



Modélisation des INformations INteropérables
pour les INfrastructures Durables

Projet National MINnD

RESEARCH REPORT / DELIVERABLE

UC8 – Underground Infrastructure WG Specifications for extension of IFC4

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1 Summary

Abstract in English

The Civil Engineering & Equipments working group of the MINⁿD-UC8 National Project was set up to gather the required expertise in order to be able to address the various domains that compose an underground infrastructure, being its civil works parts or its equipments.

This comprehensive knowledge was carried out, after a formal request for proposal process, with more than 25 experts from underground infrastructure owners, consultants and contractors, as well as with IFC experts; all with a solid experience of underground infrastructure projects, in France and internationally.

The goal of the GC working group is to provide specifications to the independent bSI organization for the production of extensions to the current IFC4.x (x being the latest version) format in order to keep fruitful exchange mechanisms of design/build/operate information representing underground infrastructures data; such information being organic, functional or spatial related.

Ultimately, such IFC extensions for underground infrastructures are to be proposed to the ISO organization for deployment as internationally applicable industry standards.

As a first step, the GC working group scoped what underground infrastructures might be: tubes, shafts and storing cells, with a view to produce a breakdown of all of their civil works structures and equipments, their interdependences (relationships) and their characteristics (properties).

The approach used to conduct this work followed a ‘why’/‘what’/‘how’ systemic analysis to outline an exhaustive perspective of the programmatic/functional/organic aspects of the infrastructures concerned. This led us to identify a series of sub-systems, as featured below:

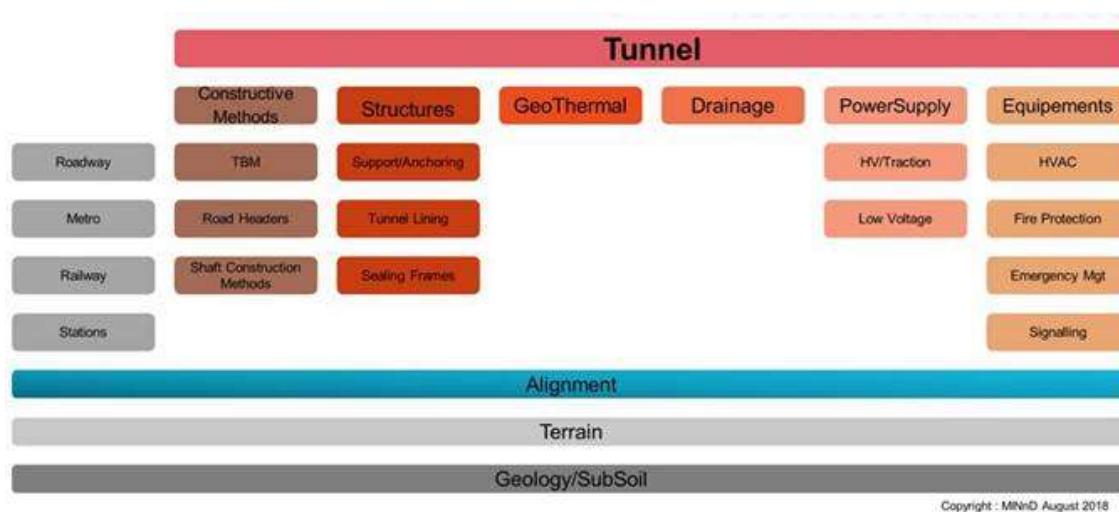


Figure 2: Breakdown into sub-systems.

In parallel, we focused on where data exchanges take place in a design process (between industry domains experts / at what phases), in a construction process (including between detailed design experts and constructive methods experts) as well as in an operate/maintain context.

As a second step, GC working group started an analysis of the possible implementation of the new objects classes (in IFC terms) needed to provide the functional, organic and spatial representations of the various components of the sub-systems, their relationships and their properties.

This work required first to leverage the existing features classes and their hierarchies available in IFC4.1, and second to propose an enrichment of these, while aiming at introducing as minimum extra complexity as possible into the existing IFC conceptual model.

Then, the GC working group will develop a proposition for an extended conceptual model and the corresponding IFC schema (based on the IFC4.1), with a view to provide definitions for the IFC5 development roadmap, in capitalizing the IFC Alignment 1.1 and IFC Overall Architecture projects led by bSI. Ultimately, this work shall help the bSI organization in:

- The development of a semantic description of underground infrastructures in a language implementing the concepts and logic used by underground construction experts;
- The set up and use a common data dictionary for underground infrastructures;
- The development of subsoil modeling (based upon industry practices and input from OCE);
- The resolution of the appropriate objects breakdown into the global IFC schema.

This initiative will also be fed by other national projects shooting for open, international standards and identify use-cases for underground infrastructures.

Résumé en français

Le groupe de travail GC (qui traite du Génie Civil et des Equipements) du Projet National MINnD-UC8 a été mis en place pour rassembler l'expertise nécessaire afin de pouvoir aborder les différents domaines qui composent une infrastructure souterraine, que ce soit ses éléments constitutifs du génie civil ou des équipements.

Cette connaissance approfondie a été réalisée en faisant appel à 25 experts issus des rangs de maîtres d'ouvrage, d'ingénieries, de consultants et d'entrepreneurs de travaux souterrains, ainsi qu'auprès d'experts des IFC, tous ayant une solide expérience des projets d'infrastructures souterraines, en France comme à l'international.

L'objectif du groupe de travail du GC est de fournir des spécifications à l'organisation indépendante building SMART International (bSI) pour la production d'extensions au format actuel IFC4.x (x étant la dernière version) afin de conserver des mécanismes d'échange fructueux d'informations de conception/construction/exploitation représentant les données des infrastructures souterraines, que ces informations soient organiques, fonctionnelles ou spatiales.

In fine, ces extensions IFC pour les infrastructures souterraines seront proposées à l'organisation ISO en vue de leur déploiement en tant que normes industrielles applicables à l'échelle internationale.

Dans un premier temps, le groupe de travail GC a défini ce que pourraient être les infrastructures souterraines : tubes, puits et cellules de stockage, en vue de produire une décomposition organique de l'ensemble de leurs structures et équipements de travaux publics, de leurs interdépendances (relations) et de leurs caractéristiques (propriétés).

