Computer Aided Design

Design Standard

DOCUMENT HIERARCHY

This document resides within the Planning component of Western Power's Asset Management System (AMS).

DOCUMENT DATE

This document was last updated February 2024

IMPLEMENTATION DATE

This document came into service February 2024

DOCUMENT CONTROL

Record of endorsement, approval, stakeholders, and notification list is provided in EDM# 44023040

RESPONSIBILITIES

Western Power's Engineering & Design Function is responsible for this document

CONTACT

Western Power welcomes your comments, questions, and feedback on this document, which can be emailed to standards.excellence@westernpower.com.au

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Contents

Revision Details

Version	Date	Summary of change
4	1/08/2022	Table 2.1 updated. 3.1, 4.5.2 & A.1 updated with new software versions. Notification list updated. Section 10 & A.4 added.
5	February 2024	Standards Online Update

1 Introduction

The purpose of this guideline is to:

Ensure a consistent and high quality of presentation for engineering drawings.

Ensure compatibility with existing drawings and the CAD environment.

This guideline is to be applied both in the preparation of new drawings and the revision of existing drawings. No departure from this guideline is permitted without written approval from Western Power or their authorised representative.

1.1 Purpose and scope

This guideline describes:

1. The practices that shall be followed in the preparation of all engineering drawings for Western Power.

The technical requirements that shall be followed when preparing Computer Aided Design (CAD) based engineering drawings for Western Power.

These practices and requirements apply to all engineering drawings produced by Western Power and contractors.

1.2 Acronyms

Acronym	Definition

1.3 Definitions

Term	Definition
Cancelled drawing	A drawing which has been made redundant or not required due to removal of the equipment to which it refers.
Revised drawing	A drawing where the content in the drawing has been altered since the last formal issue
Superseded drawing	A drawing where the information on it has been transferred to a more recent drawing with a different drawing number. Reference to original drawing numbers needs to be made on the new drawing. Old drawing must be redirected to the new drawing.
Redrawn drawing	A drawing which has been completely re-drawn but retains the same drawing number as the original drawing.

Not Maintained drawing	A drawing where, except where noted on the drawing, a decision has been made to not revise the drawing to keep it aligned with the actual installed plant. The equipment to which it refers may or may not be installed
Design Model	Consists of design geometry, can be 2D or 3D design files.
Sheet Model (Sheet Space)	Electronic drawing sheet, normally 2D but can be 3D Also known as Sheet Space.
Not to be used for new designs	Legacy standard drawings that may use equipment, materials or installation methods that are out-dated or not part of the current standard. These drawings provide information on existing installations. They shall not be issued for construction in new designs (greenfield and brownfield)

1.4 References [1]

References which support implementation of this document

Table 1.1 References

Title
Engineering Design Instruction – Drawing Numbers and Titles
EngIM Basic & CAD User Guide (ProjectWise Explorer)
Western Power – CAD Conform User Guide

2 Supporting Documentation[2]

3 Compliance

When revising existing drawings which followed standards other than **those specified in this section, the current standards shall be followed. Written permission from Western Power or its delegate is required for an exception to this rule.**

This Design Standard complies with all higher-level Western Power technical documents and relevant Australian Standards.

This Design Standard should encompass all requirements of the relevant Australian Standards which are current at the time of issue. These relevant Standards and Guidelines are listed in Table 3.1 below. A period will be set when the standard needs to be reviewed. If significant changes occur on an Australian Standard which affects safety, then an out of cycle review can be completed.

1 See Western Power Internal Document
2 See Western Power Internal Document

Table 3.1: Standards and Guidelines

Australian Standard	Title
ISO 80000-1:2009	Quantities and units – Part 1: General
AS 1100.101-1992	Technical Drawing – General Principles
AS 1101.3-2005 (R2018)	Graphical Symbols for General Engineering
IEC61082-1:2014	Preparation of documents used in electro technology
AS 1203.2-1996 (R2016)	Microfilming of Engineering Documents – Quality criteria and control
AS 1717-1975 (R2016)	Unitized Microfilm Carriers (35mm)
AS 2067:2016	Substations and high voltage installations exceeding 1 kV a.c

4 Functional Requirements

This Engineering Design Instruction is intended to be used by Substation Engineering staff and by companies completing outsourced design work for Western Power, as it outlines the Western Power requirements pertaining to the labelling and creation of drawings for Transmission Substations.

