



DEXPI - P&ID Data Exchange

Heiner Temmen

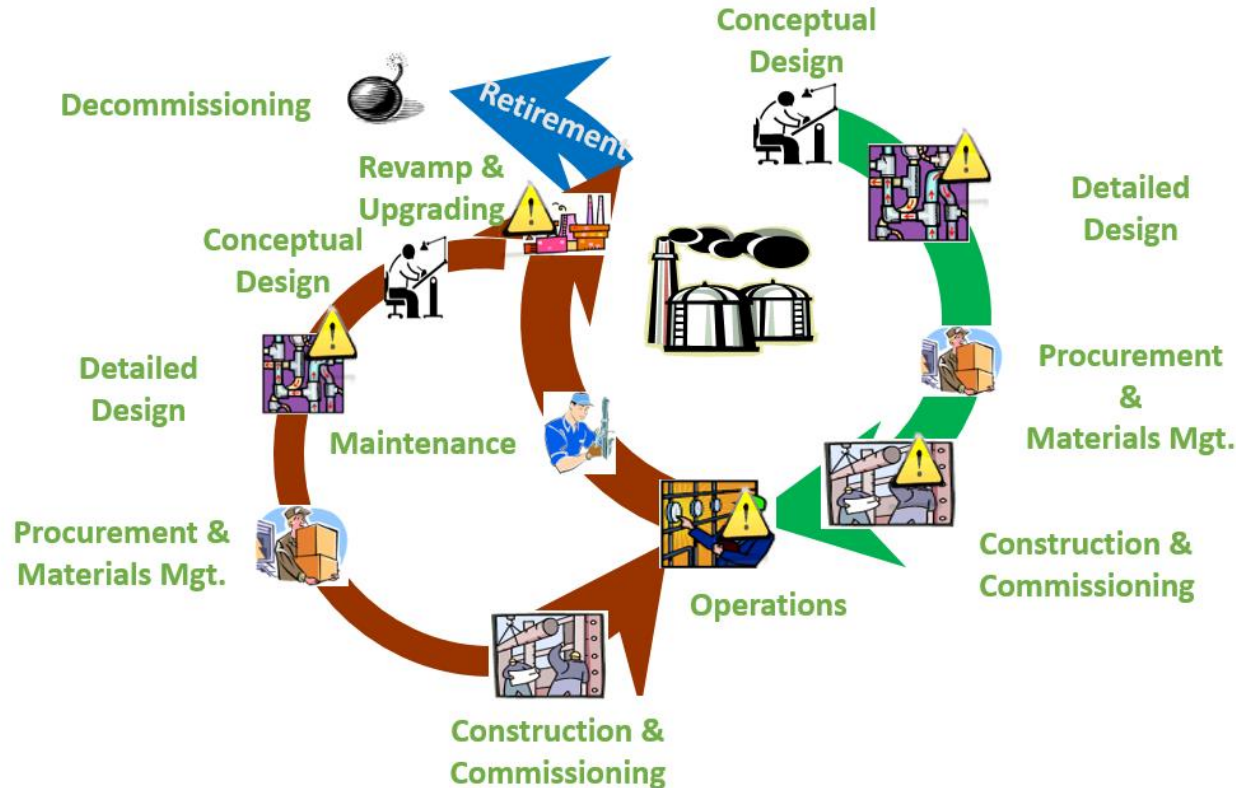
Evonik

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Motivation statement

Data Exchange in Plant Life Cycle

Process Industry



Still typical work method

Between stakeholders like organizations or disciplines





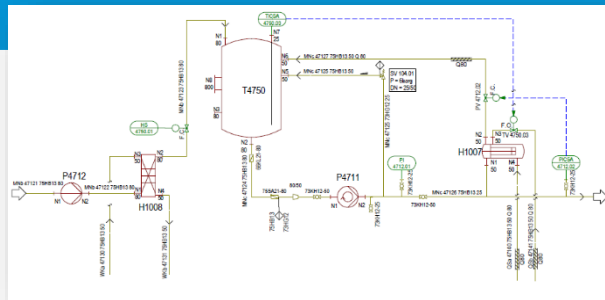
DEXPI group

DEXPI Mission

What we do

We work to create an **open**, neutral and reliable **data exchange standard** for the **process industry** to establish a future-proof **digitalized collaboration**.