L'approche utilisée pour mener ce travail a suivi une analyse systémique " pourquoi " / " quoi " / " comment " pour présenter une perspective exhaustive des aspects programmatiques, fonctionnels et organiques des infrastructures concernées. Cela nous a amenés à identifier une série de 14 sous-systèmes

Parallèlement, nous nous sommes concentrés sur l'endroit où les échanges de données ont lieu dans un processus de conception (entre experts des domaines / à quelles phases), dans un processus de construction (y compris entre experts en conception détaillée et experts en méthodes constructives) ainsi que dans un contexte d'exploitation/entretien.

Dans un deuxième temps, le groupe de travail GC a commencé à analyser la possibilité de mettre en œuvre les nouvelles classes d'objets (en termes d'IFC) nécessaires pour fournir les représentations fonctionnelles, organiques et spatiales des différentes composantes des sous-systèmes, leurs relations et leurs propriétés.

Ce travail consistait d'abord à exploiter les classes de fonctionnalités existantes et leurs hiérarchies disponibles dans IFC4.1, et ensuite à proposer un enrichissement de celles-ci, tout en visant à introduire le moins de complexité supplémentaire possible dans le modèle conceptuel existant de l'IFC.

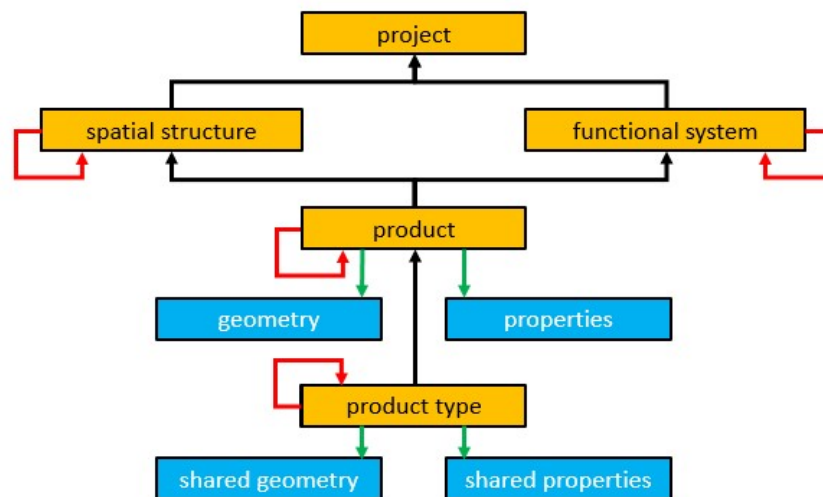


Figure 1: Conceptual Model of IFC Tunnel (simplified view)

Ensuite, le groupe de travail du GC devra élaborer une proposition pour un modèle conceptuel étendu et le schéma d'IFC correspondant (basé sur le document IFC4.1), en vue de fournir des définitions pour la feuille de route de développement de l'IFC5, en capitalisant les projets Alignement 1.1 et Architecture globale de l'IFC menés par building SMART International (bSI). En fin de compte, ce travail doit aider bSI dans :

- Le développement d'une description sémantique des infrastructures souterraines dans un langage mettant en œuvre les concepts et la logique utilisés par les experts en construction souterraine ;
- La mise en place et l'utilisation d'un dictionnaire de données commun pour les infrastructures souterraines ;
- L'élaboration d'une modélisation du sous-sol (fondée sur les pratiques de l'industrie et les commentaires de l'OGC) ;
- La résolution décomposition appropriée des objets en schéma IFC global.

Cette initiative sera également alimentée par d'autres projets nationaux visant à établir des normes internationales ouvertes et à identifier des cas d'utilisation des infrastructures souterraines.

2 Introduction

In the context of the MINnD UC8 WG, two working groups have been established to define the specifications to be implemented that are required for the underground work, in open data formats:

- Tunnel Group (GT) looked at linear underground structures for road or heavy/ light railway traffic.
- Geology Group (GC) looked at the geological data needed to capitalise on know-how and which would be useful for underground construction projects.

The two groups worked separately and produced their own deliverables in 2017 and 2018.

A process for addressing the interfaces between these two areas was then set up.

The purpose of this document is to present the methodology used by the UC8 WG and to present the specification deliverables, enclosed in the appendix.

3 Formalisation of project oriented know how (project delivery) - the Why

3.1 Context of the Project (Business Cases)

The UC8 project falls clearly within the scope of projects identified in France that are able to move the industry towards new methods based on digital technology:

- The nuclear waste disposal centre (95km tunnels) - CIGEO (Project Owner: ANDRA);
- The new automatic metro lines (200km) - Grand Paris Express (Project Owner: Société du Grand Paris; Infrastructure Management: RATP);
- The project to extend underground Line E of the Paris RER railway - EOLE (Project Owner and Infrastructure Manager: SNCF Réseau);
- The transalpine railway connection between Lyon and Turin (Project Owner: TELT).

The project also falls within the scope of major urban developments across the globe, leading to a strong increase in the need for public transport to be built in constrained environments, requiring the creation of underground infrastructure.

Specification work has therefore been focused on prioritising requirements related to new underground infrastructure, in particular:

- *infrastructure for either guided transport (metro, conveyors) or not (road, rail),*
 - *in a European and French regulatory context.*
-

3.2 Activities Covered (Use Cases)

The specifications on IFCs cover, by definition, information exchange requirements by way of a digital model in a project context and process.

There are many such activity related data exchanges and their authors must be able to be held accountable for them in a framework defined by ISO 19650 Part 1 and by the various contracts for those involved in a project.

That is why these exchanges must be situated within a global project process and the ability exist to identify which of these exchanges are covered by the UC8 Tunnel Group specification work.

A global project process was formalised in BPMN form to identify:

- The various actors (“functions” in ISO19650 Part 1 terminology) considered;
- The various activities performed by these actors and their sequence;
- Data exchanges arising from these activities, of 2 types:
 - o Exchangeable by a digital model.
 - o Not exchangeable by a digital model.

Finally data exchanges covered by the UC8 WG were identified to define the scope and limits of the work translated into the information requirements.



Figure 1: Global Project BPMN Key

Specification work principally addresses activities related to studies in the design and construction phases and partially to activities for drawing up reports/ information on completed construction work.

