Project Controls

Master Specification

PC-EDM5 Digital Engineering

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DEPARTMENT FOR INFRASTRUCTURE AND TRANSPORT

Government of South Australia
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Contents

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1 General

1.1 Austroads guides should be adopted to provide a level of consistency and harmonisation across all jurisdictions. The Austroads guides will be the primary technical reference. This supplement is issued to clarify, add to, or modify the Austroads Guides.

1.2 Digital Engineering / BIM (Building Information Modelling) is defined by Building Smart as “BIM is a digital representation of the physical and functional characteristics of a building. As such, it serves as a shared knowledge resource for information about a building, forming a reliable basis for decisions during its life cycle from inception onward.”

1.3 This document is intended to provide an overview of the minimum requirements for Digital Engineering practices on the Department’s road projects

1.4 The incorporation of Digital Engineering (DE) standards is intended to enhance the value of digital information associated with road projects within the Department and align with national and international standards. This document will outline the DE requirements for the Department’s road projects including 3D modelling and visualisation for design, clash avoidance and construction planning. There will be an emphasis on building a federated model for data sharing and reliable design decision making as well as ensuring appropriate asset handover requirements are incorporated into the models.

1.5 The Department specifically aims to encourage Digital Engineering approaches that complement existing project design and development systems but include the use of intelligent design models to satisfy technical handover requirements or Asset Information Requirements that will make up the Asset Information Model (AIM).

1.6 The Contractor shall provide:

a) a Project Information Model (PIM) which is used throughout the delivery phase; and

b) an Asset Information Model (AIM) for the asset management phase.

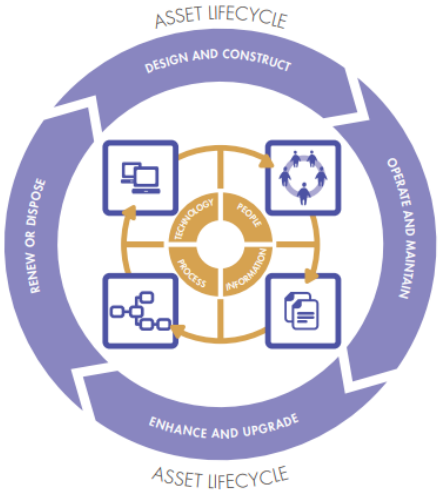
1.7 The PIM and AIM shall comply with the requirements specified in the Department’s “Asset Information Requirements (Road Projects)” (AIR).

1.8 The following documents are referenced in this Part:

a) Digital engineering standards including PAS1192.

b) The Department’s standards and guidelines are available from https://www.dpti.sa.gov.au/standards and https://www.dpti.sa.gov.au/contractor_documents/public_transport_technical_information.

Figure PC-EDM5 1-1 BIM: The whole lifecycle (UK, 2017)



1.9 BIM is a digital representation of the physical and functional characteristics of a building. As such, it serves as a shared knowledge resource for information about a building, forming a reliable basis for decisions during its life cycle from inception onward

1.10 Digital Engineering (DE) may be defined as the convergence of emerging technologies such as Building Information Modelling (BIM), Geographic Information Systems (GIS) and related systems to derive better business, project and asset management outcomes. Digital Engineering enables a collaborative way of working using digital processes to enable more productive methods of planning, designing, constructing, operating and maintaining assets through their life-cycle.

1.11 The Department recognises the importance of Digital Engineering (incorporating Building Information Modelling [BIM]) in the delivery and management of buildings and infrastructure assets and networks. Digital Engineering offers many benefits throughout the asset lifecycle and has the potential to drive efficiency, value for money, productivity and innovation. However, the application of Digital Engineering for infrastructure sectors presents a diverse set of challenges as assets can vary in nature from being discrete in stand-alone buildings, to linear when forming part of a broader network.