5 Safety in Design

The Safety in Design (SiD) process shall be adhered to when creating new drawings. Any potential risks that may cause harm, affect the operation and maintenance of assets, or impact the environment or construction activities shall be identified during the design stages.

All projects are required to have a SiD Hazard Management Register (HMR) and these risks be registered in the HMR and eliminated or minimised so far as reasonably practicable (SFAIRP).

6 Practices

6.1 CAD File Format and Drawing Production

- The nominated software for CAD engineering drawings is:
  - Bentley Systems MicroStation CONNECT Edition
  - Bentley Descartes CONNECT Edition raster editing software.
  - AutoCAD Civil 3D
- Version compatibility must be approved by the Substation Design Principal Electrical Design Engineer prior to commencement of drafting.
- All vector files must be created and supplied in Bentley Systems MicroStation CONNECT Edition file format using the default filename extension of .dgn.
- All scanned raster drawings are to be supplied in Intergraph CCITT Group 4 format using the default file extension of .cit

- All drawings sent to contractors for revision must be returned in the same format they were sent. For example, if they were sent in .dgn format, they must be returned in .dgn format.
- Revisions made to all existing Western Power CAD drawings must be performed according to CAD processes.
- Existing manual (non-CAD) drawings requiring revision must be scanned. Modification is then done using Bentley Systems MicroStation CONNECT Edition and Descartes CONNECT Edition raster editing software.
  The manual drawing shall be redrawn in CAD using Bentley MicroStation CONNECT Edition if it is not suitable for scanning.
- CAD files shall be created on the basis that one drawing model has one CAD file.
  Multiple drawing sheets stored in a single CAD file is not acceptable. An exception exists for line routes and cable routes where a model can have multiple sheets.
- The sheet within a CAD file must be named with the corporate drawing number.
  Refer to Design Standard – Drawing Numbers and Titles.
- All existing production drawings sent to contractors for revision must be returned with the same CAD File name in which they were sent.

For example, a drawing checked out by document control for revision with the CAD File name:

- ss123-05-80100-001.dgn

The windows file name and the CAD File name within the drawing must NOT be modified when returning a drawing as drawn in the example above.

- ss123-05-80100-001.dgn – CORRECT
- SS123-5-80100-1.dgn – INCORRECT

- All new non-scaled drawings such as schematics, MicroStation format material lists (.dgn) & termination drawings are to be setup as follows:
  - Select File > Models. (The Models dialog opens.)

    The default design model description is “Master Model”

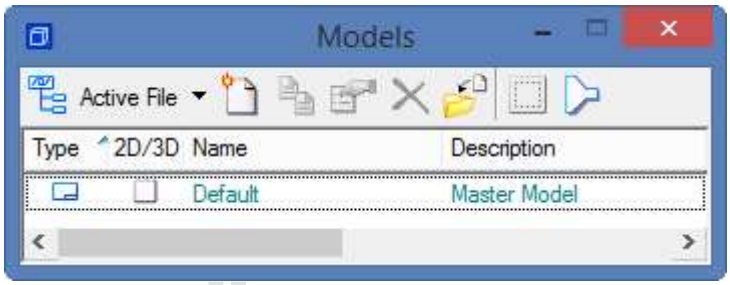


Figure 6.1: Default design model description

  - Click ‘Edit Model Properties’ icon and set the default design model type as ‘Sheet’.

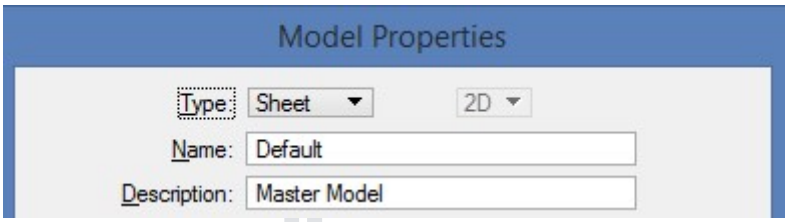


Figure 6.2: Default design model type

- Click 'Define Sheet Boundary' icon and set sheet boundary to applicable sheet size

  i.e. ISO A1, A2, A3 etc.

All legacy non-scaled drawings must also be updated to this guideline.

