facilities. ISO 15926 provides a model and library classes and templates for representing life-cycle information about technical installation and their components. Figure 5 shows the pump information model based on ISO 15926.

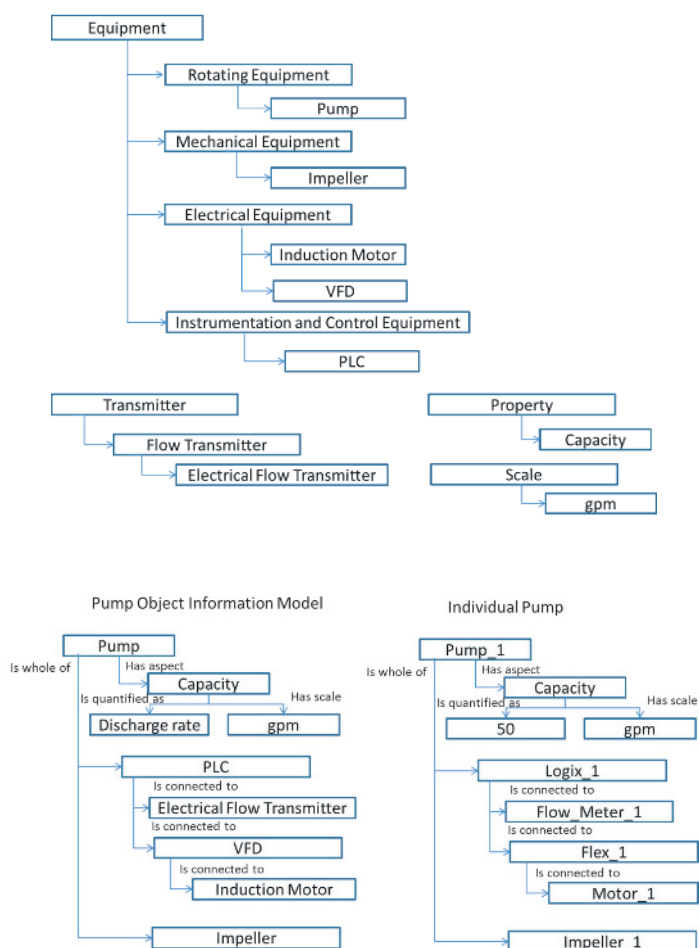


Figure 5 — Pump model based on ISO 15926

The information model based on ISO 15926 can be utilized in conjunction with ISO 18435 framework to enable information exchange. By using an ISO 15745 based application integration modelling approach, information exchange requirements for key interoperability interfaces can be identified and concisely documented in terms of resource-specific AIMEs. These AIMEs enumerate a set of particular standards for enabling context-, content- and conveyance-oriented exchanges to enable the asset interoperability and integration of applications dealing with asset information structures.

### 6.2 Resolving ambiguity using OTD

There are no well-defined methods to define the relationships between the terms and definitions common to the design environment and the operational environment. Many terms and definitions associated with assets used in both the design context and the operational context are often ambiguous or inconsistent. Their interpretation or meaning depends on the particular context. The open technical dictionary (OTD) based on ISO 22745 resolve the ambiguity or inconsistency of these terms and definitions. The benefits



of ISO 8000 (data quality) can be realized using ISO 22745 by specifying the data requirements for messages containing master data that is exchanged between organizations; specifically requirements for syntax, semantic encoding, and portability.

ISO 22745's main facilitator is the OTD, a repository of concept identifiers and associated descriptions used to define individual data elements. Once each element is described with the concept identifier from the OTD, the descriptive elements can be stored, sent, received, and displayed by different organizations without losing any meaning.

ISO 22745 also includes guidelines for the use of identification guides (IG). An IG is a set of rules for describing a particular class of items to meet the requirements of a data recipient. An IG is specified using an XML schema. If all elements are included in the description, this IG facilitates the machine-aided analysis of data quality because clear understanding is possible of what data are required without a person having to review the data. The use of an IG in constructing master data for product catalogues can be a pattern for use of concept identifiers in constructing application information exchange profiles (i.e. AIMEs and ADMEs).

The concept identifiers used in the context, content and conveyance sections of the AIMEs and ADMEs provide references registered in the OTD. These references point to the standards that define the information exchange objects. The concept identifiers are also used to fill in the capability profiles and templates required by the applications to be integrated.

NOTE 1 ISO 29002 provides a framework for mapping the ISO 22745 OTD concept identifiers to other concept identifier schemes. IEC 61987 definitions (list of device properties, classifications), ISO 13584 (parts libraries) and ISO 15926 object identifiers can be expressed in terms of ISO 22745 concept identifiers. The use of other concept identifiers and the details of these mappings are outside the scope of this Technical Report.

NOTE 2 Concept identifiers are not used in the XML examples in the annexes, for better human readability.

### **6.3 Application integration using ISO 18435**

ISO 18435 specifies provisions that applications are expected to satisfy, in terms of a set of interoperability profiles. For example, if a diagnostic application requires flow information from the control application controlling a pump to assess the overall asset condition, these two applications need to have compatible profiles for this particular information exchange. The purpose of the ADME is to describe the information exchange requirements of the applications. For each application, interfaces used for information exchange are described using the AIME. The AIME details the resource capabilities that meet the information exchange requirements to support the interoperability of two applications. A set of AIMEs represents the interface profiles supported by the applications and the corresponding resources and these AIMEs comprise an ADME.

## **7 Constructing AIME and ADME for smart pump application**

### **7.1 Overview**

The integrated smart pump application consists of two separate applications: control application and diagnostics application. By integrating these two separate applications, the resulting smart pump application exhibits an intelligent behaviour, e.g. changing pump operation modes according to pump diagnostics results to protect the equipment or processes. The sequence diagram in [Figure D.1](#) in the [Annex D](#) illustrates the example information exchange between pump control application and pump diagnostics application for the integrated smart pump application to achieve integration.

### **7.2 AIME for pump control application**

The control application for the pump consists of two separate applications with corresponding MSUs, i.e. one for pump proportional integral derivative (PID) control and the other for data acquisition from the sensors. AIMEs from the PID control and the data acquisition form one ADME which is not described in this Technical Report. Once these two applications are integrated, one resulting AIME can be formed

by replicating the context section and the conveyance section from the ADME. Symbolic names in the matrix elements inside AIMEs and ADMEs are all replaced by the concept identifiers already registered in the reference OTD. [Figure 5](#) illustrates the use of concept identifiers inside an AIME. The left hand side of [Figure 6](#) shows the conveyance section without the concept identifiers. The right hand side of [Figure 6](#) shows the concept identifiers used in the conveyance section of the AIME.

<pre> &lt;Conveyance_Section&gt; ... &lt;description&gt;Diagnostics Example&lt;/description&gt; &lt;informationType name="FlowRateRequestType"   type="tFlowRateReq"&gt; &lt;description&gt; Flow Rate Request&lt;/description&gt; &lt;/informationType&gt; &lt;informationType name="FlowRateResponseType"   type="tFlowRateRes"&gt; &lt;description&gt;Flow Rate Response&lt;/description&gt; &lt;/informationType&gt; ... &lt;channelType name="DiagnosticsChannel"   type="ISO15745_ENet_CommNet_Profile" &lt;description&gt;Ethernet/IP ISO15745-2 Profile   &lt;/description&gt; &lt;/channelType&gt; ... </pre>	<pre> &lt;Conveyance_Section&gt; ... &lt;description&gt;Diagnostics Example&lt;/description&gt; &lt;informationType name="FlowRateRequestType"   type="0161-1#01-080761#1"&gt; &lt;description&gt; Flow Rate Request&lt;/description&gt; &lt;/informationType&gt; &lt;informationType name="FlowRateResponseType"   type="0161-1#01-018902#1"&gt; &lt;description&gt;Flow Rate Response&lt;/description&gt; &lt;/informationType&gt; ... &lt;channelType name="DiagnosticsChannel"   type="0161-1#01-1074537#1"&gt; &lt;description&gt;Ethernet/IP ISO15745-2 Profile   &lt;/description&gt; &lt;/channelType&gt; ... </pre>
------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

**Figure 6 — Concept identifiers inside AIME**

Clause D.2 shows the AIME for the pump control application.

### 7.3 AIME for pump diagnostics application

The pump diagnostics application consists of single application with one corresponding MSU. If an AIME does not exist, one can be constructed. Necessary information can be obtained from the specific part of the MSU that contains methods, resources and information items to form the conveyance and context sections of the AIME. Symbolic names in the matrix elements inside AIMEs are all replaced by the concept identifiers already registered in the reference OTD.

Clause D.3 shows the AIME for the pump diagnostics application.

### 7.4 ADME for the integrated smart pump application

Elements of all the sections from the integrated application’s ADME is derived from the pump control and pump diagnostics AIMEs and information items contained in the capability profiles of the pump control and the pump diagnostics MSUs. All the remaining symbolic names in the ADMEs are all replaced by the concept identifiers already registered in the reference OTD. The concept identifiers used in the matrix elements need to be selected from the IG to qualify the allowable collections. The allowable collections can be analysed to determine if they meet the interoperability requirements of the integrated smart pump application.

Clause D.4 shows the ADME for the integrated smart pump application.

## 8 General procedures for achieving application integration

The procedure of modelling application interoperability is as follows.

- a) Specify domain(s) of interest(s) from ISO 18435 ADID and identify corresponding applications for information exchange, e.g. control and diagnostics domains.