1.12 The Department specifically aims to encourage:

a) a more consistent application of Digital Engineering in public infrastructure at a level appropriate to the size and complexity of the asset;

b) Digital Engineering data formats, standards, protocols, systems and tools that are open and harmonised across government agencies, to facilitate greater consistency in engagement with industry;

c) Digital Engineering data formats, standards, protocols, systems and tools that are harmonised across whole of asset life-cycle management processes where possible, to ensure data built up through the design and construction phases of a project is fully utilised in the asset management and operations phases;

d) Digital Engineering approaches that complement existing project design and development systems and interface with Geographic Information Systems (GIS) to graphically display and visualise relevant information captured as part of the Digital Engineering process;

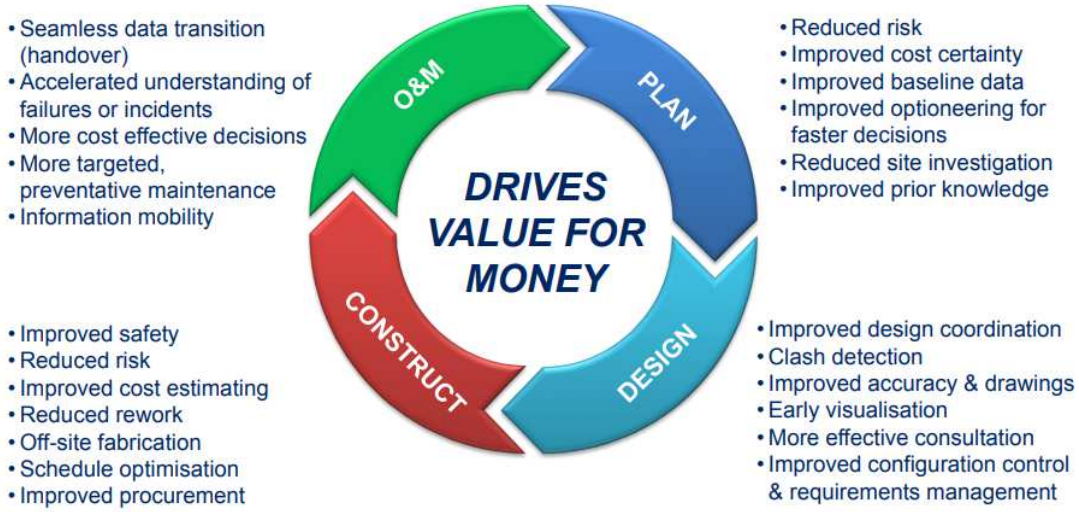
e) Government working collaboratively with the private sector to drive best practice in the application of Digital Engineering in public infrastructure development and management;

f) incorporation of lessons learned from all sectors and international experiences in the application of Digital Engineering in public infrastructure development and management; and

g) building capability within the public and private sectors to support and optimise the application of Digital Engineering across the board.

1.13 Benefits of Digital Engineering:

Figure PC-EDM5 1-2 Benefits of digital engineering (Vaux, 2015)



2 Relationship of Documents

2.1 The diagram below shows the relationship between some of the key Digital Engineering documents and the key DE outputs required on the Department's road projects.

2.2 Each project shall be designated as being either "Type A" or "Type B" in the Request For Tender Documents.

2.3 Larger projects will generally be designated as "Type A" and some of the DE requirements for these will be slightly more stringent. Smaller projects will generally be designated as "Type B".