- All new and legacy scaled drawings must consist of a:
  - Design model. Information to be captured within the design model includes:
    - Plant drawings
    - Items that are required to be drawn to a scale of 1:1. Examples are civil works, plans & layouts.
  - Sheet model. Information to be captured within the sheet model includes:
    - Title block border
    - Notes
    - Legends
    - General notations
    - Dimensions.
- The models shall be referenced into the sheet space at the required conforming scale.
- All scaled drawings must be updated with the latest border cell and sheet when revised.
- Non-scaled drawings such as secondary schematics will only need updating with the latest border cell and sheet if the requirement of section 7.1.2.5 is met.

6.2 Civil Works Drawings

- The nominated software for Civil drawings (such as Civil works, Roads and Drainage) is:
  - Autodesk Civil 3D
- Version compatibility must be approved by Substation Design Principal Electrical Design Engineer prior to commencement of drafting.

7 Principles of Operation

The following principles of operation must be adhered to:

- New CAD drawings shall be prepared using standard Western Power template drawing files that are configured for various design areas. Western Power will provide templates / seed files, models and sheets as required.
- Existing drawings are not to be used as seed files for new drawings.
- Standard Western Power design area sheets and borders shall be used for all drawings. Western Power will supply all required borders and sheet space seed files to suit individual design areas.
- All non-sheet models are to be drawn on CAD full size (i.e. one metre on the ground equals one metre in the system).
- Only cells in Western Powers CADconform cell libraries are acceptable.
- Site work drawings are to be drawn geospatially correct using an appropriate grid system (e.g. MGA94 - Map Grid Australia).

7.1 Copyright

All drawings that have been created by or for Western Power are deemed to be Western Power's intellectual property. Western Power's copyright clause cell therefore needs to be inserted in each drawing. This does not apply to plant manufacturer drawings as the manufacturer owns the intellectual property of the manufacturer drawings.

The latest copyright cell must be inserted when borders are updated.

7.2 Drawing Sheet Sizes

All new drawings are to be produced on standard ISO series sheets (e.g. A0, A1, A2, A3 and A4).

The maximum sheet size of A1 is preferred. A0 sheets should only be used when necessary. PDF files are to be created as per the sheet size, A0, A1, A2, A3 or A4.

7.3 Drawing Borders and Title Blocks

All new CAD drawings must be produced using the appropriate Western Power individual design area's seed file, border or template file.

Drawing borders are to be part of the actual file and not a reference file.

7.4 Contractor Information

7.4.1 Title block and Revision Blocks

7.4.1.1 Producing New Drawings

For new drawings the contractor's company abbreviation shall be placed in the approved section of the Western Power title block.

The approved contractor's abbreviation can be obtained from Western Power.

= Abbreviation

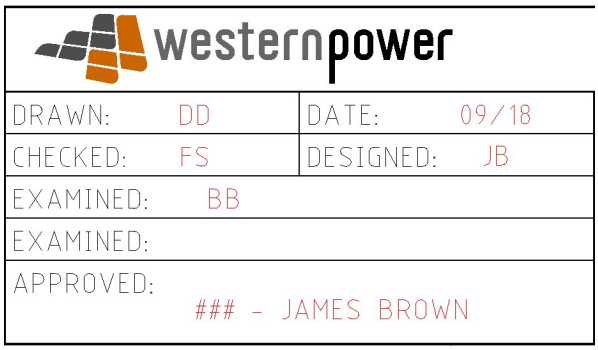


Figure 7.1: Title Block – Producing New Drawings

7.4.1.2 Revising Existing Drawings

For versioning of existing drawings, the contractor's company abbreviation shall be placed in the approved section of the Western Power revision block.

= Abbreviation

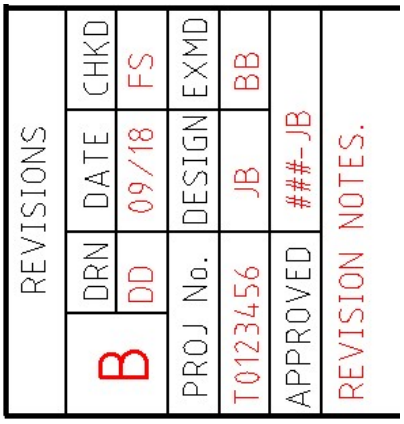


Figure 7.2: Revision Block – Revising Existing Drawings

If a field is not required or not relevant the field shall be marked as "N/A" or "-".

