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Engineering Information Standards

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Participating companies

- Shell
- LyondellBasell
- KinsmenGroup

- Semmtech
- RoyalHaskoning DHV
- DMS 365
- TechnipEnergies
- Twintech
- Kaist Univeristy
- CroonWolterendros

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1 Introduction

Background: IM-LCF project and its origins

- Challenges identified through Safaris, survey and experiences in Large Capital Facility (LCF) projects
    - The IM-LCF project was initiated by USPI after an initial Safaris which identified the need from industry users for guidelines on how to best to implement a CDE. During the Safari it became clear that implementing such a CDE in today's environment has a wide range of maturity and faces challenges based on this variety of maturity. This is emphasized by a growing safety and compliance culture in which it is necessary to have relevant, consistent, and up-to-date information available in a foreseeable timeframe to support safety cases and issues.
- Reasons for applying an information-driven approach
    - The industry users participating in the Safari recognise the value for an information-driven approach (based on structured data) versus a document-driven approach. As society is dependent on faster decision-making and hence relying on better information, document centric project approaches no longer satisfy the needs in sustaining complex organisations during and beyond the project phases.
- Dual focus:
    - The information-driven (represented by structured data) approach and (authoring) tooling gaps used by various disciplines and work streams.
    - The need for orchestration, governance, and management involvement in organizing a fit for purpose Information management organization that on one hand understands the business needs and on the other hand understands the complexity of the EPC phases of large capital facility projects in order to realize both an adequate information architecture and IT architecture. This includes concepts like semantic data, linked data, application of unified name spaces, etc.

Note: a USPI Safari is a joint workshop type session exploring a specific topic, for example researching if sufficient interest exists for further development or sharing information on a specific subject.

2 Purpose and audience of the guide

The purpose of this guideline is to provide lessons learnt to process industry supply chain to assist companies with setting up information management in their projects to be able to:

- Set feasible IM ambitions for the project and reflect on these during the project
- Improve the existing IM practices of the project through learning from others
- Avoid obstacles and barriers experienced by others
- Reduce knowledge gap within industry vertical(s)
- Create the ability to carefully consider the technology used to implement a chosen information architecture

key topics that require top priority are:

- What IM ambition is feasible in the project, given the maturity of parties involved and the available support from management and their knowledge and awareness of IM aspects
- Realistic data quality requirements in contracts
- Availability of knowledge of data integration standards
- Achieving integration of discipline domain knowledge in companies leading to harmonized and consistent information.

It was decided to report after each series to bring the results to the industry as soon as possible. There will be reports on the other series of IM-LCF as well. At the end, a decision will be taken on creating an integrated report of the whole project or keeping the individual reports of the series.

Note: This guidance is not intended to be a cookbook for implementing a CDE. Too many varying factors in each project may influence each actual CDE implementation, and it would go beyond the scope of this report to have that intention.

3 Summary

- Explain what this report brings
- This report outlines the current state challenges and lessons learned of implementing CDE with a focus on structured data (both geometric and non-geometric) rather than a document centric one. This report is not a detailed implementation guide for implementing a CDE.

4 Challenges of large capital facility projects:

- Fragmentation of the project over several disciplines and parties.
- Fragmentation over time

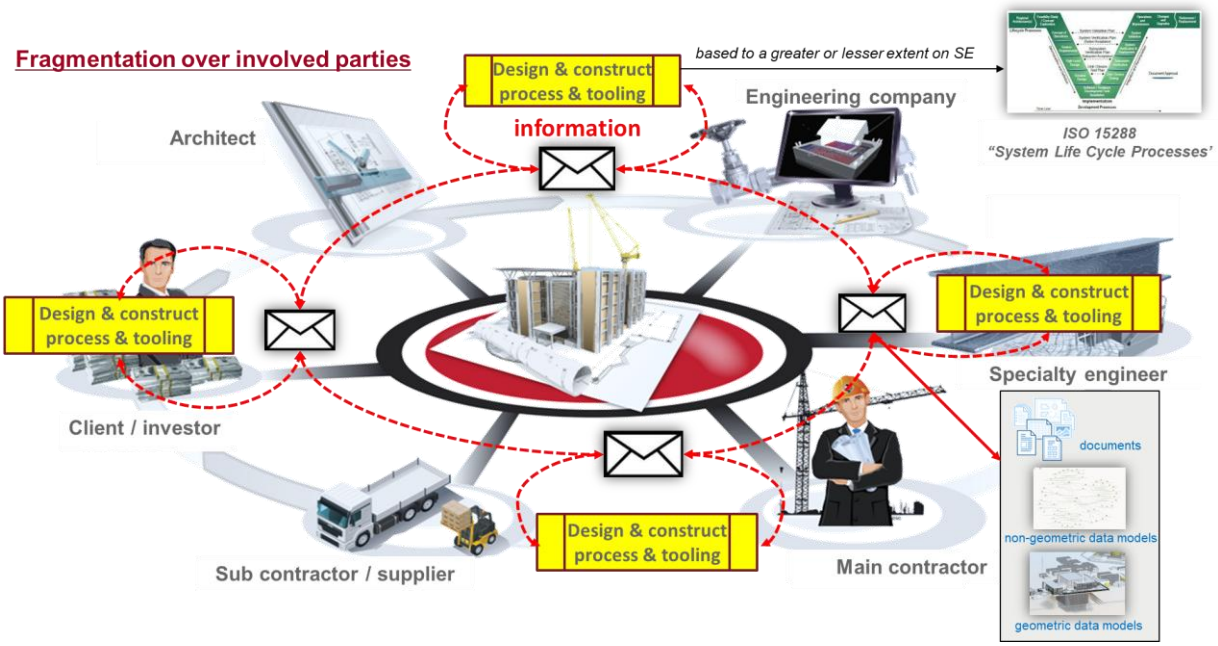

Figure 1 – Organizational fragmentation within a large capital facility project

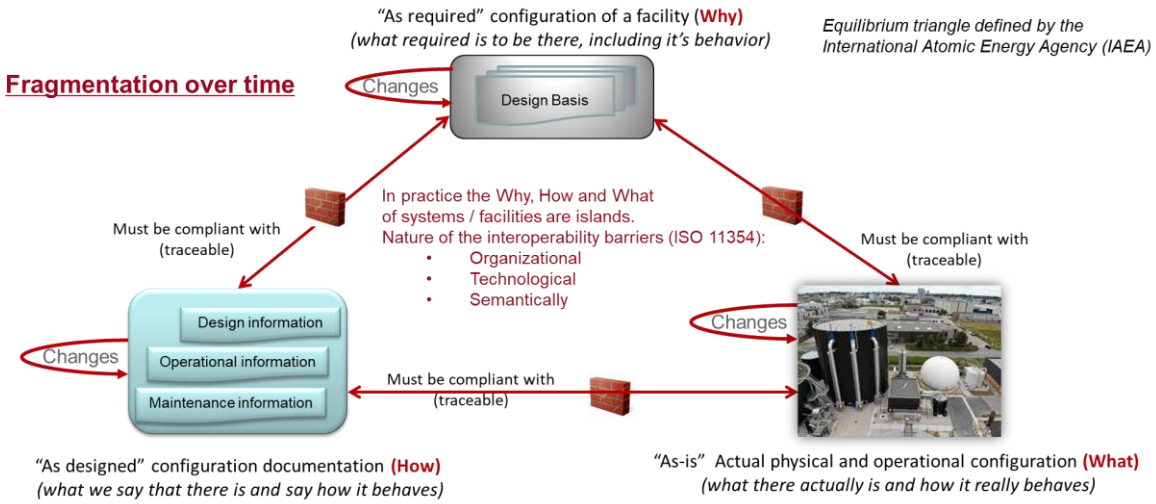

Figure 2– Fragmentation over time within a large capital facility project

The combination of both fragmentations determines the complexity of information management in large capital facility projects:

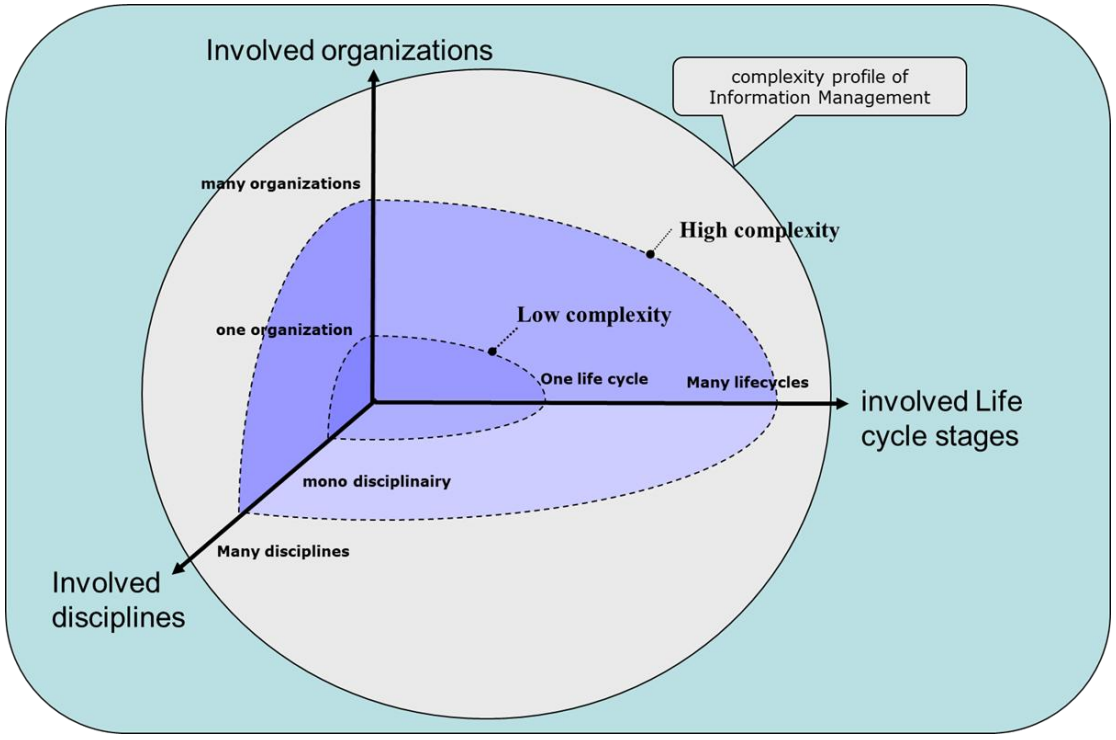

Figure 3– Complexity profile of a large capital facility project taken into account fragmentation over disciplines and time

These series of workshops are about a Common Data Environment as solution to face the fragmentation over parties and time, rather than a software vendor specific solution (including vendor lock-in).

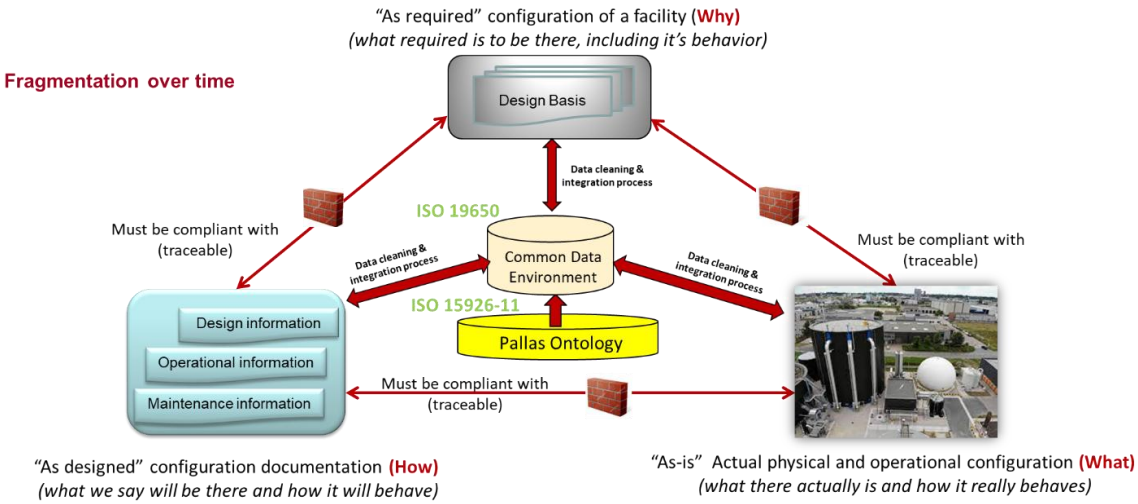

Figure 4– A common Data Environment as solution for harmonizing and integrating all relevant life cycle information of a facility

5 What is a Common Data Environment (CDE)?

A common data environment is defined as: "An agreed source of information for any given project or asset, for collecting, managing, and disseminating each information container through a managed process." (ISO 19650-1:2018)

NOTE: An information container is a structured unit of information that can be managed, exchanged, and used throughout the lifecycle of an asset or project. It can be a document, model, dataset, drawing, or even a database extract.

- In practical terms, a CDE can be referred to as a digital environment (which can be composed of several IT systems) used to manage information for a project/asset, over the lifetime of that project/asset.
  Note: the focus of a CDE during the project phase may be different compared to the operational and maintenance phase of the life of an asset. This document tries to consider aspects over the entire lifetime of the asset, from its conception to decommissioning, recognising the value propositions while changing during the various phases of its life.
- Data structures of a CDE include amongst others:

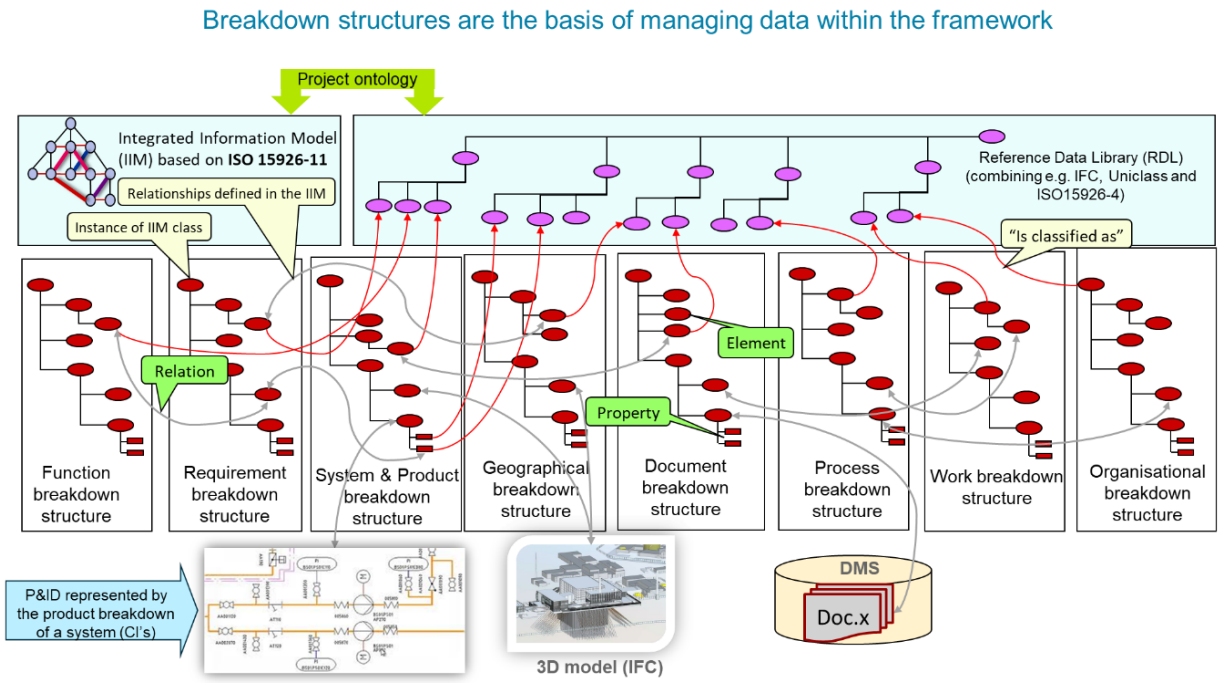

Figure 5 – breakdown structures form the basis of CDE of the Pallas Project, The Netherlands - (c) Leo van Ruijven

- Function breakdown structures
- Requirement breakdown structures
- System & Product breakdown structures
- Geographical breakdown structures
- Document breakdown structures
- Process breakdown structures
- Work breakdown structures
- Organisational breakdown structures

These are seen as the main structures, besides these main structures there will be many other specific structures within the CDE.

