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|  | AIM Addendum to tender – 3D modelling |  |

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# Introduction

3D modelling is a demanding process in the digitisation of industrial objects and therefore the introduction to this specification describes the basic vocabulary, abbreviations and definitions (1.1), the concepts (inventory of industrial objects (1.2), digital twin (1.3), georeferenced 3D model (1.4) and *master plan* showing combined 3D models in one coordinate system (1.4)). Different types of 3D models are presented (1.5) with an indication of the type that is recommended to be created during 3D modelling. For a smooth implementation of 3D modelling, it is still necessary to discuss the levels of detail with an indication of the recommended level (1.6).

## Glossary of terms, abbreviations and definitions

The following abbreviations will be used in this document (Table 1) and a list of more difficult terms used in the text of this tender specification (Table 2).

Table 1 List of abbreviations used in this specification.

|  |  |  |
| --- | --- | --- |
| **Acronym** | **Abbreviation expansion** | **Explanation** |
| AE&C | Architecture, Engineering  & Construction | Type of software for architecture, engineering and construction work. |
| AMP | ArcelorMittal Poland | Company name |
| AIM | Automation, Industrial  IT and Models | Name of the department at the AMP: Automation, Industrial IT and Models |
| BIM | Building Information Modelling | Building Information Modelling. It is a digital record of the physical and functional properties of a construction object, in parametric form, serving as a source of knowledge and all data about the object, fully accessible to the participants of the investment process and providing a reliable basis for decision-making during the operation cycle, from the first concept to the demolition of the building. |
| EPSG | European Petroleum Survey Group | A former scientific organisation associated with the European fuel industry; it has developed a database of coordinate systems. |
| GESUT | Geodetic Inventory of Terrain Armaments Network | A public register kept under the Geodetic and Cartographic Law, defined as an information system that ensures the collection, updating and provision of information on land development networks. |
| GIS | Geographic Information System | Geographical Information System - an information system used for entering, collecting, processing and visualising geographical data. |
| LoD | Level of Details | Level of Detail; the level of complexity of a three-dimensional object at a suitable distance from the viewpoint; not to be confused with *Level of Development* (also LoD). |
| P&ID | Piping and Instrumentation Diagram/Drawing | A diagram in the production process showing the piping of a single system, part of it or even a specific part together with equipment and fixtures. |
| PPM | PPM | Project number used by the Investment Department at AMP. |
| RGB | Red Green Blue | One of the colour space models. |
| TLS | Terrestrial Laser Scanning | A ground-based imaging method that rapidly acquires accurate dense 3D point cloud of object surfaces by the application of a laser. |
| VR | Virtual Reality | A simulated experience that can be similar to real world. |

Table 2 List of terms used in this specification with explanations.

|  |  |
| --- | --- |
| **The term** | **Explanation** |
| georeferenced | Having specific coordinates. |
| master plan | A comprehensive plan of the industrial plant including eventually all 3D models of the plant. |
| mesh | 3D model in the form of a triangular grid. |
| solid | 3D model as a solid model. |
| surface | 3D model as a surface model. |
| wireframe | 3D model as a skeleton model. |

## 3D modelling and industrial facility inventories

**3D modelling,** in this specification, is understood as **creating 3D models on the basis of point clouds** created in the laser scanning process. AMP has **technical specifications** for Terrestrial Laser Scanning (TLS) and for metrology, where requirements on how to prepare point clouds for use in 3D modelling are already specified.

Industrial facilities generally have a very complex structure, i.e. installations, various systems, equipment, steel structures, etc. In most cases, there is no precise documentation to inform about the spatial and real appearance of the objects. **Inventory of industrial facilities** using the traditional method is inefficient and very expensive, due to very high labour intensity. **Laser scanning** technology is currently the fastest and most accurate inventory method. This measurement technique works particularly well in complicated objects in industry and allows to create 3D models. The use of 3D scanning before the modernisation or after the installation of new systems significantly facilitates the design process. Using **AE&C** software it is possible to precisely design the course of individual elements avoiding collisions with existing objects. Such a design path significantly reduces the workload and, above all, reduces the costs of modernization to a minimum.

In the process of stocktaking industrial facilities it becomes necessary to obtain a 3D scan and then a 3D model. Having **current and georeferenced** 3D models allows for quick data transfer to design companies. Moreover, 3D models are easier to use than point clouds. Point clouds contain a very large number of points and are sometimes not very readable. A simplification of the presentation of point clouds is **the 3D model**. Table 3 shows a comparison of point clouds and the 3D model of a fragment of an industrial installation from a bird's eye view, while Table 4 illustrates a similar comparison of point clouds and the 3D model, but in the form of panoramic views (in human perspective). The combined 3D model and point cloud allows to verify the accuracy and completeness of the 3D model creation.

Table 3 Comparison of point clouds with the 3D model ("bird's eye view"). Source: blommaritime. com

|  |  |  |
| --- | --- | --- |
| **Point cloud** | **3D model** | **Combined 3D model with point cloud** |
|  |  |  |

A very important aspect in the digitalization of AMP steel plants is not only the creation of 3D models of subsequent objects, but the ability to use 3D models in the future. The creation of 3D models cannot only be an inventory of industrial objects, but must be the basis for modifications and other design work. 3D models will then reduce the expenses for design work and influence the legibility of newly created technical documentation.