7.4.2 Contractor Logo

Contractor logos are not permitted.

7.5 CADconform

CADconform is a product that has been introduced to implement the revised set of CAD standards for projects created using MicroStation CONNECT Edition 2023.

CADconform is not used across all areas of Western Power.

7.5.1 New Drawings

If CADconform is required, all new drawings created must conform 100% to Western Power Standards. This means that there is to be no legacy data in these drawing (e.g. no elements on levels 1-63).

Any drawing being modified/revised must be drawn to CADconform standards with the stamp validated in sheet space.

7.5.2 Legacy Data Drawings

When MicroStation version 7 or earlier drawings (legacy drawings), are converted to MicroStation CONNECT Edition format:

1. A marker is set in the file. CADconform will only conform those elements added or modified after that marker. It is important to note; legacy elements should not be moved within a drawing file as these elements will be flagged by CAD Conform and will then need conforming. Best Practice is not to move legacy data unless removing altogether.

Levels 1 to 63 are not to be used for additional work on any drawing.

7.5.3 External Contractors

1. The contactor will be provided with the latest version of Western Power's CADconform Feature Tables at the start of each project.

The contractor will abide by Western Power standards set by CADconform.

7.5.4 Supporting Information[3]

[3] See Western Power Internal Document

8 CAD System Compatibility

8.1 Hybrid Files

8.1.1 Scanning

All drawings that are scanned shall be saved in Intergraph compatible CCITT Group 4 file format (Intergraph Type 24). The default file extension of .cit must be used. The drawing shall be scanned in at full size and at a resolution of 300 dots per inch (dpi).

Other than the file extension, the filename for all scanned drawings shall be constructed using the same naming convention as described for each design area (e.g. Design Standard – Drawing Numbers and Titles).

Raster files must have speckles removed and holes filled after scanning. File degradation must not be visible when plotted at full size.

New drawings must not contain raster elements. The only exception to this is photos or maps used for information purposes only. These must be geo-referenced where relevant.

8.1.2 Hybrid CAD Files

Hybrid CAD files contain both a vector (.dgn) and a raster (.cit) component. The following characterise hybrid CAD files:

- The CAD filenames shall be identical with the exception of the file extension.
- The raster image must be located within the border at the bottom left corner of the design plane (XY=0, 0). An exception is when the raster is geo-referenced.
- The raster units must match the vector working units (i.e. mm). The raster file must be loaded into Descartes at full size.
  After loading, the drawing should not be scaled. This would cause the file storage requirements will increase significantly.
- Raster files are to be placed on level ss_raster-1.
- The raster drawing border is to be replaced with the relevant vector drawing border and copyright clause.

9 Technical Requirements

9.1 Orientation of Plans

A north point shall be indicated on every location plan, preferably next to the title panel. Wherever possible, all plans for a particular project shall be drawn with the same orientation on the drawing sheet. The north point is recommended to face the top of the sheet when viewing the title block.

9.2 Orthographic Drawing Projection

The preferred method of projection for civil, structural, mechanical and electrical work is "3rd angle". It shall be used wherever possible. Any variation should be noted and clearly indicated on the views.

9.3 Scales

- Drawing scales. Engineering and architectural drawing scales plus surveying and mapping drawing scales shall use ratios as recommended in AS1100.101
- Single scale on drawings. Where only one scale is used on a drawing sheet, it shall be indicated in the title block.
- Multiple scales on drawings. Where more than one scale is used on a drawing sheet, the scale shall clearly be shown adjacent to the view concerned.
  Each scale used shall be indicated in the title block.
- Different horizontal to vertical scale. Each scale should be clearly shown where different scales are used (e.g. road profiles). As an example:
  Horizontal Scale 1:500
  Vertical Scale 1:100

9.4 Co-ordinates

All co-ordinates are to be provided in MGA94 format, either Zone 50 or Zone 51.