Figure PC-EDM5 2-1 Example of documents required

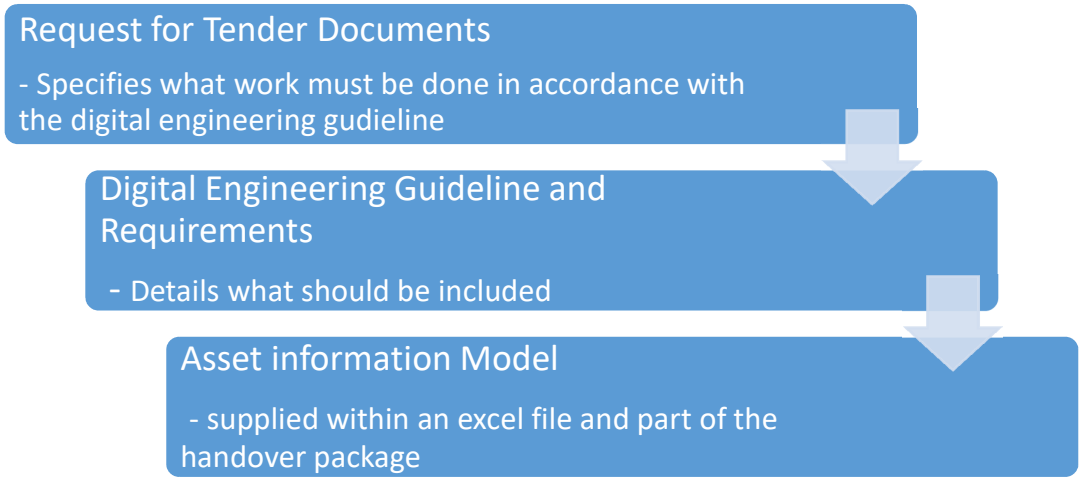
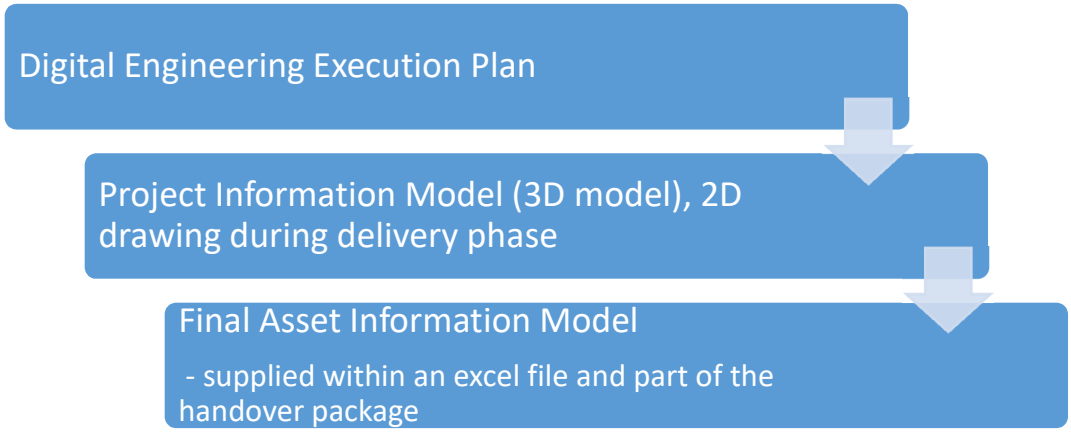


Figure PC-EDM5 2-2 Documents produced by the Contractor



2.4 Wherever the requirements vary, these will be documented.

Table PC-EDM6-1 Example of documents required

Document	Items
Digital Engineering Execution Plan	
Project Boundary	
Native Models	Bridges, Other Structures, Carriageway & Earthworks, Street Furniture, Pavement Marking, Landscaping, Electrical / ITS, Services, Pavements, Geometry Control Strings, Rail, Stormwater
IFC4 Models	Bridges, Other Structures, Carriageway & Earthworks, Street Furniture, Pavement Marking, Landscaping, Rail, Stormwater, Electrical / ITS, Services, Pavements, Geometry Control Strings
Federated Models	IFC4 format, Navisworks format
Drawings	DWG format, PDF format
As Built Survey	

3 Digital Engineering Execution Plan

3.1 A Digital Engineering Execution Plan (DEXP) explains how the contractor will carry out all aspects of information management for the project. The DEXP shall comply with all relevant departmental standards and as far as possible all relevant national and international standards including PAS1192.

3.2 The Department requires the production of both a Pre Contract DEXP and a Post Contract DEXP:

a) “Pre Contract DEXP” means a preliminary DEXP developed by all tenderers and included as part of their tender submissions.

b) “Post Contract DEXP” means a DEXP that has been further developed by the successful tenderer in conjunction with the principal and includes a detailed plan of how all Digital Engineering functions will be undertaken throughout the project up to and including handover of the finished Asset and the finished Asset Information Model.

3.3 The DEXP shall include the Contractor’s approach to:

a) the Contractor’s Common Data Environment;

b) Model Review process and schedule;

c) Clash Detection process and schedule;

d) Collaboration Strategy Internally within the contractor’s team and between the contractor and the principal. This shall include a meeting schedule and an indication of the facilities that will be provided for interaction with the federated model on site;

e) Asset Classification Matrix;

f) Responsibility Matrix;

g) Model Exchange Tables;

h) Model Element Tables;

i) Model and Data Exchange workflows; and

j) Transformation parameters to convert from the project grid to the appropriate MGA zone.