Table 4 Comparison of point clouds with the 3D model (panoramic view). Source: blommaritime. com

|  |  |  |
| --- | --- | --- |
| **Point cloud** | **3D model** | **Combined 3D model with point cloud** |
|  |  |  |

## Digital twin

The term *digital twin* refers to *a* digital copy of a physical object, process and system. The basis of this concept is the concept of the virtual equivalent of the physical world. Three-dimensional models of objects are necessary to create a digital twin. The use of this concept in AMP's steel mills will allow for more accurate analysis, development of planning and management of resources in the existing branches of our company by transforming them into an accurate digital replica.

In the process of creating **a digital twin**, it is necessary to collect **1D** documentation, all **2D** studies and **3D** models of buildings and point clouds. Then, in order to integrate the collected 1D, 2D and 3D data, a GIS system is used, which takes advantage of the fact that the created point clouds and 3D models have appropriate coordinate systems compatible with the EPSG systems. Figure 2 presents the idea of integrating various data into databases. The 3D module is highlighted, as it is precisely the 3D modelling specification. On the right side of the diagram, the potential software to handle this data is shown.

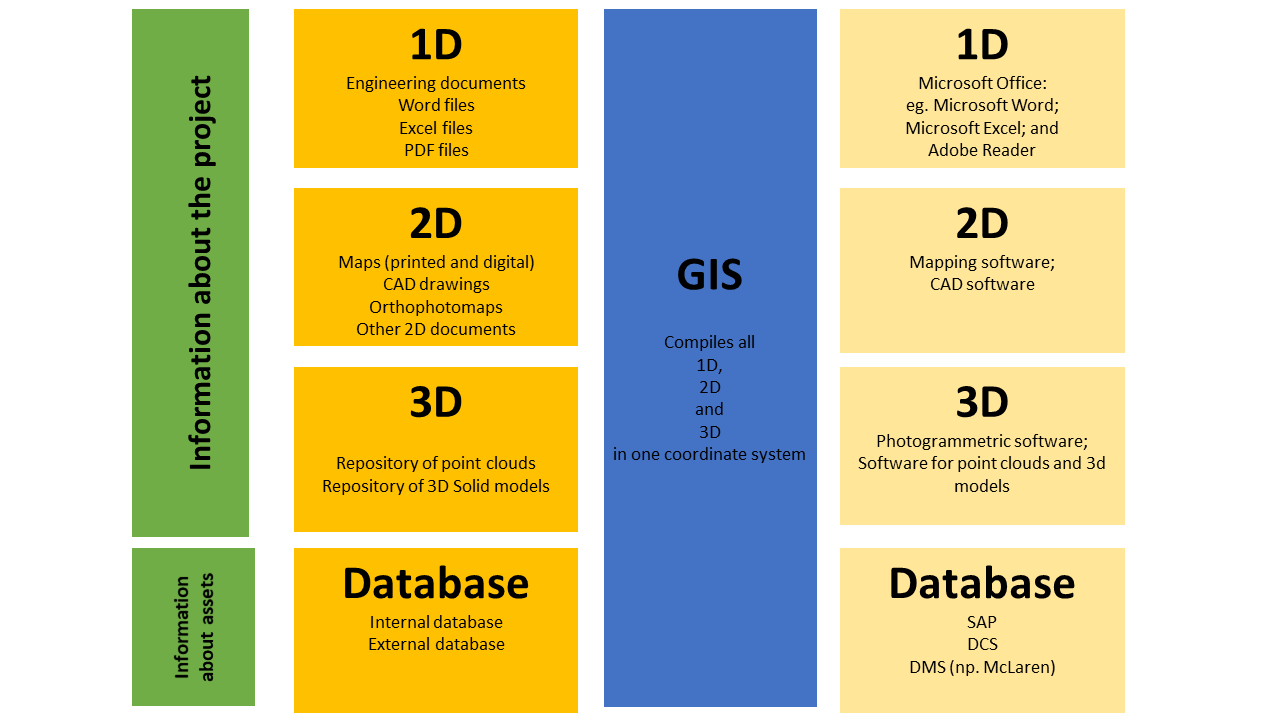


Figure 2 Concept for integrating 1D, 2D and 3D data and databases located in AMP to create a digital twin. The 3D models discussed in this specification are marked in red.

3D models allow for a significant reduction of problems typical for industrial facilities and allow for the management of facilities in the plant by conducting **simulations** and **analyses** on digital twins. In addition, 3D models enable the results of simulations and analyses to be used to **improve the operation** or **upgrade** parts of industrial installations. By analysing virtual 3D models and the associated large 1D and 2D data sets, the relevant units located in the plant can be better prepared for solving problems.