9.5 Lettering, Numerals, Symbols and Notes

- General
  - Lettering, numerals and symbols shall comply with AS 1100.
  - Lettering should be distinct, uniform and clearly legible. Upper case letters shall be used for all titles and sub-titles.
  - All lettering shall be orientated so that it can be read as the drawing is designed to be viewed:
    (i) Title block in bottom right corner for landscape drawings
    (ii) Title block in bottom left corner for portrait drawings.
  - Upper case lettering shall be used on all drawings except:
    (i) Where lower case lettering is required for conventional signs and symbols, e.g. mm; kg; kPa; kV
    (ii) File names, e.g. ss123-05-123-001.dgn
- Notes on Drawing
  - General or repeated information shall be grouped and preferably located near to and above the title block.

- Descriptive notes should be placed as close as practicable to the items to which they refer and in no case shall the lettering obscure any part of the drawing. Instructions on drawings shall be written in the imperative.

9.6 Lines

Line work on engineering drawings shall conform to AS 1100. Compliance with the requirements of this standard will ensure satisfactory reproductions from the original drawings. It will also ensure compliance with the requirements of AS 1203, Microfilming of Engineering Documents (35 mm).

9.7 Abbreviations and Symbols

Unless defined in the appendix of standard engineering abbreviation the use of abbreviations on drawings is not recommended.

Abbreviations may be used in text, notes and table heading as contained in AS1100.

Symbols shall conform to relevant codes and to AS 1100.

9.8 Referencing

- Where possible reference files should be merged into the default model (master model) before final submittal to Western Power.
- For Greenfield Substation sites it may be acceptable to submit reference files for the following disciplines, provided written approval is obtained from Western Power or their authorised representative.
  - Civil
  - Structural
  - Primary

  The reference file naming standard outlined in Design Standard – Drawing Number and Titles must be strictly adhered to.
- Reference files are not to use the 'Save Full Path' switch or 'Save Relative Path' check box when attached and are to reside in the same directory as the actual file.
  i.e. DGN, DWG, CIT, TIFF, Raster, JPEG and PDF reference files.

9.9 Conditions of File Setup

Table 9.1: Conditions of File Setup

Design File Type	Working Units
Basic engineering	1mm:1mm:1000 (default)
Layout engineering	1m:1000mm:1000
Cadastral and Mapping	1m:1000mm

9.10 Finished File Conditions

- File Screen Condition. "Save Settings" to be applied with windows tiled and set up as below:
  - View 1 - Sheet space - complete drawing (fitted)
  - View 5 - Sheet space - title block and ancillary information
- View Attributes On:
  - Text
  - Levels used displayed
  - Line Weight
  - Grid
- View Attributes Off:
  - Constructions
  - Data Fields
  - Text Nodes
  - Level Overrides
- Finished files are to be a complete drawing and border.

9.11 Drawing Location

The bottom left-hand corner of the drawing border (sheet space) shall be located on the centre of the design space and defined as XY = 0,0.

Only place the model at XY=0,0 if the drawing is not geo-referenced (e.g. schematics & termination diagrams).

9.12 Drawing Grid

Electrical schematics shall be drawn on a metric grid (e.g. 1 mm).

9.13 CAD Text Fonts

Font 27 (ISO 3098/I, type B upright) shall be used for text on drawings. Font 22 shall be used for symbols. No other font characters are acceptable without written permission from Western Power.

All text is to conform to AS 1100.

The above fonts are available using the font library 'SECFONT' which is available from Western Power.

9.14 Colour Table

Western Power's standard colour table is 'std.tbl'. This colour table is available from Western Power.

9.15 Line Styles

Only Western Power custom line styles and multi lines styles are to be used. All other line styles and multiline styles must be dropped prior to delivery to Western Power. The Western Power custom line style & multi line styles are available from Western Power.

9.16 CAD Line Weights

The table below defines the CAD line weights.

Table 9.2: CAD line weights

CAD Line Weight	Designation (line weights equating to plotted line thickness)
WT=0	0.18 mm
WT =1	0.25 mm
WT =2	0.35 mm
WT =3	0.5 mm
WT =5	0.7 mm
WT =7	1.0 mm
WT =11	1.5 mm
WT =15	2.0 mm
WT =19	2.5 mm
WT =23	3.0 mm

The minimum line weight (plotted line thickness) is to be 0.25 for A0 drawings.

10 Drawing Revisions

All revisions are to be undertaken using the CAD process. Manual drawings are to be scanned and then revised using Bentley MicroStation v8i and Descartes.