... and we started with the P&ID



DEXPI approach

Think global, start with limited scope



Methodology: ISO 15926 + Proteus (XMpLant) scheme

All main CAE software vendors involved

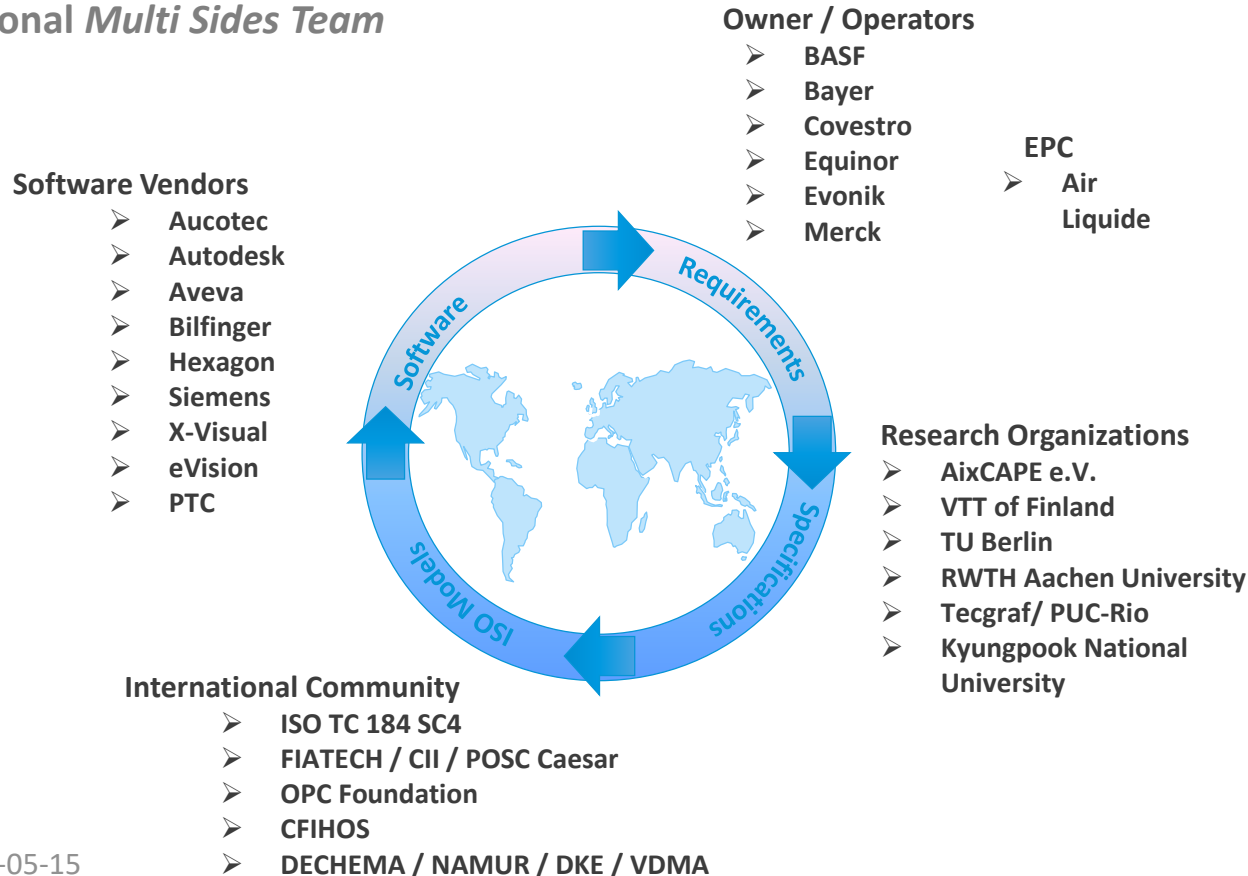
Use existing standards (Do not re-invent the wheel)

Bottom up, pragmatic approach

International coverage, not only local

DEXPI – A Successful Team

International *Multi Sides Team*



DEXPI Organization

Open community

- DEXPI f2f meetings (6 per yr)
Frankfurt
- DEXPI hackathons (2 per yr)
- DEXPI marketing and technical
web meetings
- DEXPI annual management
meeting





DEXPI Deliverables

Deliverables

public license concept: cc-by-sa

1. DEXPI Specification for Exchange of PIDs (Version 1.2)
2. Extension for the Proteus Schema (resulting in Version 4.0.1)
3. Tools & Test cases
4. CAE Interfaces of the leading PID software

Face to the community



NEWS MEMBERS SPECIFICATIONS & SERVICES PUBLICATIONS CALENDAR

The objective of the DEXPI initiative is to develop and promote a general data exchange standard for the process industry, covering all phases of the lifecycle of a (petro-)chemical plant, ranging from specification of functional requirements to assets in operation. Currently, the focus of the DEXPI initiative is the exchange of Piping and Instrumentation diagrams (P&IDs).

DEXPI Data Exchange in the Process Industry

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Upcoming Events

- May 07 till 31, 2019
DEXPI @ Interoperability Summit hosted by the LCDM Project

Latest News

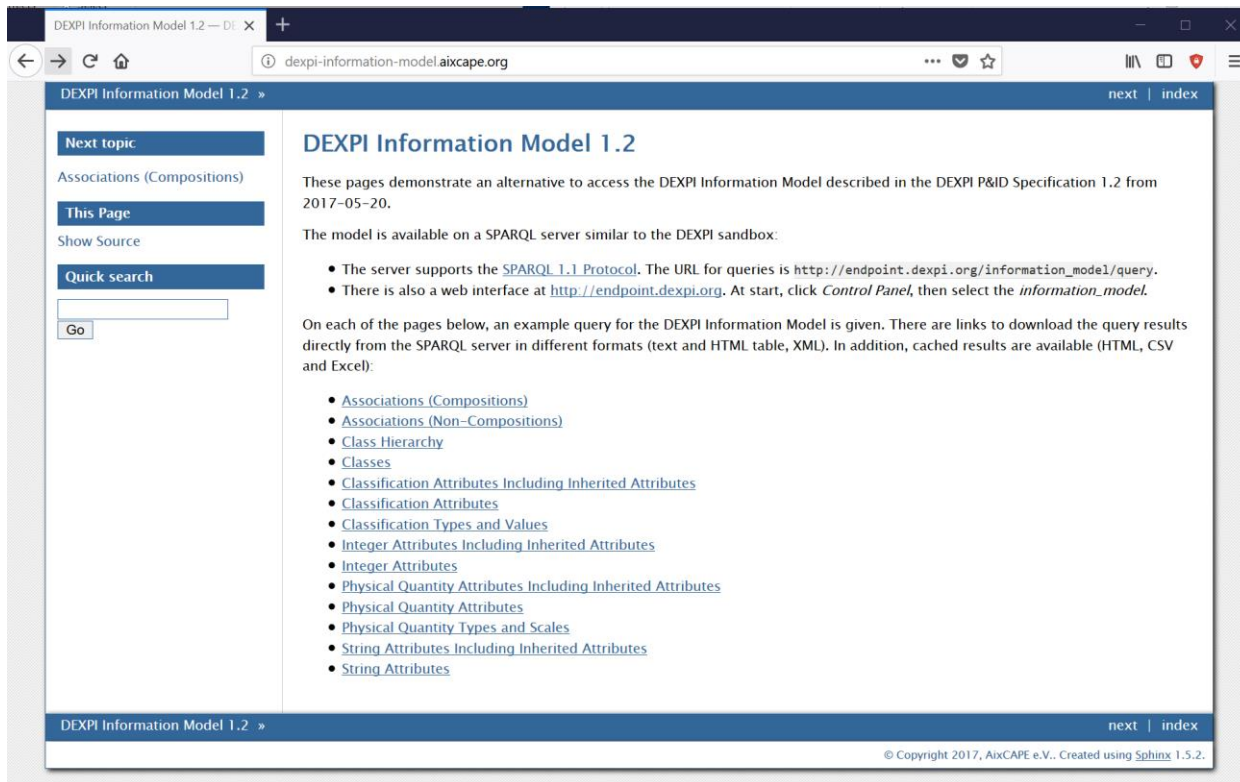
- May 03, 2019
DEXPI @ Fiatech meeting
- March 14, 2019
DEXPI Management Meeting 2019 - Summary
- December 11, 2018
Cooperation with KNU