The phases considered [BPMN columns] are:

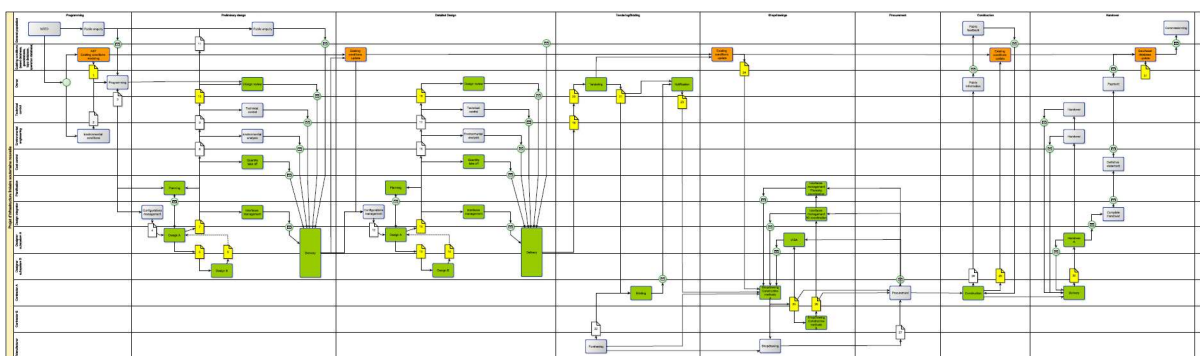
- Scheduling
- Design:
 - o Basic
 - o Project
- Awarding work contracts
- Construction and handing over of as-built.

The actors/ functions considered [BPMN rows] are:

- The general population concerned by the operational requirements definition, by the consultation, by the impact of the construction work and by the entry into service;
- Consolidator of data on the existing system;
- Project Owner.
- Technical Inspection.
- Environmental Engineer.
- Cost Controller.
- Scheduling Controller.
- Studies Integrator/ Coordinator.
- Technical Disciplines / Sub Systems Engineer:
 - Excavation/ retention.
 - Tunnel lining.
 - Water proofing of underground structures.
 - Tunnel boring construction methods.
 - Drainage.
 - Ventilation.
 - Electrical power supply.
 - Fire Protection.
 - Circulation and evacuation of persons.
 - Site monitoring and safety.
 - Transportation guidance system.
 - Geothermal.
- Works contractors.
- Product manufacturers.

The global project process was formalised by a BPMN enclosed in the appendix.

This enables the use cases selected to be put into the project context.



4 Framework for defining specifications for IFCs - the What

4.1 Conceptual Data Model

The IFC model describes the elements of a project using a spatial, organic and functional model.

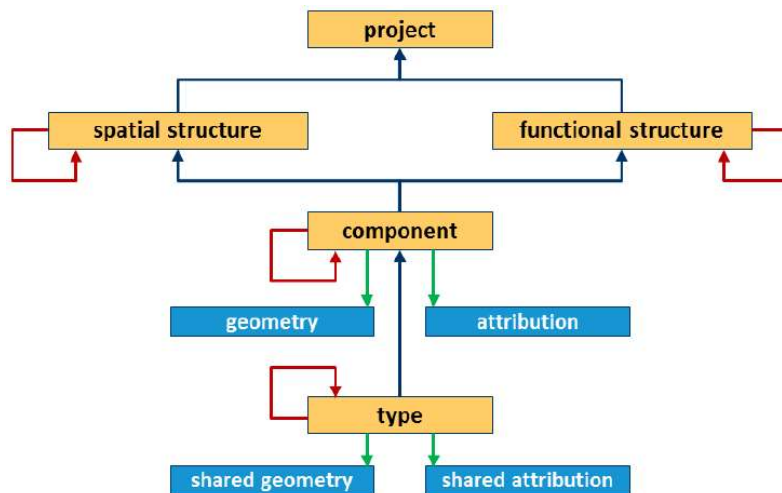


Figure 2: extract from IFC Infra Overall Architecture Project - Documentation and Guidelines – buildingSmartInternational, 2016

The data specifications for a linear underground construction project relate to:

- Cataloguing of constituent components of the project: spatial structure, components, functional structure;
- Unambiguous naming of these elements from a user point of view (technical discipline) and from a machine point of view (element classes).

Relations between these elements follow several layers of logic:

- Spatial structure, used to:
 - put the construction into its environment and into the systems being used to which it belongs;
 - locate the elements which make it up;
- Organic structure, used to describe the physical composition of an element at several levels of detail and to qualify elements that display common characters;
- identification of functional assemblies that can be described by their common functionality within a functional system.

The IFC model is therefore a relational model based on a technical discipline ontology (semantic + relations) supporting geometric representations of elements in geo-referenced spaces.

4.2 Deliverables specifying data requirements

The deliverables used to extend the IFC model to support linear underground infrastructures must contain:

- a data dictionary defining the various concepts for unambiguous understanding by that technical discipline;
- an organic breakdown (Product Breakdown Structure – PBS) to manage the different levels of detail of component descriptions (functional levels and organic levels) and the data heritage between parent and child elements;
- a list of relevant properties to describe model elements for unambiguous technical understanding; these properties are classed by property sets that can be attached to one or more model element types;
- a list of types (enum) used to pre-define normalised values to describe certain elements of the model;
- specifications on the spatial structure specific to the type of project described;
- specifications on geometric representations and positioning procedures specific to components;
- topology specifications describing the relations between components;
- description of model views needed for data exchanges for the different use cases selected (Model View Definition – MVD).

4.3 The need for governance of data standards

The extension of IFC for linear underground infrastructures cannot be completely carried out for all purposes while respecting all practices and different terminologies of the various countries which wish to adopt the standard.

For that reason there has to be:

- a change management process, limiting the impact on the pre-existing conceptual model and ensuring a sufficient level of expertise to approve modifications;
- a level of international normalisation and a level of regional normalisation;
- consistency with the technical dictionaries of the different countries.

For France, this means that:

- the data dictionary arising from proposals to extend IFC to support underground linear infrastructures must feed into the bSDD (buildingSmart Data Dictionary);
- a permanent organisation must manage the normalisation at national level and take part in governing the normalisation at national level, consistent with national reference standards.

5 Methodology for drawing up specifications - the How

5.1 The process of drawing up specifications

The UC8 WG followed the following steps to define specifications:

- 1- Definition of business cases and selection of use cases;
- 2- Definition of functions required to carry out the project (by sub-systems or transverse systems); definition of qualified experts to describe each sub-system and data exchanges needed to design and build them;
- 3- Description of use cases by IDMs (Information Delivery Manual);
- 4- Systems approach: listing of functions that have to be provided by each sub-system; listing of devices contributing to those functions;
- 5- Organic approach: description and structuring of devices (naming of components/ devices, definition of an organic breakdown, naming of properties associated with components/devices/functional assemblies, grouping of properties into property sets);
- 6- Spatial approach/ positioning of components and geometric approach: identification of geometric representation needs associated with components, identification of principles for positioning components in the space;
- 7- “Information exchange” approach: identification of information exchanged between project functions (information needs), definition of model views (Model View Definition - MVD) using a technical description (again using IFC terms);
- 8- Analysis of existing IFC classes that meet the specifications and proposals to add new classes;
- 9- Proposal of a plan for describing the conceptual model incorporating the system approach (functional assemblies) and topological, organic, spatial and geometric approaches.
- 10- Definition of data dictionary using the format defined for IFC Bridge, in French.
- 11- Translation of data dictionary into English for international purposes.

