

Annexure-4 of Corrigendum-2**EMPLOYER'S REQUIREMENTS****APPENDIX 7****DRAUGHTING AND CAD STANDARDS****1. INTRODUCTION**

- (1) The purpose of this document is to define the minimum Draughting and CAD standard to be achieved by the Contractor for all drawings produced by the Contractor for the purpose of the Works.
- (2) By defining a common format for the presentations of drawings and CAD files, the exchange of drawn information is improved and will maximize the use of CAD in the co-ordination process.
- (3) All submissions shall be made to the Employer's Requirement in a format reviewed without objection by the Employer's Requirement and in accordance with the requirements in:
- the Contract.
 - the Document Submittal Instructions to Consultants and Contractors. (4) Paper and drawing sizes shall be "A" series sheets as specified in BS 3429.
- (4) The following software latest and update version compatible for use with Intel-Windows based computers shall be used, unless otherwise stated, for the various electronic submissions required:

Document Type	Electronic Document Format
Text Documents	MS Word,
Spread Sheets	MS Excel,
Data Base Files	MS Access,
Presentation Files	MS PowerPoint,
Programmes	latest version Primavera for Windows,
Photographic	Adobe Photoshop,
Desktop Publishing	Page Maker
CAD Drawings	AutoCAD

- (5) Media for Electronic File Submission: One copy shall be submitted unless otherwise stated in DVD/CD-ROM or Suitable electronic medium.



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(6) Internet File Formats/Standards

- (a) The following guidelines shall be followed when the Contractor uses the Internet browser as the communication media to share information with the Employer.
- (b) All the data formats or standards must be supported by Microsoft Internet Explorer latest version, or above running on Windows 10.
- (c) The following lists the file types and the corresponding data formats to be used on Internet.

The Contractor shall comply with them unless prior consent is obtained from the Employer's Requirement for a different Data format:

File Type	Data Format
Photo Image	Joint Photographic Experts Group (JPEG)
Image other than Photo	GIF or JPEG
Computer Aid Design files (CAD)	Computer Graphics Metafile (CGM)
Video	Window video (.avi)
Sound	Wave file (.wav)

- (7) The following states the standards to be used on Internet when connecting to database(s). The Contractor shall comply with them unless prior consent is obtained from the Employer's Requirement for a different standard:

Function to be Implemented	Standard to be Complied With
Database connectivity	Open Database Connectivity (ODBC)
Publishing hypertext language on the World Wide Web	Hypertext Markup Language (HTML)

The hard copy of all documents shall be the contractual copy.

2. GENERAL REQUIREMENTS**a. General**

- (1) The Contractor shall adopt a title block similar to that used in the Drawings for all drawings prepared under the Contract.
- (2) Each drawing shall be uniquely referenced by a drawing number and shall define both the current status and revision of the drawing.
- (3) The current status of each drawing shall be clearly defined by the use of a single letter code as follows:

P	-	Preliminary Design Drawing
D	-	Definitive Design Drawing
C	-	Construction Reference Drawing
W	-	Working Drawing
B	-	As-Built Drawing
M	-	As Manufactured Drawing
E	-	Employer's Drawing

b. Types of Drawing

- 1) 'Design drawings' mean all drawings except shop drawings and as-built drawings.
- 2) 'Working drawings' are design drawing of sufficient detail to fully describe the works and adequate to use for construction or installation.
- 3) Site drawings and sketches are drawings, often in sketch form, prepared on site to describe modifications of the Working drawings where site conditions warrant changes that do not invalidate the design.
- 4) 'Shop drawings' are special drawings prepared by the manufacturer or fabricator of various items within the Works to facilitate manufacture or fabrication.
- 5) 'As-built drawings' show the Works exactly as constructed or installed. They are usually prepared by amending the working drawings to take into account changes necessitated by site conditions and described in Site drawings. These drawings shall be completed on a regular basis as the works progress and shall not be left until completion of the entire works.