In the future, AMP will aim to use intelligent 3D models that are linked to intelligent documents and diagrams (**P&ID).** Tapping on a selected object in a 3D model will display the associated 1D and 2D documents and open them without tediously searching through archived files on computer disks (Figure 4).

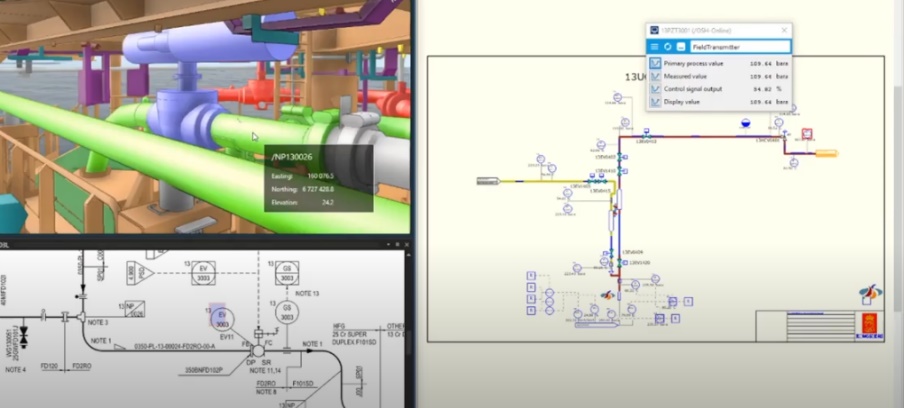
****

Figure 4 3D models in the digital twin are linked to 1D and 2D documentation.   
Source: https://www. youtube. com/watch? v=y6ZfYuor9Os

## Georeferenced 3D model and *master plan*

The inventory of industrial objects related to the 3D modelling process must include:

* georeferenced point cloud (created by terrestrial laser scanning);
* 3D georeferenced model with the appropriate model type (1.5) and level of detail (1.6);
* DWG drawings, projections, cross-sections (as results of point cloud processing and the effect of 3D modelling work);
* georeferential orthophotomaps for each inventoried level.

With this data it will be possible to build the so-called ***master plan*** (Figure 6), which will integrate the 3D models of various objects or fragments of the installation into one whole. For this purpose, the process of creating 3D models should be unified by defining the types of 3D models (1.5) and levels of detail (1.6).



Figure 6 Illustration of combined 3D models in the so-called master plan. Source: https://www. turbosquid. com

The software that can link this data is Autodesk Navisworks, which opens NWD, NWC and NWF files. It is also possible to create a master plan   
and display it in the **VR** room in AMU DG. There are several versions of Autodesk Navisworks software. **Autodesk Navisworks Manage (**a paid license included in the Autodesk AE&C package; the license is AIM) is an end-to-end design verification solution that improves coordination and analysis, and communicates design assumptions and projections about the feasibility of building a facility. Multi-discipline design data created in a variety of building information modeling (BIM), digital prototyping and process design applications can be combined into a single, integrated model. Collision detection and correction tools help designers and construction professionals to anticipate potential problems and avoid them even before construction starts, reducing costly delays and corrections. The program combines model coordination functions with the ability to schedule and quantify, thus facilitating simulations and analyses of the costs and duration of individual actions. Complete project models can be published and freely viewed using the free **Autodesk Navisworks Freedom** application (a free tool that AMP employees can use).

The main feature of Navisworks is the ability to **combine 3D files** from different programs and then analyse the resulting data set (collisions, dimensions, etc.). The program converts files received from external programs into its own format, which **does not allow to edit the files**, but has a very high processing efficiency. The converted files allow to work on very large assemblies that are many times larger than the size of the assemblies that can be processed in typical design programs.

## Types of 3D models

Four basic 3D models can be distinguished (Figure 7):

* 3D Wireframe model;
* 3D Solid model;
* 3D Surface model;
* 3D Mesh model.

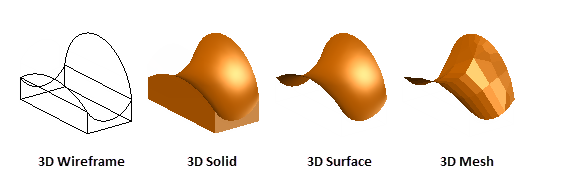


Figure 7 Autodesk 3D model types. Source: https://knowledge. autodesk. com

Below are the basic features of **the 3D Solid model**, which, unlike others, is recommended for use in AMP. The 3D Solid model was chosen because of the following features:

* efficient in use;
* easy to use objects such as pipes;
* offers the possibility of making cross sections;
* consists of objects such as: blocks, cylinders, cones, spheres, pipes;
* the most realistic way to reflect real objects;
* represents a full and complete representation of the object;
* the model is converted to a 3D Wireframe model;
* it is easy to generate a 3D model of complex components;
* requires increased computer memory and disk space for data storage;
* allows you to open files in a free 3D model browser available for free on the computers of AMP employees - Navisworks Freedom.

Figure 8 shows an example 3D Solid model of an object from the AMP. 3D Mesh, 3D Wireframe and 3D Surface models are not recommended and are not described in this specification.

