

Standard

S1037 A7 Computer Aided Design (CAD)

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1 Purpose

- 1.1 The purpose of this standard is to define the technical requirements for TfL's Computer Aided Design (CAD) data.

- Note:
- i. Defines formats, document numbering, layer classification and geographical location requirements for CAD files.
 - ii. Structured to ensure TfL CAD data is consistently produced to maximise reuse by projects, operations and asset teams.
 - iii. CAD Data is structured to interface with systems which support digital engineering and management.
 - iv. Provides a collaborative platform/environment based on the BS EN ISO 19650-1 workflow.
 - v. Ensures that TfL CAD data has provenance and technical assurance, tracked by metadata.
 - vi. Defines the templates that shall be provided via the CAD resource packs and used to generate TfL CAD data.

2 Scope

- 2.1 Applies to TfL CAD data created by TfL or delivered to TfL by its suppliers.
- 2.2 The requirements within this document shall be read in conjunction with Standard [S1760](#) and the reference documents listed in section 9.

3 Requirements

3.1 General Requirements

- 3.1.1 The acceptable file formats are: DGN, I.DGN, DWG, RVT, NWD, IFC.
- 3.1.2 Either London Survey Grid (LSG) or British National Grid (BNG) shall be used for all surveys related to geographically fixed assets. The most suitable of the two shall be determined on a site-specific basis and will be defined within the survey specification documentation.
- 3.1.3 The height datum for data in CAD files when using BNG is Newlyn. For files using LSG the height datum shall be set at Newlyn plus 100m (to avoid negative values for underground works).

Note: Newlyn is the mean sea level (MSL) calculated from observation taken at Newlyn, Cornwall and used as the official basis of height calculation. Setting the height datum 100m below Newlyn helps to keep all coordinates in the positive range.

- 3.1.4 Files shall be named in accordance with [S1760](#) Common Data Environment (CDE)

Note: TfL CAD file templates can be provided by the TfL CAD Support Team. See appendix B for list of templates.

3.2 Metadata Requirements

- 3.2.1 Drawing and Model tag sets shall be placed in each CAD file containing the following mandatory file metadata:

Project
Originator
Location
Discipline
Document Number
TfL Asset Class
TfL Security Classification
Suitability Code
Lifecycle
Title
Revision
Created
Created Date
Technical Check
Technical Check Date
Technical Approval
Technical Approved Date
Project Approval
Project Approval Date
Accepted
Accepted Date



3.3 CAD File Requirements

- 3.3.1 CAD file requirements shall apply to model files, composite models and drawing definition files.
- 3.3.2 CAD file numbers shall be assigned following the naming convention set out in [S1760](#).
- 3.3.3 Custom line styles/line types shall use a scale factor of 1 (one).

3.4 Model File Requirements

- 3.4.1 The Model file number shall be assigned following the naming conventions set out in [S1760](#).
- 3.4.2 Model files shall contain two models:
 - a) Design model
 - b) Title block model (containing metadata tag set/attributes).
- 3.4.3 All non-displayed reference/xref files within model files shall be detached unless they form part of the design.
- 3.4.4 Models must be purged and audited before handover, to ensure file sizes are at minimum.

3.5 Drawing Definition Requirements

- 3.5.1 Drawings shall be composed using a 'drawing definition file' (DRG), which contains only the relevant annotation, dimensions etc.; with all design information (M2/M3) attached as reference file(s)
- 3.5.2 A drawing definition file shall comprise of 2 models listed below:
 - a) 1 assembly model
 - b) 1 sheet model (see Appendix A Drawing Composition).
- 3.5.3 Multi-sheet drawings must have a separate drawing definition file for each sheet.
- 3.5.4 Drawing borders shall be referenced in the drawing definition at a scale of 1:1.
- 3.5.5 Annotation, dimensioning etc. shall be placed on presentational CAD layers as defined in section 3.11 CAD layer Naming convention (for CAD Layers only)
- 3.5.6 Dimensions shall be associative for all 'drawn to scale' drawings. Indicative or not to scale dimensions should have, 'NTS' or Not to Scale placed next to them.
- 3.5.7 All files shall be compressed/purged to remove redundant shared cell/block definitions and audited prior to being issued.
- 3.5.8 Reference file nesting depth shall be as follows:
 - a) Limit nested references to depth of 1 for Assembly/design Model or Geospatial Model in drawing file or
 - b) Limit nested references to depth of 3 for drawing definitions.