3. COMPUTER AIDED DESIGN & DRAFTING (CAD) STANDARDS

3.1 Introduction

Scope of Use

Data input procedures between the Engineer and contractors must be coordinated, and the key parameters used to form CAD data files must be standardized. The production of all CAD data files shall comply with the following requirements.

3.2 Objectives

The main objectives of the CAD standards are as follows:

- (a) To ensure that the CAD data files produced for Project are coordinated and referenced in a consistent manner.
- (b) To provide the information and procedures necessary for a CAD user from one discipline or external organization to access (and use as background reference), information from a CAD data file prepared by another discipline or external organization.
- (c) To standardize the information contained within CAD data files which may be common to more than one discipline such as drawing borders, title boxes, grid lines etc.
- (d) To establish procedures necessary for the management of CAD data files.
- (e) To ensure all contractors use 'Model space' and 'Paper space' in the production of their CAD files.

3.3 General

- (1) To facilitate co-ordination between contractors, it is a requirement that all drawings issued by contractors for co-ordination or record purposes shall be produced using CAD methods. Drawings shall be issued in digital format in addition to the paper copies.
- (2) The intent of the issue of digital information is to aid the related design by others. The definitive version of all drawings shall always be the paper or polyester film copies which have been issued by the contractor or organization originating the drawing.
- (3) Drawings and drawing packages issued for co-ordination, record purposes or for acceptance shall be accompanied by a complete set of the corresponding CAD data files.
- (4) Any contractor or organization making use of the CAD data from others shall be responsible for satisfying him that such data is producing an accurate representation of the information on the corresponding paper drawing which is satisfactory for the purpose for which he is using it. Provided the general principles of this section have been achieved by the originator of the CAD data, contractors making use of the CAD data from others shall not be entitled to require alterations in the manner in which such CAD

data is being presented to them.

- (5) In particular, automatic determination of physical dimensions from the data file shall always be verified against the figured dimensions on the paper or polyester drawings. Figured dimensions shall always be taken as correct where discrepancies occur.

3.4 Terminology & Associated Standards / Guidelines

Any terminology used within this section that is ambiguous to the user shall be clarified with the Employer's Requirement. British Standard BS1192 is used in principle as a guide for drawing practice, convention, CAD data structure and translation.

3.5 Paper Drawings

- (1) For the Project "Paper" drawings are considered to be the main vehicle for the receipt and transmittal of design and production information, typically plans, elevations and sections.
- (2) The Project wide accepted media for the receipt and transmittal of "Paper" drawings will be paper and polyester film of various standard ISO 'A' sizes. The composition of this information shall be derived from a CAD "Model".
- (3) The CAD derived "Paper" drawing composition will reflect a window of information contained within a CAD "Model Space" file together with a selection of information contained within the associated CAD "Paper Space" file.

3.6 CAD Data Creation, Content & Presentation

A consistent method of CAD data creation, together with content and presentation is essential. The method of CAD "Model Space and Paper Space" creation is as follows:

- (1) Model Space Files
 - (a) Typically, CAD "Model Space" files are required for general arrangement and location plans and will consist of a series of other "Model Space" referenced CAD files covering the total design extents at a defined building level (the number of referenced files should be kept to an absolute minimum). Data contained within a CAD "Model Space" files is drawn at full size (1:1) and located at the correct global position and orientation on the Project Grid / or defined reference points.
 - (b) Each CAD "Model Space" file will relate to an individual discipline. Drawing border / text, match / section lines or detailed notation shall NOT be included within a CAD "Model Space" file. Dimensions shall be included within a CAD "Model Space" but located on a dedicated layer. Elevations, Long Sections and Cross Sections shall also be presented in CAD "Model Space" as defined above, but do not need to be positioned and orientated on the Project Grid.