The breakdown structures as mentioned in fact are integrating data of many disciplines, each creating data using their discipline specific authoring tools. In general, these tools lack interoperability and use their own (proprietary) core models and terminology.

Note: a full CDE (as ideally proposed) will achieve this integration. This report is intended to provide a guideline for achieving the CDE, however is not a detailed manual establishing all the detailed relationships per breakdown, since these are application specific. An example of a breakdown could be found in ISO 14224 or ISO 81346. Software tooling will be discussed in Workshop Series 4.

This phenomenon requires a "car wash" process allowing data from various engineering tools (Revit, SolidWorks, Aveva, Bentley, etc.) to be cleaned and classified using the IIM and project RDL, ensuring data integrity before the data can be integrated in the CDE.

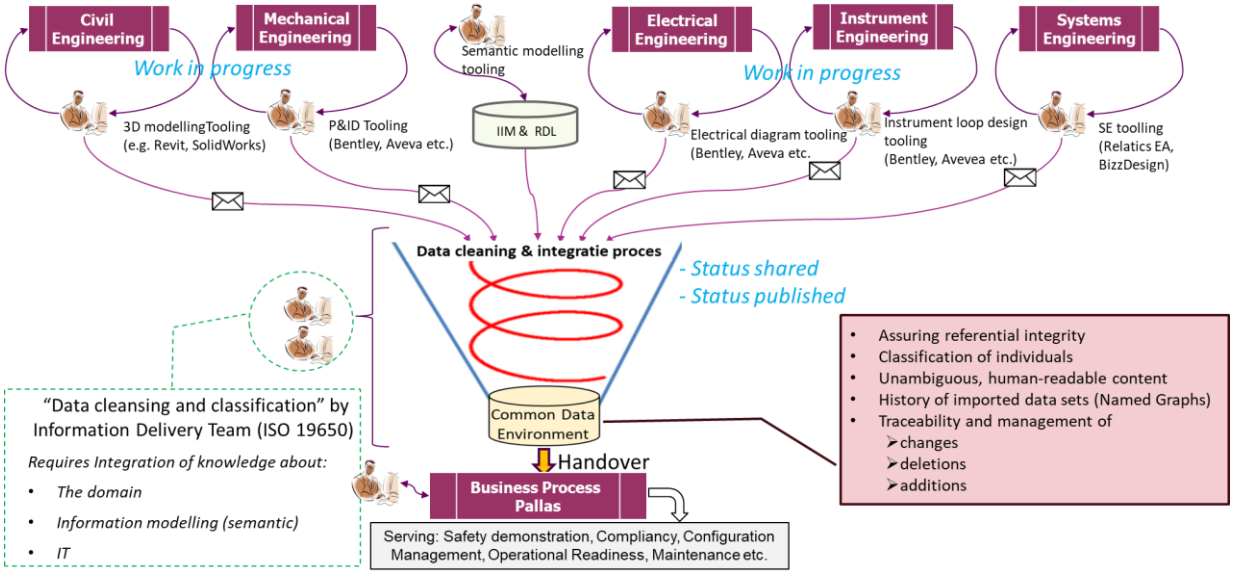

Figure 6– The main challenge of harmonizing and integrating data from various discipline-oriented authoring tools, each with their own core model and terminology

The carwash for data provides data cleaning and mapping processes (based on ISO 8000: syntactic, semantic & pragmatic data quality) for assuring reliability and integrity for acceptance of the CDE as a Single Point of Truth.

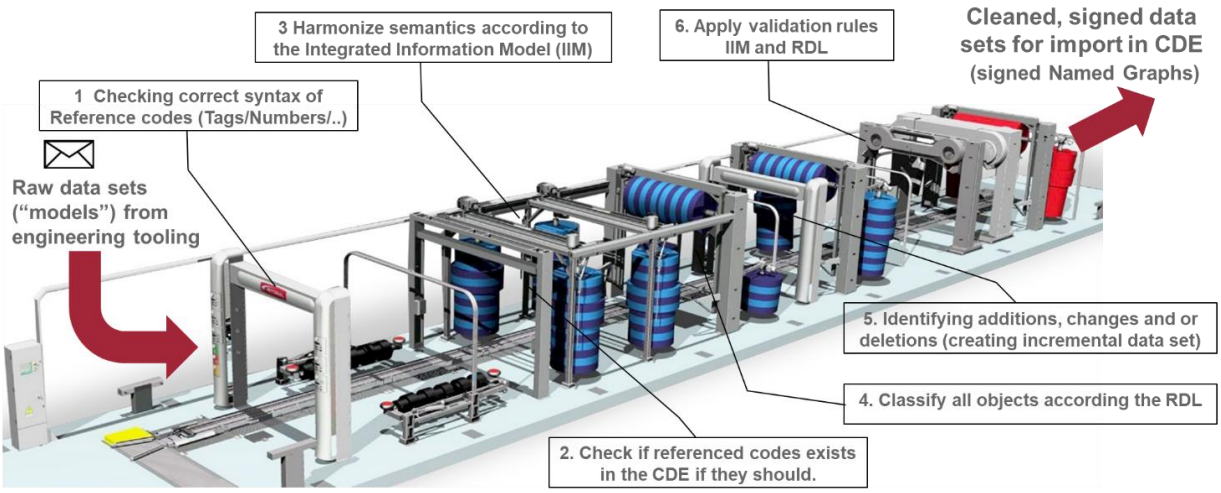

Figure 7– This figure represents the in the PALLAS project introduced 'carwash for data" with 6 major steps

5.1 Benefits and consequences of working with a CDE

Strategic Value of ISO 15926 Implementation:

- The implementation of ISO 15926 as the foundation for a Common Data Environment (CDE) represents a strategic leap toward digital maturity, operational excellence, and possibly long-term competitiveness.
- By adopting ISO 15926, companies will:
    - Enable Seamless Interoperability across engineering, operations, and maintenance systems—reducing integration costs and eliminating data silos.
    - Unlock Lifecycle Intelligence by integrating technical and operational data from design to decommissioning—empowering data-driven decisions.
    - Enhance Collaboration with EPCs, suppliers, and partners through standardized data exchange—accelerating project delivery and reducing rework.
    - Future-Proof Infrastructure by aligning with semantic web technologies and big data principles—ensuring scalability and adaptability.
    - Support Sustainability and Compliance by improving traceability, auditability, and data governance across the asset lifecycle.
- This initiative is not just a technology upgrade—it is a transformation of how we manage, share, and leverage information. It positions companies to lead in an increasingly data-centric industry, where agility, insight, and collaboration define success.
- Adopting ISO 15926 is not an easy task and requires a roadmap approach and requires senior management vision and visual support through means of finance and resources.

5.2 Why ISO 15926 Matters to Engineering

Engineers are the architects of plant performance, safety, and innovation. The implementation of ISO 15926 empowers engineers to work smarter, faster, and more collaboratively across the entire asset lifecycle.

By adopting ISO 15926, engineers will:

- Eliminate Data Re-entry and Redundancy
- Standardized templates and semantic modeling reduce manual data handling and ensure consistency across disciplines and systems.
- Preserve Engineering Knowledge
- Design decisions, specifications, and functional data are captured in a structured, query-able format—enabling future reuse and analysis.
- Improve Design Quality and Accuracy
- Integrated data from multiple sources (P&IDs, equipment specs, vendor data) ensures better-informed decisions and fewer design errors.
- Enhance Collaboration with EPCs and Vendors
- ISO 15926 enables seamless data exchange, reducing miscommunication and rework during handovers and project transitions.
- Enable Lifecycle Traceability
- Every design element is linked to its operational and maintenance history, supporting root cause analysis and continuous improvement.
- Enable robust configuration management including baselining with full traceability of history
- However, achieving these capabilities in most cases requires a rethinking of the application landscape within an organization or the addition of a specific application layer above the regular authorization tools.
- This is more than a data standard—it's a foundation for digital engineering. It allows us to focus on engineering excellence while letting the data work for us.
- ISO 15926 leads to data quality supporting high-quality decisions on many fronts.