3.6 Presentation Requirements

- 3.6.1 All measurements (dimensions, volumes, weights etc.) shall be expressed using units based on the metric system (international system of units, SI).
- 3.6.2 Refer to [S1036](#) 'Presentation of Engineering Drawings' for detailed drawing presentation requirements.
- 3.6.3 Terms and abbreviations not defined in [Glossary of Terms](#) and Abbreviations shall be clearly defined on the associated drawing sheet.
- 3.6.4 Standard TfL border size is A1.
- 3.6.5 Drawing definitions shall be presented to allow drawing renditions and printed drawings to be derived as an exact copy.

Note:	i. If drawing renditions / printed drawings are intended to be displayed as monochrome, the drawing definition shall be presented in monochrome, not colour.
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- 3.6.6 A seed file summary is shown in Appendix B

3.7 Revision, Status and Suitability

- 3.7.1 Refer to [S1760](#)

3.8 TfL Security Classification

- 3.8.1 CAD files shall carry the meta-data of 'TfL Security Classification', to indicate the integrity, availability and confidentiality of information and shall correspond with the 'TfL Information Security Classification Standard' [S1782](#).



3.9 Ordnance Survey licensing and copyright

- 3.9.1 Drawings displaying OS mapping shall acknowledge the Crown Copyright.
- 3.9.2 The copyright statement shall read "© Crown copyright and database rights [year of supply] Ordnance Survey [licence number]."

Note: i. OS Mapping can be supplied in BNG and LSG grids on request.

3.10 CAD File naming convention

- 3.10.1 CAD file and layer names shall be delineated using the "-" hyphen character.
- 3.10.2 The CAD document and file name shall follow the section on unique file identification / document numbering in [S1760](#). Examples are given below.
- 3.10.3 Codes shall be selected from attribute codes defined within [S1760](#).
- 3.10.4 Codes shall not imply meaning that may be duplicated in other fields.
- 3.10.5 Characters shall be uppercase.

Example: Rail Asset: ABC1234-MMD-PRM-B073-M3D-AR-00001

Project Code	Originator	Asset Class	Location	Type	Discipline	Number
ABC1234	MMD	PRM	B073	M3D	AR	00001

Example: Surface Asset: ABC1234-MMD-PRM-10-M2D-AR-00001

Project Code	Originator	Asset Class	Location	Type	Discipline	Number
ABC1234	MMD	PRM	10	M2D	AR	00001

Example: Rolling Stock Asset: 73TUBE-BOM-RSK-14-M2D-AR-00001

Project Code	Originator	Asset Class	Location	Type	Discipline	Number
73TUBE	BOM	RSK	14	M2D	RS	00001

- 3.10.6 Drawing Sheets shall also comply with the file naming convention as stated in [S1760](#).

3.11 CAD Layer naming convention

- 3.11.1 Layer names within CAD files are a concatenation of the following attribute codes, each divided by hyphens. The only exceptions are fields 'Presentation' and 'Description', which are joined using an underscore '_'

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- Notes:
- i. CAD layer naming is compliant with BS EN ISO 13567-2
 - ii. If additional levels are required for the Organisation or Project specific it should be added to your organisation role library and supplied back to TfL at hand over.

Example: CE-Pr_20_85_13_32-M_Concrete foundation pads

Discipline	Classification	Presentation	Description	View
CE	Pr_20_85_13_32	M	Concrete foundation pads	(optional)

Example: ME-Pr_70_65_03-M_Air conditioning units

Discipline	Classification	Presentation	Description	View
ME	Pr_70_65_03	M	Air conditioning units	(optional)

3.11.2 Layer names within CAD files shall be composed by joining the fields shown in the table below:

Field	Obligation	Characters	Description
Discipline S1760 Appendix E)	Required	2	Discipline codes indicate the discipline responsible for the creation of the CAD Layer. Owner organisations shall be allocated one or more codes. Discipline codes shall be 2 alpha characters aligned with 'file name' discipline codes; refer to S1760 appendix E for discipline codes
Classification (for CAD layers only)	Required	6-11	The Classification code describes the design component and is the most important field in identifying the component. Classification codes selected from BS ISO 12006-2 (Uniclass 2015) are preferred. However, Uniclass 1.4 is also acceptable. Each layer within a CAD file shall be classified by a single code to describe the individual assets represented.
Presentation (for CAD layers only)	Required	1	Each layer within a CAD file shall be consistent in its presentational conventions, distinguishing between graphical and textual content etc. Presentation codes shall be 1 character (D