10.1 Drawing Revision Block

Each drawing shall contain a revision block for recording the revision history. Each revision shall contain a sequential revision reference as a letter or number. The nature of the revision shall be sufficiently explained in:

a. The drawing revision block
b. A separate document with an EDM reference located in the reference block.

The area where information is added or removed from a drawing shall be clouded. This is to aid in locating the area where a modification has occurred. A revision triangle containing the revision reference shall be placed in a suitable location with proximity to the revision cloud.

10.2 Drawing Revisions in ProjectWise[4]

ProjectWise Explorer CONNECT Edition and the web version ProjectWise Web View are used for the management of engineering and other technical documents (i.e. MicroStation .dgn drawings and .pdf files).

New versions of documents should be created when a new revision of the document is required.

10.3 Drawing Revision Status and cells

At the end of a drawing file's lifecycle the file must be revised and marked with the correct term to describe the status of the drawing (see Section 1.3 Definitions), as the file must still be kept for record purposes.

A Banner must be placed across the centre of a drawing clearly indicating its current state.

Cells to be used are contained within CADconform. 'Trans_SHEET_space/Sheetspace/cells_sheet space'.

Table 10.1: Cell Library

Term	Cell Name
Cancelled	Cancelled
Superseded	Superseded
Not to be used for new designs	2DSHT_N2BU

ProjectWise Explorer's meta data must also be updated accordingly.

10.4 Not Maintained

If a decision has been made to no longer maintain a drawing (see section 1.3 Definitions)

the file must be revised, the drawing or section of the drawing is to be hatched and labelled

'Not Maintained'

i.e. Arrangements, Schematics, wiring diagrams or material lists.

[4] See Western Power Internal Document

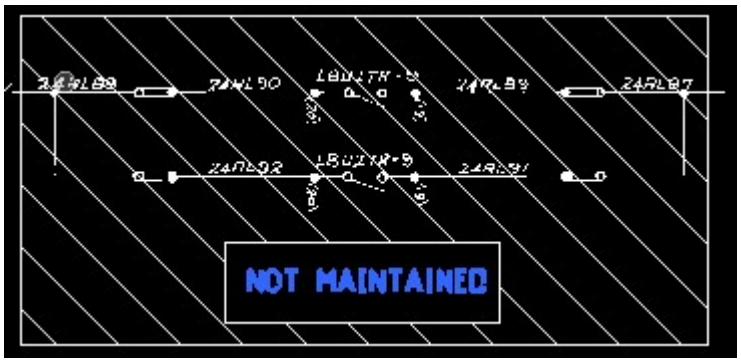


Figure 7.1: Not maintained example

11 Drawing Approval

11.1 General

Prior to the issue of a new or revised drawing, the drawing shall be checked and approved for:

1. Technical compliance

Drafting accuracy

Presentation

The approved drawing must be signed by the individuals undertaking these tasks.

No construction work shall commence until an “Approved for Construction” drawing has been issued.

11.2 Title Block Signatures

11.2.1 New Drawings

For the first issue of a drawing, all checks and approvals are required in the title block. There is no need for a revision block (revision A), as the information is captured in the title block.

11.2.2 Revisions

The check and approval signatures are required in the revision block for revisions on existing drawings.

12 Drawing Mark-Up

Hand mark-up of drawings is typically required to indicate the changes required on a drawing prior to it being re-issued. A consistent approach in drawing mark-up will ensure an accurate and efficient drawing revision.

Refer to Table 12.1 for mark-up colours.

Table 12.1: Mark-up colour table

Action	Colour	Description
Additions	Red	New additions to the drawing
Deletions	Green	Lines and text to be deleted
Temporary notes	Blue	These are NOT considered to be part of the drawing revision
Back drafting	Pink	Additions marked complete by Draftsperson
Checked back drafting	Orange	Work checked and is correct after back drafting
Checked items - Correct	Yellow	Work checked and is correct

13 Plot Standard (Design Vendors Only)

To consistently produce reliable prints with accurate line weights and colours the following plot configuration files should be used for the submission of drawing packages to Western Power either for audit or final submission.