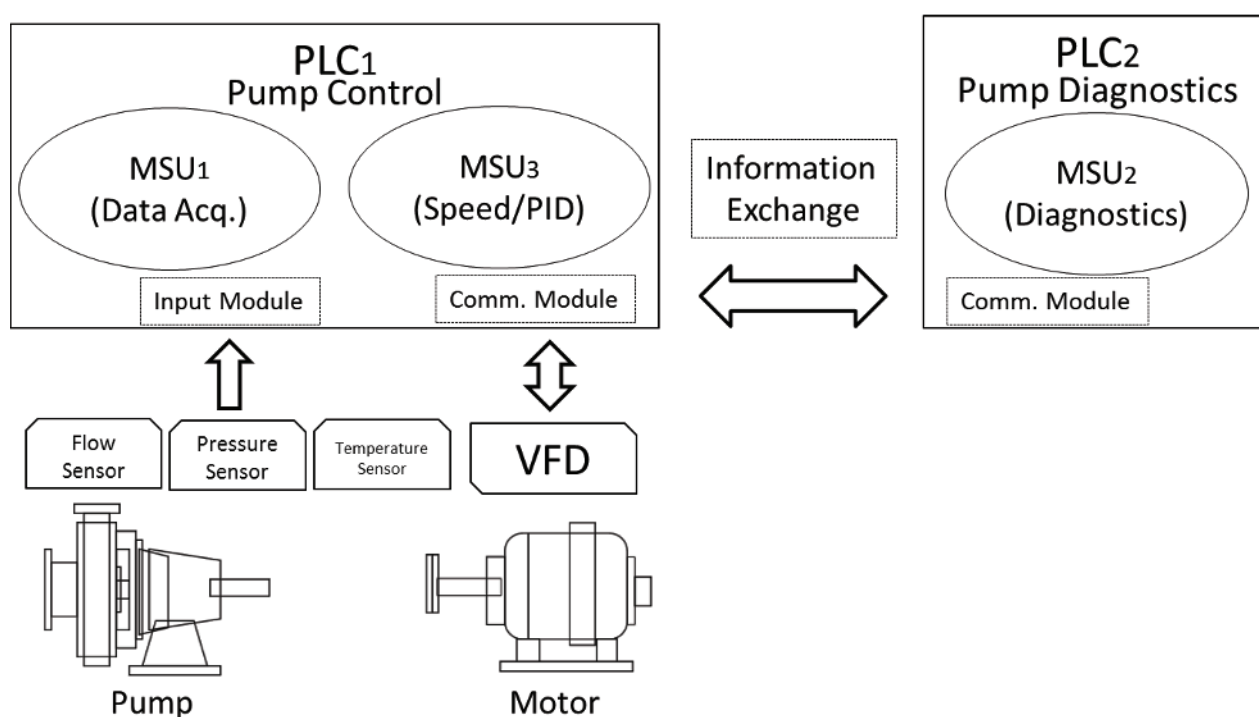
- b) Profile the information exchange requirements between applications based on ISO 15745 profiling methodology.
- c) Identify elements of application integration model of ISO 15745, i.e. information exchanges and MSU resources that enable exchanges, e.g. information exchange between the pump control and the pump diagnostics applications.
- d) ISO 16100 MSU capability profiles need to exhibit information exchange and application capabilities.
- e) Retrieve or construct the CCS for application requirements. CCSs are expressed in terms of concept identifiers based on ISO 22745 OTD.
- f) Identify AIMEs which fulfil the necessary information exchange between applications resources including MSUs.
- g) Identify ADMEs which fulfil the necessary information exchange between applications.
- h) If the capability requirements of the applications are provided by the ISO 16100 required capability profiles:
  - 1) use capability requirements of ISO 16100 and fill in AIMEs and ADMEs corresponding contexts;
  - 2) use capability requirements of ISO 16100 and fill in AIMEs and ADMEs corresponding conveyance;
  - 3) use capability requirements of ISO 16100 and fill in AIMEs and ADMEs corresponding contents.
- i) If the capability requirements of the applications are provided by the ISO 18435 ADMEs:
  - 1) use capability requirements of ISO 18435 ADMEs in context, content, and conveyance sections to construct ISO 16100 required profiles to obtain corresponding MSUs;
  - 2) use MSU identifiers from the ISO 16100 profile matcher to fill in the resource sections of the ADMEs and corresponding AIMEs;
  - 3) update the ADMEs and AIMEs accordingly.

## Annex A (informative)

### Modelling smart pump application

#### A.1 Application of smart pump system

The integrated smart pump system information model described in this annex is extended from the conventional ISO 15926 pump model illustrated in [Figure 5](#). [Figure A.1](#) shows the system diagram for the smart pump as an example.



**Figure A.1 — Smart pump system diagram**

There are three MSUs in the integrated smart pump application in this example. The pump control application consists of a programmable logic controller (PLC), and appropriate input and communication modules to process sensor information and communicate with VFD for adjusting the pump speed. There are two MSUs in the pump control application:

- data acquisition MSU acquires the sensor data from the sensors, e.g. flow rate, discharge pressure and temperature;
- pump control MSU has pump control capability, e.g. speed and PID control for flow and pressure.

It is assumed that these two MSUs along with other resources comprising the pump control application are already integrated within the pump control application as described in [7.2](#) and the information exchange within the pump control application is not discussed in this annex.

The stand-alone pump diagnostics application has one MSU: pump diagnostics MSU receives sensor information from the pump control application, performs diagnostics, and sends the diagnostics result back to the pump control application.

The data flow is as follows:

- a) sensor information, e.g. flow, discharge pressure and temperature, is read by MSU1 (data acquisition) of the pump control application;
- b) necessary sensor data are sent to pump diagnostics application to perform pump diagnostics;
- c) pump diagnostics, e.g. cavitation detection, is performed by MSU2 of pump diagnostics application;
- d) the diagnostic result, e.g. degree of pump cavitation, is sent back to pump control application;
- e) MSU3 of the pump control application changes the pump operation profile, e.g. it slows down the pump to protect the equipment or process.

## A.2 Integrated smart pump application CCS

The following XML example represents the CCS of the integrated smart pump application.

```
<?xml version="1.0" encoding="utf-8"?>
<CapabilityClassStructure xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:noName
spaceSchemaLocation="C:\SmartPump1108\SmartPumpCCS.xsd">
  <CCS_Creator_Name name="WG4_WG7" />
  <CCS_ID id="SmartPumpCCS" />
  <CCS_Root_Node_ID id="IntSmartPump" />
  <Capability_Class>
    <Capability_Class_ID id="IntSmartPump" />
    <Parent_Node_ID id="NONE" />
    <Child_Node_ID>
      <Capability_Class>
        <Capability_Class_ID id="SmatPumpControl_PLC1" />
        <Parent_Node_ID id="IntSmartPump" />
        <Child_Node_ID>
          <Capability_Class>
            <Capability_Class_ID id="MSU1" />
            <Parent_Node_ID id="SmartPumpControl_PLC1" />
          </Capability_Class>
        </Child_Node_ID>
        <Child_Node_ID>
          <Capability_Class>
            <Capability_Class_ID id="MSU3" />
            <Parent_Node_ID id="SmartPumpControl_PLC1" />
          </Capability_Class>
        </Child_Node_ID>
      </Capability_Class>
    </Child_Node_ID>
    <Child_Node_ID>
      <Capability_Class>
        <Capability_Class_ID id="SmartPumpDiagnostics_PLC2_MSU2" />
        <Parent_Node_ID id="IntSmartPump" />
      </Capability_Class>
    </Child_Node_ID>
  </Capability_Class>
</CapabilityClassStructure>
```

## Annex B (informative)

### Capability profiling templates of application software units

#### B.1 Smart pump data acquisition capability profiling template

The following XML example represents the MSU capability template for the data acquisition MSU.

```
<?xml version="1.0" encoding="utf-8" ?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema">
  <xs:element name="CapabilityProfiling">
    <xs:complexType>
      <xs:sequence maxOccurs="unbounded">
        <xs:element name="Template">
          <xs:complexType>
            <xs:attribute fixed="SmartPumpControl_PLCl1_MSU_1" form="unqualified" name="id"
type="xs:string" />
            <xs:attribute fixed="SmartPumpDaq" name="name" type="xs:string" use="required"
/>
          </xs:complexType>
        </xs:element>
        <xs:element name="Type">
          <xs:complexType>
            <xs:attribute fixed="MSU_profile" name="id" type="xs:string" use="required" />
          </xs:complexType>
        </xs:element>
        <xs:element name="CapabilityProfile">
          <xs:complexType>
            <xs:sequence>
              <xs:element name="Pkgtype">
                <xs:complexType>
                  <xs:attribute form="unqualified" name="version" type="xs:string" />
                </xs:complexType>
              </xs:element>
              <xs:element name="Common" type="CommonPartType" />
              <xs:element name="Specific" type="SpecificPartType" />
            </xs:sequence>
            <xs:attribute form="unqualified" name="date" type="xs:string" />
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:complexType name="CommonPartType">
    <xs:sequence>
      <xs:element name="MSU_Capability">
        <xs:complexType>
          <xs:sequence>
            <xs:element fixed="SmartPumpDaqMSU1" name="ID" type="xs:string" />
          </xs:sequence>
        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
  <xs:sequence maxOccurs="unbounded">
    <xs:element name="ReferenceCapabilityClassStructure">
      <xs:complexType>
        <xs:attribute fixed="SP_MSU1" form="unqualified" name="id" type="xs:string" />
        <xs:attribute form="unqualified" name="name" type="xs:string" />
        <xs:attribute form="unqualified" name="version" type="xs:string" />
        <xs:attribute form="unqualified" name="url" type="xs:string" />
      </xs:complexType>
    </xs:element>
  </xs:sequence>
</xs:schema>
```

```

<xs:element name="Capability_Class_Name">
  <xs:complexType>
    <xs:attribute fixed="SmartPumpDaq" form="unqualified" name="name" type="xs:string"
  />
  </xs:complexType>
</xs:element>
<xs:element name="Reference_Capability_Class_Structure_Name">
  <xs:complexType>
    <xs:attribute fixed="SmartPump_Daq" form="unqualified" name="name"
type="xs:string" />
  </xs:complexType>
</xs:element>
<xs:element name="Version">
  <xs:complexType>
    <xs:attribute form="unqualified" name="major" type="xs:string" />
    <xs:attribute form="unqualified" name="minor" type="xs:string" />
  </xs:complexType>
</xs:element>
<xs:element name="Owner">
  <xs:complexType>
    <xs:sequence>
      <xs:element minOccurs="0" name="Name" type="xs:string" />
      <xs:element minOccurs="0" name="Street" type="xs:string" />
      <xs:element minOccurs="0" name="City" type="xs:string" />
      <xs:element minOccurs="0" name="Zip" type="xs:string" />
      <xs:element minOccurs="0" name="State" type="xs:string" />
      <xs:element minOccurs="0" name="Country" type="xs:string" />
      <xs:element minOccurs="0" name="Comment" type="xs:string" />
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element minOccurs="0" maxOccurs="unbounded" name="ComputingFacilities">
  <xs:complexType>
    <xs:sequence>
      <xs:element minOccurs="0" maxOccurs="unbounded" name="Processor">
        <xs:complexType>
          <xs:attribute form="unqualified" name="type" type="xs:string" />
        </xs:complexType>
      </xs:element>
      <xs:element minOccurs="0" maxOccurs="unbounded" name="OperatingSystem">
        <xs:complexType>
          <xs:attribute form="unqualified" name="type" type="xs:string" />
        </xs:complexType>
      </xs:element>
      <xs:element minOccurs="0" maxOccurs="unbounded" name="Language">
        <xs:complexType>
          <xs:attribute form="unqualified" name="name" type="xs:string" />
        </xs:complexType>
      </xs:element>
      <xs:element minOccurs="0" maxOccurs="unbounded" name="Memory">
        <xs:complexType>
          <xs:attribute form="unqualified" name="size" type="xs:string" />
          <xs:attribute form="unqualified" name="unit" type="xs:string" />
        </xs:complexType>
      </xs:element>
      <xs:element minOccurs="0" maxOccurs="unbounded" name="DiskSpace">
        <xs:complexType>
          <xs:attribute form="unqualified" name="size" type="xs:string" />
          <xs:attribute form="unqualified" name="unit" type="xs:string" />
        </xs:complexType>
      </xs:element>
    </xs:sequence>
    <xs:attribute form="unqualified" name="type" type="xs:string" />
  </xs:complexType>
</xs:element>
<xs:element name="ReferenceDictionaryName">
  <xs:complexType>
    <xs:attribute form="unqualified" name="name" type="xs:string" />
  </xs:complexType>
</xs:element>
<xs:element minOccurs="0" maxOccurs="unbounded" name="NumberOfProfileAttributes">