Latest Publications

- January 17, 2019
Article in CIT: ENPRO Data Integration: Extending DEXPI Towards the Asset Lifecycle
- June 12, 2018
PraxisForum Data exchange in the process industry @ AICHEMA 2018
- November 20, 2017
DEXPI release presentation at PAAT 2017

DEXPI Information Model published

<http://dexpi-information-model.aixcape.org/>



The screenshot shows a web browser displaying the DEXPI Information Model 1.2 website. The browser's address bar shows the URL dexpi-information-model.aixcape.org. The website has a blue header with the title "DEXPI Information Model 1.2" and navigation links "next" and "index". On the left side, there is a sidebar with sections: "Next topic" (Associations (Compositions)), "This Page" (Show Source), and "Quick search" (with a search input field and a "Go" button). The main content area is titled "DEXPI Information Model 1.2" and contains the following text:

These pages demonstrate an alternative to access the DEXPI Information Model described in the DEXPI P&ID Specification 1.2 from 2017-05-20.

The model is available on a SPARQL server similar to the DEXPI sandbox:

- The server supports the [SPARQL 1.1 Protocol](#). The URL for queries is http://endpoint.dexpi.org/information_model/query.
- There is also a web interface at <http://endpoint.dexpi.org>. At start, click *Control Panel*, then select the *information_model*.

On each of the pages below, an example query for the DEXPI Information Model is given. There are links to download the query results directly from the SPARQL server in different formats (text and HTML table, XML). In addition, cached results are available (HTML, CSV and Excel):

- [Associations \(Compositions\)](#)
- [Associations \(Non-Compositions\)](#)
- [Class Hierarchy](#)
- [Classes](#)
- [Classification Attributes Including Inherited Attributes](#)
- [Classification Attributes](#)
- [Classification Types and Values](#)
- [Integer Attributes Including Inherited Attributes](#)
- [Integer Attributes](#)
- [Physical Quantity Attributes Including Inherited Attributes](#)
- [Physical Quantity Attributes](#)
- [Physical Quantity Types and Scales](#)
- [String Attributes Including Inherited Attributes](#)
- [String Attributes](#)

The footer of the website shows "DEXPI Information Model 1.2" and "next | index" links, along with a copyright notice: "© Copyright 2017, AixCAPE e.V.. Created using [Sphinx](#) 1.5.2."

SPARQL Endpoint Service

DEXPI ENDPOINT (fuseki)



Server Management

[Control Panel](#)

Documentation

[Fuseki documentation](#)

Validators

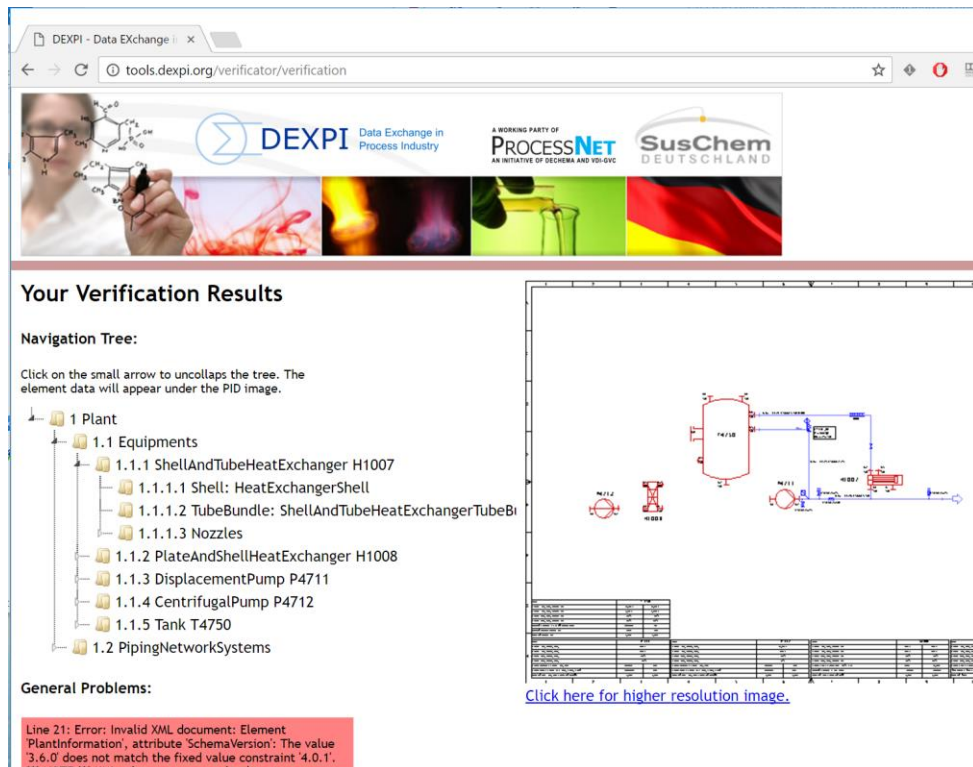
- [SPARQL query validator](#)
- [SPARQL update validator](#)
- [RDF data validator](#)
- [IRI validator](#)

Standards

- [SPARQL 1.1 Query](#)
- [SPARQL 1.1 Update](#)
- [SPARQL 1.1 Protocol](#)
- [SPARQL 1.1 Uniform HTTP Protocol for Managing RDF Graphs](#)

DEXPI Verificator

As offline versions available



The screenshot shows the DEXPI Verificator web interface. The browser address bar displays `tools.dexpi.org/verificator/verification`. The page header includes the DEXPI logo and logos for PROCESSNET and SusChem DEUTSCHLAND. The main content area is titled "Your Verification Results" and features a "Navigation Tree" on the left. The tree lists the following structure:

- 1 Plant
 - 1.1 Equipments
 - 1.1.1 ShellAndTubeHeatExchanger H1007
 - 1.1.1.1 Shell: HeatExchangerShell
 - 1.1.1.2 TubeBundle: ShellAndTubeHeatExchangerTubeB
 - 1.1.1.3 Nozzles
 - 1.1.2 PlateAndShellHeatExchanger H1008
 - 1.1.3 DisplacementPump P4711
 - 1.1.4 CentrifugalPump P4712
 - 1.1.5 Tank T4750
 - 1.2 PipingNetworkSystems

The right side of the interface displays a process flow diagram (PFD) with various equipment and piping. Below the diagram is a table with verification results. A red box at the bottom left indicates an error:

Line 21: Error: Invalid XML document: Element 'PlantInformation', attribute 'SchemaVersion': The value '3.6.0' does not match the fixed value constraint '4.0.1'.

Below the error message is a link: [Click here for higher resolution image.](#)

DEXPI Tools by AixCAPE®

DEXPI Verificator

The DEXPI verficator for Proteus XML files can be used from the command line or with a GUI. Both v same results: an HTML verification report (model structure and detected errors) and a separate error log can be read with recent versions of LibreOffice or Excel, for example). In some cases, Windows will ask use certain system ports when either program is used for the first time. You may need to have administra this permission.

dexpi-verificator.exe

Command line version of the verficator. The only required argument is the name or path of the Proteus : Run the program from a console with option -h to get more information.

dexpi-verificator-gui.exe

GUI version of the verficator.

Distributions

Current Version

- [Version 0.7 \(2018-04-17\)](#)


Older Versions

- [Version 0.6 \(2018-03-30\)](#)
- [Version 0.5 \(2018-01-25\)](#)
- [Version 0.4.2 \(2017-09-05\)](#)
- [Version 0.4.1 \(2017-06-19\)](#)
- [Version 0.4 \(2017-05-30\)](#)









[Home](#)

Test Cases

Free available on <https://gitlab.com/dexpi/TrainingTestCases>

 **Public Training Test Cases**
Project ID: 8453791

[Add license](#) [320 Commits](#) [9 Branches](#) [0 Tags](#) [20.5 MB Files](#)

 C01V01-HEX.EX03-VER.IM01.html	SHAPE LIBRARY AND PLANT STRUCTURE ADD
 C01V01-HEX.EX03.png	SHAPE LIBRARY AND PLANT STRUCTURE ADD
 C01V01-HEX.EX03.xml	SHAPE LIBRARY AND PLANT STRUCTURE ADD
 C01V01-SAG.EX01.XML	Added SAG V01EX01
 C01V01-SAG.EX02.XML	Upload C01V01-SAG.EX02.XML
 C01V01-SAG.EX02.pdf	Upload C01V01-SAG.EX02.PDF
 C01V01.pptx	Description of the new complete DEXPI P&ID
 readme.md	Update readme.md to point to conformance te

  Star 1  Fork 1 [Clone](#)

stability experimental

DEXPI Interoperability Matrix








Automatically created by DEXPI-Matrix-Crawler version 0.3 Tue Jul 17 19:28:00 CEST 2018

Interoperability Matrix:

—	AUD	AVV	HEX	SAG	VTT	XVT
AUD	0%	0%	0%	1,8%	14,3%	1,8%
AVV	7,1%	0%	0%	5,4%	14,3%	3,6%
HEX	19,6%	0%	0%	10,7%	17,9%	5,4%
SAG	21,4%	1,8%	0%	3,6%	17,9%	1,8%
VTT	0%	0%	0%	0%	0%	0%
XVT	0%	0%	0%	0%	0%	0%

DEXPI interfaces of software systems

CAE and smart applications

CAE Vendor	Product	DEXPI Interface
Autodesk  AUTODESK	AutoCAD P&ID 2019	Import & Export
Aucotec  AUCOTEC	Engineering Base	Export
Aveva  AVEVA <small>CONTINUAL PROGRESSION</small>	Aveva PID	Import & Export
Bilfinger  BILFINGER	PIDGraph	Export
Hexagon  HEXAGON	SmartPlant PID	Export
PCT  ptc	ThingWorx	Import
Siemens SIEMENS	Comos PID	Import & Export
VTT  VTT	Apros	Import
X-Visual  VISUAL	PID	Import



DEXPI Technical Design Principles

DEXPI and the ENPRO Lifecycle

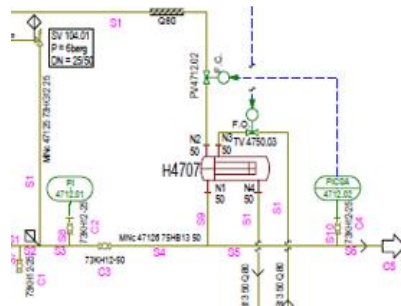
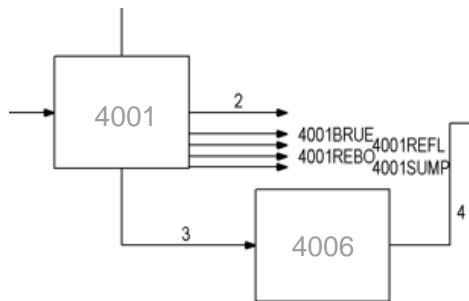
The asset lifecycle is separated into four aspects with three underlying data structures

**Functional
Requirements**

**Functional
Design**

**Asset
Specification**

**Asset
in Operation**



Process Structure

Plant Structure

Asset Structure

Design Principles

The DEXPI activities are driven by several basic development guidelines

Openness and transparency of the data model, test cases and communication

Usage of international accepted standards

Relation to different life cycle aspects

Digitalization = step from Documents to Data

Separation between engineering content and graphics

use of UML concepts like specialization and decomposition for the modelling of engineering and plant objects