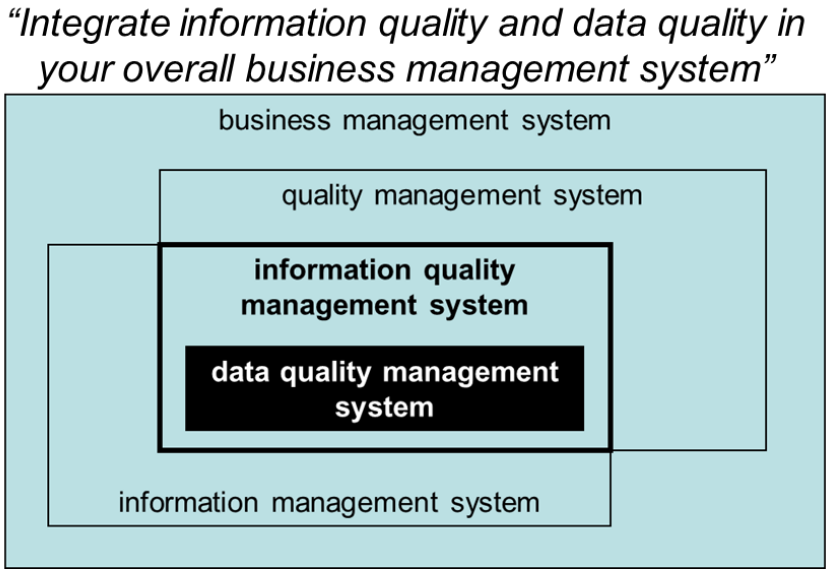

Figure 8– This figure positions data quality in the quality framework

5.3 How ISO 15926-11 is used to build the CDE

- ISO 19650 provides the management process and activity framework for handling information in projects.
- ISO 15926 provides the semantic and technical foundation for structuring and exchanging that information in a machine-readable, interoperable way.

- ISO 15926 supports the systems engineering process as defined in ISO 15288 (system life cycle processes)
- ISO 19650 vs ISO 15926:
  A comparison table between ISO 19650 vs ISO 15926 has been included in Annex 2 for reference.

Example of an implementation of a CDE: PALLAS project model

6 Why CDEs can fail and how to make them work

During the workshops presentations were provided by amongst others Shell, LyondellBasell, KinsmenGroup, RoyalHaskoning DHV, DMS 365, discussing the state of information management on their large capital projects.

The lessons learned from the workshops can be summarised as (in random order):

6.1 Organisational:

- Ambiguity in information ownership between global capital projects and site-level teams.
- Dual roles in projects: software provider and information project manager.
- Different levels of digital maturity of involved parties
- Lack of knowledge of (specifically data integration) standards
- Lack of knowledge of SQL database technology related to ISO ontology technology
- Changing the existing working method or creation of an adaption layer above it
- High turnover and long onboarding times reduce efficiency.
- Lack of strong, integrated leadership.
- Finding balance between complexity and simplicity in other words balance between semantic data quality and pragmatic data quality.
- Governance misalignment (strategy, tooling, ambition, lifecycle concerns, etc.)
- Change management and procurement alignment are critical.
- Engineer acceptance of harmonized data (what has been done with their data?) is a barrier.
- Operational deferral of data quality is inefficient, however sometimes unavoidable.

6.2 Technical:

- Many site-specific platforms which are still legacy based.
- Structured, standardized, and interoperable data is essential.
- Legacy infrastructure lacks accessible digital models due to proprietary solutions.
- Engineers rebuild models from scratch due to incomplete/missing/outdated data.
- Poor data quality leads to costly errors and rework and even safety issues.
- Movement from BIM to digital twin and or digital thread with emphasis on lifecycle data integrity.
- Ontologies and knowledge graphs support enterprise architecture.
- Metadata and naming conventions are standardized (maintained in a Reference Data Library).
- Standards-based, vendor-neutral CDEs are preferred to ensure seamless migration for decades to come
- Validation rules and controlled vocabularies (RDL) are essential.
- AI can assist but requires strong ontologies and domain knowledge.
- CDEs must integrate graphical/geometric, non-graphical/geometric data, and still documents.
- Interfaces between systems must be bidirectional and traceable.

- A decision tree or 'wizard' could help classify projects and define data cleaning strategies.
- Fragmented data environments each with their own core models and terminology
- Insufficient software support for new semantic technologies
- How was the CDE created in the Pallas project (data Information-Driven Approach)

6.3 Background and why

The Pallas project sets out to create a data information driven project approach to overcome the traditional project challenges of:

- How to manage the large amount of documents and their mutual deep linked relations (if these are known at least) during the life of a project and once the project is completed in its operational life
- How to ensure compliance with specifications and requirements, especially since this is the build of a nuclear facility, which is subject to much more stringent regulations and standards than other processing plants normally are.
- Objectives
  The objective of the data- and information-driven project approach was to enable full traceability of all engineering throughout all phases of the project (concept to as-built) and allow the verification of the data for consistency, changes, against codes and regulations, etc.

6.4 How to achieve this?

To achieve the data information approach, a common data environment (CDE) based on open standards, vendor neutral, was selected, which would allow all participants to the project to work on the same data, jointly, in respect of their roles and responsibilities.

6.5 Basic design of the CDE

The basic design of the CDE consists of a data model with an elaborate breakdown structure consisting of the following elements:

- Function breakdown structures
- Requirement breakdown structures
- System & Product breakdown structures
- Geographical breakdown structures
- Document breakdown structures
- Process breakdown structures
- Work breakdown structures
- Organisational breakdown structures

6.6 Technical aspects of the CDE

- As standards for the CDE were chosen:
  - ISO 15926 – Part 4 (extended with civil libraries like UniClass for the BIM side
  - ISO 8000 – data quality requirements
- Other technical aspects:
  - SPARQL and W3C stack: human- and machine-readable data

- Adaptation to the RDL was required to fit specific needs for the Pallas project. The project ontology was created to harmonise the data across disciplines. This required to introduce a large amount of private classes in the nuclear domain.
- The CDE allows for documents for those suppliers who can only provide document formats and where documents are required as an output for authority requirements. The meta data of documents are maintained in the CDE, and documents are classified accordingly to the RDL.

6.7 Organisational aspects of the CDE:

- The CDE was supported not only by strong IT knowledge, but mainly by strong project engineering and information modelling knowledge.
- Change management was adopted with roles and responsibilities on the CDE to fully support configuration management on the facility. This to ensure a digital thread throughout the life cycle of the facility.
- A "car wash" process was set up allowing data from various engineering tools (Revit, SolidWorks, Aveva, Bentley, etc.) to be cleaned and classified using the IIM and project RDL, ensuring data integrity within the CDE.
- Bridging the gap between "BIM" (mostly geometric centric) and non-geometric data-integration
  - In general, BIM modelers are no data modelers.
  - The overlap of knowledge of people about Geometric data standards and knowledge of non-geometric standards is very low.
  - In general, data quality in geo-metric models in terms of classification and naming conventions is low
  - Software that can integrate geo-metric data models with non-geometric data models and visualise is rare

7 Current state of CDE with parties participating in Series 1 Workshops

The current state of CDE's with parties participating in the Series 1 Workshops can best be illustrated by the following qualitative picture:

- **DMS365**: Tool-based approach, structured data pipelines, barriers and lessons from China projects. Applying RDL, through data mapping from disciplines overcoming pain points in project execution: inconsistencies
- **Kinsmen Group**: supporting clients with larger scale data integration efforts, in support of long-term asset reliability support. Various maturity levels seen with their clients from basic document management to more advanced data management and projects including the delivery of data class libraries & taxonomies.
- **LyondellBasell**: while addressing various aspects of information management for capital projects, mostly is still document oriented. Mostly driven by EPCM contractors.
- **Pallas Project**:
  The PALLAS project will replace the High Flux Reactor (HFR), securing the future global supply of medical isotopes. In Petten, we are developing a complete nuclear infrastructure that will support both nuclear medicine and scientific research. The PALLAS Programme is the dedicated project organization responsible for the construction of the reactor and its supporting infrastructure. The mission of the Pallas project was:

- "A data driven isotope production and data driven Asset Management".

Foundation: Information Management (IM) and Configuration Management (CM) at the start of the design: The information management set out with the ambition level to implement a full CDE that covers the entire project life from requirements definition, through design/engineering up to construction and handover, with a key contributor of demonstrating compliance in context against all relevant nuclear regulations.

