Computer Aided Design (CAD) Specification

ALL AIRPORTS

March 2011

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1. BACKGROUND

As part of its drive to be a world class airport authority the Airports Company of South Africa SOC Limited has developed and implemented an enterprise-wide Geographic Information System (GIS) as part of its numerous IT management systems.

The major source of spatial data for the Company GIS is the many Computer Aided Design (CAD) drawings produced for planning, design and construction purposes during the expansion and re-development of infrastructure on and around the airport by various consultants and contractors.

This CAD drafting specification is intended to simplify the CAD-to-GIS conversion process by specifying a number of good practices and protocols to be followed by consultants submitting CAD drawings to the Company. These good practises and protocols are in line with industry and international best practice.

The specification is not intended to be inflexible and completely prescriptive, but rather to be a set of overall principles and guidelines that CAD personnel can apply to their production processes. These changes in methodology shall generally be fairly minor and shall be incorporated into the design & drafting process without much difficulty.

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2. SUMMARY OF MAIN REQUIREMENTS

	During setting up of CAD model for design	Detail
1	Draft CAD *models* in model space or viewport view and compile CAD final *drawing layouts* with frames in CAD paper space or layout view. No frames to be drawn in model space.	3.1
2	Draft CAD plan *models* in the correct geographically coordinated location. If this is not possible, as a minimum, *drawing layouts* shall include a labelled coordinate grid or reference points to allow for geo-referencing.	3.2
3	Layer structure used shall split features into logical and airport specific layers as recommended in this document. See full list in 3.2. In addition hatching, text and tables shall be on different layers to the drawing elements.	3.3
4	All polygon features to be properly closed shapes and all line features to join at a point with no gap or overlaps. Hatched areas to include polygon boundary line.	3.4
5	If symbols are used to indicate point type features, e.g. valves, joints, poles etc. these shall be on separate layers. If possible, a point shall be placed on the corresponding main layer indicating the exact position or centre of these features.	3.5
6	Lines joining at these point type features shall not stop at the start and end of symbols, but shall continue to meet at the point in the centre of the feature. In addition, lines passing through multiple points shall be separate line segments starting and ending at each point, irrespective if they are all in a continuous straight line.	3.5
7	All text to be on a single layer as far as possible. Any text associated with a feature to be placed as close to the feature as possible. E.g. stormwater pipe diameters as close as possible to the line representing the stormwater pipe – avoid using arrows or lead lines as much as possible	3.6
	During compiling *drawing layouts* in paper space / layout view	Detail
8	All *drawing layouts* to be contained with a neat and appropriate drawing frame.	4.1
9	Frame to include a Company logo and the Company project name.	4.1
10	Frame to include a logical drawing number complete with a revision number.	4.1
11	Frame to include a date.	4.1
12	Frame to include full details of consultant – Logo, name, address, telephone number.	4.1
13	Frame to note details of applicable coordinate system and other survey info.	4.1
14	Frame to indicate status of drawing e.g. For information, For tender purposes, For construction, As-Built.	4.1
15	Frame to include the name of the CAD drawing that contains the model	4.1
	Submission to the Company	Detail
16	Drawings to be submitted to the Company at the end of each stage of design and construction cycle E.g. Planning and architectural design complete, engineering design complete, construction complete with as-built corrections.	5.1

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17	Submission shall be made per project on a single or set of CDs or DVDs.	5.1
18	PDF electronic hard copy of every drawing to be submitted. Size of PDF not to exceed 500kB. Filename of electronic hard copy to be the Consultants drawing number plus the revision number. Egg. P0921-ACSA-PIER-001_REV0.pdf	5.2
19	The Company Drawing Submission Form to be completed and submitted with drawings. See 5.2 for pro-forma. To be submitted as Microsoft Excel as far as possible.	5.3
20	CDs/DVDs labels to include airport name, project name, project stage, consultant name, submission date, total number of disks in set and number of each disk within set as a minimum. Labels to appear directly on the media and not on the media cover.	5.4
21	CAD drawings to be submitted in an approved CAD file format. Approved formats include .dxf, .dwg, .dgn. CAD drawings to be submitted without reference files. Reference files to be merged into the master drawing and clipped as required.	5.5

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3.   DETAIL – SETTING UP OF THE CAD MODEL