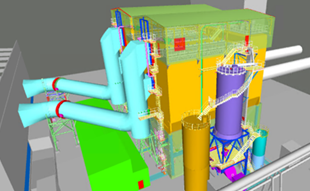


Figure 8 Example of 3D Solid model. Source: AMP.

## Levels of detail

Thanks to the use of measurement technologies such as 3D laser scanning and photogrammetry, complete spatial data can be obtained. Based on the point cloud, 3D models are created at different **levels of detail**.

When working with a point cloud, at the beginning you have to define how exactly the object is to be modelled. This is determined by the levels of detail, which are defined differently in different countries. In the United States you can find levels called LoD100, LoD200, LoD300, LoD400, while in the UK the terms LoD1, LoD2 and LoD3 are mainly used. In AMP, we adopt a way of specifying levels of detail corresponding to LoD1, LoD2 and LoD3 and are named as follows:

* low level of detail (corresponds to LoD1) (Figure 9);
* average level of detail (corresponds to LoD2) (Figure 10);
* high level of detail (corresponds to LoD3) (Figure 11).

Figures 9-11 illustrate the differences in 3D modelling at different levels of detail. In AMP, an **average level of accuracy** is recommended because of the optimal solution between the time of development of a 3D model and the number of details shown on 3D models.

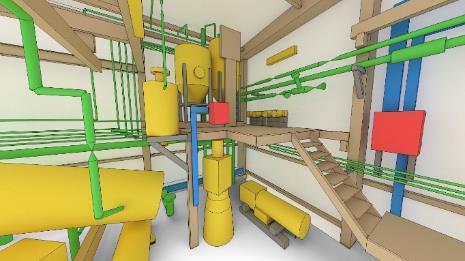


Figure 9 Low level of detail. Source: https://www.3deling. en



Figure 10 Average level of detail. Source: https://www.3deling. en



Figure 11 High level of detail. Source: https://www.3deling. pl

# Definition of design requirements

Collecting the following information will allow the buyer to prepare precisely for the 3D modelling service and select the most optimal 3D model for the needs of the plant.

## Design requirements for the buyer

Answers to the following questions must be sent to the AIM. The buyer must copy the table into a new Word document, complete it and send it back to AIM.

|  |  |
| --- | --- |
| **Issue for 3D modelling** | **Buyer's reply** |
| 1. Provide names of the objects. |  |
| 1. Provide a location of the AMP branch. |  |
| 1. Specify the number of objects. |  |
| 1. Describe the objective. |  |
| 1. Specify what the 3D model is to be used for. |  |
| 1. Has a laser scan been carried out? If so, please provide details. |  |
| 1. Have there been any modifications after the laser scan? If so, please provide details. |  |
| 1. Has the object undergone a 3D modelling process in the past? If so, please provide details. |  |
| 1. Determine the accuracy of 3D modelling and explain why such accuracy is required. |  |
| 1. Mark on any map (it can be a snapshot from OpenstreetMap. org location of the object on the premises of the steelworks. |  |
| 1. Specify the level (storey) of the location of the object to be modeled in 3D. |  |
| 1. Specify the frequency of performing and updating 3D models (how many times in the next 5 years may there be a need to perform another laser scanning and 3D modeling?). |  |
| 1. Describe which places are important for the safety and completeness of 3D modelling. |  |
| 1. Specify the type of model to be supplied (see 1.4) (if different from 3D Solid model). |  |
| 1. Specify the level of detail (see 1.5) (if other than medium level of detail). |  |
| 1. Specify the software that is used in the plant (to work with 3D models). |  |
| 1. Specify the requirements of the external company (if applicable). |  |
| 1. Specify ISO or other standards and norms that will allow objects to be modelled in three dimensions objects. |  |
| 1. Determine which elements must be modelled. |  |
| 1. In a separate ZIP file, upload photos of objects (machines, devices) and mark on them the areas that need to be modelled. |  |

**3D models** must **be updated to 1 year** after 3D modelling. The buyer is **obliged to** inform the contractor and AIM about the upgrade.

Buyer must define a reference point that is well visible on site and also well represented in the point cloud. This reference point must be materialized on site by e.g. a topographic plate and cannot change its position. Additional sub-reference plate must be installed by AM in each area that was scanned using terrestrial laser scanner.

## Design requirements for the contractor

3D modelling is a complex process, especially when 3D models are built based on point clouds. In the following subsections, the file formats (2.2.1), the way objects are modelled in three dimensions (2.2.2), the necessary layers and colours (2.2.3) and the metadata necessary for placing in the NWD file (2.2.4) are distinguished. Additionally, the contractor must take into account the requirements for georeferenced files (2.2.5), point cloud integration with 3D models (2.2.6), reports (2.2.7), training (2.2.8) and updating 3D models (2.2.9).

### File formats

3D models must be supplied in **NWD** format with integrated **DWG** files, as well as NWC and NWF files. DWG files must also be available as separate files.