A diagram of the process can be found in the appendix.

5.2 Contributors to the UC8 Tunnel Group and their functions

The UC8 WG was made of experts qualified in linear underground infrastructure projects.

Specifications were defined by sub-system:

- SETEC: ventilation, electrical power supply and fire protection.
- INCAS-GEOS: excavation & retention, tunnel lining, tunnel waterproofing, coordination with the work of AFTES on bored tunnels;
- EGIS: drainage, guidance system, geothermal.
- CETU: circulation and evacuation of persons, site monitoring and safety.
- DODIN / CAMPENON BERNARD: tunnel construction systems.

Particular roles were allocated:

- P&I: methodological framework and verification of “system” descriptions.
- Claude DUMOULIN: definition of IFC modelling requirements, verification of production.
- VIANOVA, EGIS, SETEC: methodological frameworks, integration of operating experience from the linear infrastructure BIM modelling project, verification of production.

6 Deliverables Content

This section describes:

- Sec. 1: the content and structure of the **type data dictionary** (based upon the work done by the MINnD UC3 WG for IFC Bridge).
- Sec. 2 and 3: the content and structure of the spread sheet describing the **break down of each sub-system** and associated data so that UC8 can reproduce the work on IDMs with a view to this going into the DD and then the MVDs.
- Sec. 4: **method** for defining the data dictionary for UC8;
- Sec. 5: **reference documentation baseline** for the technology that applies to underground construction and translations into English;

The first objective is therefore to understand the format of the data dictionary expected by bSI. The second aim of Sections 2 and 3 is to explain the information in the dictionary, which can only be filled in by technical specialists: what are the elementary objects and the breakdown to get there which the experts need to create a good tunnel design? And what are the properties needed to describe them completely and unambiguously? The third objective is to translate these technical elements into the reference documentation required by bSI. This can be performed by more generalist staff.

6.1 1 – Data Dictionary Type UC3 - IFC Bridge

A data dictionary format was established by the UC3 WG in an Excel spreadsheet including French and English terminology (tab Bridge_DD_v20 in file DD_Drainage-Assainissement_VKELLER_v2.xlsx).

The format was satisfactory for data exchanges with Building Smart International and could be fed into the bSDD (building Smart Data Dictionary) with a utility program.

Niveau hiérarchique de l'objet	Name (French)	Definition (French)	Name (English)	Definition (English)	Property group	Parent group	Child group	Measure
1	Superstructure Pont	Groupe d'informations représentant la superstructure d'un pont	Bridge superstructure	Data set for the bridge superstructure definition			Bridge configuration Deck Pierhead Girder layout Steel girder Bearing Cross frame and diaphragm Sillwork Roaming Parapet Median Railing	
2	Configuration Pont	Groupe d'éléments représentant la configuration du pont	Bridge configuration	Data set for the bridge configuration definition		Bridge superstructure	Lengths of the bridge Clearance	
3	Travée	Groupe d'éléments pour la définition des travées	Span	Data set of the bridge spans		Bridge configuration	Number of spans Number of supports	
4	Nombre de travées	Nombre de travées	Number of spans	Number of spans	Span	Span		Numerical value
4	Nombre d'appuis	Nombre d'appuis	Number of supports	Number of supports	Span	Span		Numerical value
3	Longueurs de l'ouvrage	Groupe des longueurs de l'ouvrage	Lengths of the bridge	Data set of the bridge lengths		Bridge configuration	Bridge length Pier to pier length Precast girder length Bearing to bearing length Release span length Pier centerline to precast beam end	
4	Longueur Pont	Longueur du Pont	Bridge length	Bridge length	Length	Lengths of the bridge		Length
4	Longueur entre piles	Longueur entre piles	Pier to pier length	Pier to pier length	Length	Lengths of the bridge		Length
4	Longueur des poutres préfabriquées	Longueur des poutres préfabriquées	Precast girder length	Precast girder length	Properties	Lengths of the bridge		Length
4	Longueur entre appuis	Longueur entre appuis	Bearing to bearing length	Bearing to bearing length	Length	Lengths of the bridge		Length
4	Portée libre	Portée libre	Release span length	Release span length	Length	Lengths of the bridge		Length
4	Distance entre axe pile et fin de la poutre préfabriquée	Distance entre axe pile et fin de la poutre préfabriquée	Pier centerline to precast beam end	Pier centerline to precast beam end	Length	Lengths of the bridge		Length
3	Ouverture	Groupe d'information pour la définition de l'ouverture de l'ouvrage	Clearance	Data set of the clearance of the bridge		Bridge configuration	Minimum vertical clearance Minimum horizontal clearance	
4	Tirant d'air vertical minimum	Tirant d'air vertical minimum	Minimum vertical clearance	Minimum vertical clearance	Clearance	Clearance		Length
4	Tirant d'air horizontal minimum	Tirant d'air horizontal minimum	Minimum horizontal clearance	Minimum horizontal clearance	Clearance	Clearance		Length

The data dictionary (see tab bridge_CC_v20) references the terms (rows) in the following way:

- Name in French; name in English; definition in French; definition in English (4 columns);

and the hierarchies on 4 levels:

- using the following logic: a property (level 4) belongs to a set of properties (level 3) which is applied to a component/ information type (level 2) that is part of a sub-assembly (level 1) of a sub-system.

Sub-system (e.g. the bridge).

→ 1 - sub assembly (in dark grey and level 1 in column A) - e.g. in row 213 the bridge superstructure;

→ 2 - type of component /information (in light grey and level 2 in Column A) e.g. rows 228 deck, 278 girder, 355 support device, 396 cross member and brace, 489 guardrail before going on to the sub-structure of the bridge on row 503;

→ 3 - set of properties (in light grey and level 3 in Column A) e.g. in row 236 the dimensions of the deck coming after the deck in row 228);

→ 4 - properties (in white and level 4 in Column A) e.g. rows 237 to 240 specifying those dimensions as being the name of a cross section, two types of thickness and the width.