Refer to this website for more information on the project: NRG PALLAS | Nuclear. For Life.

Note: while the operations and maintenance phase of the asset life are not part of the project, the intention of the CDE is to deliver all relevant data and information required for that phase at handover in a consistent, integrated and coherent structure.

- **Semmtech**: digital information service provider working with various clients in the capital-intensive industry. Dependent on clients' needs, creating an ontology and semantic layer definition, enabling virtual integration. Largely based on open standards.
- **Shell**: Integrated data approach including requirements and bidding, however not including full engineering. Uses both data modelling as well as relational databases and document management during project life cycle. Has developed a digital bidding allowing projects to be submitted to contenders digitally and compliance and commercial responses to those project scopes to be handled digitally too. Work during the project life requires continuous oversight
- **Technip**: discussed the challenges of information management from an engineering contractor perspective. Trying to bridge the gap between a tag (being a logical identifier of a function) and the actual equipment (being the physical entity delivering the function). Not at the level of a true CDE and also still managing large amounts of documents satisfying client's requirements.

Part of the decision process applying a CDE is what is the ambition level of the organisation for semantic precision within the project, including considerations to the pros and cons over the entire life cycle of the facility. Investments in the CDE during the project phase could yield in savings during the operational and maintenance phase.

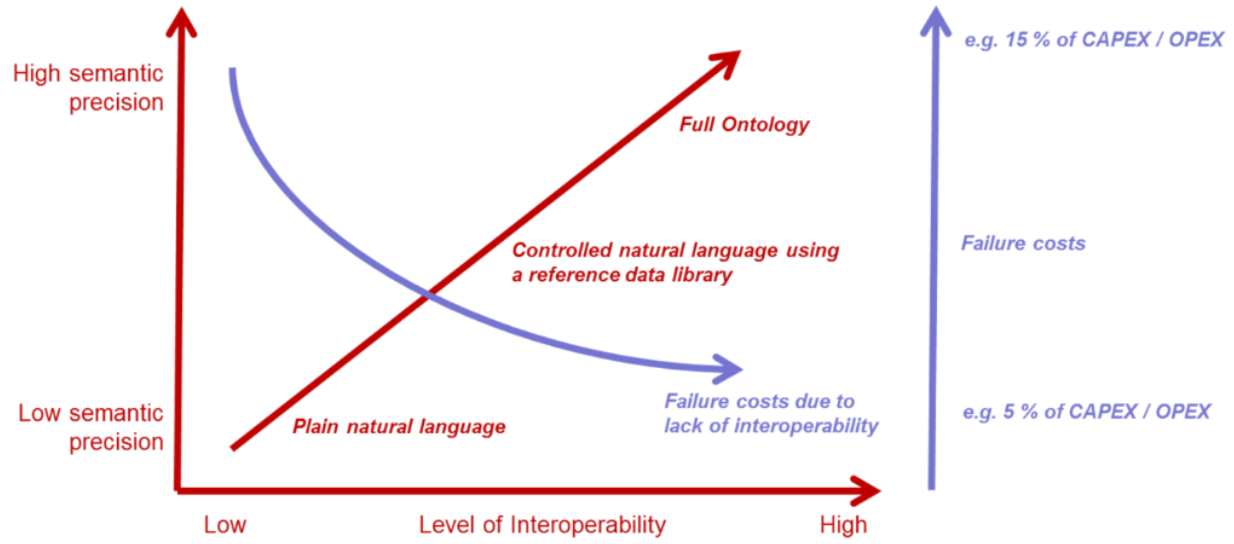

Figure 10 – Relationship between required effort and returns through different scenarios for explicit and traceable life cycle information

The following observations to Figure 10:

- Part of the challenge is who funds the CDE: while there is clear evidence that there is value during the life of the project, there is an additional cost to the project too. In addition, further value will be achieved in the operational life of the asset, hence should the CDE be funded, at least partially, from the OPEX budget.
- It is fair to expect that the breakeven point will become at a lower cost point as more and more companies move their technologies towards a CDE, or CDE like environment. Even in today's world of large capital projects, sophisticated engineering and construction tools are embedded in day-to-day work, whereas 20 or 30 years ago they would be delivered at incremental cost to the project.

8 IM-LCF Use cases of participating companies

During the Series 1 Workshops some use cases were provided demonstrating the value of a common data environment specifically and a data driven approach more generally:

- Preventing fines from authorities (Operational Phase)
- During the life of an asset (LPG storage spheres), fireproofing of the supporting legs needed replacement. Since the fireproofing prevents the legs from collapsing during a pool fire under the spheres, mitigating measures need to be in place after the fireproofing was removed. A fine was received by one of the companies, since it was insufficiently documented that mitigating measures were considered for the pool fire scenario and hence adequate for the scenario.
- Functionality test of Safety Instrument Functions (Operational Phase)
- During the operational phase of an asset, asset owners need to demonstrate to authorities that their safety instrumented functions are capable of performing the scenarios they intend to mitigate. This implies that traceability of test & inspection records related to SIF design and PHA scenarios is crucial for maintaining proper compliance with regulatory requirements.
- Project compliance: with a fully enabled CDE, project requirements defined upfront can be easily compared to engineered designed and as built delivered solutions and hence a compliance validation against the original project requirements can be tracked along the life cycle of the project.
- A proper developed CDE enables the bidding process on large capital projects, allowing the commercial process to be accelerated and comparison of bidders by the owner to become less time consuming, with much clarity on scope of compliance.
- Other use cases may be added during the following Series and Workshops and further details may be provided.

A more holistic summary provides the table below where a summary of opportunities and risks are summarised:

Opportunities	Operator Owner	EPC	Supplier	Construction	Software Suppliers
Reduced cost for data management	√	√		√	
Improved handover	√	√	√	√	

Accelerated commissioning	√	√		√	
Consistent information	√	√	√	√	√
Improved compliance determination	√	√	√	√	√
Notes: **Opportunities depend on maturity of organisations, competences and project agreements.**					

Table 1: qualitative summary of opportunities when applying CDE

Risks	Operator Owner	EPC	Supplier	Construction	Software Suppliers
Increased cost for data management	√	√	√	√	
Incompatible company maturity levels, leading to complex information management	√	√	√	√	
Project delays due to information mismatches	√	√	√	√	
Losing vision on the information management end goal when project delays and budget overruns become too challenging	√	√		√	
Lack of alignment of the information management vision, both internally in organizations as between contract parties	√	√	√	√	√

Table 2: qualitative summary of risks when applying CDE

9 Information Maturity and Readiness

- The presentations during the Series 1 workshops of the IM-LCF showed a variety of maturity and readiness in respect of the CDE.
- Main topics that will be covered during the Series 3 workshops will be:
    - Information maturity assessment definition
    - Available Maturity Models (can be extended), such as ISO 8000, Orchid, DAMA-NL and others.
    - Fitness of maturity models for IM-LCF

10 Shortcomings of existing commercial software when implementing CDE in Pallas using ISO 15926-11 (RDFS)

During the Series 1 workshops of the IM-LCF project it became clear that currently available software does not yet fully support a CDE (as described in the previous sections) out of the box.

The following are the main challenges with current commercially available software:

- Not supporting ISO 15926 data model or compatible interpretation of it, either as core data model or as model to adapt to (export to)
- No interface to “export” into an ISO 15926 data model
- No knowledge of adapting the ISO 15926 to accommodate for project specific objects
- Most actual engineering authoring tools are running on legacy databases with proprietary data models and terminology.

One of the lessons learned during the Pallas project was that many data items received from suppliers needed to be adapted to be able to be stored into the CDE, i.e. made compatible with the Pallas ISO 15926 ontology, simply because suppliers were not able to deliver data other than in Excel, PDF, or .csv formats.