3.1   Models and drawing layouts

Most modern CAD packages employ the concept of *model space* in which a CAD model is set up and *paper or layout space* in which views of this model are extracted, framed and set up as individual drawings. The drawing below illustrates this. Setting up drawings in this matter is efficient as many drawings can be contained with a single CAD file.
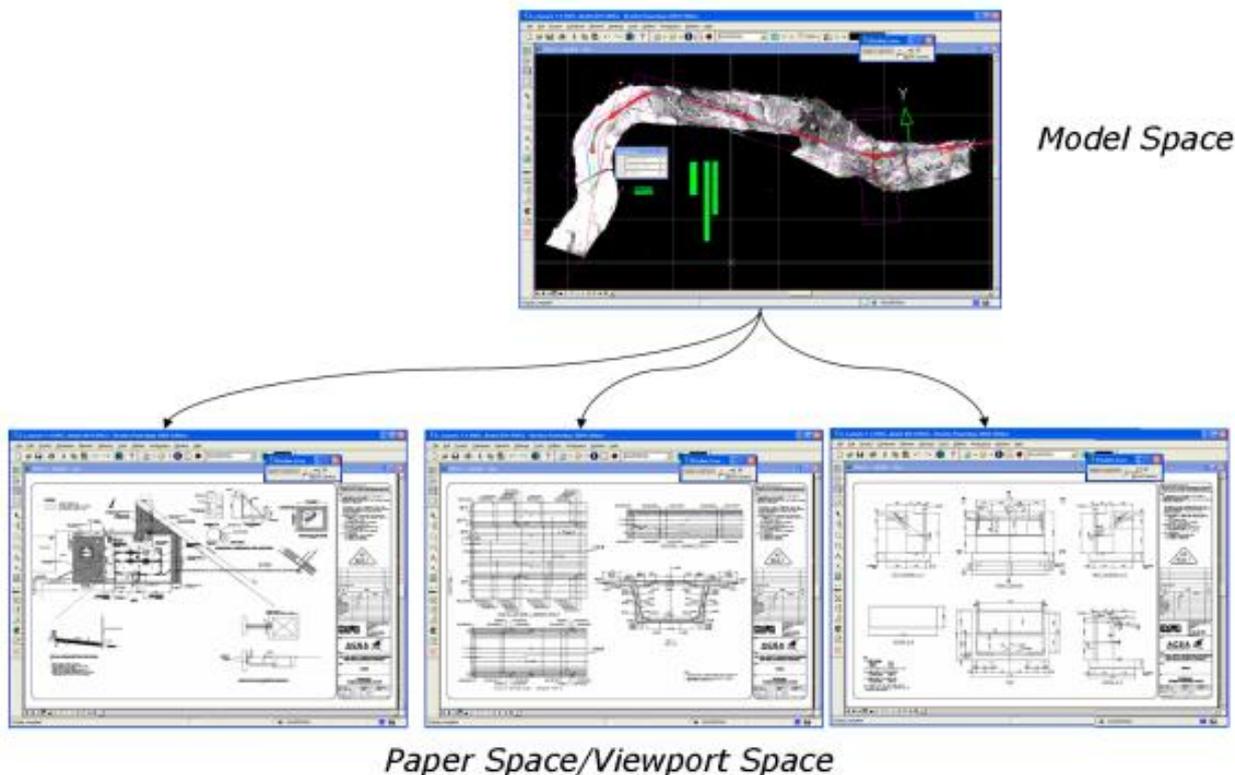

Figure 1 – Layout showing model and paper/viewport space

NOTE: - If CAD detailing is done directly in paper/viewport space, the data is often not visible to GIS software, which vastly complicates the inclusion of data into the Company GIS. It is therefore imperative that CAD models or designs are detailed in model space as per the recommendation above.

The terminology above differs from one CAD package to another and the manner in which they operate may differ somewhat, but the general concepts remain the same. The notes below refer to the two main CAD packages used in South Africa.

AutoCAD DWG - Is made up of two parts: Model space and Paper space. The Model space is where you draw your design. The paper space is where you reference in your drawing border and create what are called view ports. A view port punches a hole in the paper space, to look through to the design in the model space. Each viewport you create can zoom into a part, or whole, of the design at different scales. A DWG can only have one model space but can have multiple Paper spaces.

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Microstation (DGN) **-** May consist of multiple spaces or models as Bentley terms them. A DGN consists of at least one model – the Default Model. The file may contain any number of additional models, but unlike AutoCAD these do not only have to be Paperspace, they may be either Design Models or Sheet Models. Draw your design in the Model Space. The Sheet Model is where you reference in your drawing border and self reference in the model, to create your layout or plot. A DGN can have multiple models and multiple Sheets.

3.2   Models in correct geographic space / coordinate grid

It is a requirement that all CAD drawings in plan are detailed in the correct geographic space such that a coordinate point on the drawing shall correspond to its actual coordinate point on the ground. It is common for coordinates on older drawings to be adjusted by having a constant value subtracted from the actual coordinate. Modern CAD packages can handle the larger values of the actual coordinates and thus the practise of removing the constant shall be discouraged.

In addition, it is vital that all drawings set up in *paper or viewport space* note the applicable coordinate reference systems, datums and other relevant survey information.

If, for some reason, the drawing cannot be drawn in the correct geographic space, as a bare minimum, a labelled coordinate grid shall be provided over each drawing to allow the drawing to be geo-referenced into the correct position.