```



```

    <xs:complexType>
      <xs:attribute form="unqualified" name="number" type="xs:string" />
    </xs:complexType>
  </xs:element>
  <xs:element minOccurs="0" maxOccurs="unbounded" name="NumberOfMethods">
    <xs:complexType>
      <xs:attribute form="unqualified" name="number" type="xs:string" />
    </xs:complexType>
  </xs:element>
  <xs:element minOccurs="0" maxOccurs="unbounded" name="NumberOfResources">
    <xs:complexType>
      <xs:attribute form="unqualified" name="number" type="xs:string" />
    </xs:complexType>
  </xs:element>
  <xs:element minOccurs="0" maxOccurs="unbounded" name="NumberOfConstraints">
    <xs:complexType>
      <xs:attribute form="unqualified" name="number" type="xs:string" />
    </xs:complexType>
  </xs:element>
  <xs:element minOccurs="0" maxOccurs="unbounded" name="NumberOfExtensions">
    <xs:complexType>
      <xs:attribute form="unqualified" name="number" type="xs:string" />
    </xs:complexType>
  </xs:element>
  <xs:element minOccurs="0" maxOccurs="unbounded" name="NumberOfLowerLevels">
    <xs:complexType>
      <xs:attribute form="unqualified" name="number" type="xs:string" />
    </xs:complexType>
  </xs:element>
  <xs:element minOccurs="0" maxOccurs="unbounded" name="NumberOfSubtemplatesAtNextLowerLevel">
    <xs:complexType>
      <xs:attribute form="unqualified" name="number" type="xs:string" />
    </xs:complexType>
  </xs:sequence>
</xs:complexType>
<xs:complexType name="SpecificPartType">
  <xs:sequence>
    <xs:element name="Reference_MDM_Name">
      <xs:complexType>
        <xs:attribute form="unqualified" name="domain_name" type="xs:string" />
      </xs:complexType>
    </xs:element>
    <xs:element name="MDD_Description_Format">
      <xs:complexType>
        <xs:attribute form="unqualified" name="format_name" type="xs:string" />
      </xs:complexType>
    </xs:element>
    <xs:element name="MDD_Description">
      <xs:complexType>
        <xs:sequence>
          <xs:choice>
            <xs:element name="Set_Of_MDD_Objects">
              <xs:complexType>
                <xs:sequence minOccurs="0" maxOccurs="unbounded">
                  <xs:element name="MDD_Name">
                    <xs:complexType>
                      <xs:sequence>
                        <xs:element name="MDD_Information_Exchange">
                          <xs:complexType>
                            <xs:sequence maxOccurs="unbounded">
                              <xs:sequence>
                                <xs:element minOccurs="0" maxOccurs="unbounded"
name="information_in">
                                  <xs:complexType>
                                    <xs:attribute form="unqualified" name="name"
type="xs:string" use="required" />
                                    <xs:attribute form="unqualified" name="value"
type="xs:string" use="required" />
                                  </xs:complexType>
                                </xs:sequence>
                              </xs:sequence>
                            </xs:complexType>
                          </xs:element>
                        </xs:sequence>
                      </xs:complexType>
                    </xs:element>
                  </xs:sequence>
                </xs:complexType>
              </xs:element>
          </xs:choice>
        </xs:sequence>
      </xs:complexType>
    </xs:element>
  </xs:sequence>
</xs:complexType>

```



```

        </xs:element>
    </xs:sequence>
<xs:sequence>
    <xs:element minOccurs="0" maxOccurs="unbounded"
name="information_out">
        <xs:complexType>
            <xs:attribute form="unqualified" name="name"
type="xs:string" use="required" />
            <xs:attribute form="unqualified" name="value"
type="xs:string" use="required" />
        </xs:complexType>
    </xs:element>
</xs:sequence>
<xs:sequence>
    <xs:element minOccurs="0" maxOccurs="unbounded"
name="information_inout">
        <xs:complexType>
            <xs:attribute form="unqualified" name="name"
type="xs:string" use="required" />
            <xs:attribute form="unqualified" name="value"
type="xs:string" use="required" />
        </xs:complexType>
    </xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
<xs:element name="MDD_Constraints">
    <xs:complexType>
        <xs:sequence>
            <xs:element minOccurs="0" maxOccurs="unbounded"
name="Constraint_name">
                <xs:complexType>
                    <xs:attribute form="unqualified" name="name"
type="xs:string" use="required" />
                    <xs:attribute name="property" type="xs:string"
use="required" />
                </xs:complexType>
            </xs:element>
        </xs:sequence>
    </xs:complexType>
</xs:element>
<xs:element name="MDD_Resources">
    <xs:complexType>
        <xs:sequence>
            <xs:element minOccurs="0" maxOccurs="unbounded"
name="Resource_name">
                <xs:complexType>
                    <xs:attribute form="unqualified" name="name"
type="xs:string" />
                </xs:complexType>
            </xs:element>
        </xs:sequence>
    </xs:complexType>
</xs:element>
<xs:attribute form="unqualified" name="name" type="xs:string"
use="required" />
    <xs:attribute form="unqualified" name="action" type="xs:string"
use="required" />
</xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
<xs:element name="List_Of_MDD_Objects">
    <xs:complexType>
        <xs:sequence minOccurs="0" maxOccurs="unbounded">
            <xs:element name="MDD_Name">
                <xs:complexType>
                    <xs:attribute form="unqualified" name="name" type="xs:string"

```

```

use="required" />
    <xs:attribute form="unqualified" name="action" type="xs:string"
use="required" />
    </xs:complexType>
  </xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
<xs:element name="Time_Ordered_MDD_Objects">
  <xs:complexType>
    <xs:sequence minOccurs="0" maxOccurs="unbounded">
      <xs:element name="Time_Occurrence_Of_MDD_Object">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="MDD_Name">
              <xs:complexType>
                <xs:attribute form="unqualified" name="name" type="xs:string"
/>
                <xs:attribute form="unqualified" name="action"
type="xs:string" />
              </xs:complexType>
            </xs:element>
            <xs:element name="MDD_Qualifiers">
              <xs:complexType>
                <xs:sequence minOccurs="0" maxOccurs="unbounded">
                  <xs:element name="Qualifier_Name">
                    <xs:complexType>
                      <xs:attribute form="unqualified" name="name"
type="xs:string" />
                    </xs:complexType>
                  </xs:element>
                </xs:sequence>
              </xs:complexType>
            </xs:element>
          </xs:sequence>
        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="Event_Ordered_MDD_Objects">
  <xs:complexType>
    <xs:sequence minOccurs="0" maxOccurs="unbounded">
      <xs:element name="Event_Occurrence_Of_MDD_Object">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="MDD_Name">
              <xs:complexType>
                <xs:attribute form="unqualified" name="name" type="xs:string"
/>
                <xs:attribute form="unqualified" name="action"
type="xs:string" />
              </xs:complexType>
            </xs:element>
            <xs:element name="MDD_Qualifiers">
              <xs:complexType>
                <xs:sequence minOccurs="0" maxOccurs="unbounded">
                  <xs:element name="Qualifier_Name">
                    <xs:complexType>
                      <xs:attribute form="unqualified" name="name"
type="xs:string" />
                    </xs:complexType>
                  </xs:element>
                </xs:sequence>
              </xs:complexType>
            </xs:element>
          </xs:sequence>
        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>

```

```

        </xs:element>
      </xs:choice>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element minOccurs="0" maxOccurs="unbounded" name="List_Of_CC_Attributes" />
<xs:element minOccurs="0" maxOccurs="unbounded" name="List_Of_CC_Methods" />
<xs:element minOccurs="0" maxOccurs="unbounded" name="List_Of_CC_Resources" />
<xs:element minOccurs="0" maxOccurs="unbounded" name="List_Of_CC_Constraints" />
<xs:element minOccurs="0" maxOccurs="unbounded" name="List_Of_CC_Extensions" />
<xs:element minOccurs="0" maxOccurs="unbounded" name="List_Of_CC_Lower_Levels" />
<xs:element minOccurs="0" maxOccurs="unbounded" name="List_Of_CC_Subtemplates" />
</xs:sequence>
</xs:complexType>
</xs:schema>