P&ID main components

Data, graphics and topology

Piping

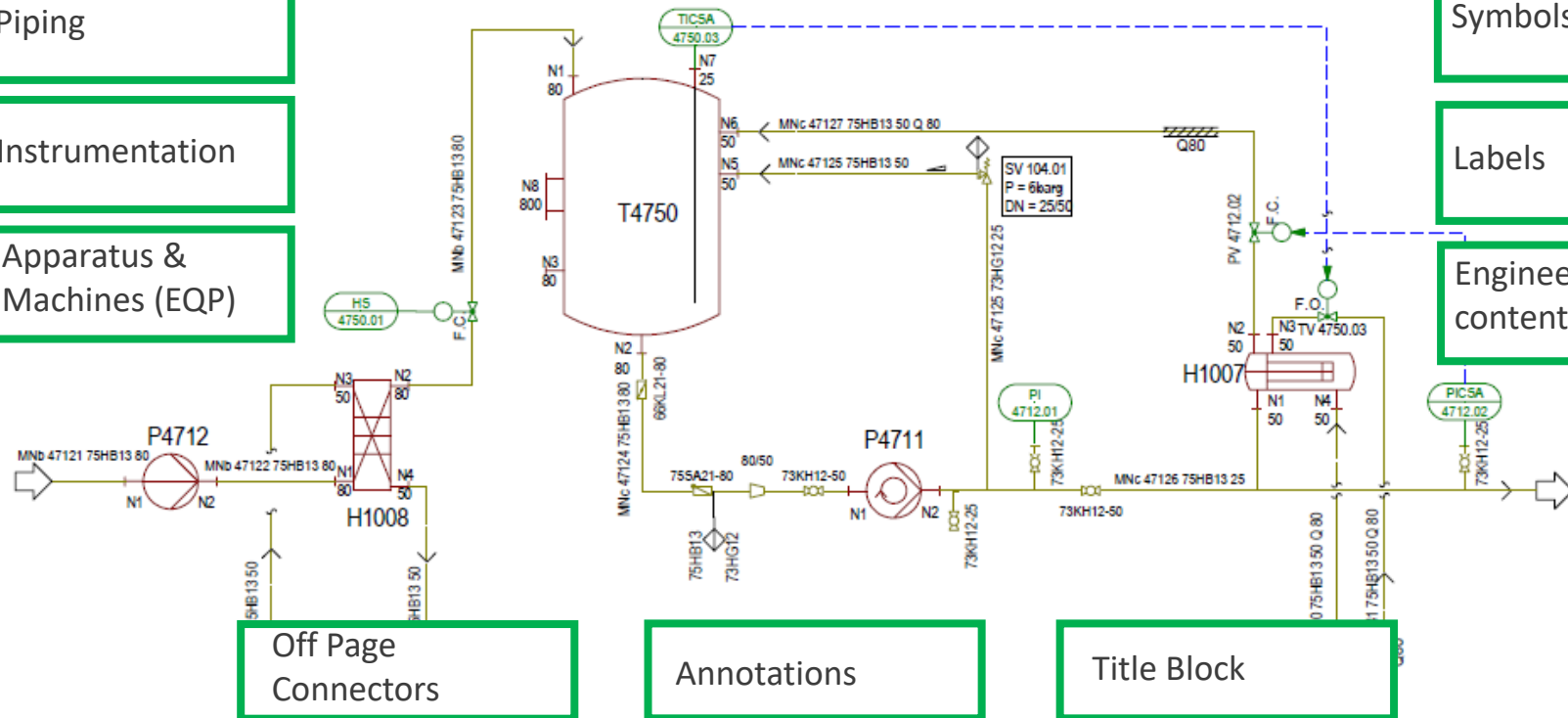
Instrumentation

Apparatus &
Machines (EQP)

Symbols

Labels

Engineering
content



International Standards

ISO and IEC

- **DEXPI specification based on international standards**
- **Applicable for IEC, ISA and DIN based P&IDs**

Plant Structure	Apparatus / Machines	Piping components	Instrumentation	Communication
ISO 10209	ISO 10628	ISO 10628	IEC 62424	ISO 15926
			IEC 61987	Proteus 4.0.1 (formerly XMPlant)