3.4 The Digital Engineering Execution Plan shall comply with all relevant departmental standards and as far as possible align with the principles of recognised international digital engineering standards including PAS1192.

3.5 Digital Engineering functions will be undertaken throughout the project up to and including handover of the finished Asset and the finished Asset Information Model.

3.6 For the majority of projects, each designer or discipline will produce their own model, e.g. Drainage, PUP, Structures, Road. These models can be then combined or "federated" to create a single shared model. Interdisciplinary coordination, a process also known as clash detection, can be confirmed in the federated model.

3.7 Required changes are made in the individual discipline models. On large projects discipline models may be split into multiple, smaller models to cater for internal processes and make file sizes more manageable

3.8 The 3D federated digital model or models reflective of the as built arrangement.

3.9 The Digital Engineering Execution Plan shall include the Contractor's approach to:

a) satisfy the Department's asset information requirements in Part PC-RW60;

b) satisfy the Department's "Asset Information Requirements (Road Projects)";

c) Asset Information Model (AIM) structure;

d) management of data in a project information model (PIM);

e) the Contractor's Common Data Environment (12D synergy, Project wise etc.);

f) Model Review process and schedule;

g) Clash Detection process and schedule;

h) Collaboration Strategy for interaction with the federated model; and

i) Transformation parameters to convert from the project grid to the appropriate MGA zone (refer DP001) via: https://www.dpti.sa.gov.au/__data/assets/pdf_file/0014/101264/DOCS_AND_FILES-3743988-v14-Road_Design_-_Standards_And_Guidelines_-_Design_Presentation_-_DP_001_-_General_Requirements.pdf.

3.10 All projects have slightly different drivers and all companies will have different modelling standards and protocols. It is not the intention of this guide to try and make all projects the same. This is both impractical and would inhibit innovation. However as a minimum, all planning and modelling processes shall comply with the department's survey and modelling standards / policies / and guidelines. Refer to the following references for more details:

a) Drafting and Design Presentation Standards;

b) The Department's Surveying Standards;

c) Specifications;

d) Other relevant departmental technical policies;

e) Standards and guidelines found on the departmental website via https://www.dpti.sa.gov.au/standards; and

f) Naming conventions and structures as per the departments drafting and design presentation via: https://www.dpti.sa.gov.au/standards.

4 Level of Development

4.1 LOD is a scale that can be used to show the reliability of content that is expected to be included for specific model elements at different times during model development.

4.2 The NATSPEC BiM Paper "BIM and LOD" references the American Institute of Architects Draft Document G202-2012 Building Information Modelling Protocol Form which defines Level of Development as follows:

a) "The Level of Development (LOD) describes the minimum dimensional, spatial, quantitative, qualitative, and other data included in a Model Element to support the Authorised Uses associated with such LOD".

4.3 The NATSPEC BiM Paper defines five LODs as described below. Each subsequent level builds on the previous level and includes all the characteristics of the previous levels. The levels defined (with associated content requirements) are:

a) LOD 100 Conceptual: the Model Element may be graphically represented in the model with a symbol or other generic representation, but does not satisfy the requirements for LOD 200. Information related to the Model Element (i.e. cost per square metre, etc.) can be derived from other model elements.