```

## B.2 Smart pump diagnostics capability profiling template

The following XML example represents the MSU capability template for the pump diagnostics MSU.

```

<?xml version="1.0" encoding="utf-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema">
  <xs:element name="CapabilityProfiling">
    <xs:complexType>
      <xs:sequence maxOccurs="unbounded">
        <xs:element name="Template">
          <xs:complexType>
            <xs:attribute fixed="SmartPumpDiag_PLC2_MSU2" form="unqualified" name="id"
type="xs:string" />
            <xs:attribute fixed="SmartPumpDiagnose" name="name" type="xs:string"
use="required" />
          </xs:complexType>
        </xs:element>
        <xs:element name="Type">
          <xs:complexType>
            <xs:attribute fixed="MSU_profile" name="id" type="xs:string" use="required" />
          </xs:complexType>
        </xs:element>
        <xs:element name="CapabilityProfile">
          <xs:complexType>
            <xs:sequence>
              <xs:element name="Pkgtype">
                <xs:complexType>
                  <xs:attribute form="unqualified" name="version" type="xs:string" />
                </xs:complexType>
              </xs:element>
              <xs:element name="Common" type="CommonPartType" />
              <xs:element name="Specific" type="SpecificPartType" />
            </xs:sequence>
            <xs:attribute form="unqualified" name="date" type="xs:string" />
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:complexType name="CommonPartType">
    <xs:sequence>
      <xs:element name="MSU_Capability">
        <xs:complexType>
          <xs:sequence>
            <xs:element fixed="SmartPumpDiagnoseMSU2" name="ID" type="xs:string" />
          </xs:sequence>
        </xs:complexType>
      </xs:element>
    </xs:sequence maxOccurs="unbounded">
      <xs:element name="ReferenceCapabilityClassStructure">
        <xs:complexType>
          <xs:attribute fixed="SP_MSU2" form="unqualified" name="id" type="xs:string" />
          <xs:attribute form="unqualified" name="name" type="xs:string" />
          <xs:attribute form="unqualified" name="version" type="xs:string" />
        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>

```

```

    <xs:attribute form="unqualified" name="url" type="xs:string" />
  </xs:complexType>
</xs:element>
</xs:sequence>
<xs:element name="Capability_Class_Name">
  <xs:complexType>
    <xs:attribute fixed="SmartPumpDiagnose" form="unqualified" name="name"
type="xs:string" />
  </xs:complexType>
</xs:element>
<xs:element name="Reference_Capability_Class_Structure_Name">
  <xs:complexType>
    <xs:attribute fixed="SmartPump_Diag" form="unqualified" name="name"
type="xs:string" />
  </xs:complexType>
</xs:element>
<xs:element name="Version">
  <xs:complexType>
    <xs:attribute form="unqualified" name="major" type="xs:string" />
    <xs:attribute form="unqualified" name="minor" type="xs:string" />
  </xs:complexType>
</xs:element>
<xs:element name="Owner">
  <xs:complexType>
    <xs:sequence>
      <xs:element minOccurs="0" name="Name" type="xs:string" />
      <xs:element minOccurs="0" name="Street" type="xs:string" />
      <xs:element minOccurs="0" name="City" type="xs:string" />
      <xs:element minOccurs="0" name="Zip" type="xs:string" />
      <xs:element minOccurs="0" name="State" type="xs:string" />
      <xs:element minOccurs="0" name="Country" type="xs:string" />
      <xs:element minOccurs="0" name="Comment" type="xs:string" />
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element minOccurs="0" maxOccurs="unbounded" name="ComputingFacilities">
  <xs:complexType>
    <xs:sequence>
      <xs:element minOccurs="0" maxOccurs="unbounded" name="Processor">
        <xs:complexType>
          <xs:attribute form="unqualified" name="type" type="xs:string" />
        </xs:complexType>
      </xs:element>
      <xs:element minOccurs="0" maxOccurs="unbounded" name="OperatingSystem">
        <xs:complexType>
          <xs:attribute form="unqualified" name="type" type="xs:string" />
        </xs:complexType>
      </xs:element>
      <xs:element minOccurs="0" maxOccurs="unbounded" name="Language">
        <xs:complexType>
          <xs:attribute form="unqualified" name="name" type="xs:string" />
        </xs:complexType>
      </xs:element>
      <xs:element minOccurs="0" maxOccurs="unbounded" name="Memory">
        <xs:complexType>
          <xs:attribute form="unqualified" name="size" type="xs:string" />
          <xs:attribute form="unqualified" name="unit" type="xs:string" />
        </xs:complexType>
      </xs:element>
      <xs:element minOccurs="0" maxOccurs="unbounded" name="DiskSpace">
        <xs:complexType>
          <xs:attribute form="unqualified" name="size" type="xs:string" />
          <xs:attribute form="unqualified" name="unit" type="xs:string" />
        </xs:complexType>
      </xs:element>
    </xs:sequence>
    <xs:attribute form="unqualified" name="type" type="xs:string" />
  </xs:complexType>
</xs:element>
<xs:element name="ReferenceDictionaryName">
  <xs:complexType>

```

```

        <xs:attribute form="unqualified" name="name" type="xs:string" />
    </xs:complexType>
</xs:element>
<xs:element minOccurs="0" maxOccurs="unbounded" name="NumberOfProfileAttributes">
    <xs:complexType>
        <xs:attribute form="unqualified" name="number" type="xs:string" />
    </xs:complexType>
</xs:element>
<xs:element minOccurs="0" maxOccurs="unbounded" name="NumberOfMethods">
    <xs:complexType>
        <xs:attribute form="unqualified" name="number" type="xs:string" />
    </xs:complexType>
</xs:element>
<xs:element minOccurs="0" maxOccurs="unbounded" name="NumberOfResources">
    <xs:complexType>
        <xs:attribute form="unqualified" name="number" type="xs:string" />
    </xs:complexType>
</xs:element>
<xs:element minOccurs="0" maxOccurs="unbounded" name="NumberOfConstraints">
    <xs:complexType>
        <xs:attribute form="unqualified" name="number" type="xs:string" />
    </xs:complexType>
</xs:element>
<xs:element minOccurs="0" maxOccurs="unbounded" name="NumberOfExtensions">
    <xs:complexType>
        <xs:attribute form="unqualified" name="number" type="xs:string" />
    </xs:complexType>
</xs:element>
<xs:element minOccurs="0" maxOccurs="unbounded" name="NumberOfLowerLevels">
    <xs:complexType>
        <xs:attribute form="unqualified" name="number" type="xs:string" />
    </xs:complexType>
</xs:element>
<xs:element minOccurs="0" maxOccurs="unbounded" name="NumberOfSubtemplatesAtNextLowerLevel">
    <xs:complexType>
        <xs:attribute form="unqualified" name="number" type="xs:string" />
    </xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
<xs:complexType name="SpecificPartType">
    <xs:sequence>
        <xs:element name="Reference_MDM_Name">
            <xs:complexType>
                <xs:attribute form="unqualified" name="domain_name" type="xs:string" />
            </xs:complexType>
        </xs:element>
        <xs:element name="MDD_Description_Format">
            <xs:complexType>
                <xs:attribute form="unqualified" name="format_name" type="xs:string" />
            </xs:complexType>
        </xs:element>
        <xs:element name="MDD_Description">
            <xs:complexType>
                <xs:sequence>
                    <xs:choice>
                        <xs:element name="Set_Of_MDD_Objects">
                            <xs:complexType>
                                <xs:sequence minOccurs="0" maxOccurs="unbounded">
                                    <xs:element name="MDD_Name">
                                        <xs:complexType>
                                            <xs:sequence>
                                                <xs:element name="MDD_Information_Exchange">
                                                    <xs:complexType>
                                                        <xs:sequence maxOccurs="unbounded">
                                                            <xs:sequence>
                                                                <xs:element minOccurs="0" maxOccurs="unbounded"
name="information_in">
                                                                    <xs:complexType>
                                                                        <xs:attribute form="unqualified" name="name"

```

```

type="xs:string" use="required" />
    <xs:attribute form="unqualified" name="value"
type="xs:string" use="required" />
    </xs:complexType>
    </xs:element>
</xs:sequence>
<xs:sequence>
    <xs:element minOccurs="0" maxOccurs="unbounded"
name="information_out">
    <xs:complexType>
    <xs:attribute form="unqualified" name="name"
type="xs:string" use="required" />
    <xs:attribute form="unqualified" name="value"
type="xs:string" use="required" />
    </xs:complexType>
    </xs:element>
</xs:sequence>
<xs:sequence>
    <xs:element minOccurs="0" maxOccurs="unbounded"
name="information_inout">
    <xs:complexType>
    <xs:attribute form="unqualified" name="name"
type="xs:string" use="required" />
    <xs:attribute form="unqualified" name="value"
type="xs:string" use="required" />
    </xs:complexType>
    </xs:element>
</xs:sequence>
</xs:sequence>
</xs:complexType>
</xs:element>
<xs:element name="MDD_Constraints">
    <xs:complexType>
    <xs:sequence>
    <xs:element minOccurs="0" maxOccurs="unbounded"
name="Constraint_name">
    <xs:complexType>
    <xs:attribute form="unqualified" name="name"
type="xs:string" use="required" />
    <xs:attribute name="property" type="xs:string"
use="required" />
    </xs:complexType>
    </xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
<xs:element name="MDD_Resources">
    <xs:complexType>
    <xs:sequence>
    <xs:element minOccurs="0" maxOccurs="unbounded"
name="Resource_name">
    <xs:complexType>
    <xs:attribute form="unqualified" name="name"
type="xs:string" />
    </xs:complexType>
    </xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:sequence>
<xs:attribute form="unqualified" name="name" type="xs:string"
use="required" />
    <xs:attribute form="unqualified" name="action" type="xs:string"
use="required" />
    </xs:complexType>
    </xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
<xs:element name="List_Of_MDD_Objects">
    <xs:complexType>