Requirements for NWD files:

* A full hierarchical tree with an NWD file;
* solid model (3D Solid model);
* unit: metres;
* defined and applied EPSG system according to the location of the facility (EPSG 2177 for DG&Śląsk and EPSG2178 for KR);
* does not include a loaded point cloud, but should allow integration into Navisworks software.

### 3D object modelling

In order to create a *master plan, it is* necessary to define the 3D modelling of different types of objects. For example, it is important to maintain flange dimensions on pipeline connections (the dimensions will define the type of flange). Modelling of steel structure must be carried out according to profiles. If parameters and attributes of individual elements are known, they must be added to the objects. 3D models must be modelled according to the **medium level of detail**. Tables 5-8 show the basic differences between the 3D modelling of selected elements in the three levels of detail. Despite the recommended average level of detail, the other two levels are also given in order to distinguish how 3D modelling is carried out.

Table 5 Comparison of 3D modeling of the flange connection at three   
levels of detail. Source: http://www. blommaritime. com

|  |  |  |
| --- | --- | --- |
| **Low level  level of detail** | **Average level of detail** | **High level  details** |
|  |  |  |
|  |  |  |
| Flange connection modelled as a single cylinder. | Flange connection represented by two cylinders, valve actuator roughly modelled. | Compared to the low level of detail, additionally modelled screws, the valve actuator is made of more elements. |

Table 6 Comparison of ventilation system modelling on three   
levels of detail. Source: http://www. blommaritime. com

|  |  |  |
| --- | --- | --- |
| **Low level of detail** | **Average level of detail** | **High level of detail** |
|  |  |  |
| Ventilation system modeled as a perpendicular. | Ventilation system modelled as joints accurately reproduced. | The ventilation system is modeled as perpendiculars, details and connections accurately mapped. |

Table 7 Comparison of structure modelling on three objects   
levels of detail. Source: http://www. blommaritime. com

|  |  |  |
| --- | --- | --- |
| **Low level of detail** | **Average level of detail** | **High level of detail** |
|  |  |  |
| All elements represented by cuboids. | All construction elements are modelled with a distinction of profile type and size. | All structural elements modelled with distinction of profile type and size, including space-occupying secondary elements such as gusset plates. Structural deformations shown. |

Table 8 Comparison of pipe bracket modelling at three levels of detail.  
Source: http://www. blommaritime. com

|  |  |  |
| --- | --- | --- |
| **Low level of detail** | **Average level of detail** | **High level of detail** |
|  |  |  |
| Simple cantilever representation using cuboids without brackets on the tube. | Clamp presented with a cylinder, bracket as profile. | Exact mapping of the clamp  and the pipe support. |

### Layers and colours

The design must include specific layers of a particular colour (Table 9). The layer name must contain a three-digit number at the beginning of the name and be visible in the hierarchical tree in Navisworks. If a layer is not included, a new layer must be added with the corresponding object type number (e.g. piping related layers are numbered: 100, 101, 102). Table 9 shows sets of names with selected colours. Table 10 illustrates the comparison in displaying GIS and GESUT layers.

Table 9 Overview of layer names and colours.

|  |  |
| --- | --- |
| **Layer name / sets of layers** | **RGB colour** |
| 010 GIS | According to GIS |
| 020 GESUT | According to Table 11 |
| 030 Point cloud | n.a. |
| 100 Pipes | 195,195,10 |
| 101 Piping components (flanges, valves, instruments, etc.) | 200,100,20 |
| 102 Pipeline support structures | 0,200,0 |
| 200 Equipment | 0,255,255 |
| 201 Tanks | 0,0,255 |
| 202 Pumps | 200,200,30 |
| 203 Motors | 250,200,200 |
| 204 Filters | 200,200,200 |
| 300 Electricity | 255,0,255 |
| 301 Cable trays | 255,125,0 |
| 302 Support structures for cable trays | 255,125,90 |
| 303 Electrical/ control cabinets | 255,100,50 |
| 304 Lighing | 255,255,0 |
| 400 Buildings | 0,0,175 |
| 401 Structures | 10,255,0 |
| 402 Stairs | 255,30,30 |
| 403 Railings | 200,195,0 |
| 404 Bridge gratings | 0,0,190 |
| 405 Architecture | 0,0,220 |
| 406 Ladders | 200,190,20 |
| 407 Foundations | 20,0,255 |
| 408 Walls | 50,50,190 |
| 500 Roads | 100,100,100 |
| 600 Gas | 200,200,0 |
| 700 Fire prevention | 240,0,0 |
| 800 Hydraulic | 100,150,200 |
| 900 Pneumatic | 100,100,150 |
| 1000 HVAC | 0,200,50 |

All the pipe must be included in 3D model. However, Pipes (set: 100 Pipes) with a nominal diameter below ND 50 can be modelled in a low level of detail. Of course this depends on the purpose of the model and the buyer must be consulted.

Table 10 Overview of 3D model display without and with GESUT and GIS. Source: 3D model from AMG.

|  |  |
| --- | --- |
| **3D model without GIS and GESUT layers** | **3D model with GESUT and GIS layers** |
|  |  |

The following colours should be used to distinguish the different network objects present in the 3D model. Table 11 shows the colours used in the GESUT manual. Figure 12 illustrates selected network objects in three dimensions in the selected colours.