- Each term is linked to:
 - One or more parent terms (set, type of component/ information) > *parent group*.
 - One or more child terms (except for Level 4 properties) > *child group*.

- Each property is associated with:
 - o a group of properties > *property group*.
 - o a type of variable > *measure*.

Duplicates are not relevant or allowed for 2 terms which mean exactly the same thing. However terms which describe the same property in a different context should be differentiated (e.g. the height of a door can be defined differently from the height of an item of ventilation equipment).

The hierarchical level (1, 2, 3 or 4) is transferred into the organic breakdown and the use of a filter makes it easier to read the spreadsheet.

The columns further to the right than those discussed above go into more detail on the nature of the property and its attributes and values. Filling in these details does not require knowledge of that technical area; they can be completed by IFC modellers and the experts can check the details entered.

6.2 2 - Organic break-down table for a sub-system

This spreadsheet (“ASS Objects” tab in the case of drainage) must enable earlier analysis work to be incorporated into an organic breakdown of the sub-system and information associated with its components as far as the properties level.

Therefore it is structured differently from the type data dictionary.

In order to communicate the previously performed analysis as effectively as possible to the working group, which includes a breakdown of operational, functional and organic views, we propose the following breakdown:

LE <COMPOSANT DU SYSTÈME> doit			être constitué de <QUELQUECHOSE>		qui satisfait à un <NIVEAU DE PERFORMANCE>		
Niveau métier (lettres)	Niveau DD (1 à 4)	Doublon	Groupe d'ouvrages (Français)	Objets (décomposition organique)	Domaine d'application	Jeu de propriétés (décomposition fonctionnelle)	Propriétés
Niveau hiérarchique de l'objet	Niveau hiérarchique de l'objet	Doublon	Name (French)	Name (French)	Name (French)	Name (French)	Name (French)
A	1		Drainage-assainissement				
B	2		RESEAU DE DRAINAGE-ASSAINISSEMENT				
C	1		TRANSPORT DES EFFLUENTS				
D	2		Canalisation (objet/branche de réseau pour calcul)				
Caractérisation d'élément de réseau							
	3						Données physiques
	4						Masse
	3						Données hydrauliques
	4						Débit capable gravitaire
	4						Débit capable pression
	4						Débit d'absorption linéique
	4						Nom de l'espace drainé
	4						Surface collectée (m2)
	4						Surface utile collectée (m2)
	4						Débit transité calculé pour un type d'événement (venues d'eau)
	4						Temps de parcours amont>aval calculé pour un type d'événement (venues d'eau)
	4						Volume stocké

The hierarchical structure corresponds to an initial breakdown (detailed or zoom, in this case the two levels 1 and 2) aiming to characterise all components of the sub-system being

studied (in accordance with the sub-system diagram). This breakdown then continues by detailing line by line (level 4) all properties liable to be exchanged (as per the previous IDMs and functional analysis) and to class them into relevant **property sets** (level 3) corresponding to a use defined by the IDMs (cost analysis, mechanical calculations, supply procurement etc.).

Property sets can be classed by **areas of application**.

The hierarchical level of the organic breakdown is described by letters: A, B, C, D, etc. to differentiate it from the data dictionary.

6.3 Definition of information needs for the View Model (Model View Definition)

Each technical specialist [in the column in the spread sheet] states his needs in terms of information (by component or property) for each sub-system, giving the use case from the five following:

- E>C: information on Operations to be sent for Design;
- C>C: information from Design for Design;
- C>R: information from Design for Implementation;
- R>R: information from Implementation for Implementation;
- R>E: information from Implementation for Operations.

[illegible]

In addition to the organic breakdown defining relations:

- a UML diagram is created to define certain additional relations:

- between components and spaces;
- between components and geometry;
- between systems and sub-systems;
- between instances of components (topology, sequencing).

MINHD UOC – MODÈLE CONCEPTUEL DE DONNÉES
Sous-système de drainage – assainissement
Produit CANALISATION

The diagram is a conceptual data model for a drainage and sewerage subsystem. It features several entities represented by colored boxes: orange for general system and product entities, yellow for spatial entities, green for product categories, and blue for specific product types. Relationships are indicated by lines with labels such as 'Appartient à' (belongs to), 'Se situe en relation avec' (is related to), and 'Se situe en relation avec' (is related to). Cardinalities are noted at the ends of the relationship lines, such as 1..N, 0..1, and 1. The model includes entities for project/asset, system, spatial, product, and specific product types, along with their attributes and relationships.

- the allocation of properties to several levels (functional assembly/ IfcSystem; component; geometry);
- a type for property sets (functional, physical, geometric).

Figure 1: Diagramme de l'architecture globale du système de traitement des eaux usées. Le diagramme illustre le flux des eaux usées depuis les zones d'habitat (Habitat individuel, Habitat collectif, Zone commerciale, Zone industrielle, Zone agricole) à travers divers équipements (Pompes, Bâches, Bassins, Filtres, etc.) jusqu'au traitement final (Traitement biologique, Traitement chimique, Traitement physique) et au rejet final (Rejet en mer, Rejet en rivière, Rejet en lac).

7 Practical Methods

7.1 Sub-System Organic Breakdown Method

For each sub-system,

- Initially, allocate the organic breakdown to several levels (A, B, C etc.).

Niveau métier (lettres)	Compilation	Groupe d'ouvrages (Français)	Catégorie d'objets (décomposition organique)	Domaine d'application	Jeux de propriétés (décomposition fonctionnelle)	Propriétés
Niveau hiérarchique de l'objet	Compilation	Name (French)	Name (French)	Name (French)	Name (French)	Name (French)
A	Drainage-assainissement	Drainage-assainissement				
B	Réseau		Réseau			
B	Surface collectée		Surface collectée			
B	Point d'eau		Point d'eau			
C	Canalisation (produit/gamme)		Canalisation (produit/gamme)			
C	Canalisation (objet/branche de réseau pour calcul)		Canalisation (objet/branche de réseau pour calcul)			
D	Géométrie élément de canalisation				Géométrie élément de canalisation	
E	Géométrie en plan d'élément de canalisation				Géométrie en plan d'élément de canalisation	
E	Géométrie en long d'élément de canalisation				Géométrie en long d'élément de canalisation	
D	Informations de contrôles de réseau			Informations de contrôles de réseau		
D	Informations de réalisation (mise en œuvre)			Informations de réalisation (mise en œuvre)		
D	Informations de construction			Informations de construction		
D	Information de maintenance			Information de maintenance		
D	Informations de démantèlement			Informations de démantèlement		
C	Enrobage		Enrobage			
C	Fouille		Fouille			
C	Couverture (remblai de tranchée)		Couverture (remblai de tranchée)			
C	Accroches		Accroches			
C	Fourreau		Fourreau			
C	Regard		Regard			
C	Pompes		Pompes			
C	Eau		Eau			
C	Rétention/confinement/traitement ;		Rétention/confinement/traitement ;	Système de recueil des matières dangereuses		
B	Coupes types de pose		Coupes types de pose			
B	Bibliothèque de matériaux		Bibliothèque de matériaux			

If technical knowledge led to more levels being adopted than the three shown in the example to arrive at elementary objects, it is possible to either create an additional column or to use the column on the far left to increase the letter to D and then E.