```

```

        <xs:sequence minOccurs="0" maxOccurs="unbounded">
          <xs:element name="MDD_Name">
            <xs:complexType>
              <xs:attribute form="unqualified" name="name" type="xs:string"
use="required" />
              <xs:attribute form="unqualified" name="action" type="xs:string"
use="required" />
            </xs:complexType>
          </xs:element>
        </xs:sequence>
      </xs:complexType>
    </xs:element>
    <xs:element name="Time_Ordered_MDD_Objects">
      <xs:complexType>
        <xs:sequence minOccurs="0" maxOccurs="unbounded">
          <xs:element name="Time_Occurrence_Of_MDD_Object">
            <xs:complexType>
              <xs:sequence>
                <xs:element name="MDD_Name">
                  <xs:complexType>
                    <xs:attribute form="unqualified" name="name" type="xs:string"
/>
                    <xs:attribute form="unqualified" name="action"
type="xs:string" />
                  </xs:complexType>
                </xs:element>
              </xs:sequence>
            </xs:complexType>
          </xs:element>
        </xs:sequence>
      </xs:complexType>
    </xs:element>
    <xs:element name="MDD_Qualifiers">
      <xs:complexType>
        <xs:sequence minOccurs="0" maxOccurs="unbounded">
          <xs:element name="Qualifier_Name">
            <xs:complexType>
              <xs:attribute form="unqualified" name="name"
type="xs:string" />
            </xs:complexType>
          </xs:element>
        </xs:sequence>
      </xs:complexType>
    </xs:element>
    <xs:element name="Event_Ordered_MDD_Objects">
      <xs:complexType>
        <xs:sequence minOccurs="0" maxOccurs="unbounded">
          <xs:element name="Event_Occurrence_Of_MDD_Object">
            <xs:complexType>
              <xs:sequence>
                <xs:element name="MDD_Name">
                  <xs:complexType>
                    <xs:attribute form="unqualified" name="name" type="xs:string"
/>
                    <xs:attribute form="unqualified" name="action"
type="xs:string" />
                  </xs:complexType>
                </xs:element>
              </xs:sequence>
            </xs:complexType>
          </xs:element>
        </xs:sequence>
      </xs:complexType>
    </xs:element>
    <xs:element name="MDD_Qualifiers">
      <xs:complexType>
        <xs:sequence minOccurs="0" maxOccurs="unbounded">
          <xs:element name="Qualifier_Name">
            <xs:complexType>
              <xs:attribute form="unqualified" name="name"
type="xs:string" />
            </xs:complexType>
          </xs:element>
        </xs:sequence>
      </xs:complexType>
    </xs:element>
  </xs:sequence>

```

```

        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>
</xs:choice>
</xs:sequence>
</xs:complexType>
</xs:element>
<xs:element minOccurs="0" maxOccurs="unbounded" name="List_Of_CC_Attributes" />
<xs:element minOccurs="0" maxOccurs="unbounded" name="List_Of_CC_Methods" />
<xs:element minOccurs="0" maxOccurs="unbounded" name="List_Of_CC_Resources" />
<xs:element minOccurs="0" maxOccurs="unbounded" name="List_Of_CC_Constraints" />
<xs:element minOccurs="0" maxOccurs="unbounded" name="List_Of_CC_Extensions" />
<xs:element minOccurs="0" maxOccurs="unbounded" name="List_Of_CC_Lower_Levels" />
<xs:element minOccurs="0" maxOccurs="unbounded" name="List_Of_CC_Subtemplates" />
</xs:sequence>
</xs:complexType>
</xs:schema>

```

### B.3 Smart pump control capability profiling template

The following XML example represents the MSU capability template for the pump control MSU.

```

<?xml version="1.0" encoding="utf-8" ?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema">
  <xs:element name="CapabilityProfiling">
    <xs:complexType>
      <xs:sequence maxOccurs="unbounded">
        <xs:element name="Template">
          <xs:complexType>
            <xs:attribute fixed="SmartPumpControl_PLCC1_MSU3" name="id" type="xs:string" />
            <xs:attribute fixed="SmartPumpControl" name="name" type="xs:string"
use="required" />
          </xs:complexType>
        </xs:element>
        <xs:element name="Type">
          <xs:complexType>
            <xs:attribute fixed="MSU_profile" name="id" type="xs:string" use="required" />
          </xs:complexType>
        </xs:element>
        <xs:element name="CapabilityProfile">
          <xs:complexType>
            <xs:sequence>
              <xs:element name="Pkgtype">
                <xs:complexType>
                  <xs:attribute form="unqualified" name="version" type="xs:string" />
                </xs:complexType>
              </xs:element>
              <xs:element name="Common" type="CommonPartType" />
              <xs:element name="Specific" type="SpecificPartType" />
            </xs:sequence>
            <xs:attribute form="unqualified" name="date" type="xs:string" />
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:complexType name="CommonPartType">
    <xs:sequence>
      <xs:element name="MSU_Capability">
        <xs:complexType>
          <xs:sequence>
            <xs:element fixed="SmartPmupControlMSU3" name="ID" type="xs:string" />
          </xs:sequence>
        </xs:complexType>
      </xs:element>
      <xs:sequence maxOccurs="unbounded">
        <xs:element name="ReferenceCapabilityClassStructure">
          <xs:complexType>

```



```

    <xs:attribute fixed="SP_MSU3" form="unqualified" name="id" type="xs:string" />
    <xs:attribute form="unqualified" name="name" type="xs:string" />
    <xs:attribute form="unqualified" name="version" type="xs:string" />
    <xs:attribute form="unqualified" name="url" type="xs:string" />
  </xs:complexType>
</xs:element>
</xs:sequence>
<xs:element name="Capability_Class_Name">
  <xs:complexType>
    <xs:attribute fixed="SmartPumpControl" form="unqualified" name="name"
type="xs:string" />
  </xs:complexType>
</xs:element>
<xs:element name="Reference_Capability_Class_Structure_Name">
  <xs:complexType>
    <xs:attribute fixed="SmartPump_Control" form="unqualified" name="name"
type="xs:string" />
  </xs:complexType>
</xs:element>
<xs:element name="Version">
  <xs:complexType>
    <xs:attribute form="unqualified" name="major" type="xs:string" />
    <xs:attribute form="unqualified" name="minor" type="xs:string" />
  </xs:complexType>
</xs:element>
<xs:element name="Owner">
  <xs:complexType>
    <xs:sequence>
      <xs:element minOccurs="0" name="Name" type="xs:string" />
      <xs:element minOccurs="0" name="Street" type="xs:string" />
      <xs:element minOccurs="0" name="City" type="xs:string" />
      <xs:element minOccurs="0" name="Zip" type="xs:string" />
      <xs:element minOccurs="0" name="State" type="xs:string" />
      <xs:element minOccurs="0" name="Country" type="xs:string" />
      <xs:element minOccurs="0" name="Comment" type="xs:string" />
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element minOccurs="0" maxOccurs="unbounded" name="ComputingFacilities">
  <xs:complexType>
    <xs:sequence>
      <xs:element minOccurs="0" maxOccurs="unbounded" name="Processor">
        <xs:complexType>
          <xs:attribute form="unqualified" name="type" type="xs:string" />
        </xs:complexType>
      </xs:element>
      <xs:element minOccurs="0" maxOccurs="unbounded" name="OperatingSystem">
        <xs:complexType>
          <xs:attribute form="unqualified" name="type" type="xs:string" />
        </xs:complexType>
      </xs:element>
      <xs:element minOccurs="0" maxOccurs="unbounded" name="Language">
        <xs:complexType>
          <xs:attribute form="unqualified" name="name" type="xs:string" />
        </xs:complexType>
      </xs:element>
      <xs:element minOccurs="0" maxOccurs="unbounded" name="Memory">
        <xs:complexType>
          <xs:attribute form="unqualified" name="size" type="xs:string" />
          <xs:attribute form="unqualified" name="unit" type="xs:string" />
        </xs:complexType>
      </xs:element>
      <xs:element minOccurs="0" maxOccurs="unbounded" name="DiskSpace">
        <xs:complexType>
          <xs:attribute form="unqualified" name="size" type="xs:string" />
          <xs:attribute form="unqualified" name="unit" type="xs:string" />
        </xs:complexType>
      </xs:element>
    </xs:sequence>
    <xs:attribute form="unqualified" name="type" type="xs:string" />
  </xs:complexType>

```

```

</xs:element>
<xs:element name="ReferenceDictionaryName">
  <xs:complexType>
    <xs:attribute form="unqualified" name="name" type="xs:string" />
  </xs:complexType>
</xs:element>
<xs:element minOccurs="0" maxOccurs="unbounded" name="NumberOfProfileAttributes">
  <xs:complexType>
    <xs:attribute form="unqualified" name="number" type="xs:string" />
  </xs:complexType>
</xs:element>
<xs:element minOccurs="0" maxOccurs="unbounded" name="NumberOfMethods">
  <xs:complexType>
    <xs:attribute form="unqualified" name="number" type="xs:string" />
  </xs:complexType>
</xs:element>
<xs:element minOccurs="0" maxOccurs="unbounded" name="NumberOfResources">
  <xs:complexType>
    <xs:attribute form="unqualified" name="number" type="xs:string" />
  </xs:complexType>
</xs:element>
<xs:element minOccurs="0" maxOccurs="unbounded" name="NumberOfConstraints">
  <xs:complexType>
    <xs:attribute form="unqualified" name="number" type="xs:string" />
  </xs:complexType>
</xs:element>
<xs:element minOccurs="0" maxOccurs="unbounded" name="NumberOfExtensions">
  <xs:complexType>
    <xs:attribute form="unqualified" name="number" type="xs:string" />
  </xs:complexType>
</xs:element>
<xs:element minOccurs="0" maxOccurs="unbounded" name="NumberOfLowerLevels">
  <xs:complexType>
    <xs:attribute form="unqualified" name="number" type="xs:string" />
  </xs:complexType>
</xs:element>
<xs:element minOccurs="0" maxOccurs="unbounded" name="NumberOfSubtemplatesAtNextLowerLevel">
  <xs:complexType>
    <xs:attribute form="unqualified" name="number" type="xs:string" />
  </xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
<xs:complexType name="SpecificPartType">
  <xs:sequence>
    <xs:element name="Reference_MDM_Name">
      <xs:complexType>
        <xs:attribute form="unqualified" name="domain_name" type="xs:string" />
      </xs:complexType>
    </xs:element>
    <xs:element name="MDD_Description_Format">
      <xs:complexType>
        <xs:attribute form="unqualified" name="format_name" type="xs:string" />
      </xs:complexType>
    </xs:element>
    <xs:element name="MDD_Description">
      <xs:complexType>
        <xs:sequence>
          <xs:choice>
            <xs:element name="Set_Of_MDD_Objects">
              <xs:complexType>
                <xs:sequence minOccurs="0" maxOccurs="unbounded">
                  <xs:element name="MDD_Name">
                    <xs:complexType>
                      <xs:sequence>
                        <xs:element name="MDD_Information_Exchange">
                          <xs:complexType>
                            <xs:sequence maxOccurs="unbounded">
                              <xs:sequence>
                                <xs:element minOccurs="0" maxOccurs="unbounded"
  