Plant Breakdown Structure

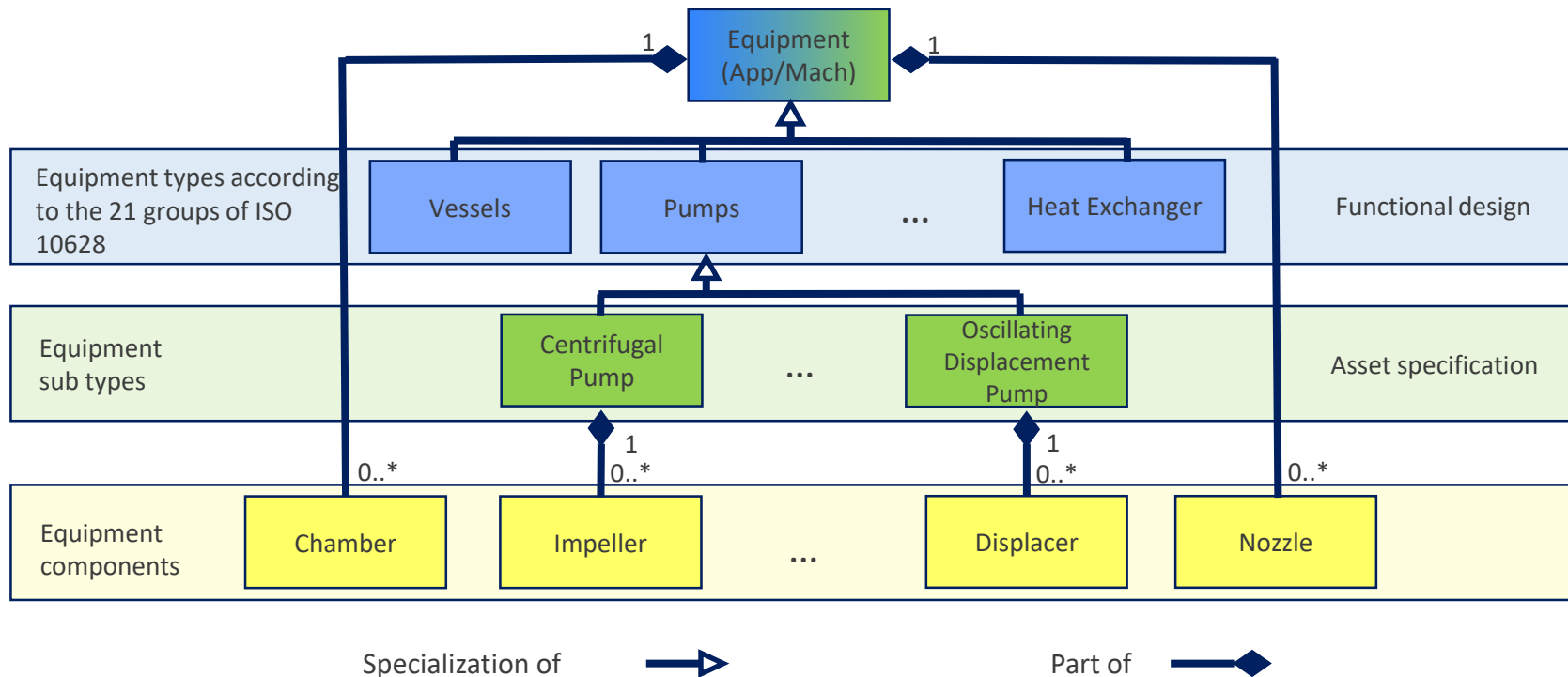
Based on ISO 10209

Elements of the identification system for a process plant

ISO 10209:2012		ISA 95	DIN 28000-3		DEXPI	
en	de		en	de	major	additional
		Enterprise			Enterprise	
works	Werk	Site	Site	Standort	Site	
		Area				Area
industrial complex	Anlagenkomplex		Industrial Complex	Anlagenkomplex, Betrieb	Industrial Complex	
process plant	verfahrenstechnische Anlage	Process Cell	Process Plant/Plant Unit	Verfahrenstechnische Anlage	Process Plant	
plant	Anlage					
plant section	Teilanlage	Unit	Subprocess/Plant Component	Teilanlage	Plant Section	
Equipment	Anlagenteil		Technical Item	Technische Einrichtung	Plant Item	

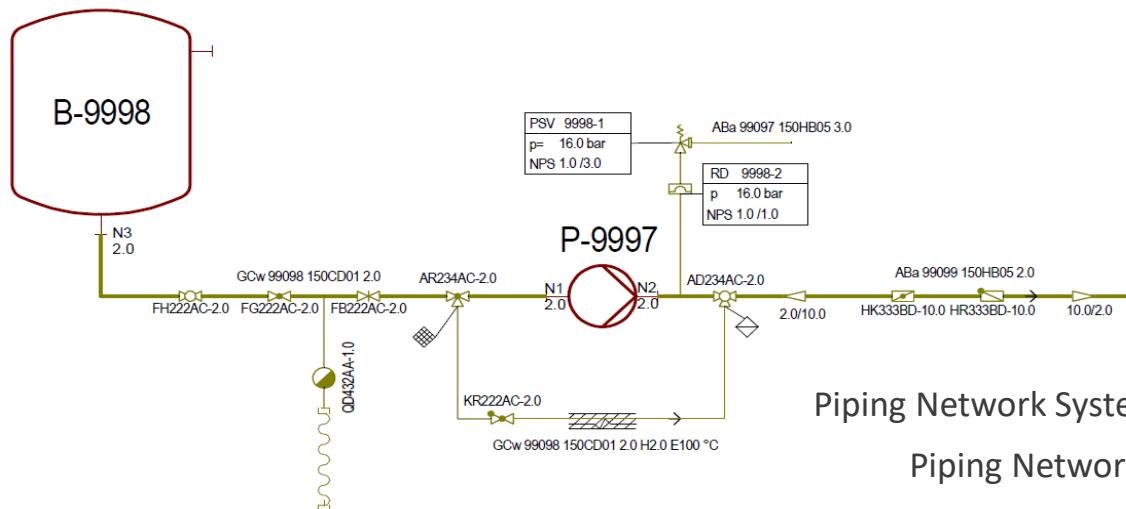
Equipment Taxonomy

Based on ISO 10628 and ISO 14224



Piping Taxonomy

Based on ISO 10628



Piping Network System

Piping Network Segment

Piping Components (ISO 10628:2012)