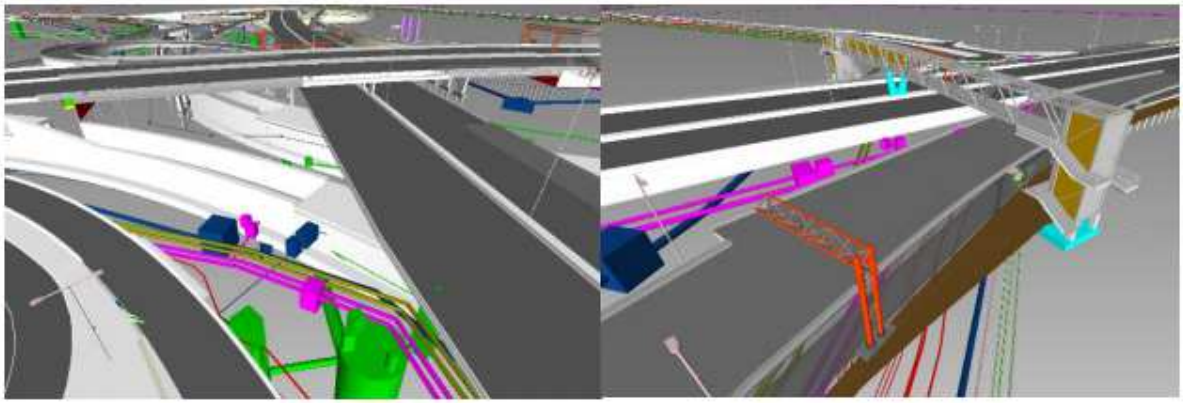
b) LOD 200 Approximate geometry: the Model Element is graphically represented in the model as a generic system, object, or assembly with approximate quantities, size, shape, location and orientation. Non-graphic information may also be attached to the Model Element.

c) LOD 300 Precise geometry: the Model Element is graphically represented in the model as a specific system, object, or assembly accurate in terms of quantity, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element.

d) LOD 400 Fabrication: the Model Element is graphically represented in the model as a specific system, object, or assembly that is accurate in terms of quantity, size, shape, location, and orientation with detailing, fabrication, assembly, and installation information. Non-graphic information may also be attached to the Model Element.

e) LOD 500 As-built: the Model Element is a field verified representation accurate in terms of size, shape, location, quantity and orientation. Non-graphic information may also be attached to the Model Element.

Figure PC-EDM5 4-1 Federated Model illustrating above / below ground structures / utilities & gantries / bridges



4.4 The LOD will be specified during project tender phase.

5 Information Models

Project Information Model (PIM)

5.1 The PIM represents the collection of data files including 3D models, 2D drawings and other project documents developed and used by the Contractor during the delivery phase of the project.

5.2 A key component of the PIM on Type A projects will be a federated model in Navisworks .NWD format. This federated model shall provide a complete digital representation of the physical and functional characteristics of the project in order to provide a shared knowledge resource for information about the works and form a reliable basis for decisions throughout the delivery phase.

5.3 This federated model must enable collaboration, review and checking of the coordination and relationship between the elements and disciplines. This model must be used for all design reviews, to develop simulations of the construction works including temporary works, major structural elements and provide work completed and projected.

Asset Information Model (AIM)

5.4 The AIM will be a key project deliverable. It shall comprise a collection of data files including 3D models, 2D drawings and other structured data and project documents.

5.5 As part of the AIM the contractor shall provide a spreadsheet named “AIM Document Index.xls”. This file shall contain a listing of all items that make up the AIM and shall be produced using the template “AIM Document Index.xlt” available at https://dpti.sa.gov.au/standards/roads-all.

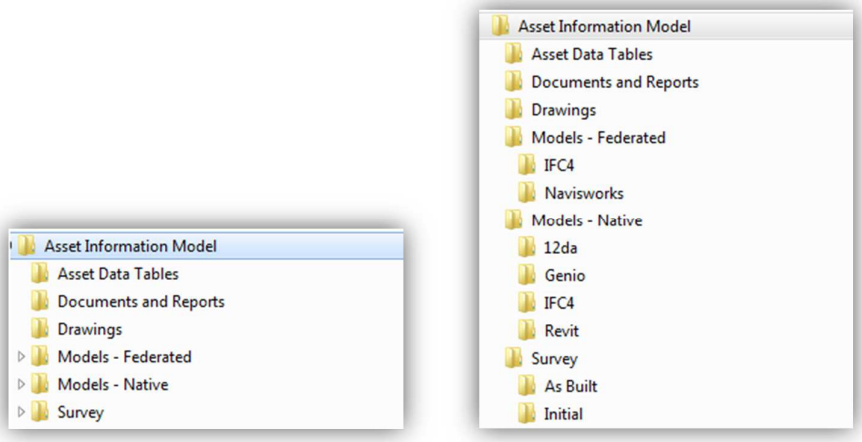
5.6 All relevant items listed in this template shall be included in the AIM and all relevant fields in the index shall be populated.