```

```

name="information_in">
    <xs:complexType>
        <xs:attribute form="unqualified" name="name"
type="xs:string" use="required" />
        <xs:attribute form="unqualified" name="value"
type="xs:string" use="required" />
    </xs:complexType>
</xs:element>
</xs:sequence>
<xs:sequence>
    <xs:element minOccurs="0" maxOccurs="unbounded"
name="information_out">
        <xs:complexType>
            <xs:attribute form="unqualified" name="name"
type="xs:string" use="required" />
            <xs:attribute form="unqualified" name="value"
type="xs:string" use="required" />
        </xs:complexType>
    </xs:element>
</xs:sequence>
<xs:sequence>
    <xs:element minOccurs="0" maxOccurs="unbounded"
name="information_inout">
        <xs:complexType>
            <xs:attribute form="unqualified" name="name"
type="xs:string" use="required" />
            <xs:attribute form="unqualified" name="value"
type="xs:string" use="required" />
        </xs:complexType>
    </xs:element>
</xs:sequence>
</xs:sequence>
</xs:complexType>
</xs:element>
<xs:element name="MDD_Constraints">
    <xs:complexType>
        <xs:sequence>
            <xs:element minOccurs="0" maxOccurs="unbounded"
name="Constraint_name">
                <xs:complexType>
                    <xs:attribute form="unqualified" name="name"
type="xs:string" use="required" />
                    <xs:attribute name="property" type="xs:string"
use="required" />
                </xs:complexType>
            </xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
<xs:element name="MDD_Resources">
    <xs:complexType>
        <xs:sequence>
            <xs:element minOccurs="0" maxOccurs="unbounded"
name="Resource_name">
                <xs:complexType>
                    <xs:attribute form="unqualified" name="name"
type="xs:string" />
                </xs:complexType>
            </xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:sequence>
<xs:attribute form="unqualified" name="name" type="xs:string"
use="required" />
        <xs:attribute form="unqualified" name="action" type="xs:string"
use="required" />
    </xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>

```

```

</xs:element>
<xs:element name="List_Of_MDD_Objects">
  <xs:complexType>
    <xs:sequence minOccurs="0" maxOccurs="unbounded">
      <xs:element name="MDD_Name">
        <xs:complexType>
          <xs:attribute form="unqualified" name="name" type="xs:string"
use="required" />
          <xs:attribute form="unqualified" name="action" type="xs:string"
use="required" />
        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="Time_Ordered_MDD_Objects">
  <xs:complexType>
    <xs:sequence minOccurs="0" maxOccurs="unbounded">
      <xs:element name="Time_Occurrence_Of_MDD_Object">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="MDD_Name">
              <xs:complexType>
                <xs:attribute form="unqualified" name="name" type="xs:string"
/>
                <xs:attribute form="unqualified" name="action"
type="xs:string" />
              </xs:complexType>
            </xs:element>
          </xs:sequence>
        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="MDD_Qualifiers">
  <xs:complexType>
    <xs:sequence minOccurs="0" maxOccurs="unbounded">
      <xs:element name="Qualifier_Name">
        <xs:complexType>
          <xs:attribute form="unqualified" name="name"
type="xs:string" />
        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="Event_Ordered_MDD_Objects">
  <xs:complexType>
    <xs:sequence minOccurs="0" maxOccurs="unbounded">
      <xs:element name="Event_Occurrence_Of_MDD_Object">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="MDD_Name">
              <xs:complexType>
                <xs:attribute form="unqualified" name="name" type="xs:string"
/>
                <xs:attribute form="unqualified" name="action"
type="xs:string" />
              </xs:complexType>
            </xs:element>
          </xs:sequence>
        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="MDD_Qualifiers">
  <xs:complexType>
    <xs:sequence minOccurs="0" maxOccurs="unbounded">
      <xs:element name="Qualifier_Name">
        <xs:complexType>
          <xs:attribute form="unqualified" name="name"
type="xs:string" />
        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>

```

```

        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:choice>
</xs:sequence>
</xs:complexType>
</xs:element>
<xs:element minOccurs="0" maxOccurs="unbounded" name="List_Of_CC_Attributes" />
<xs:element minOccurs="0" maxOccurs="unbounded" name="List_Of_CC_Methods" />
<xs:element minOccurs="0" maxOccurs="unbounded" name="List_Of_CC_Resources" />
<xs:element minOccurs="0" maxOccurs="unbounded" name="List_Of_CC_Constraints" />
<xs:element minOccurs="0" maxOccurs="unbounded" name="List_Of_CC_Extensions" />
<xs:element minOccurs="0" maxOccurs="unbounded" name="List_Of_CC_Lower_Levels" />
<xs:element minOccurs="0" maxOccurs="unbounded" name="List_Of_CC_Subtemplates" />
</xs:sequence>
</xs:complexType>
</xs:schema>

```

## Annex C (informative)

### Application software unit capability profiles

#### C.1 Smart pump data acquisition capability profile

The following XML example represents the capability profile of the data acquisition application.

```
<?xml version="1.0" encoding="utf-8"?>
<CapabilityProfiling xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:noNamespaces
chemaLocation="C:\ISO\SmartPump\SmartPumpDaq.xsd">
  <Template id="SmartPumpControl_PLCl_MSU_1" name="SmartPumpDaq" />
  <Type id="MSU_profile" />
  <CapabilityProfile date="2012-12-30">
    <Pkgtype version="1.0.0" />
    <Common>
      <MSU_Capability>
        <ID>SmartPumpDaqMSU1</ID>
      </MSU_Capability>
      <ReferenceCapabilityClassStructure id="SP_MSU1" />
      <Capability_Class_Name name="SmartPumpDaq" />
      <Reference_Capability_Class_Structure_Name name="SmartPump_Daq" />
      <Version major="1" minor="1" />
      <Owner>
      </Owner>
      <ComputingFacilities>
        <Processor type="logix" />
        <OperatingSystem type="AB" />
        <Language name="EN" />
        <Memory size="32" unit="MB" />
        <DiskSpace size="20" unit="GB" />
      </ComputingFacilities>
      <ReferenceDictionaryName />
      <NumberOfProfileAttributes />
      <NumberOfMethods />
      <NumberOfResources />
      <NumberOfConstraints />
      <NumberOfExtensions />
      <NumberOfLowerLevels />
      <NumberOfSubtemplatesAtNextLowerLevel />
    </Common>
    <Specific>
      <Reference_MDM_Name domain_name="SmartPumpModel" />
      <MDD_Description_Format format_name="Set_of_MDD_Objects" />
      <MDD_Description>
        <Set_Of_MDD_Objects>
          <MDD_Name name="DataAcq" action="Receive">
            <MDD_Information_Exchange>
              <information_in name="flow" value="" />
              <information_in name="pressure" value="" />
              <information_in name="temperature" value="" />
            </MDD_Information_Exchange>
            <MDD_Constraints>
              <Constraint_name name="ProcessID" property="SensorDataAcquisit
ion" />
            </MDD_Constraints>
            <MDD_Resources>
              <Resource_name name="ControlLogix01" />
            </MDD_Resources>
          </MDD_Name>
          <MDD_Name name="CavInfoRequestEx" action="Send">
            <MDD_Information_Exchange>
```

```

        <information_out name="CavInfoRequest" value="" />
    </MDD_Information_Exchange>
    <MDD_Constraints>
</MDD_Constraints>
    <MDD_Resources>
        <Resource_name name="ControlLogix01" />
    </MDD_Resources>
    </MDD_Name>
</Set_Of_MDD_Objects>
</MDD_Description>
</Specific>
</CapabilityProfile>
</CapabilityProfiling>

```

## C.2 Smart pump diagnostics capability profile

The following XML example represents the capability profile of the pump diagnostics application.

```

<?xml version="1.0" encoding="utf-8"?>
<CapabilityProfiling xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:noNamespaces
chemaLocation="C:\ISO\SmartPump\SmartPumpDiag.xsd">
    <Template id="SmartPumpDiag_PLC2_MSU2" name="SmartPumpDiagnose" />
    <Type id="MSU_profile" />
    <CapabilityProfile date="2012-12-30">
        <Pkgtype version="1.0.0" />
        <Common>
            <MSU_Capability>
                <ID>SmartPumpDiagnoseMSU2</ID>
            </MSU_Capability>
            <ReferenceCapabilityClassStructure id="SP_MSU2"/>
            <Capability_Class_Name name="SmartPumpDiagnose" />
            <Reference_Capability_Class_Structure_Name name="SmartPump_Diag" />
            <Version major="1" minor="1" />
            <Owner>
</Owner>
            <ComputingFacilities>
                <Processor type="logix" />
                <OperatingSystem type="AB" />
                <Language name="EN" />
                <Memory size="32" unit="MB" />
                <DiskSpace size="20" unit="GB" />
            </ComputingFacilities>
            <ReferenceDictionaryName />
            <NumberOfProfileAttributes />
            <NumberOfMethods />
            <NumberOfResources />
            <NumberOfConstraints />
            <NumberOfExtensions />
            <NumberOfLowerLevels />
            <NumberOfSubtemplatesAtNextLowerLevel />
        </Common>
        <Specific>
            <Reference_MDM_Name domain_name="SmartPumpModel" />
            <MDD_Description_Format format_name="Set_Of_MDD_Objects" />
            <MDD_Description>
                <Set_Of_MDD_Objects>
                    <MDD_Name name="CavInfoRequestEx" action="Receive">
                        <MDD_Information_Exchange>
                            <information_in name="CavInfoRequest" value="" />
                        </MDD_Information_Exchange>
                        <MDD_Constraints>
</MDD_Constraints>
                        <MDD_Resources>
                            <Resource_name name="ControlLogix02" />
                        </MDD_Resources>
                    </MDD_Name>
                    <MDD_Name name="Diagnostics" action="Send">
                        <MDD_Information_Exchange>
</MDD_Information_Exchange>
                        <MDD_Constraints>