- Secondly, list the properties for each sub-system component and define them if necessary:

Definition (French)	Name (French)	Name (French)	Name (French)
Canalisation (objet/branche de réseau pour calcul)			
		Référence asset	
		Neuf/existant	
Extrémité amont de l'axe de la canalisation dans le sens théorique d'écoulement (sans retranchement des regards ou autres ouvrage de raccordement)		Point départ axe (amont)	
Extrémité aval de l'axe de la canalisation dans le sens théorique d'écoulement (sans retranchement des regards ou autres ouvrage de raccordement)		Point arrivée axe (aval)	
		Nom de l'axe de référence	
Valeur de l'abscisse curviligne sur l'axe de référence par projection		Chainage départ axe (amont)	
Valeur de l'abscisse curviligne sur l'axe de référence par projection		Chainage arrivée axe (aval)	
Extrémité amont de la canalisation dans le sens théorique d'écoulement (avec retranchement des regards ou autres ouvrage de raccordement)		Point départ canalisation (amont)	
Extrémité aval de la canalisation dans le sens théorique d'écoulement (avec retranchement des regards ou autres)		Point arrivée canalisation (aval)	
		Éléments amont	
		Éléments aval	
		Masse	
		Débit capable gravitaire	
		Débit capable pression	
		Débit d'absorption linéique	
		Nom de la surface collectée	
		Surface collectée (m2)	
		Surface utile collectée (m2)	
... pour l'événement (venues d'eau)		Débit transité calculé pour un type d'événement (venues d'eau)	
... pour l'événement (venues d'eau)		Temps de parcours amont>aval calculé pour un type d'événement (venues d'eau)	
Volume d'effluent stocké dans l'élément de canalisation pour l'événement (venues d'eau) considéré		Volume stocké	

- Thirdly, classify properties into relevant property sets:

Catégorie d'objets (décomposition organique)	Jeux de propriétés (décomposition fonctionnelle)	Propriétés	Référentiel
Name (French)	Name (French)	Name (French)	
Canalisation (objet/branche de réseau pour calcul)			
		Données d'identification	
		Référence asset	
		Neuf/existant	
		Données de localisation	
		Point départ axe (amont)	
		Point arrivée axe (aval)	
		Nom de l'axe de référence	
		Chainage départ axe (amont)	
		Chainage arrivée axe (aval)	
		Point départ canalisation (amont)	
		Point arrivée canalisation (aval)	
		Liaisons	
		Eléments amont	
		Eléments aval	
		Données physiques	
		Masse	
		Données hydrauliques	
		Débit capable gravitaire	
		Débit capable pression	
		Débit d'absorption linéique	
		Nom de la surface collectée	
		Surface collectée (m2)	
		Surface utile collectée (m2)	
		Débit transité calculé pour un type d'événement (venues d'eau)	
		Temps de parcours amont>aval calculé pour un type d'événement (venues d'eau)	
		Volume stocké	

Since the organic breakdown may need a variable number of levels, it is proposed that the level of property sets be indicated (step 3) by pA and that of properties by pB.

Even if it is not essential at this stage to create a data dictionary, it is possible to check in the IFC Bridge (and if necessary in IFC Building) what data is already described by asking:

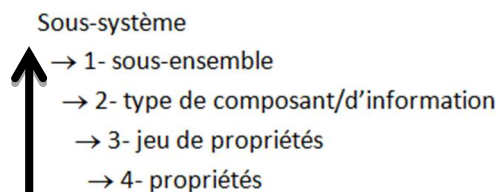
- 1- Is the object described:
- 2- If yes, is the description complete with respect to my technical approach?

7.2 Method for defining the data dictionary

- 1- Fill in the breakdown of the sub-system chosen in a new “xxx Objects” tab in format “ASS Objects” and indicate the “technical area” hierarchical levels.
- 2- In order to ensure convergence between IFC Bridge and IFC Tunnel refer as far as possible to the UC8 data dictionary in the tab “Bridge_DD_v20” for terms/ properties already defined for IFC Bridge and which are relevant for IFC Tunnel. In this case, fill in the term in the spread sheet using the function “=Bridge_DD_v20!D134”. The corresponding property will appear in green with a “.” prefix to identify it as a “bridge” term or property.

Géométrie élément de conduite
.Profil en long
=Bridge_DD_v20!D134
.Droite
.Lignes du profil en long
Fil d'eau
.Profil en long sur axe en plan

- 3- For each object in the organic breakdown incorporate as many rows as necessary to list the necessary properties and their classification (level 3 and 4).



- 4- Look for the appropriate terms in the terminology reference documentation.
- 5- Open a tab which will be specific to you “Tunnel_DD_XXX_v0” using the format from the template tab “Tunnel_DD_ASS_v0”, fill in the new terms introduced for the IFC-Tunnel and the following columns:

Niveau hiérarchique de l'objet	Name (French)	Definition (French)	Name (English)	Definition (English)
1	Informations du projet	Ensemble des informations de définition et de description du projet		

Niveau hiérarchique de l'objet	Name (French)	Property group	Parent group	Child group	Measure
1	Informations du projet				

6- In this tab “Tunnel_DD_xxx_v0” , fill it in using the illustrations and references:

Niveau hiérarchique de l'objet	Name (French)	Illustration	Références documentaires	Classe Unifomat 2015	Classe Uniclass	Classe Omniclass
1	Informations du projet					

8 Reference Documentation

The reference documentation baseline defined by CETU for the terminology contains in order of priority:

- 1 - AFTES Dictionary (1999), relative to tunnel construction.
- 2 - AITS Dictionary (1978), relative to underground construction work.
- 3 - CETU Multilingual Dictionary (2017).