			Dimensioning, H Hatching and Shading, M Model related elements, P Plot/paper related elements, T Text)
Description	Required	As defined in Uniclass 2015	Descriptive text shall correspond with the published Uniclass 2015 definition (see 6.2 – Industry Standards).
View	Optional	3	<p>The optional View suffix defines how the element is viewed, i.e. whether it is shown in elevation, section or hidden.</p> <p>Cut - Information lying on the cut line.e.g. walls in plan or floors in a section.</p> <p>Fwd - Elements viewed forward of the section cut line. e.g. a kerb edge or floor outline in plan; walls in an elevation.</p> <p>Hid - Elements hidden from view by another object, but still shown. e.g. a structural beam below a floor or buried drainage runs.</p> <p>Rfl - Reflected information above the section cut line. e.g. ceiling layouts.</p> <p>PR = Proposed EX = Existing RM = Removed</p>

3.12 File Metadata

3.12.1 Metadata requirements shall follow the requirements set out in [S1760](#).

4 Responsibilities

4.1 Author

- 4.1.1 Accuracy of graphical and non-graphical elements within a CAD file.
- 4.1.2 Compliance with this standard.

4.2 Technical Checker / Approver

- 4.2.1 Reviewing CAD files against discipline engineering requirements and authorising (accept / reject) for use in accordance with the Suitability indicated.

4.3 Project Approver

- 4.3.1 Reviewing CAD files against Project engineering requirements and authorising (accept / reject) for use in accordance with the Suitability indicated.

4.4 TfL Authoriser

- 4.4.1 On behalf of TfL, authorising (accept / reject) CAD files submitted to TfL for publishing for use in accordance with the Suitability indicated.



5 Supporting information

- 5.1 If you need any technical assistance with any of the requirements within this document, you can contact the TfL CAD Support Team at:
cadsupport@tube.tfl.gov.uk

6 Person accountable for this document

Name	Job title
John Park	Principal Engineering Leader, Digital Engineering, Central Engineering

7 Definitions

Term	Definition	Source
Asset Class	TfL Engineering Assets classification	Jargon Buster
CAD File (Computer Aided Design)	Electronic file produced by a CAD application. Examples of CAD files include Drawing Definitions and Model files.	Jargon Buster
Common Data Environment (CDE)	An environment, with processes set out in SMP and BIM Execution Plan, for the production, use and management of Model File(s), Composite Model(s), Non-Graphical Data, Document Definition(s) and Document Rendition(s) as agreed between the Parties and set out in the MIDP(s).	Jargon Buster
Composite Model	Computer Aided Design (CAD) file(s) displaying one or more Model Files (attached as references) for the purpose of performing coordination activities and / or compiling Drawing Definitions.	Jargon Buster
Data	Set of digital values stored, but not yet interpreted or analysed (un-processed), in a form that is convenient to move or process. Data is generally represented in a structured and often tabulated form (rows and columns). 'Raw Data' is a relative term and therefore not used.	Jargon Buster
Document	Information recorded for a specific purpose, providing a means to communicate the briefing, design, construction, operation, maintenance or decommissioning of an asset. This includes, but is not limited to, correspondence, Drawing Renditions, schedules, specifications, calculations,	Jargon Buster