```

```

        <Constraint_name name="ProcessID" property="CurrentHealthEvalu
ation" />
        </MDD_Constraints>
        <MDD_Resources>
          <Resource_name name="ControlLogix02" />
        </MDD_Resources>
      </MDD_Name>
      <MDD_Name name="CavInfoResponseEx" action="Send">
        <MDD_Information_Exchange>
          <information_out name="CavInfoResponse" value="" />
        </MDD_Information_Exchange>
      </MDD_Constraints>
    </MDD_Constraints>
    <MDD_Resources>
      <Resource_name name="ControlLogix02" />
    </MDD_Resources>
  </MDD_Name>
</Set_Of_MDD_Objects>
</MDD_Description>
</Specific>
</CapabilityProfile>
</CapabilityProfiling>

```

### C.3 Smart pump control capability profile

The following XML example represents the capability profile of the pump control application.

```

<?xml version="1.0" encoding="utf-8"?>
<CapabilityProfiling xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:noNamespaces
chemaLocation="C:\ISO\SmartPump\SmartPumpControl.xsd">
  <Template id="SmartPumpControl_PLC1_MSU3" name="SmartPumpControl" />
  <Type id="MSU_profile" />
  <CapabilityProfile date="2012-12-30">
    <Pkgtype version="1.0.0" />
    <Common>
      <MSU_Capability>
        <ID>SmartPmupControlMSU3</ID>
      </MSU_Capability>
      <ReferenceCapabilityClassStructure id="SP_MSU3" />
      <Capability_Class_Name name="SmartPumpControl" />
      <Reference_Capability_Class_Structure_Name name="SmartPump_Control" />
      <Version major="1" minor="1" />
      <Owner>
      </Owner>
      <ComputingFacilities>
        <Processor type="logix" />
        <OperatingSystem type="AB" />
        <Language name="EN" />
        <Memory size="32" unit="MB" />
        <DiskSpace size="20" unit="GB" />
      </ComputingFacilities>
      <ReferenceDictionaryName />
      <NumberOfProfileAttributes />
      <NumberOfMethods />
      <NumberOfResources />
      <NumberOfConstraints />
      <NumberOfExtensions />
      <NumberOfLowerLevels />
      <NumberOfSubtemplatesAtNextLowerLevel />
    </Common>
    <Specific>
      <Reference_MDM_Name domain_name="SmartPumpModel" />
      <MDD_Description_Format format_name="Set_Of_MDD_Objects" />
      <MDD_Description>
        <Set_Of_MDD_Objects>
          <MDD_Name name="CavInfoResponseEx" action="Receive">
            <MDD_Information_Exchange>
              <information_in name="CavInfoResponse" value="" />
            </MDD_Information_Exchange>
          </MDD_Constraints>

```



```

    </MDD_Constraints>
    <MDD_Resources>
      <Resource_name name="ControlLogix01" />
    </MDD_Resources>
  </MDD_Name>
  <MDD_Name name="AdjustPumpSpeed" action="Send">
    <MDD_Information_Exchange>
      <information_out name="Pump Speed" value="" />
      <information_out name="Pump Flow PID" value="" />
      <information_out name="Pump Pressure PID" value="" />
    </MDD_Information_Exchange>
    <MDD_Constraints>
      <Constraint_name name="ProcessID" property="FlowPIDControl" />
      <Constraint_name name="ProcessID" property="SpeedControl" />
      <Constraint_name name="ProcessID"
property="PressurePIDControl" />
    </MDD_Constraints>
    <MDD_Resources>
      <Resource_name name="PowerFlex00" />
    </MDD_Resources>
  </MDD_Name>
</Set_Of_MDD_Objects>
</MDD_Description>
</Specific>
</CapabilityProfile>
</CapabilityProfiling>

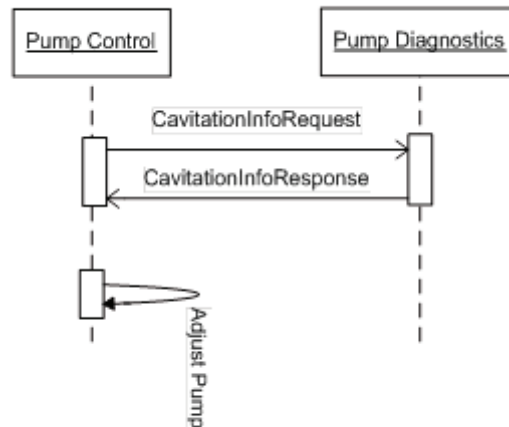
```

## Annex D (informative)

### AIME and ADME in smart pump application

#### D.1 Overview

The sequence diagram in [Figure D.1](#) shows the simple information exchange between the pump control application and the pump diagnostics application. ADME supports the information exchange between the applications based upon the resource capabilities identified in the AIMEs. In this scenario, the pump control application requests the diagnostic information (degree of pump cavitation) from the pump diagnostics application and adjusts the pump speed accordingly.



**Figure D.1 — Simple information exchange between two applications**

Clauses D.2 and D.3 show the example set of AIMEs for the pump control and the pump diagnostics. Clause D.3 shows the example of an ADME for the integrated smart pump application. More complicated information exchange will involve multiple ADMEs and AIMEs.

#### D.2 AIME for pump control

The following XML example represents the AIME for the pump control.

```
<?xml version="1.0" encoding="utf-8"?>
<ISO_AIME xmlns="http://www.iso.org/aime" xmlns:xsd="http://www.w3.org/2001/XMLSchema-
instance">
  <MatrixElementHeader>
    <MEidentification>PumpControlAIME</MEidentification>
    <MErevision>1a</MErevision>
    <MEname>D.1.2.Ay_D.1.1Az</MEname>
    <MEsource>ISO</MEsource>
    <MEclassID>AIP</MEclassID>
    <MEdate>2012-12-30</MEdate>
    <MEregistry>Industry_specific_registry_name_ISO_13774_DM</MEregistry>
  </MatrixElementHeader>
  <MatrixElementBody>
```

```

<Context_Section>
  <domainSection>
    <domainSourceHandle>D1.1</domainSourceHandle>
    <domainDestinationHandle>
      </domainDestinationHandle>
    </domainSection>
  <applicationSection>
    <applicationSourceHandle>PumpControl</applicationSourceHandle>
    <applicationDestinationHandle>
      </applicationDestinationHandle>
    </applicationSection>
  <applicationRelationshipSection>
    <applicationDomainRelationshipName>Pump_DM_Context</applicationDomainRela-
tionshipName>
  </applicationRelationshipSection>
  <processSection>
    <processSourceHandle>FlowPIDControl</processSourceHandle>
    <processDestinationHandle>
      </processDestinationHandle>
    </processSection>
  <resourceSection>
    <resourcePack name="PLC">
      <resourceName>ControlLogix01</resourceName>
      <resourceProfile>PLCiso15745profile</resourceProfile>
    </resourcePack>
    <resourcePack name="VFD">
      <resourceName>PowerFlex00</resourceName>
      <resourceProfile>VFDiso15745profile</resourceProfile>
    </resourcePack>
  </resourceSection>
</Context_Section>
<Conveyance_Section>
  <description>PumpControl to Diagnostics (Cavitation Detection) Example</
description>
  <informationType name="CavInfoRequestType" type="tCavInfoRequest">
    <description>
      Diagnostics Request Message - AIME XML schema type
      CavInfoRequestMsg will have sensor values for flow, pressure and tem-
perature
    </description>
  </informationType>
  <informationType name="CavInfoResponseType" type="tCavInfoResponse">
    <description>
      Diagnostics Response Message - AIME XML schema type
      CavInfoResponseMsg will have degree of cavitation
    </description>
  </informationType>
  <roleType name="PumpControlRole">
    <description>Role for Pump Control</description>
    <behavior name="PumpControl" interface="PumpControlInterface">
      <description>Behavior for PumpControl - use CIP for VFD control</
description>
    </behavior>
  </roleType>
  <participantType name="PumpFlowControl">
    <description>Pump Control Participant</description>
    <roleType typeRef="PumpControlRole" />
  </participantType>
  <channelType name="PumpControl2PumpMonitor" type="ISO15745_ENet_CommNet_Pro-
file">
    <description>Pump Control to Diagnostics Channel Type
      Ethernet/IP channel based on ISO15745-2 Comm Profile
    </description>
  </channelType>
</Conveyance_Section>
</MatrixElementBody>
</ISO_AIME>

```

### D.3 AIME for pump diagnostics

The following XML example represents the AIME for the pump diagnostics.

```
<?xml version="1.0" encoding="utf-8"?>
<ISO_AIME xmlns="http://www.iso.org/aime" xmlns:xsd="http://www.w3.org/2001/XMLSchema-
instance">
  <MatrixElementHeader>
    <MEidentification>PumpDiagAIME</MEidentification>
    <MErevision>1a</MErevision>
    <MENAME>D.1.2.Ay_D.1.1Az</MENAME>
    <MESource>ISO</MESource>
    <MEclassID>AIP</MEclassID>
    <MEdate>2012-12-30</MEdate>
    <MEregistry>Industry_specific_registry_name_ISO_13774_SD</MEregistry>
  </MatrixElementHeader>
  <MatrixElementBody>
    <Context_Section>
      <domainSection>
        <domainSourceHandle>
          </domainSourceHandle>
        <domainDestinationHandle>D1.2</domainDestinationHandle>
      </domainSection>
      <applicationSection>
        <applicationSourceHandle>
          </applicationSourceHandle>
        <applicationDestinationHandle>PumpDiagnostics</applicationDestinationHan-
dle>
      </applicationSection>
      <applicationRelationshipSection>
        <applicationDomainRelationshipName>Pump_SD_Context</applicationDomainRela-
tionshipName>
      </applicationRelationshipSection>
      <processSection>
        <processSourceHandle>
          </processSourceHandle>
        <processDestinationHandle>CurrentHealthEvaluation</processDestinationHan-
dle>
      </processSection>
      <resourceSection>
        <resourcePack name="PLC">
          <resourceName>ControlLogix02</resourceName>
          <resourceProfile>PLCiso15745profile</resourceProfile>
        </resourcePack>
      </resourceSection>
    </Context_Section>
    <Conveyance_Section>
      <description>PumpControl to Diagnostics (Cavitation Detection) Example</
description>
      <informationType name="CavInfoRequestType" type="tCavInfoRequest">
        <description>
          Diagnostics Request Message - AIME XML schema type
          CavInfoRequestMsg will have sensor values for flow, pressure and tem-
perature
        </description>
      </informationType>
      <informationType name="CavInfoResponseType" type="tCavInfoResponse">
        <description>
          Diagnostics Response Message - AIME XML schema type
          CavInfoResponseMsg will have degree of cavitation
        </description>
      </informationType>
      <roleType name="PumpDiagnosticsRole">
        <description>Role for Diagnostics - Cavitation Detection</description>
        <behavior name="PumpCavitationDetection" interface="PumpMonitorInterface">
          <description>Behavior for Diagnostics Role - Cavitation Detection</
description>
        </behavior>
      </roleType>
      <participantType name="CavitationDetection">