Series 3 of the IM-LCF project will address specifically the issues of software further with themes like:

- Common functional needs identified in workshops
- Differentiating EPC and Owner-Operator requirements
- Mapping to existing tools vs unmet needs
- Summary of tooling gaps and opportunities for vendors

11 Summary of the recommendations as obtained from the lessons learnt

While the CDE offer benefits during all the phases of the project and during the operational phase of the asset, a number of variables/prerequisites are required to achieve the best value for implementation of the CDE and achieving its value during all the phases:

- Clear vision, however, is not overstated in relation to the maturity capabilities of the partners involved in the project.
- Understand current software limitations and plan how to address these
- Respect the learning cycle when working in a complex partnership of large projects
- Define clear roles and responsibilities, not only technically, however also organisationally.
- Identify relevant life cycle information streams, the models behind them and their owners and stakeholders.
- Use data standards and open-source technology to ensure seamless migration for decades to come.
- Availability of required (new) competences and new roles acknowledged.
- Organize integration of domain knowledge, semantic modelling knowledge, and IT.
- Allow time to define the requirements and definitions up front and scale up (and start at day one)
- Select the standards that support the project effort and the operational phase of the asset after the project.

12 Annex 1 : Glossary of Terms

CDE	Common Data Environment: A federated, standards-based digital ecosystem that enables the structured, semantic, and lifecycle-integrated exchange of technical and operational data across disciplines, systems, and organizations involved in the design, construction, operation, and maintenance of industrial facilities. The content can consist of a combination of geometric data models, non-geometric data models, and documents with their meta data. Key Characteristics: • Semantic Interoperability: Data is modeled using ISO 15926 ontologies and templates, enabling machine-readable meaning and cross-system understanding. • Lifecycle Integration: Supports data continuity from conceptual design through decommissioning. • Federated Architecture: Data is stored in distributed triple stores, accessible via SPARQL queries, with access control and versioning. • Optional making use Template-Based Modeling according to ISO 15926 Part 7 templates to encapsulate relationships and metadata. • Immutable Data History: Data is never overwritten; instead, it is versioned and timestamped, enabling traceability and auditability. • Reference Data Libraries (RDLs): Ensures consistent terminology and classification across systems and organizations.
IM	Information Management
IM-LCF	Information Management – Large Capital Facilities
ISO 14224:2016	Petroleum, petrochemical and natural gas industries — Collection and exchange of reliability and maintenance data for equipment ISO 14224:2016 provides a comprehensive basis for the collection of reliability and maintenance (RM) data in a standard format for equipment in all facilities and operations within the petroleum, natural gas and petrochemical industries during the operational life cycle of equipment. It describes data collection principles and associated terms and definitions that constitute a "reliability of language" that can be useful for communicating operational experience. The failure modes defined in the normative part of this International Standard can be used as a "reliability of thesaurus" for various quantitative as well as qualitative applications. This International Standard also describes data quality control and assurance practices to provide guidance for the user.
ISO 15288:2015	Systems and software engineering — System life cycle processes
ISO 15926	Standard for data integration, sharing, exchange, and hand-over between computer systems:

	• Part 1 - Overview and fundamental principles • Part 2 - Data model [2] • Part 3 - Reference data for geometry and topology • Part 4 - Reference Data, the terms used within facilities for the process industry • Part 6 - Methodology for the development and validation of reference data • Part 7 - Template methodology • Part 8 - OWL/RDF implementation • Part 10 - Conformance testing • Part 11 - Methodology for simplified industrial usage of reference data • Part 12 - Life cycle integration ontology in Web Ontology Language (OWL2) • Part 13 - Integrated lifecycle asset planning
ISO 19650-1:2018	Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) — Information management using building information modelling Part 1: Concepts and principles
ISO 8000-1:2022	Data Quality and Enterprise Master Data: • Part 1 – Data Quality • Part 2 – Data Quality and Enterprise Master Data • Part 8 – Information and data quality: Concepts and measuring • Part 61 – Data quality management: Process reference model • Part 63 – Part 63: Data quality management: Process measurement
ISO 81346	Reference Designation System for Industrial Systems – All part of this standard as relevant Industrial systems, installations and equipment and industrial products — Structuring principles and reference designations – various parts
Orchid	ORCHID provides a maturity model that can assist in visualizing how far companies are with their information management, and it can point to where the bottlenecks may be. The digitization programs are developments to improve the quality of information and by digitalizing the information through international standards. ORCHID Roadmap
RDL	Reference Data Library in context of ISO 15926: A structured, authoritative collection of standardized classes, properties, relationships, and identifiers used to semantically define and classify data within the ISO 15926 framework. It ensures consistent interpretation and interoperability of lifecycle information across systems, organizations, and disciplines. Key Characteristics:

	• Semantic Backbone: RDLs provide the vocabulary used in ISO 15926 templates and ontologies, enabling machine-readable meaning. • Standardized Terminology: Includes definitions for equipment types, activities, properties, units of measure, and more. • Extensible: Organizations can create RDL extensions for project-specific or proprietary terms, as long as they subclass from ISO 15926-4 base classes. • Global Interoperability: Facilitates data exchange between EPCs, OEMs, operators, and software systems. • Used in Templates: Every ISO 15926 template references RDL classes to define the roles and relationships of data elements.
USPI	Uitgebreid Samenwerkingsverband Proces Industrie Nederland USPI

13 Annex 2 : ISO 19650 vs ISO 15926

Feature	**ISO 19650**	**ISO 15926**
Full Title	*Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) — Information management using building information modelling. Is lacking data integration aspects of non-geometric data*	*Integration of life-cycle data for process plants including oil and gas production facilities*
Primary Focus	Information management processes in BIM projects	Semantic data modeling and integration across the asset lifecycle
Industry Origin	Construction and infrastructure (AEC) focusing on the utility building environment with their typical building services.	Process industries (oil & gas, chemicals, energy)
Scope	Defines how to manage information through the lifecycle of built assets using BIM, specifically 3D models and documents	Provides a semantic framework for integrating and exchanging technical and operational data
CDE Definition	Introduces and defines the concept of a Common Data Environment (CDE) as a shared source of information	Provides the data modeling and semantic infrastructure to implement a CDE

Feature	**ISO 19650**	**ISO 15926**
Data Format	Neutral on data format; focuses on workflows and responsibilities	Uses RDF, OWL, and SPARQL for semantic web-based data exchange
Key Concepts	Information containers, naming conventions, roles and responsibilities, approval workflows	Ontologies, reference data libraries (RDLs), templates, triple stores
Implementation Level	Process-oriented (who does what, when, and how)	Data-oriented (what the data means and how it connects)
Complementarity	Provides governance and process structure for managing information	Provides the technical foundation for semantic interoperability and machine-readable data

14 Annex 3 : Key Stakeholder List

Stakeholder Categories & Roles

Stakeholder Group	Role	Engagement Strategy
Executive Leadership	Sponsor, approve funding, strategic oversight	Executive briefings, ROI presentations, quarterly reviews
Data Governance Team	Define data policies, ensure compliance	Workshops, policy reviews, governance board participation
Engineering & Design Teams	Provide source data, validate mappings	Hands-on training, pilot project involvement, feedback loops
IT & Digital Transformation	Build infrastructure, manage triple stores	Agile sprints, architecture reviews, integration planning

Stakeholder Group	Role	Engagement Strategy
Application Owners & Vendors	Develop adapters, certify tools	Technical workshops, certification roadmap, vendor SLAs
Operations & Maintenance	Use CDE for performance and maintenance	Use-case demos, training sessions, feedback surveys
Document & Workflow Teams	Integrate EDMS and workflows	Process mapping sessions, SPARQL query design
Ontology & RDL Experts	Manage templates and reference data	Template governance meetings, semantic modeling workshops
External Partners (EPCs, Suppliers)	Collaborate on data exchange	Onboarding sessions, data handover protocols, joint pilots
AI & Data Science Teams	Automate mapping, enable analytics	Innovation labs, AI-assisted mapping trials
Project Management	Manage the project scope and budget	Executive briefings, ROI presentations, quarterly reviews, scope changes, change management

15 Annex 4 : CDE Charter Template

Project Charter: Common Data Environment (CDE) Implementation

1. Purpose

The purpose of this project is to establish a Common Data Environment (CDE) that enables consistent, secure, and interoperable management of engineering, operational, and lifecycle data across large capital facilities. The CDE will serve as a single source of truth for multidisciplinary collaboration, data integration, and digital transformation initiatives.

2. Scope

This charter covers the design, development, and deployment of a CDE based on ISO 15926 standards. It includes integration with existing Digital Enterprise Strategy systems (e.g., EDMS, ERP, CMMS), development of semantic adapters, setup of federated triple stores, and training of stakeholders. The scope spans the full asset lifecycle—from design and construction to operations and decommissioning.