Table 11 Selected network colours. Created based on GESUT instructions.

|  |  |  |  |
| --- | --- | --- | --- |
| **No** | **Type** | **Colour** | **RGB marking** |
| 1 | Water supply network | blue | 0,0,255 |
| 2 | Sewerage network | brown | 165 42 42 |
| 3 | Gas network | yellow | 255 255 0 |
| 4 | District heating network | violet | 238 130 238 |
| 5 | Electricity grid | red | 255 0 0 |
| 6 | Telecommunications network | orange | 255 165 0 |
| 7 | Non-identified network | green | 0 128 0 |
| 8 | Design network | light green | 152 251 152 |
| 9 | Computer network | black/white | 0 0 0 / 255 255 255 |

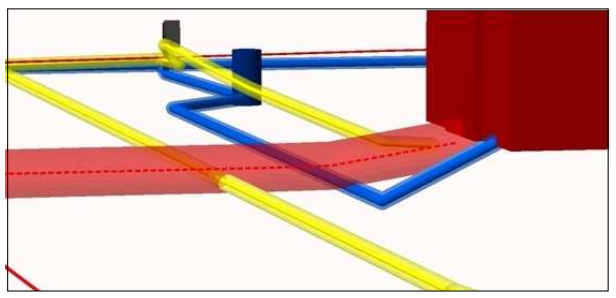


Figure 12: The colours of network objects. Source: http://rg. ptip. org.pl/index. php/rg/article/viewFile/RG2014-4-MrozWisniewskaFijalkowska/1570

Any changes made to the layer sets and colours must be included in the **technical report**.

#### **Z-fighting**

It is mandatory to remove double lumps in order to avoid the effect indicated in figure 13. To this end, overlapping objects must be removed or concealed, or, as a last resort, given the same colours.

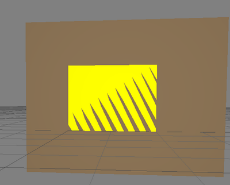


Figure 13 The problem of Z-fighting occurs when there are overlaps   
at least two lumps on top of each other.

### Tree structure

First level of master plan is divided by 3D Engineering Supplier as follows (nonexhaustive list; example of BF2):

* BP Proper
* Water cooling
* Gas Cleaning
* CH Didusting
* BF Charger.

This structure must permit to have an efficient integration of the part of the subcontractor on the 3D model. Second level of master plan (first level of 3D Engineering contractor) must be done by area. Each area must be shared by activities and by specific detailed activity in order to reach the part to be erected. The Tree Structure must be adjusted regarding specific scope of each 3D Modelling contractor. Each 3D Modelling contractor must send its Tree Structure for the approval by AM/AIM before 3D modelling.Names of third levels must include 4-digit code (see table 9) and 4-element code (2 letters + 2 digits).

Legend of the structure tree:

* **First level**
  + **Second level**
    - * **100 Third level**
        + **101 Third level**

**Third level element AB01**

* + - * + **102 Third level**

**Third level element CD01**

Description:

**AB01, CD01 – first letter relates to third level category:**

Piping (P)

Equipment (E)

Electricity (C)

Buildings (B)

Example of three structure:

* **BP Proper**
  + **BF Top**
  + **BF Inside**
    - **BF Top**
      * **010 GIS**
      * **020 GESUT**
      * **030 Point cloud**
      * **…**
      * **100 Piping**
        + **101 Piping components**

Flange PF01

Flange Part01 PN01

…

Valve PV01

Valve Part01 PP01

…

Instrument PM01

Instrument Part01 PE01

…

* + - * + **102 Piping support structures**

Piping support PS01

Piping support Line PU01

Piping Support Part 01 PR01

Piping Support Part 02 PR01

…

* + - * + Pipe PP01

Line PL01

Isometric PI01

Isometric PI02

…

* + - * **200 Equipment**
        + **201 Tanks**
        + **202 Pumps**
        + **203 Motors**
        + **204 Filters**
        + **…**
        + Equipment EE01