```

```

        <description>Diagnostics Participant</description>
        <roleType typeRef="PumpDiagnosticsRole" />
    </participantType>
    <channelType name="PumpControl2PumpMonitor" type="ISO15745_ENet_CommNet_Pro-
file">
        <description>Pump Control to Diagnostics Channel Type
            Ethernet/IP channel based on ISO15745-2 Comm Profile
        </description>
    </channelType>
</Conveyance_Section>
</MatrixElementBody>
</ISO_AIME>

```

## D.4 ADME for integrated smart pump application

The following XML example represents the ADME for the integrated smart pump application.

```

<?xml version="1.0" encoding="utf-8"?>
<ISO_ADME xmlns="http://www.iso.org/adme" xmlns:xsd="http://www.w3.org/2001/XMLSchema-
instance">
    <MatrixElementHeader>
        <MEidentification>SmartPumpADME</MEidentification>
        <MErevision>1a</MErevision>
        <MENAME>D.1.2.Ay_D.1.1Az</MENAME>
        <MESOURCE>ISO</MESOURCE>
        <MECLASSID>AIP</MECLASSID>
        <MEDATE>2012-12-30</MEDATE>
        <MEREISTRY>Industry_specific_registry_name_ISO_13774_DM_SD</MEREISTRY>
    </MatrixElementHeader>
    <MatrixElementBody>
        <Context_Section>
            <domainSection>
                <domainSourceHandle>D1.1</domainSourceHandle>
                <domainDestinationHandle>D1.2</domainDestinationHandle>
            </domainSection>
            <applicationSection>
                <applicationSourceHandle>PumpControl</applicationSourceHandle>
                <applicationDestinationHandle>PumpDiagnostics</applicationDestinationHan-
dle>
            </applicationSection>
            <applicationRelationshipSection>
                <applicationDomainRelationship
Name>Pump_DM_Context</applicationDomainRelationshipName>
                <applicationDomainRelationshipName>Pump_SD_Context</applicationDomainRelationshipName>
            </applicationRelationshipSection>
            <processSection>
                <processSourceHandle>FlowPIDControl</processSourceHandle>
                <processDestinationHandle>CurrentHealthEvaluation</processDestinationHan-
dle>
            </processSection>
            <resourceSection>
                <resourcePack name="PLC">
                    <resourceName>ControlLogix01</resourceName>
                    <resourceProfile>PLCiso15745profile</resourceProfile>
                </resourcePack>
                <resourcePack name="VFD">
                    <resourceName>PowerFlex00</resourceName>
                    <resourceProfile>VFDiso15745profile</resourceProfile>
                </resourcePack>
                <resourcePack name="PLC">
                    <resourceName>ControlLogix02</resourceName>
                    <resourceProfile>PLCiso15745profile</resourceProfile>
                </resourcePack>
            </resourceSection>
        </Context_Section>
        <Conveyance_Section>
            <description>PumpControl to Diagnostics (Cavitation Detection) Example</
description>
            <informationType name="CavInfoRequestType" type="tCavInfoRequest">
                <description>
                    Diagnostics Request Message - AIME XML schema type
                </description>
            </informationType>
        </Conveyance_Section>
    </MatrixElementBody>
</ISO_ADME>

```

```

    CavInfoRequestMsg will have sensor values for flow, pressure and tem-
perature
    </description>
  </informationType>
  <informationType name="CavInfoResponseType" type="tCavInfoResponse">
    <description>
      Diagnostics Response Message - AIME XML schema type
      CavInfoResponseMsg will have degree of cavitation
    </description>
  </informationType>
  <roleType name="PumpDiagnosticsRole">
    <description>Role for Diagnostics - Cavitation Detection</description>
    <behavior name="PumpCavitationDetection" interface="PumpMonitorInterface">
      <description>Behavior for Diagnostics Role - Cavitation Detection</
description>
    </behavior>
  </roleType>
  <roleType name="PumpControlRole">
    <description>Role for Pump Control</description>
    <behavior name="PumpControl" interface="PumpControlInterface">
      <description>Behavior for PumpControl - use CIP for VFD control</
description>
    </behavior>
  </roleType>
  <relationshipType name="PumpControl2PumpDiagnostics">
    <description>Pump Control to Cavitation Detection Relationship</descrip-
tion>
    <roleType typeRef="PumpControlRole" />
    <roleType typeRef="PumpDiagnosticsRole" />
  </relationshipType>
  <participantType name="PumpFlowControl">
    <description>Pump Control Participant</description>
    <roleType typeRef="PumpControlRole" />
  </participantType>
  <participantType name="CavitationDetection">
    <description>Diagnostics Participant</description>
    <roleType typeRef="PumpDiagnosticsRole" />
  </participantType>
  <channelType name="PumpControl2PumpMonitor" type="ISO15745_ENet_CommNet_Pro-
file">
    <description>Pump Control to Diagnostics Channel Type
      Ethernet/IP channel based on ISO15745-2 Comm Profile
    </description>
  </channelType>
</Conveyance_Section>
<Content_Section>
  <informationExchange name="smartPumpInformationExchange">
    <description>Smart Pump Information Exchange</description>
    <relationship type="PumpControl2PumpDiagnostics" />
    <variableDefinitions>
      <variable name="PumpCtrl2CavDetectionC" channelType="PumpControl2PumpM
onitor" roleTypes="PumpControlRole PumpDiagnosticsRole">
        <description>Channel Variable</description>
      </variable>
      <variable name="CavInfoRequest" informationType="CavInfoRequestType"
roleTypes="PumpControlRole PumpDiagnosticsRole">
        <description>Cavitation Information Request Message</description>
      </variable>
      <variable name="CavInfoResponse" informationType="CavInfoResponseType"
roleTypes="PumpCtrlRole PumpDiagnositcsRole">
        <description>Cavitation Information Response Message</description>
      </variable>
    </variableDefinitions>
    <interaction name="CavInfoElicitation" operation="getCavitationInfo" chann
elVariable="PumpCtrl2CavDetectionC">
      <description>Cavitation Information Elicitation
        (This could be mapped to WSDL operation or topic in
Publish/Subscribe)
      </description>
    <participate relationshipType="PumpControl2PumpDiagnostics" fromRoleTy
peRef="PumpControlRole" toRoleTypeRef="PumpDiagnosticsRole" />

```

```

    <exchange name="CavInfoRequestEx" informationType="CavInfoRequestType"
action="request">
    <description>Cavitation Detection Request Message Exchange</
description>
        <send variable="CavInfoRequest" />
        <receive variable="CavInfoRequest" />
    </exchange>
    <exchange name="CavInfoResponseEx" informationType="CavInfoResponseT
ype" action="respond">
    <description>Cavitation Detection Response Message Exchange</
description>
        <send variable="CavInfoResponse" />
        <receive variable="CavInfoResponse" />
    </exchange>
    </interaction>
</informationExchange>
</Content_Section>
</MatrixElementBody>
</ISO_ADME>

```

## Bibliography

- [1] ISO 8000-100, *Data quality — Part 100: Master data: Overview*
- [2] ISO 13584 (all parts), *Industrial automation systems and integration — Parts library*
- [3] ISO 15745 (all parts), *Industrial automation systems and integration — Open systems application integration framework*
- [4] ISO 15926-1, *Industrial automation systems and integration — Integration of life-cycle data for process plants including oil and gas production facilities — Part 1: Overview and fundamental principles*
- [5] ISO 15926-2, *Industrial automation systems and integration — Integration of life-cycle data for process plants including oil and gas production facilities — Part 2: Data model*
- [6] ISO/TS 15926-4, *Industrial automation systems and integration — Integration of life-cycle data for process plants including oil and gas production facilities — Part 4: Initial reference data*
- [7] ISO 16100-1, *Industrial automation systems and integration — Manufacturing software capability profiling for interoperability — Part 1: Framework*
- [8] ISO 16100-2:2003, *Industrial automation systems and integration — Manufacturing software capability profiling for interoperability — Part 2: Profiling methodology*
- [9] ISO 16100-6, *Industrial automation systems and integration — Manufacturing software capability profiling for interoperability — Part 6: Interface services and protocols for matching profiles based on multiple capability class structures*
- [10] ISO 18435-1, *Industrial automation systems and integration — Diagnostics, capability assessment and maintenance applications integration — Part 1: Overview and general requirements*
- [11] ISO/IEC 19501, *Information technology — Open Distributed Processing — Unified Modeling Language (UML) Version 1.4.2*
- [12] ISO 22745-1, *Industrial automation systems and integration — Open technical dictionaries and their application to master data — Part 1: Overview and fundamental principles*
- [13] ISO 22745-2, *Industrial automation systems and integration — Open technical dictionaries and their application to master data — Part 2: Vocabulary*
- [14] ISO/TS 29002-5, *Industrial automation systems and integration — Exchange of characteristic data — Part 5: Identification scheme*
- [15] IEC 61987 (all parts), *Industrial-process measurement and control — Data structures and elements in process equipment catalogues*
- [16] REC-xmlschema-1-20041028, *XML Schema Part 1: Structures — W3C Recommendation 28 October 2004*
- [17] REC-xmlschema-2-20041028, *XML Schema Part 2: Datatypes — W3C Recommendation 28 October 2004*









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