	spreadsheets. Note: Documentation must either be in an immutable format or incorporate a means of controlling changes.	
Drawing Definition	A CAD file created solely for the purpose of producing a Drawing Rendition or Printed Drawing. The graphical content of the drawing definition is contained in other CAD files (e.g. Model files and/or Composite Models) which are attached as References. Only annotation and dimensions are 'live' within the Drawing Definition file. Examples may include As-built Drawing Definitions.	Jargon Buster
Drawing Rendition	Electronic file, in an immutable format such as PDF, derived from a Drawing Definition. Examples may include As-built Drawing Renditions.	Jargon Buster
Drawing Sheet	CAD file containing the graphics of a blank drawing border and title block, of predefined paper sizes. Used as a reference by all drawing definitions.	Jargon Buster
Layer	Synonymous with the level functionality in the Bentley DGN file format.	Jargon Buster
Level	Floor level within a building (refer to S0135, Location Coding System)	Jargon Buster
Metadata	'Data about the data'. Information about one or more aspects of certain item's content. For example: size of document, date created etc.	Jargon Buster
Model File	A Computer Aided Design (CAD) file which consists of geometry that represents the physical characteristics (may also include functional characteristics) of the works, produced at a scale of 1:1. It may form part of the Composite Model and/or Drawing Definition.	Jargon Buster
Model Rendition	An immutable file, in a format such as PDF, which is derived from a Model File or Composite Model.	Jargon Buster
Reference	A Bentley Microstation term meaning a CAD file attached to another CAD file such that all or part of the graphical content is visible but not editable in the file to which it is attached.	Jargon Buster
Seed-file	A Bentley MicroStation term meaning an empty Design File, with basic parameters, used as a template.	Jargon Buster

Tag	A Bentley MicroStation term meaning a non-graphical attribute attached to an element within a CAD file.	Jargon Buster
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8 Abbreviations