(2) Paper Space CAD Files

- (a) Paper Space" CAD files are utilized to aid the process of plotting "Paper" drawings and are primarily a window of the CAD "Model Space" file. A "Paper Space" CAD file will typically contain drawing borders, text, match or section lines & detailed notation. Once these files are initially set up and positioned the majority of "Paper Drawing" plots at various approved scales re efficiently and consistently generated by displaying different combinations of element verse and symbology contained within the "Paper Space" file and the referenced "Model pace"files.
- (b) The purpose is to ensure that total co-ordination is achieved between the CAD "Model Space" file and the "Paper Drawing" output during the revision cycle of the design and production process. Duplicated data in "Model and paper Space" files will not be acceptable unless an automatic update link exists between the two data sets. "Paper Space" files are not typically required as part of the CAD Media Receipt from contractors, unless specifically requested.

3.7 CAD Quality Control Checks

- (1) Random CAD Quality Control Audits will be carried out by Engineer on all CAD media received and transmitted.
- (2) These checks DO NOT verify the technical content of the CAD data received or transmitted (as this is the responsibility of the originating organization), however compliance with Project CAD and Draughting Standards shall be checked.
- (3) In addition, all contractors who transmit and receive CAD data from the Project shall have CAD quality control procedures in place. A typical quality control procedure shall contain CAD data quality checking routines coupled with standards for CAD data transmittal and archiving.

3.8 CAD Data Transfer Media and Format

When CAD data is received & transmittal between Engineer and the Contractor, the media shall be as follows:

- (a) Data Exchange Format - AutoCAD 2019 (.DWG) or latest version
- (b) Operating System -/ Window 10 /windows Latest version
- (c) Data Transfer Media:CD ROM/ RW /pen drive plus E-mail

All Data TransferMedia must be labeled on the data shield with:

- (i) Name of Company
- (ii) Project Title

- (iii) Drawing Filenames (for diskettes only)
- (iv) CD/pen drive no.
- (d) All data Transfer Media shall be submitted with a completed Form
- (e) The Contractor must ensure the supplied Data Transfer media is free from virus. SUB-directories on tapes or disks are not permitted. If CAD Data is created using UNIX, archive commands must be unrooted.

3.9 CAD Media Receipt & Transmittal

- 1) CAD Media Transmittal (from the Contractor to Engineer) - this will consist of the following:
 - a) CAD Digital Media
 - b) CAD data sheet
 - c) CAD issue / revision sheet
 - d) CAD Quality Checklist confirming compliance.
 - e) Plot of each "Model Space" file issued on an A1 drawing sheet (to best fit).
- 2) The above CAD media will be collectively known as "CAD Media Transmittal Set". The CAD data file transmittal format required by Employer 's Representative from all contractors shall be in AutoCAD (Latest version)
- 3) All CAD media received from contractors will be retained by Engineer except for SCSI disk (if used) as an audit trail / archive of a specific contractor's design evolution.
- 4) CAD Media Receipt (from Engineer to the Contractor)
 - a) CAD media should normally be obtained from the respective interfacing contractor(s), but should Engineer issue CAD media it will consist of the following:
 - i. CAD Digital Media typically contain only CAD "Model Space"files.
 - ii. CAD data sheet.
 - iii. CAD issue / revision sheet
 - b) The above CAD media will be collectively known as the "CAD Media Receipt Set". The CAD data file transmittal format used by Engineer to all contractors will be in AutoCAD (latest version)
 - c) Each CAD transmittal digital medium will be labeled with proper label as approved by the Engineer/ Any CAD data transmitted without this label is assumed to be provisional information not to have been quality checked and therefore not formally issued.

3.10 Revisions

- (1) All 'Revisions', 'In Abeyance' and 'Deletions' shall be located on a common layer. This layer can be turned on or off for plotting purposes.
- (2) The following example text indicates the current CAD file revision, i.e. 'Revision [A]'. This shall be allocated to a defined layer on all CAD "Model Space" files, in text of a size that will be readable when the CAD "Model Space" file is fitted to the screen, with all levelson.