3. Objectives

Ensure the Common Data Environment (CDE) is capable of validating design requirements against engineering and as-built deliverables, enabling traceability and conformance checks throughout the asset lifecycle.

- Implement a standards-based CDE using ISO 15926.
- Enable semantic interoperability across engineering and operational systems.
- Reduce data silos and manual data handling.
- Improve data traceability, governance, and lifecycle intelligence.
- Support collaboration with external partners and vendors.
- Engineering Teams
- Equipment Suppliers (OEM)
- Engineering & Procurement Contractors (EPC)
- Project Construction Organisation
- Project Management Organisation
- Safety demonstration team
- Quality Assurance / Quality Control

4. Key Stakeholders

- Executive Leadership (CIO, CTO, VP of Engineering, VP of Manufacturing)
- Project Management Teams
- Site Management Teams
- IT & Digital Transformation Teams
- Engineering & Design Teams
- Data Governance & Compliance Teams
- Application Owners & Software Vendors
- Operations & Maintenance Teams
- Document Management & Workflow Teams
- Reference Data Librarians / Ontology Experts
- External Partners (EPCs, Suppliers)

5. Governance

A cross-functional governance board will be established to oversee the CDE implementation. This board will define data policies, approve reference data extensions, manage template versioning, and ensure compliance with ISO standards. Regular reviews and audits will be conducted to maintain data quality and system integrity.

6. Success Criteria

- Deployment of certified ISO 15926 adapters for key systems.
- Operational federated triple stores with validated data.
- Stakeholder adoption and training completion.
- Reduction in data exchange errors and manual rework.
- Improved decision-making through integrated lifecycle data.

16 Annex 5 : Data quality checklist

Data Quality Checklist for Common Data Environment (CDE)

This checklist outlines key data quality criteria for ensuring reliable, interoperable, and standards-compliant data within a Common Data Environment (CDE). It is designed to support validation against ISO 15926 and other lifecycle data standards.

1. Completeness

- All required fields are populated for each data object.
- No missing metadata for documents, models, or datasets.
- Design requirements are fully represented in the data model.

2. Consistency

- Data values are consistent across systems and disciplines.
- Naming conventions and units of measure are standardized.
- Reference data usage aligns with ISO 15926 RDL.

3. Accuracy

- Data reflects the correct values as per source documents and specifications.
- Measurements and calculations are verified against engineering standards.
- No typographical or transcription errors.

4. Traceability

- Each data item is linked to its source (e.g., document, model, vendor spec).
- Change history is maintained and accessible.
- Design requirements are traceable to engineering and as-built deliverables.

5. Timeliness

- Data is updated according to project milestones and lifecycle events.
- No outdated or obsolete information is present.
- Timestamp metadata is accurate and complete.

6. Conformance to Standards

- Data structure conforms to ISO 15926 templates and ontology.
- RDF triples are validated using SHACL shapes.
- Adapters and systems are certified per ISO 15926-10.

Data Validation Procedures (Aligned with ISO 8000)

1. Define data quality dimensions: completeness, accuracy, consistency, timeliness, and traceability.
2. Establish validation rules for each data type and source.
3. Use automated tools to check conformance to ISO 15926 and ISO 8000 standards.
4. Perform periodic audits to verify data integrity and correctness.
5. Maintain logs of validation results and corrective actions taken.

6. Ensure metadata is present and conforms to reference data libraries (RDLs).
7. Validate data against engineering and as-built deliverables using semantic queries (e.g., SPARQL).

Roles and Responsibilities for Data Quality Management

1. Data Governance Lead: Oversees data quality strategy and compliance with ISO standards.
2. Data Stewards: Ensure data accuracy and completeness within their domain.
3. IT Team: Implements validation tools and maintains infrastructure.
4. Engineering Team: Provides source data and validates technical accuracy.
5. Project Management Team: Ensures timely data delivery and lifecycle traceability.
6. External Partners (EPCs, OEMs): Provide validated data and participate in quality reviews.
7. Quality Assurance Team: Conducts audits and monitors data quality metrics.

17 Annex 6 : Examples of ISO 15926 CDE data model

ANNEX 6 Examples of ISO 15926 Integrated Information Model (IIM)

ISO 15926-11 is based on RDFS (Resource Description Framework Schema). RDF is a language for expressing data models using statements in triple formats and sharing them with other people and machines. Since it is a W3C “Recommendation”, large collections of tools and services are available. The principle of using statements describing a “specific world” (an ontology) can replace fixed data models and provides an extensible ontology with reference data with the aim of defining, customizing and harmonizing systems. For this aim, the methodology described in ISO 15926-11 uses for this goal taxonomy of relationships and a taxonomy of “things” to be able to describe the world in a consistent and explicit way (in fact a fully controlled language). This is provided by the rule that relevant things in the real world must be classified by a class in a reference data library (RDL). The simplicity and flexibility of the triple in combination with the use of URIs for globally unique names for subjects, predicates and objects makes RDF unique, and very powerful. It's a specification that fills a very particular niche for decentralized, distributed knowledge and provides a framework to enable computer applications to answer complex questions.

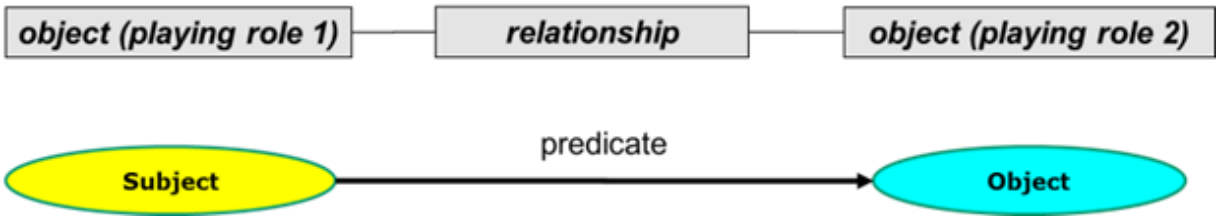

Figure 1 — Adopted RDF triple principle to represent a statement

ISO 15926-11 defines a broad set of relationships with predefined domain and range in order to validate if a relationship is correctly used in terms of a valid subject (instance of the domain) and valid object (instance of the range).

Specilized relationship	rdfs:domain	rdfs:range
iim:Activity_affects_PhysicalObject	iim:Activity	iim:PhysicalObject
iim:Activity_hasInput_Individual	iim:Activity	iim:PossibleIndividual
iim:Activity_hasOutput_Document	iim:Activity	iim:Document
iim:Activity_isLocatedAt_SpatialLocation	iim:Activity	iim:SpatialLocation
iim:Activity_isParticipatedInBy_Stream	iim:Activity	iim:Stream
iim:Activity_isPerformedBy_Party	iim:Activity	iim:Party
iim:Activity_isPerformedIn_PeriodInTime	iim:Activity	iim:PeriodInTime
iim:Activity_isPerformedIn_State	iim:Activity	iim:StateOfIndividual
iim:Activity_isWholeFor_Activity	iim:Activity	iim:Activity
iim:Baseline_aggregates_Document	iim:Baseline	iim:Document
iim:Condition_isConditionFor_Process	iim:Condition	iim:Process
iim:Document_hasVersion_DocumentVersion	iim:Document	iim:DocumentVersion
iim:Document_isWholeFor_DocumentSection	iim:Document	iim:DocumentSection
iim:Event_begins_State	iim:Event	iim:StateOfIndividual
iim:Function_contributesTo_Process	iim:Function	iim:Process
iim:Individual_hasProperty_QualitativeProperty	iim:PossibleIndividual	iim:QualitativeProperty
iim:Individual_hasProperty_QuantitativeProperty	iim:PossibleIndividual	iim:QuantitativeProperty
iim:Organization_isWholeFor_Person	iim:Organization	iim:Person
iim:Organization_isWholeFor_Role	iim:Organization	iim:Role
iim:PhysicalObject_directConnects_PhysicalObject	iim:PhysicalObject	iim:PhysicalObject
iim:PhysicalObject_hasLocation_PointInSpace	iim:PhysicalObject	iim:PointInSpace
iim:PhysicalObject_hasState_StateOfIndividual	iim:PhysicalObject	iim:StateOfIndividual
iim:PhysicalObject_isWholeFor_PhysicalObject	iim:PhysicalObject	iim:PhysicalObject
iim:Process_isWholeFor_Activity	iim:Process	iim:Activity
iim:Requirement_hasSource_DocumentSection	iim:Requirement	iim:DocumentSection
iim:Requirement_isHierarchicallySubordinatedTo_Requ	iim:Requirement	iim:Requirement
iim:Requirement_specifies_Thing	iim:Requirement	iim:Thing
iim:Stream_isTransferredBy_PhysicalObject	iim:Stream	iim:PhysicalObject

Figure 2 — Fragment of the set of relationships defined in ISO 15926-11

Figure 3 shows an example of an instantiation (in the green box) of an ISO 15926-11 relationship (in the upper box). The object (testing pump P101) is an instance (rdf:type) of an activity and the subject (Pump P101) is an instance (rdf:type) of Physical object meaning that the statement is valid. Both the relationship "testing pump p101 rdf:type performance testing" and the relationship "pump p101 rdf:type physical object "are statements on their own. Also, the classification according to the RDL of the subject (performance testing) and the classification of the subject (firefighting pump) are statements on their own.