Abbreviation	Meaning
BNG	British National Grid
BS EN	British adoption of a European standard
CAD	Computer Aided Design
CDE	Common Data Environment
DGN	Bentley's CAD file format
DWG	Autodesk's CAD file format
LSG	London Survey Grid
SI	International System of Units
NTS	Not To Scale
OS Mapping	Ordnance Survey Mapping

9 References

Document no.	Title or URL
S1760	Standard Method and Procedure (SMP) and Common Data Environment (CDE)
S1782	TfL Information Security Classification Standard
S1036	Presentation of Engineering Drawings. Requirements for the appearance of drawings, including layout, size, text types, line styles, symbols, drawing scales etc.
BS EN ISO 19650 1 2018	Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) – Information management using building information modelling - Part 1: Concepts and principles
BS EN ISO 19650 2 2018	Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) – Information management using building information modelling - Part 2: Delivery phase of the assets

10 Document history

Issue no.	Date	Changes	Author
A1	October 2007	Authorised for use.	David Lapsley
R20	25/08/11	For initial consultation	Paul Shillcock
R21	07/01/12	For Approval	Paul Shillcock
R22	08/02/12	Incorporated comments and issued to DRACCT	Paul Shillcock
R23	05/03/12	Incorporated comments from Head	Paul Shillcock

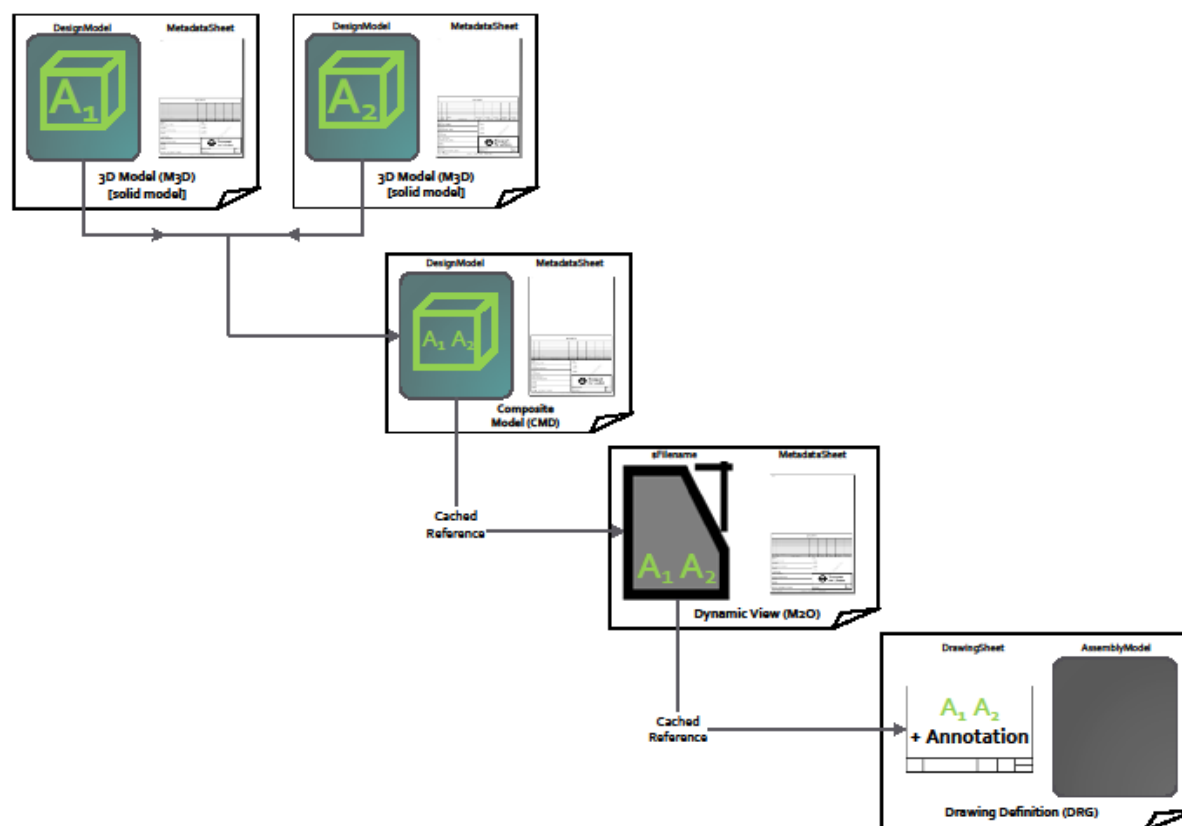
		of Engineering Information	
A2	March 2012	1-037 renumbered, reformatted and updated as per DRACCT No. 00833	Paul Shillcock
A3	May 2014	Incorporated comments from Engineering Information and Asset Groups	Paul Davis
A4	February 2020	Reviewed, updated and reclassified to become a pan TfL standard as per change No. CR-12167.	Mathew Brett
A5	September 2022	Modified wording to layer naming and seed file summary and revised nested reference limit to 3. Change No. CR-16542.	John Park
A6	September 2022	Diagrams in the appendices amended to remove reference to "extractions", as this is not best practice. Change No. CR-16592.	John Park
A7	February 2024	Minor errors in standard references and also images in Appendix A corrected. Change No. CR-18729.	John Park