13.1 Black and White

Navigate to where the Western Power CAD build is located on your network

13.1.1 Hard Copies

Western Power CAD Build v4.0\Standards\pltcfg**printer-black-wpc.pltcfg**

13.1.2 Pdf Format

Western Power CAD Build v4.0\Standards\pltcfg**pdf-wpc-issue.pltcfg**

13.2 Colour

Navigate to where the Western Power CAD build is located on your network

13.2.1 Hard Copies

Western Power CAD Build v4.0\Standards\pltcfg**printer-colour-wpc.pltcfg**

13.2.2 Pdf Format

Western Power CAD Build v4.0\Standards\pltcfg**printer-colour-wpc.pltcfg**

Generally drawing files are printed in black and white except for complex civil works drawing packages where it might be necessary to print drawings with colour legends.

Appendix A: Manufacturer Drawing Requirements

Western Power produces all drawings by Computer Aided Design (CAD) processes. The nominated software for CAD engineering drawings is Bentley System's MicroStation CONNECT Edition. This is also preferred software for manufacturer's drawings. If the manufacturer does not have Bentley System's MicroStation CONNECT Edition the minimum delivery requirements are outlined below. The files must be in either DXF or DWG format, stating what version of software is used. e.g. if AutoCAD 2014 or AutoCAD 2022 was used to produce the file.

A.1. Software Version

The delivery of design models such as plant drawings shall be in 3D (drawn at a scale of 1:1) schematics, wiring & termination diagrams shall be in 2D.

The manufacturer must ensure data has been converted correctly if converted or exported to Bentley System's MicroStation CONNECT Edition from another design package, e.g. AutoCAD or Solid Works.

It is also the responsibility of the manufacturer to guarantee;

1. No linked attribute data

No custom developed line styles

Acceptable font styles are ISO 3098 and system supplied Arial

Text is to consist of 0 – 9, Aa – Zz. No special characters. English language only to be used.

No embedded documents within the drawing

CAD files will be created on the basis of one drawing sheet for one CAD file.

Borders are to be integral within each drawing and not referenced to the drawing.

The delivery of any CAD data must be accompanied with Adobe Acrobat files (PDF) produced from the native software package in which the files were created.

A.2. Drawing Numbering

The drawing numbering of manufacturer drawings is to be determined by Western Power in accordance with each design area's requirements

A.3. Drawing Supplied by Vendor or Manufacturer

All drawings supplied by the Vendor shall have a box located adjacent to the Vendors title block providing the following information.

Western Power Drawing Number

Western Power Specification Number

Western Power Specification Item Number

Western Power Stock Code

Western Power Revision Number

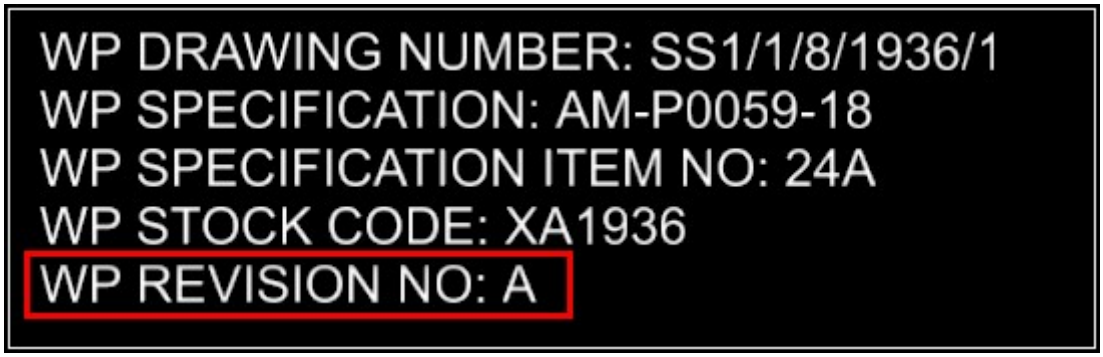
This box shall be completed by the Vendor. Western Power will advise the Vendor of the Western Power drawing numbers upon awarding of the contract.

A.4. Drawing Revisions on Final Submittal to Western Power

All drawings received for final submittal (as constructed) shall be submitted using an Alphabetical revision status, see figure A.4.1

The first in the sequence being Revision 'A', the second being 'B' and so on so forth.

Figure A.4.1 Drawing Revisions on Final Submittal to Western Power



Appendix B: Approval Record and Document Control[5]

[5] See Western Power Internal Document