21	Valves
22	Check valves
23	Valves and fittings with safety function
24	Fittings

Class referencing

Use of ISO 15926 industry sandboxes

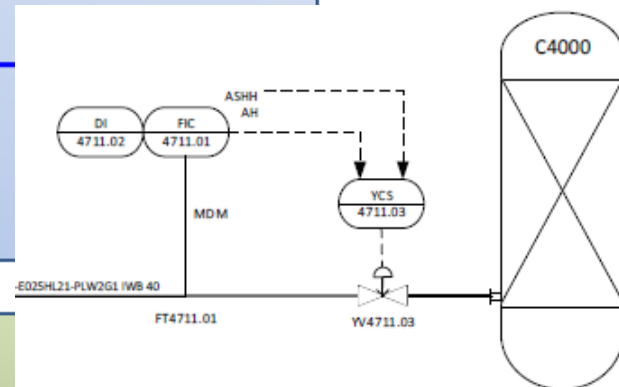
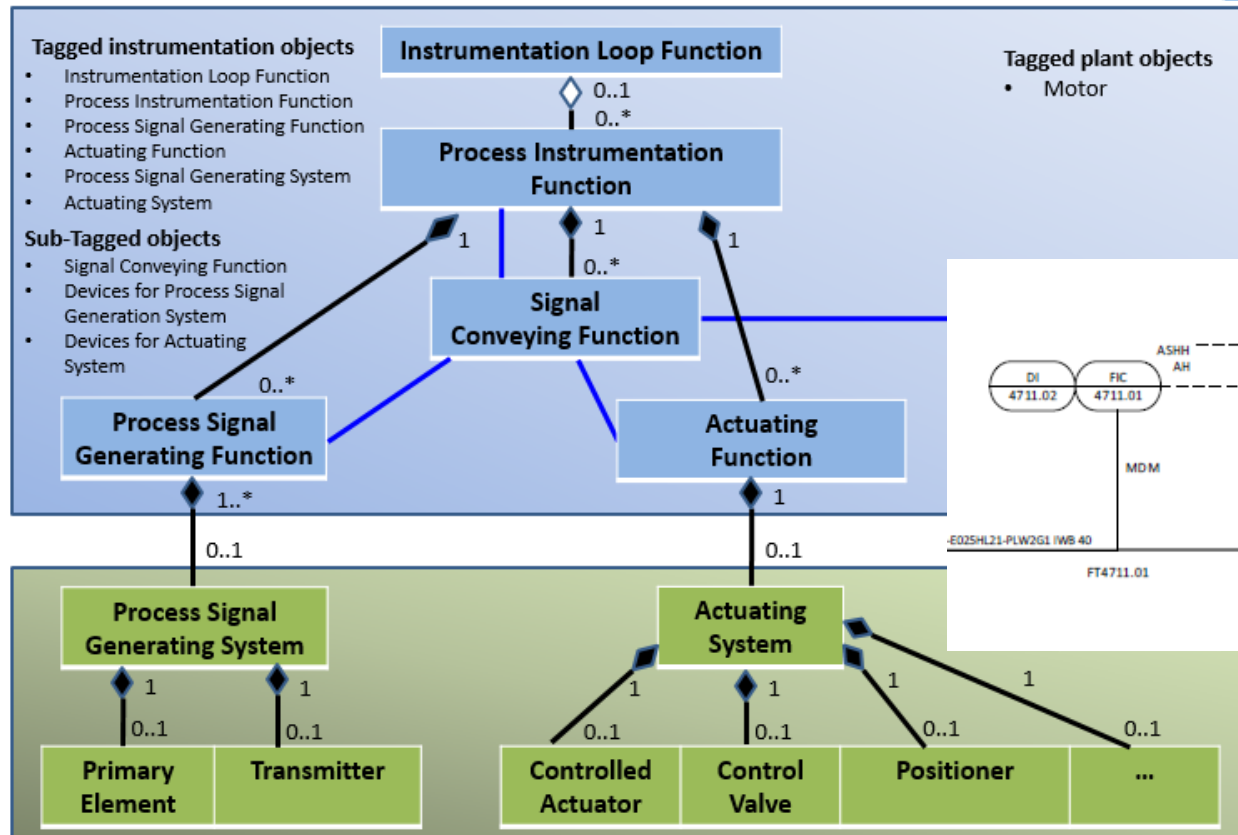
Examples for Equipment Subtypes:

EQP Type	EQP Sub Type	RDL Class
VESSEL		http://data.posccaesar.org/rdl/RDS414674
	PRESSURE VESSEL	http://data.posccaesar.org/rdl/RDS427229

EQP Type	EQP Sub Type	RDL Class	
VESSEL		http://data.posccaesar.org/rdl/RDS414674	45139
	PRESSURE VESSEL	http://data.posccaesar.org/rdl/RDS427229	322399
	TANK	http://data.posccaesar.org/rdl/RDS445139	acialVessel
	SILO	http://data.posccaesar.org/rdl/RDS1022399	34199
	SPECIAL VESSEL	http://sandbox.dexpi.org/rdl/data/SpecialVessel	19084
HEAT EXCHANGER		http://data.posccaesar.org/rdl/RDS304199	41719
	SHELL AND TUBE HEAT EXCHANGER	http://data.posccaesar.org/rdl/RDS419084	ralHeatExchanger
	PLATE AND SHELL HEAT EXCHANGER	http://data.posccaesar.org/rdl/RDS441719	4070475
	<u>SpiralHeatExchanger</u>	http://sandbox.dexpi.org/rdl/data/SpiralHeatExchanger	77379
	ELECTRIC HEATER	http://data.posccaesar.org/rdl/RDS14070475	ThinFilmEvaporator
	AIR COOLING SYSTEM	http://data.posccaesar.org/rdl/RDS277379	27239
	<u>ThinFilmEvaporator</u>	http://sandbox.dexpi.org/rdl/data/ThinFilmEvaporator	16834
			16969
			20749
			30624
			acialPump
			4286497
			17194
			17284
			35374
			17239
			770157
			acialCompressor