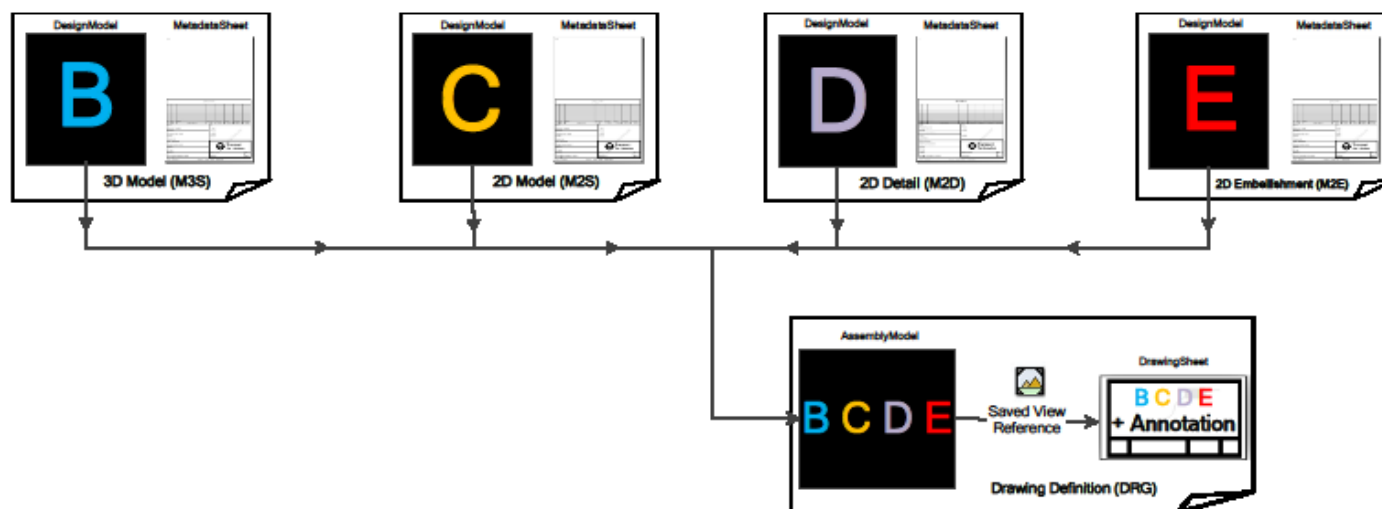
11 Appendices

11.1 Appendix A – Drawing Production Composition and Workflow

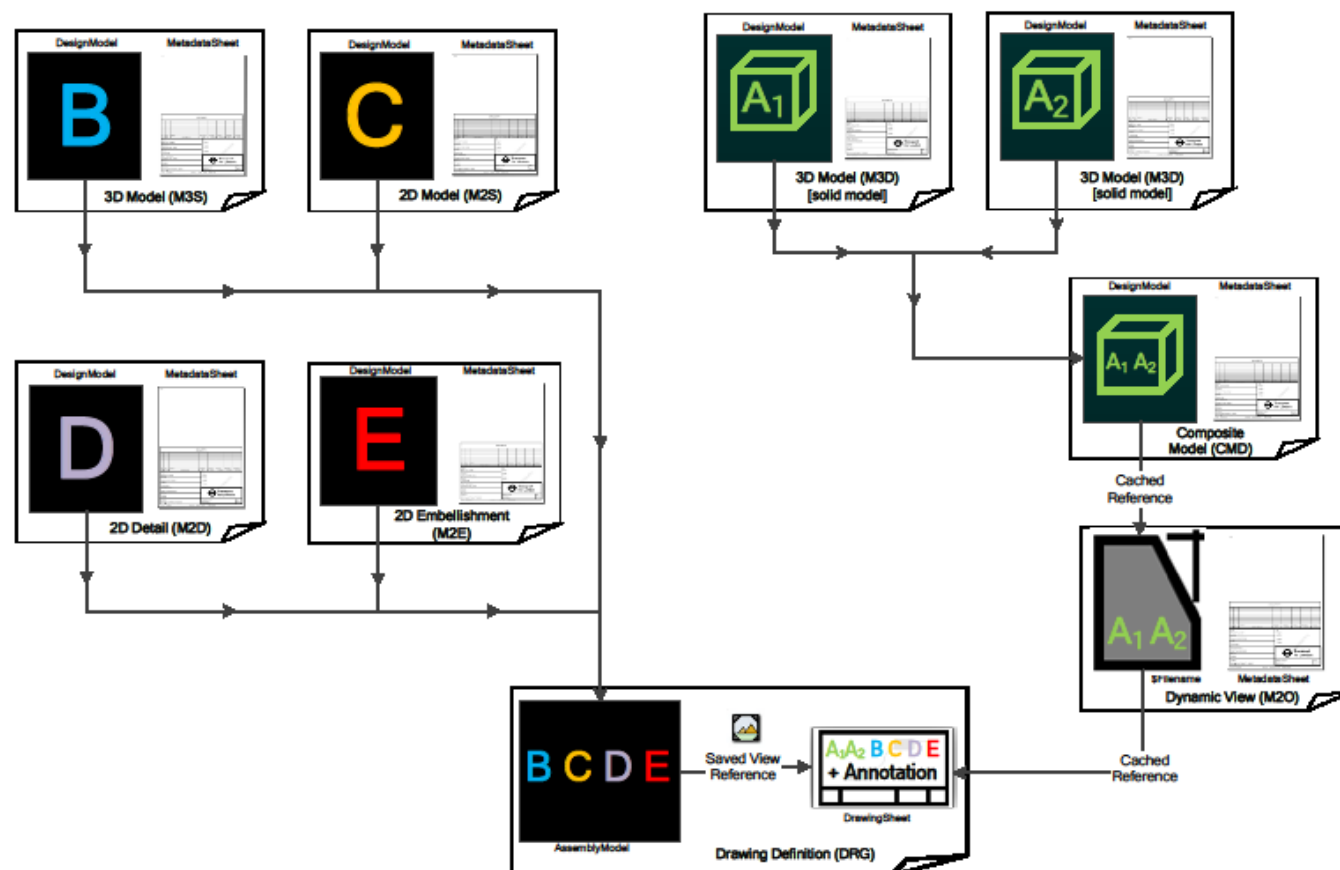
Drawing Production Workflow - Option 1 - Using Solid Models in a Drawing via Dynamic Views