5.7 The Asset Information Model shall all be produced from the Project Information Model.

5.8 It is expected that the AIM will basically be a subset of the PIM. Most of items in the AIM will also exist in the PIM or can be generated via automated processes, hence the creation of the AIM is not anticipated to be onerous. The AIM will need to be submitted at all major milestones to allow the principal to check the structure of the model along with the quality and progress of content population.

5.9 The AIM shall be delivered as a series of files stored in a standard folder structure as shown below (empty folders do not need to be included)

Figure PC-EDM5 5-1 Standard Folder Structure for AIM Files



6 Geometric Models and Drawings

Native Format Models

6.1 Models shall be supplied in their native format (this includes 12da for 12d models, .Rvt files for Revit models) All models shall conform to the relevant standards available at https://dpti.sa.gov.au/standards/roads-all.

6.2 String labelling shall conform to the Department’s Layer Matrix available at https://dptiapps.com.au/fileshare/

6.3 The file version for Revit files shall be as agreed between the contractor and the principal prior to commencement of work and at any stage where a version upgrade is proposed by either party.

6.4 In addition to the 3D geometry, the contractor should aim to link 4D (time) and 5D (cost) data into the models where possible along with other relevant properties and attributes.

6.5 All project models shall use the coordinate system consistent with the principal's survey model.

IFC4 Models

6.6 All native format models shall also be provided in IFC version 4 Format with each element being prescribed in a model element table. Where a specific IFC discipline standard is unavailable, the contractor must describe the means they are going to use to achieve IFC version 4 compatibility in an appendix to the Digital Engineering Execution plan.

6.7 Where the contractor does not believe it is feasible to supply IFC version 4 files because of software limitations, the proposed version to be supplied shall be listed in the DEXP.

2D Drawings

6.8 Drawings shall be prepared in accordance with the Department's standards and guidelines (in particular "DP001 General Requirements") available at https://dpti.sa.gov.au/standards/roads-all and also the Department's CAD Matrix available at https://dptiapps.com.au/fileshare/ .

6.9 All drawings shall be derived from the native 3D models to the fullest extent possible. Where an object has been modelled and is required to be shown on the drawings, the representation on the drawing must be generated from the model rather than be recreated on the drawings.

6.10 All project drawings shall use the coordinate system consistent with the principal's survey model.

6.11 Drawings shall be supplied in both DWG and PDF format.

7 Glossary

Term	Definition
4D	A 3D model linked to time or scheduling data. Model objects and elements with this data attached can be used for construction scheduling analysis and management. It can also be used to create animations of project construction processes.
5D	A 4D BIM linked to cost data. The time data adds another dimension to cost data, allowing expenditure to be mapped against the project program for cash flow analysis, etc

8 Reference Guide

a) IndiaMART. (n.d.). Building Information Modelling. Retrieved from https://www.google.com.au/search?q=building+information+modelling&rlz=1C1GGRV_enAU805AU805&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjB66X5jOvcAhUJ8LwKHVE4AfIQ_AUICigB&biw=1920&bih=1045#imgrc=2EYgaj6slJJTEM:.

b) QMR. (2017, May). Building Information Modelling (BIM) for Transport and Main Roads. Queensland: Department of Transport and Main Roads.

c) Reuters. (2018, April 24). Building Information Modeling (BIM) Market 2018. Retrieved from Reuters: https://www.reuters.com/brandfeatures/venture-capital/article?id=34655

d) UK, D. o. (2017, December 7). BIM Guidance for Infrastructure Bodies. Retrieved from BIM Guidance for Infrastructure Bodies: https://webcache.googleusercontent.com/search?q=cache:f5p0hCm52g8J:https://www.roads.org.au/Portals/3/FELLOWSHIP%2520PHOTOS/20170904%2520Building%2520Information%2520Modelling%2520-%2520Asset%2520Managment%2520in%2520Civil%2520Infrastructure_FINAL.PDF%3Fv

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