Instrumentation

based on:
IEC 62424



based on:
IEC 61987

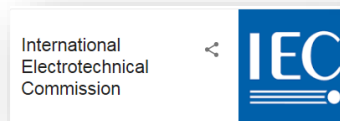


DEXPI Collaboration

DEXPI's Influence and cooperation

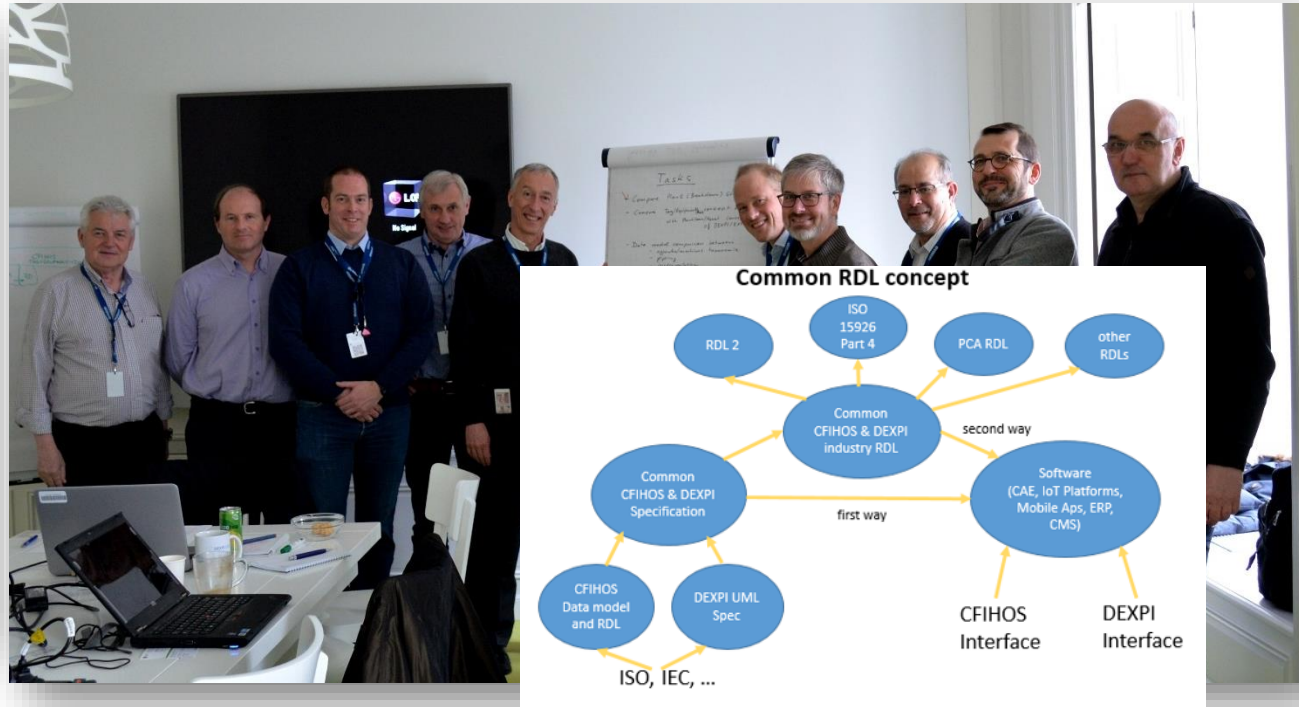


Other big player

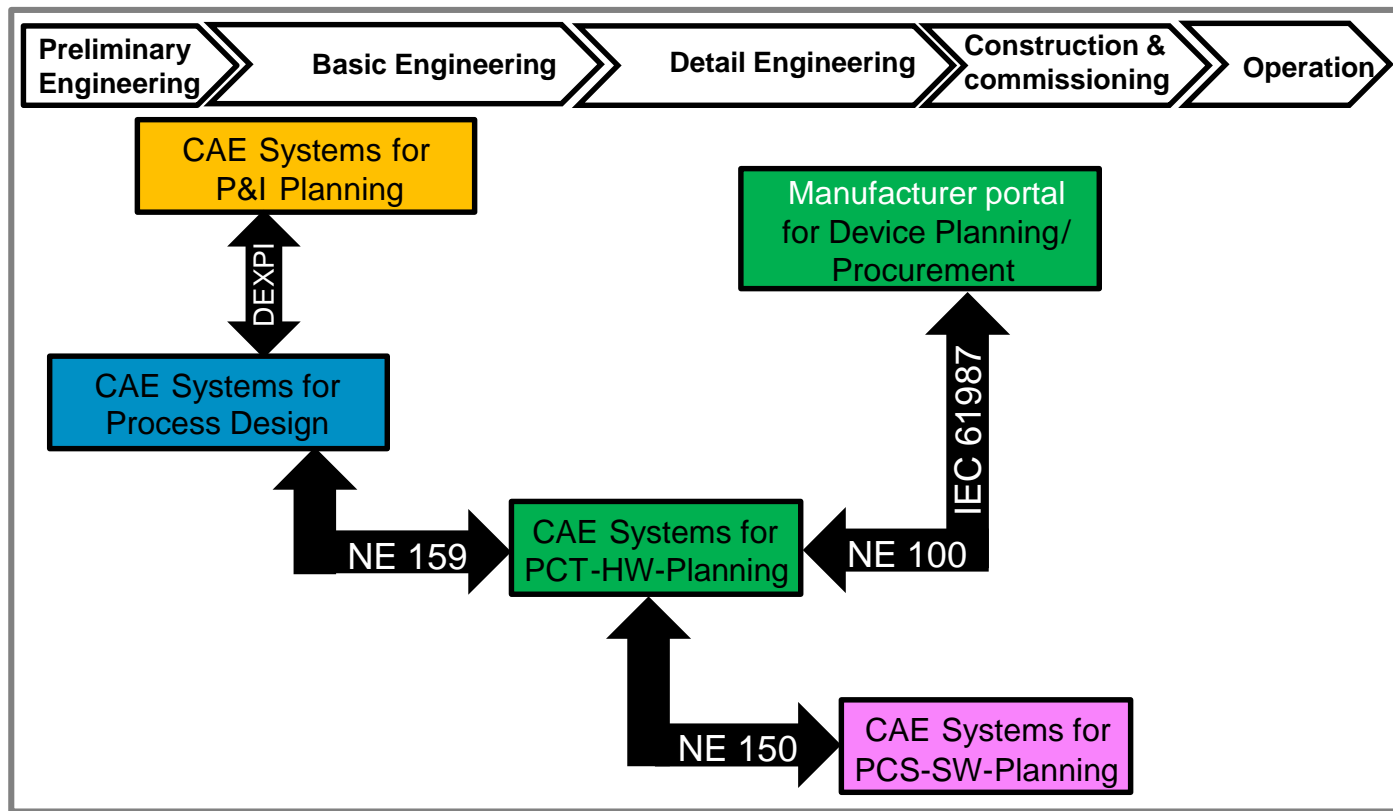


DEXPI & CFIHOS

Working closer together: MoU signed and content alignment takes place



Instrumentation data models aligned with DEXPI



NAMUR and DEXPI

Outlook: Instrumentation – international standardization





Next steps

Next steps

DEXPI into the daily business

- use in capital projects
 - P&ID exchange
 - Interface to other disciplines like cost estimation, instrumentation, 3D, ...
 - Handover together with CFIHOS
 - Generation of the Plant Maintenance structure
 - smart construction and maintenance support
 - Data analysis by use of OPC UA adapter – predictive maintenance
 - ...
- DEXPI product management: operation, maintenance and extensions
- future cooperation with CFIHOS, NAMUR, OPC UA, ...
- more global presence