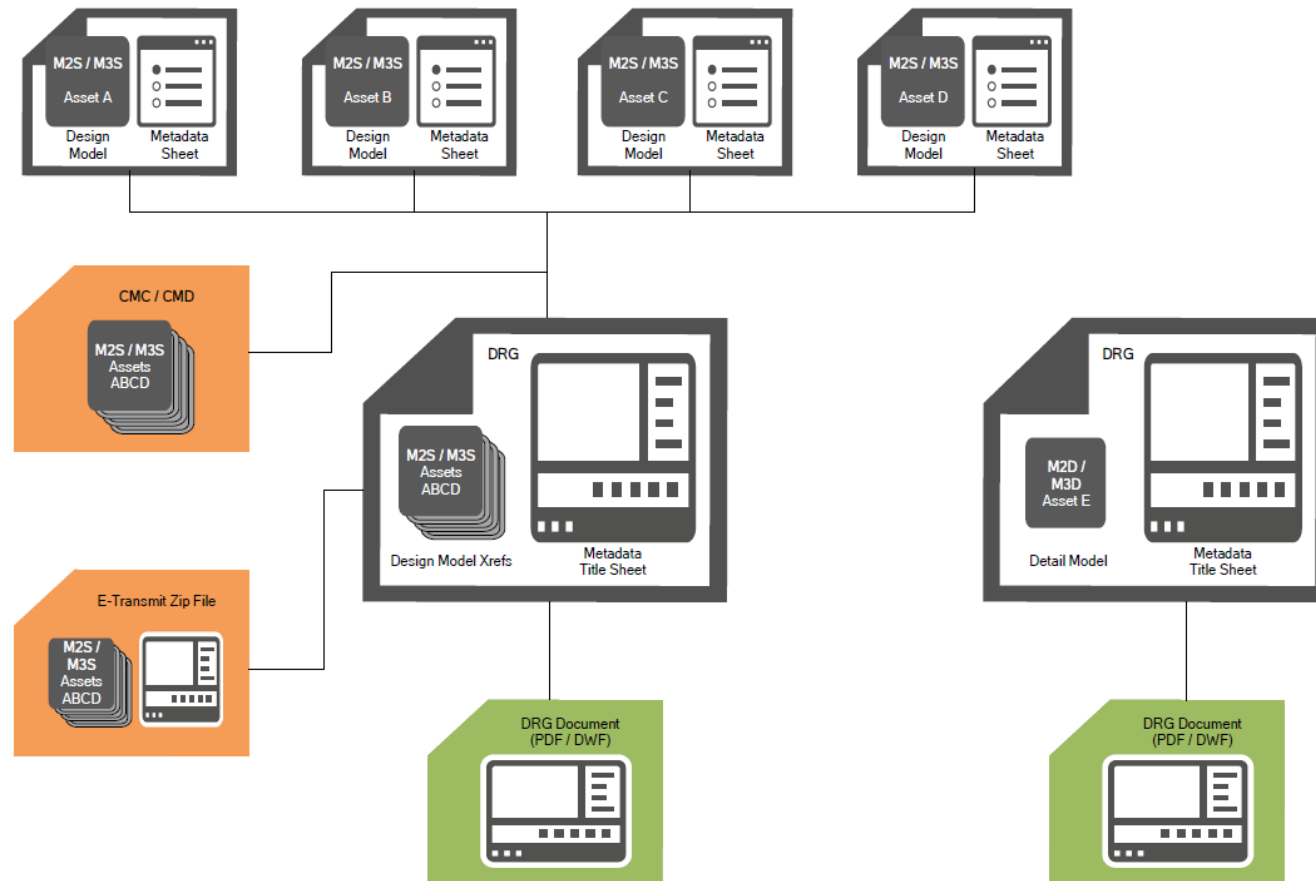
Drawing Production Workflow - Option 2 - Using Saved Views created from an Assembly Model in a Drawing



Drawing Production Workflow - Option 3 - Using 3D Solid Models and 3D Spatial Models in a Drawing