Other documents on tunnels are available on the MINnD platform.

Comments: The question arises of including already available German translations, in that there are a large number of German speaking companies involved in underground construction in Europe.

It is also interesting to associate terms/ properties with the codes and terms already specified in the following classifications:

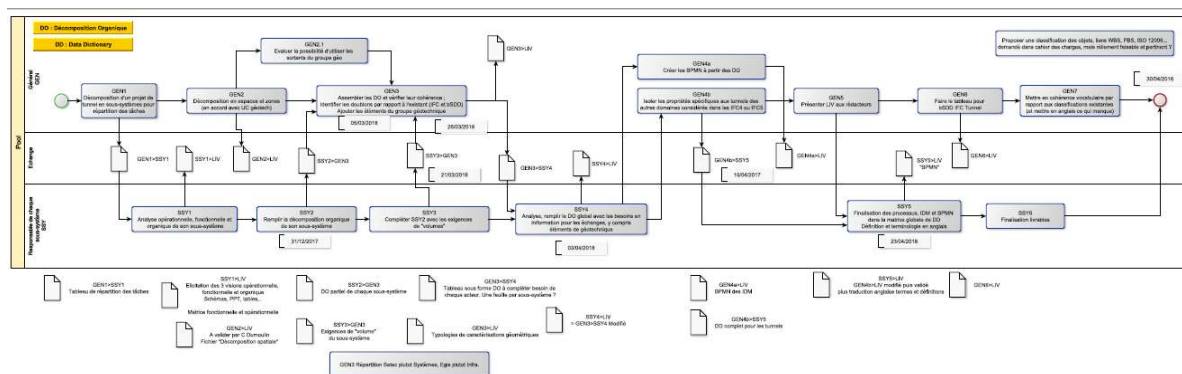
- [Unifomat 2015](#) (US)
- [Uniclass](#) (UK)
- [Omniclass 49](#) (UK)

The context of the work comes under ISO19650 “Organisation and Digitisation of Information about Buildings and Civil Engineering Works - Information management using building information modelling”:

- Part 1: Concepts and Principles.
- Part 2: Delivery phase of the assets.

9 Appendices

9.1 Diagram of the work process



9.2 (DD - Data dictionary) :

Discipline
Excavation/ retention.
Tunnel lining.
Water proofing of underground structures.
Tunnel digging construction methods.
Drainage.
Ventilation.
Electrical power supply.
Fire Protection.
Circulation and evacuation of persons.
Site monitoring and safety.
Transportation guidance system.
Geothermal.

[illegible]

9.3 Functional breakdown:

Discipline
Excavation/ retention.
Tunnel lining.
Water proofing of underground structures.
Tunnel digging construction methods.
Drainage.
Ventilation.
Electrical power supply.
Fire Protection.
Circulation and evacuation of persons.
Site monitoring and safety.
Transportation guidance system.
Geothermal.

<p>MINnD UC8 – Analyse fonctionnelle DRAINAGE-ASSAINISSEMENT</p> <p>UC8 - GC Analyse fonctionnelle Drainage-Assainissement</p> <p>DEFINITION</p> <p>Dispositif permettant :</p> <ul style="list-style-type: none"> - le maintien hors d'eau du système à exploiter par collecte et le transport d'effluents vers un exutoire - le cas échéant, de réguler le débit transporté et/ou rejeté - le cas échéant, de traiter les effluents avant leur rejet en dehors du système exploité <p>ACTEURS</p> <p>MOA MDE DIP MAT ENT ROR CTC LSE GEO DNV HYD</p>					
Système	Pourquoi	Quoi		Acteurs	Comment
	Fonction	Exigence	Organe		Echanges
	ABSORPTION DES EAUX	Géométrie : positionnement approprié (point bas, ... par rapport aux espaces drainés ou aux points d'eau	Ouvrages d'absorption Regarde		
		Hydraulique : avoir une capacité d'absorption appropriée	Ouvrages d'absorption Regarde		
		Fiabilité : permettre de maintenir la capacité d'absorption pour le type d'effluent collecté, dans des conditions normales d'entretien pour une probabilité d'occurrence pour les venues d'eau définies et pendant la durée de service définie	Ouvrages d'absorption Regarde		
		Solides : supporter les charges mécaniques susceptibles d'être appliquées au dispositif d'absorption	Ouvrages d'absorption Regarde		
		Stabilité : rester en place sous l'effet des charges mécaniques et hydrauliques susceptibles d'être appliquées au dispositif d'absorption	Ouvrages d'absorption Regarde		
		Anti-vandalisme : limiter et restreindre les possibilités de manipulation et de mouvement du dispositif à des personnels habilités ou des systèmes de commande autorisés	Dispositifs anti-vandalisme Ouvrages d'absorption Regarde		
		Maintenabilité : permettre des opérations d'entretien visant à maintenir la capacité d'absorption minimale	Ouvrages d'absorption Regarde Accès		
		Géométrie : canaliser les effluents des points d'absorption vers le point de rejet dans le milieu externe au système	Canalisation (en béton/cuvelage) ... Regarde Ouvrages de tête Déversoir Pompes Dispositifs d'acoustique		

- | Discipline |
|---|
| Excavation/ retention. |
| Tunnel lining. |
| Water proofing of underground structures. |
| Tunnel digging construction methods. |
| Drainage. |
| Ventilation. |
| Electrical power supply. |
| Fire Protection. |
| Circulation and evacuation of persons. |
| Site monitoring and safety. |
| Transportation guidance system. |
| Geothermal. |

[illegible]