Equipment Subpart 01 ES01

Equipment Subpart 02 ES02

…

* + - * + Temporary Equipment ET01

Crane EC01

Steel Structure Temp ER01

Scaffolding EA01

…

* + - * **300 Electricity**
        + **301 Cable trays**

Cable trays CC01

ControlCommand CM01

Cable trays CT01

Cable trays CT02

…

* + - * + **302 Support structures for cable trays**

Cable trays Support CO01

Cable trays Support CR01

Cable trays Support CR01

…

* + - * + **303 Electrical/control cabinets**

Electrical Cabinet CE01

Electronic Cabinet CB01

Electronic Cabinet CB01

…

* + - * + **304 Lighting**

Lighting CL01

Lighting Cabinet CQ01

Lighting Cabinet CQ01

…

* + - * **400 Buildings**
        + **401 Structure**

Structure BS01

Structure PreFabPart01 BF01

Structure PreFabPart02 BF02

…

* + - * + **402 Stairs**

Stairs Element BR01

Stairs PreFabPart01 BA01

Stairs PreFabPart02 BA02

…

* + - * + **403 Railings**

Railings Element BN01

Railings PreFabPart01 BR01

Railings PreFabPart02 BR02

…

* + - * + **404 Gratings**

Gratings Element BG01

Gratings PreFabPart01 BP01

Gratings PreFabPart02 BP02

…

* + - * + **405 Architecture**

Architecture Element BE01

Architecture PreFabPart01 BC01

Architecture PreFabPart02 BC02

…

* + - * + **406 Ladders**

Ladders Element BL01

Ladders PreFabPart01 BX01

Ladders PreFabPart02 BX02

…

* + - * + **407 Foundations**

Foundations Element BO01

Foundations PreFabPart01 BV01

Foundations PreFabPart02 BV02

…

* + - * + **408 Walls**

Walls Element BW01

Walls PreFabPart01 BZ01

Walls PreFabPart02 BZ02

…

* + - * **500 Gas**
      * **600 Fluids**
      * **700 Fire Prevention**
      * **800 Hydraulic**
      * **900 Pneumatic**
      * **1000 HVAC**
    - **Bosh&Body**
    - **Tuyeres and heard**
  + **BF Tower**
    - **Under CastFloor**
    - **Tuyeres Zone**
    - **Body**
  + **CastHouse**
    - **TH1**
    - **TH3**
    - **TH4**
  + **StockHouse**
  + **Tunnel**
  + **Pumphouse**
  + **Cooling Farm**
  + **Dusttank**
  + **Scrubber**
  + **BF gaz Line**
  + **Cooling tower**
  + **Wind Stove**
* **Water colling**
* **Gas cleaning**
* **CH Didusting**
* **BF Charger**
* **Other**

### Metadata

#### Project metadata

In the Navisworks NWD file in the Properties panel, create an ArcelorMittal tab with basic information about the project (Figure 14). Table 12 lists the metadata that must be included in the project description. The metadata about the project should be visible in Navisworks Freedom in the properties window in the structural tree under ArcelorMittal (Figure 15). Structural names that are not on the 3D model should not be included (Figure 16). Information about the metadata must also be included in the technical report.

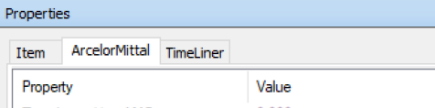


Figure 14 The tab created in the Navisworks file properties.

Table 12 Summary of metadata that must be included in the project properties.

|  |  |
| --- | --- |
| **The property** | **Value** |
| File name |  |
| No PPM | Number obtained from the Engineering Department of AMP |
| AMP Project Manager | Surname, First Name |
| Name of the company implementing the project |  |
| Project Manager from the company implementing the project | Surname, First Name |
| Contact details for the project manager of the project company |  |
| Plant |  |
| Area |  |
| Date of scan (or date range) | YYYYY.MM.DD-YYYY.MM.DD |
| EPSG | 4-digit code (e.g. 2178) |
| Notes |  |

|  |  |
| --- | --- |
| Figure 15 Screenshot of NWD file design properties. | Figure 16 Sets of structural names visible in the structural tree in Navisworks Freedom. |

#### Item metadata

Each modelled item must have specific metadata. The objective of these metadata is to make easier the estimation of the bill of quantity for each activity and to reduce detailed engineering schedule. The definition of the metadata is the responsibility of the 3D Engineering contractor, but the minimum required is described in Table 13. All names must be in English.

Table 13 Summary of metadata that must be included in the project properties.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Item** | **Meta1** | **Meta2** | **Meta3** | **Meta4** | **Meta5** | **Meta6** | **Meta7** | **Meta8** |
| Equipment | Functional Ref | Designation | Drawing | Weight |  |  |  |  |
| Equipment Sub Part | Reference | Designation | Ref of Equip | Drawing | Weight |  |  |  |
| Steel Structure | Reference | Materials | Weight |  |  |  |  |  |
| Steel Structure Sub Part | Reference | Ref of steel structure | Materials | Weight |  |  |  |  |
| Piping Isometric | Reference | Function Ref of the Line | Fluid | DN | PS | TS | Piping class | Length |
| Piping support | Reference | Materials | Weight |  |  |  |  |  |
| Piping support Sub part | Reference | Ref of piping sup. | Materials |  |  |  |  |  |
| Piping Bulk | Type | Designation | Piping class | DN1 | DN2 | DN3 | Length |  |
| Valves&Instrum | Functional Ref | Designation | Piping class | DN |  |  |  |  |
| Cable Tray | Reference | Type | Section | Materials | Lenght | HV/LV/CC |  |  |
| Cable Tray support | Reference | Type | Materials | Weight |  |  |  |  |
| Electric Cabinet | Reference | Designation | Drawing | Weight |  |  |  |  |
| Foundation | Reference | Designation |  |  |  |  |  |  |

### Geo-reference files

In addition to the 3D georeferenced model, the contractor must provide georeferenced **orthophotomaps** (or orthophotos) for each inventoried level in **GeoTIFF** format. In addition, georeferential **projections, cross-sections according to the** buyer's order must be made. The geo-referential **point cloud must be** delivered together with the 3D modelling project, if not delivered to the AMP together with the TLS project.