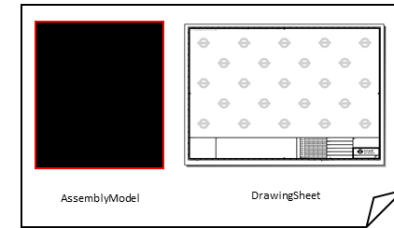
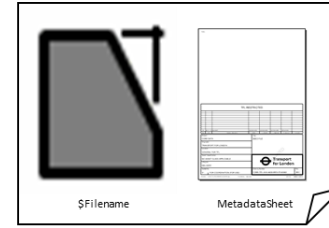
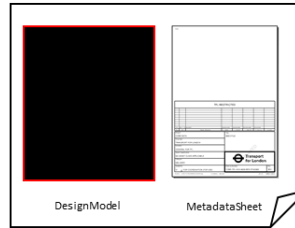
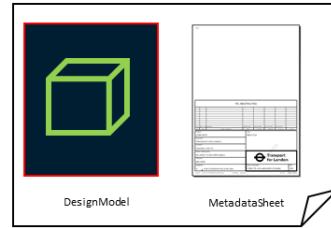
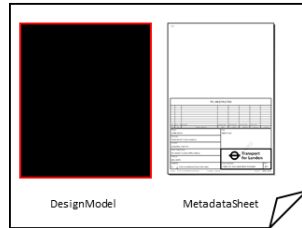


AutoCAD Drawing Production Workflow



11.2 Appendix B – Templates/Seed Files

Bentley Seed File Summary



SEED FILE	LSG - SPATIAL MODEL - M3S
APPLICABLE TYPES	M3S
RESOLUTION	10,000 UOR/m
SOLIDS WORKING AREA	429 km
GLOBAL ORIGIN OFFSET	-214748.3648, -214748.3648
GEOGRAPHIC COORDINATE SYSTEM (GCS) APPLIED	London Survey Grid (no offsets / modifiers)

SEED FILE	M3D MODEL M3D-CMC-CMD MODEL NO ZONE
APPLICABLE TYPES	M3D, CMC, CMD
RESOLUTION	1,000 UOR/mm
SOLIDS WORKING AREA	4.29 km
GLOBAL ORIGIN OFFSET	0,0
GEOGRAPHIC COORDINATE SYSTEM (GCS) APPLIED	Helmert Transformation With appropriate GCS modifier

SEED FILE	LSG - SPATIAL MODEL - M2S-M2E-CMC-CMD-M2O
APPLICABLE TYPES	M2S, M2E, M2O, CMC, CMD
RESOLUTION	10,000 UOR/m
SOLIDS WORKING AREA	429 km
GLOBAL ORIGIN OFFSET	-214748.3648, -214748.3648
GEOGRAPHIC COORDINATE SYSTEM (GCS) APPLIED	London Survey Grid (no offsets / modifiers)

SEED FILE	M2O EXTRACTION SEED TFL DRAWING SEED GENERAL DGNLIB
APPLICABLE TYPES	M2O
RESOLUTION	1,000 UOR/mm
SOLIDS WORKING AREA	4.29 km
GLOBAL ORIGIN OFFSET	0,0
GEOGRAPHIC COORDINATE SYSTEM (GCS) APPLIED	Helmert Transformation With appropriate GCS modifier

SEED FILE	LSG - DRG - DRAWING SHEET
APPLICABLE TYPES	DRG
RESOLUTION	10,000 UOR/m
SOLIDS WORKING AREA	429 km
GLOBAL ORIGIN OFFSET	-214748.3648, -214748.3648
GEOGRAPHIC COORDINATE SYSTEM (GCS) APPLIED	London Survey Grid (no offsets / modifiers)

SEED FILE	BNG - M3S SPATIAL MODEL
APPLICABLE TYPES	M3S
RESOLUTION	1,000 UOR/m
SOLIDS WORKING AREA	4,294 km
GLOBAL ORIGIN OFFSET	0,0
GEOGRAPHIC COORDINATE SYSTEM (GCS) APPLIED	British National Grid (no offsets / modifiers)

SEED FILE	BNG - SPATIAL MODEL - M2S-M2E-CMC-CMD-M2O
APPLICABLE TYPES	M2S, M2E, M2O, CMC, CMD
RESOLUTION	1,000 UOR/m
SOLIDS WORKING AREA	4,294 km
GLOBAL ORIGIN OFFSET	0,0
GEOGRAPHIC COORDINATE SYSTEM (GCS) APPLIED	British National Grid (no offsets / modifiers)

SEED FILE	BNG - DRG - DRAWING SHEET
APPLICABLE TYPES	DRG
RESOLUTION	1,000 UOR/m
SOLIDS WORKING AREA	4,294 km
GLOBAL ORIGIN OFFSET	0,0
GEOGRAPHIC COORDINATE SYSTEM (GCS) APPLIED	British National Grid (no offsets / modifiers)