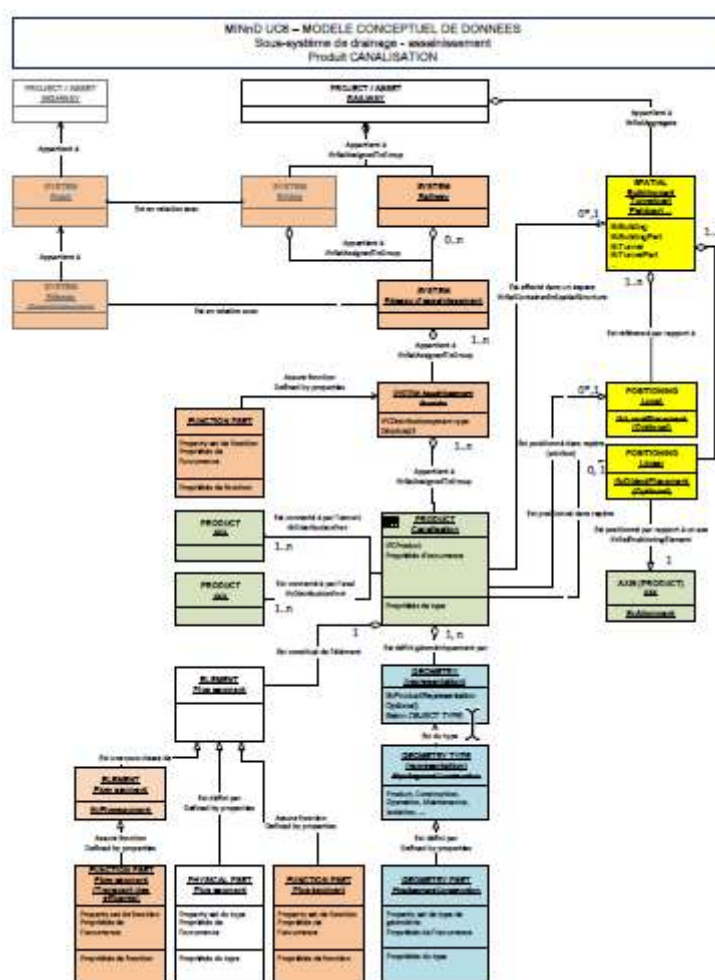
9.4 Geometry and Positioning Specifications (PBS_GEOM_POSIT):

Discipline
Excavation/ retention.
Tunnel lining.
Water proofing of underground structures.
Tunnel digging construction methods.
Drainage.
Ventilation.
Electrical power supply.
Fire Protection.
Circulation and evacuation of persons.
Site monitoring and safety.
Transportation guidance system.
Geothermal.

MINnD - UC8
DRAINAGE-ASSAINISSEMENT

Niveau Hiérarchique Fonction	DISCIPLINE GÉNÉRALISÉE PROJET / TRANSPORT / INFRASTRUCTURE		GÉOMÉTRIE / POSITIONNEMENT / VOLUMES ASSOCIÉS GÉOMÉTRIE POSITIONNEMENT / VOLUMES			MÉTÉOROLOGIE	VOLUMES ASSOCIÉS / FONCTIONS
	Tronçon (ouvrage principal)	Objet (élémentaire objet)	REPRÉSENTATION GÉOMÉTRIQUE Précision de localisation autocollante	REPRÉSENTATION GÉOMÉTRIQUE Précision de localisation intégrée	REPRÉSENTATION GÉOMÉTRIQUE Type d'axe utilisé		
Level 1: PBS	Tronçon d'ouvrage	Objet	Localisation géométrique représentative	Localisation géométrique représentative	Type d'axe utilisé	Positioning	Représentation volumique
A	Drainage-assainissement						
B	RESEAU DE DRAINAGE-ASSAINISSEMENT						
C	TRANSPORT DES EFFLUENTS						
D		Canalet (souterrain/branche de rue pour collecteur)	R3-extraction	R3-extraction	A2-alignements (axe et profil en long)	AXE	OUI
D		Enrobage de canalet	R3-extraction	R2-profil paramétrique	A2P-alignements (axe et profil en long)/Découpage en parties d'ouvrages	AXE	OUI
D		Ruisselle	R3-extraction	R2-profil paramétrique	A2P-alignements (axe et profil en long)/Découpage en parties d'ouvrages	AXE	OUI
D		Paviment de tranchée ou autre couverture	R3-extraction	R2-profil paramétrique	A2P-alignements (axe et profil en long)/Découpage en parties d'ouvrages	AXE	OUI
D		Dispositif d'assec	R5-géométrie procédurale complexe	R5-géométrie procédurale complexe	A5-Droites et cercles	LOCAL	OUI
D		Ruisselle	R3-extraction	R3-extraction	A2-alignements (axe et profil en long)	AXE	OUI
D		Regard	R5-géométrie procédurale complexe	R5-géométrie procédurale complexe	A5-Droites et cercles	LOCAL	OUI
E		Relevé dans regard	R5-géométrie procédurale complexe	R5-géométrie procédurale complexe	A2P-alignements (axe et profil en long)/Découpage en parties d'ouvrages	LOCAL	OUI
D		Ensemble de pompage	R5-géométrie procédurale complexe	R5-géométrie procédurale complexe	A5-Droites et cercles	LOCAL	OUI
C	ABSORPTION DES EFFLUENTS (TERMINAUX)						
D		Ouvrage d'absorption ponctuel	R5-géométrie procédurale complexe	R5-géométrie procédurale complexe	A5-Droites et cercles	AXE	OUI
D		Ouvrage d'absorption linéaire	R3-extraction	R5-géométrie procédurale complexe	A2P-alignements (axe et profil en long)/Découpage en parties d'ouvrages	AXE	OUI
D		Ouvrage d'absorption collective	R5-BREP	R5-BREP	A5-Droites et cercles	LOCAL	OUI
C	ACCÈS AUX OUVRAGES DU RESEAU						
D		Dispositif de couverture de regard	R5-géométrie procédurale complexe	R5-géométrie procédurale complexe	A5-Droites et cercles	AXE	OUI
D		Trémie d'accès pour personnel	R5-géométrie procédurale complexe	R5-géométrie procédurale complexe	A2P-alignements (axe et profil en long)/Découpage en parties d'ouvrages	LOCAL	OUI
D		Trémie d'accès pour matériel	R5-géométrie procédurale complexe	R5-géométrie procédurale complexe	A2P-alignements (axe et profil en long)/Découpage en parties d'ouvrages	LOCAL	OUI
C	GESTION DES EFFLUENTS						
D		Ouvrage de rétention/confinement/traitement à l'usage des matières dangereuses	R5-géométrie procédurale complexe	R5-géométrie procédurale complexe	A2P-alignements (axe et profil en long)/Découpage en parties d'ouvrages	LOCAL	OUI
D		Quai de rétention/confinement/traitement à l'usage des matières dangereuses	R5-géométrie procédurale complexe	R5-géométrie procédurale complexe	A2P-alignements (axe et profil en long)/Découpage en parties d'ouvrages	LOCAL	OUI
B		RESEAU DRAINAGE					
B		POINT D'EAU					

Discipline / Product or Component or Functional Assembly
Tunnel lining/ Ring.
Drainage / Pipe routing.
Drainage / Drainage Systems.
Ventilation/ Fans
Ventilation/ Ventilation System



Discipline
Tunnel lining.
Drainage.
Electrical power supply.

[illegible]