### Integration of point clouds and 3D models

It is also mandatory to create a free point cloud viewer with a presentation covering the integration of point clouds with created 3D models. Figure 14 shows a combined point cloud with a 3D model of the pipeline. The PoTree application enables such integration and is an open-source solution. It is important that the integration is carried out in one EPSG layout compliant with the branch location.

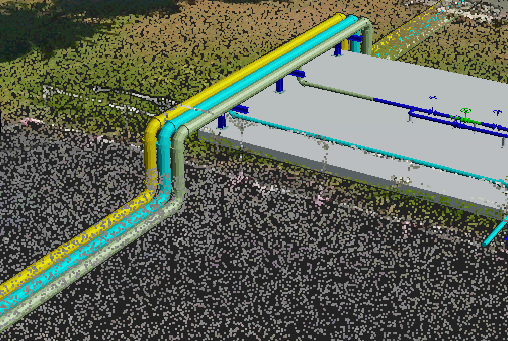


Figure 14 Integration of point cloud with 3D pipeline models in the open-source application PoTree.

### Report

**The technical report** has to refer to the 3D modelling work carried out together with a description of the parameters used (e.g. colours, level of detail). The report must contain drawings explaining the 3D modelling process.

The report must include information on:

1. The laser scanning **dates**, which was used for 3D modelling;
2. 3D modelling terms;
3. **metadata** (see 3.2.3)
4. information on the EPSG **coordinate system** used;
5. **conclusions** on 3D modelling and recommendations for subsequent 3D modelling processes;
6. **Notes on** 3D modelling;
7. **Updates** performed - if a 3D model update has been performed, attach a **report on the accuracy of fitting the** new cloud to the larger (older) point cloud.

### Training

**The training** must be carried out after the completion of the 3D modelling work in such a way that AMP employees who will use the acquired data can use the created 3D models. The training should be designed for 3-4 people, min. 4 hours in AMP headquarters or by meeting in Microsoft Teams application. The training should be prepared in such a way that AMP employees can reproduce it on their company computers.

The buyer must oblige employees who will use 3D models to install the free Navisworks Freedom application before the training.

### Update

The contractor must perform a 3D model update within **1 year** from the date the last file was delivered to AMP. The company performing the update performs a 3D scan of the part of the installation that has changed and then adjusts the new point cloud to the old one, based on which the 3D model is updated.

In case of updating 3D models, the Contractor delivers:

* updated point cloud
* updated 3D model;
* updated 3d browser;
* report on the accuracy of fitting a new cloud into a larger (older) point cloud.

**All details must be agreed and approved by the AIM.**

**Any deviation from the standard must be approved by AIM.**

# Delivery of 3D MODELING data

## Delivery of data

The process of providing data to the AMP takes place in the following way:

1. Once the 3D modelling of the first part of the object / part of the object has been completed, the processed data must be delivered to the AIM in order to **check** if it meets the specifications for 3D modelling;
2. The first delivery of files must be made via **FTP**;
3. The files listed below must be supplied on **a hard disk**:
   * + data models in **formats**:
     + native, including catalogs.
       - DWG;
       - NWD with integrated DWG, NWF and NWC files;
       - GeoTIFF;
       - point clouds in E57 structured format (if the point cloud was not delivering to AMP with the TLS project);
     + **reports and notes** in PDF format;
4. For each object, the location of the object should be marked on **the map** (PDF format);
5. the final data delivery must be saved on **an external** hard **disk** (2.5 "or 3.5" USB 3.0); the hard disk will not be returned by AIM;
6. the **file names** must include the date corresponding to the 3D modelling performed;
7. the **identifier** in the file must contain the following sequence of digits:

**YYMMDD\_XXXX**

where:  
**YY** - year (e.g. 20)  
**MM** - month (e.g. 10)  
**DD** - day (e.g. 09)  
**XXXX** - a unique number (e.g. 0001).

1. When creating file names, the possibility of updating the 3D model in the future must be taken into account.

## Publication of 3D models

* 1. The prepared project must be prepared to be made available **free of charge** in the intranet **on the AMP3D server**;
  2. The project must open on **computers** that are in the resources of most AMP employees (the preferred program is Navisworks Freedom) and using the PoTree application;
  3. It is not allowed to publish 3D models on servers **outside AMP**;
  4. The viewer of the project must be able to perform basic operations in **Autodesk Navisworks Freedom** (rotate the object, cut out a model fragment, create sections).

## Directory structure

The directory structure copied from an external disk to the AMP server must be in this order:

+++ 3D model (the name of the project should start with a date in the following format: YYYYMMDD\_)

++ 01 NWD

++ 02 DWG

++ 03 NWF

++ 04 NWC

++ 05 TIF

++ 06 E57

++ 07 Native

+++ Reports

++ PDF

+++ Intranet data

++ 01 PoTree