3.11 Block Libraries, Blocks, & Block Names

- (1) All Construction Industry symbols produced as CAD Cells shall typically conform to British Standard BS1192 - part 3.
- (2) All Blocks created shall be Primitive (i.e. NOT Complex) and shall be placed Absolute (i.e. NOT Relative).
- (3) The Contractor's specific block libraries shall be transmitted to Engineer together with an associated block library list containing the filename (max. 6 characters) and block description. The Contractor shall ensure that the library is regularly updated and circulated to all other users, together with the associated library listing.
- (4) All Blocks of a common type, symbols or details should initially be created within a CAD "Model Space File" specifically utilized for that purpose. These files will be made available on request by Employer's Representative.
- (5) Blocks created will typically be 2D unless 3D is specifically requested. In both instances they shall have an origin at a logical point located within the extents of each Block's masked area or volume.

3.12 CAD Dimensioning

Automatic CAD Dimensioning will be used at all times. Any dimensional change must involve the necessary revision to the model space file. If the CAD Quality Control Checks find that the revisions have not been correctly carried out, the rejection of the entire CAD submission will result.

3.13 CAD Layering

All CAD elements shall be placed on the layers allocated for each different discipline. The layer naming convention to be adopted by the Contractor shall be submitted for acceptance and inclusion within these standards.

3.14 Global origin, Location & Orientation on the Alignment Drawing.

- (1) Location or Plan information in "Model Space" files shall coincide with the correct location and orientation on the Project grid for each specific contract.
- (2) Location plans shall have at least three setting out points shown on each CAD "Model Space" file. Each setting out point shall be indicated by a simple crosshair together with related Eastings and Northings co-ordinates. The Civil Contractor(s) will establish the three setting out co-ordinates for their respective works, which will then be used by all other contractors including the Contractor.

3.15 Line Thickness and Colour

To assist plotting by other users, the following colour codes will be assigned to the following linethickness / pen sizes.

Colour	Code No	Line Thickness
Red	10	0.18
White	7	0.25
Yellow	2	0.35
Brown	34	0.5
Blue	130	0.7
Orange	30	1.0
Green	3	1.4
Grey	253	2.0

3.16 CAD Utilization of 2D & 3DFiles

Although the project standard is 2D CAD files, certain disciplines and contractors may use 3D CAD files for specific applications or where the isolated use of 3D aids the design and visualization process (i.e., Architecture, Survey and Utilities). In these specific instances 3D CAD data will only be transmitted if all other users can use this data. If this is not the case, 3D to 2D translation shall be processed by the creator prior to issue.

3.17 CAD File Numbering

- (1) Contractors CAD File Numbering shall be described in 2.2above.
- (2) Employer CAD File numbering unlike most of the contractors, Employer will not be required to produce numerous CAD files. This will follow the numbering system Except that the status of the drawing in 2.1(3) shall be"E".

3.18 CAD File Naming Convention - General

CAD "Model Space" files shall be named in accordance with general drawing conventions.

Note: The CAD standards shall be compatible with 5D BIM platform of MahaMetro

3.19 ERP, OSO and 5D-BIM Platform

Maha-Metro have created a Digital platform for Project Management comprising an ERP system and a 5D Building Information Modeling system along with other components. This will be the central repository of all information used by Maha-Metro. It will require information on project timelines, progress reports, estimates of material and costs, 2D and 3D drawings, to be submitted to the central system by contractors executing engineering, construction and other activities on site. The central system will also provide information to the contractors for execution.

All effort will be made to create interfacing mechanisms using standards-based approach such that it can take and provide inputs to all kinds of systems built using industry recognized standards. Some of the systems under consideration include SAP ERP, Primavera/Microsoft Project for project management and AutoCAD/Bentley/RIB for 5D BIM.

The ERP will have published standard APIs for integration and similarly the project management solutions can interchangeably read formats from the abovementioned popular tools. The standards used for drawing interchange include the popular DXF (Drawing Exchange Format) and ANSI standard IGES (Initial Graphics Exchange Specification).

The bidder should have such experts conversant with the above proposed digital platform for the entire duration of the work.