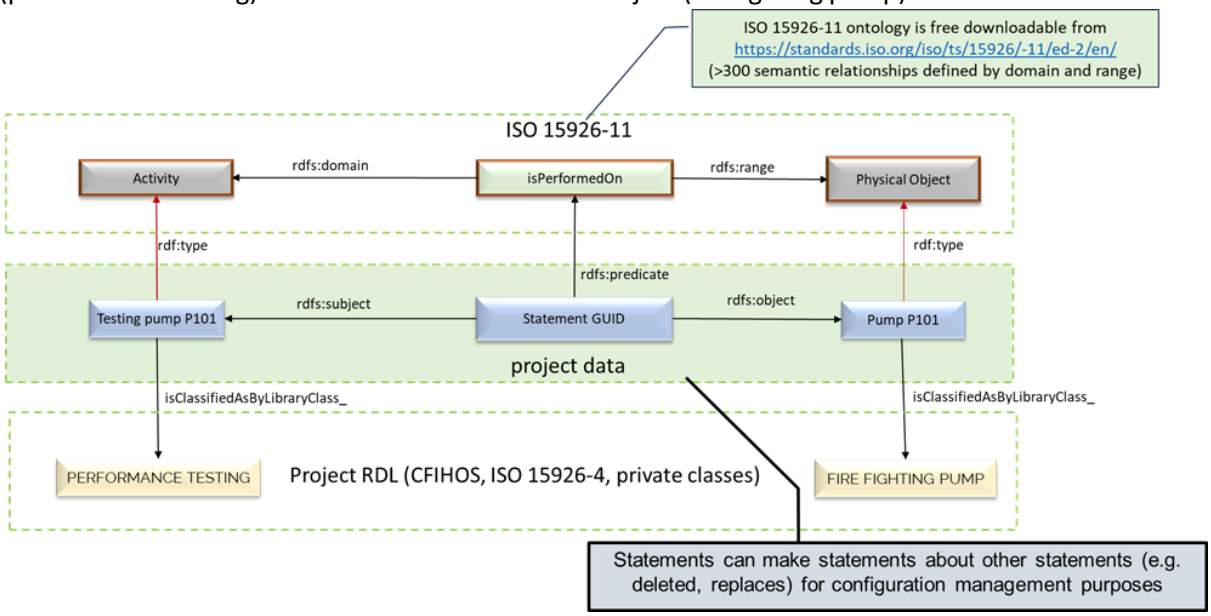

Figure 3 — Example of a RDF Statement (green block) as adopted in ISO 15926-11

When industry parties communicate (exchanging statements) with each other in general, there is a need for explicit statements about exchanged statements. These statements about statements support both the workflow of processing industrial data along the supply chain and configuration management. Together with providing provenance, these are fundamental requirements for exchanging as well as referencing and archiving industrial data electronically. The following statements about statements are examples to facilitate engineering transactional usage:

— replacement of a statement by another statement
— deletion of a statement

Below an example of several statements which together form a network of nodes and edges representing knowledge about a pump.

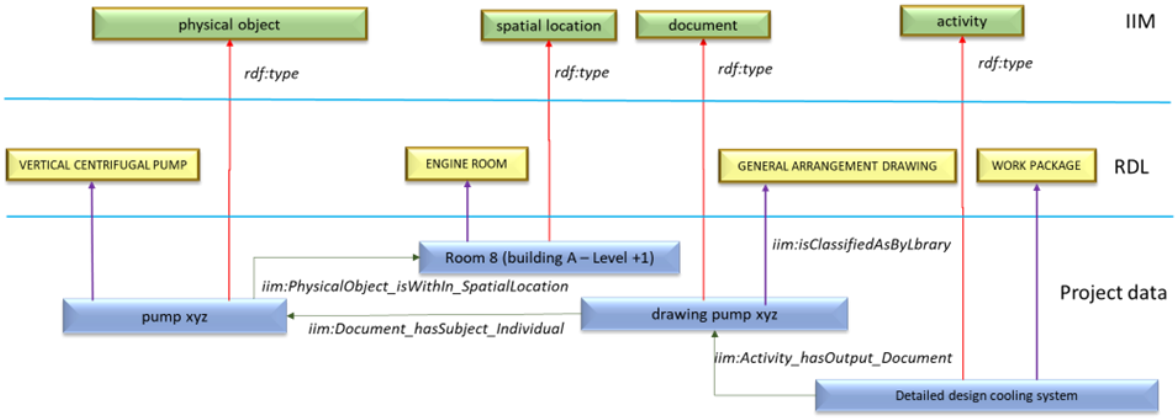

Figure 4 — Example of a collection of RDF Statements describing a specific pump on a specific location where the pump can be found a specific drawing which is an output of a specific activity classified as a work package.

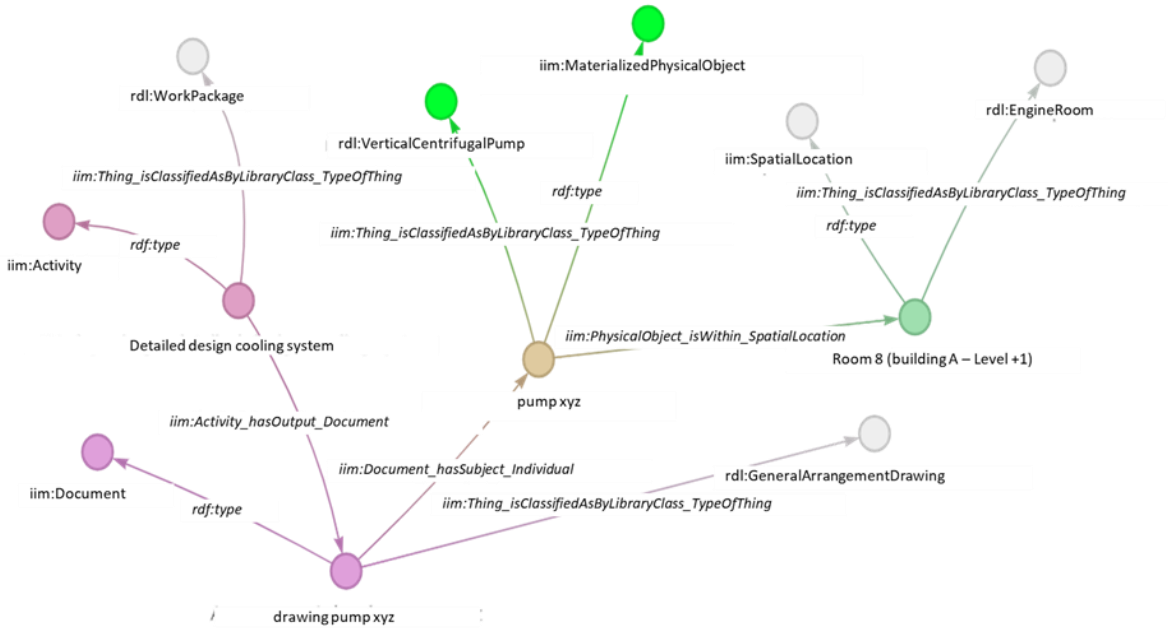

Figure 5— The example of figure 4 implemented in graph database environment (representing the same semantics of Figure 4)