Even if the drawing is in the correct geographic space it is good practise to include this grid. The figure below illustrates this.
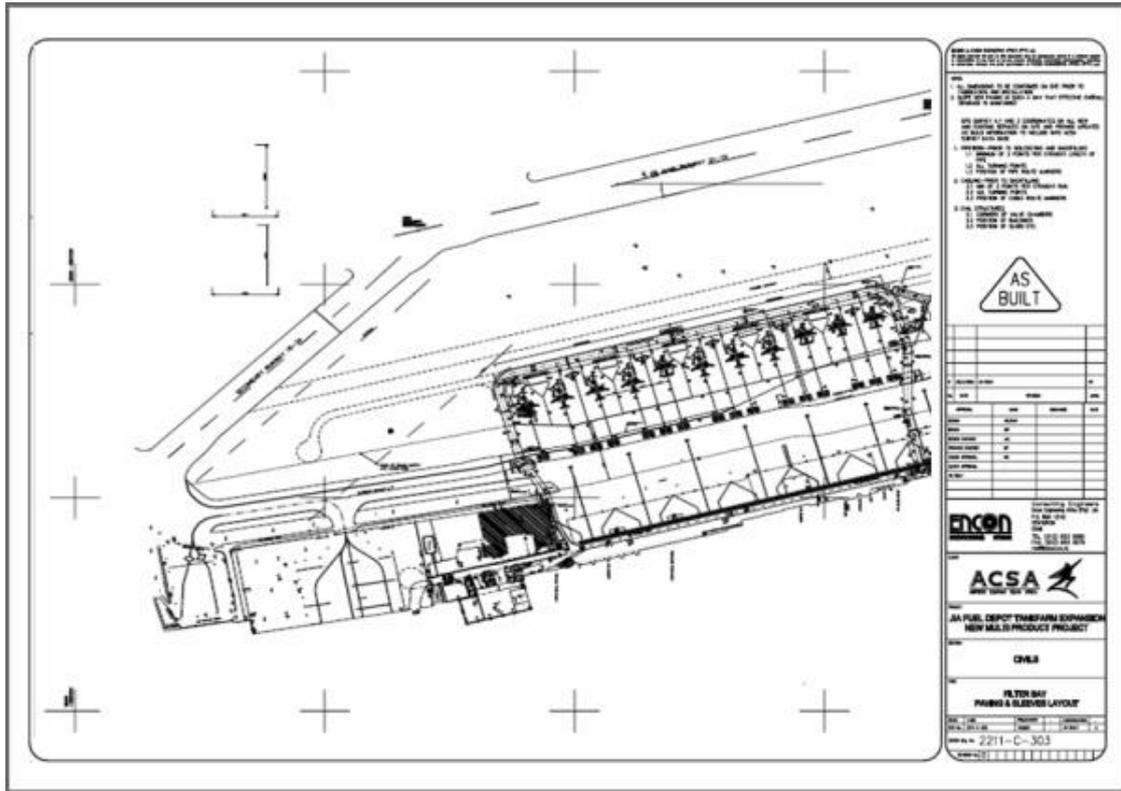
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Figure 2 – Drawing showing coordinate grid

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3.3   Logical layer structure

The layer list below is the required breakdown of layers to be used for CAD detailing by consultants working on Company projects. The list is mainly relevant to plan drawings, as these shall largely contain information that shall be added to the Company GIS. Adopting these layers during CAD detailing shall assist the Company in populating their GIS with this information as efficiently as possible.

The list is not exhaustive and shall be added to as required to accommodate any content on the drawing that is not included in the list.

Layers used shall be logical and shall contain only single type of feature or a set of features that can be logically grouped. *E.g. All stormwater pipes and culverts shall be on a single layer; electrical cables shall be on a separate layer etc.*

Hatching, text and tables shall be included on separate layers. There are two suggested ways in doing this.
- Placing hatching, text and tables pertaining to a specific drawing layer on their own individual layers. *E.g. Drawing layer=Airside_surfaces; Hatching layer=Airside_surfaces_hatch; Text layer=Airside_surfaces_text etc.*
- Placing all hatching, text and tables each on a single layer *E.g. Hatching layer= Hatch_All, Text layer=Text_All etc.*

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Access_points	Lighting
Airside_surfaces	Networkcomcables
Airside_surface_markings	Noise_contours
Buildings	Obstacle_surfaces
Cadastral	Obstacles
Control_cables	Parking
Conveyors	Retaining_walls
Ducts	Roads_bridges
Electrical_cables	Road_markings
Electrical_substations	Security_cables
Fences_Walls	Servitudes
Flood_lines	Sewer_pipes
Floor_plans	Sewer_tanks
Fuel_lines	Signs
Fuel_tanks	Survey_control_points
Landuse	Stormwater_pipes_culverts
Landside_surfaces	Water_main_pipes
Lifts	Water_tanks

Table 1 – ASCA List for Layering

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## 3.4 Clean polygon and line features

Area or polygon features such as erven boundaries; building footprints etc. shall be clean polygons and shall be properly closed off.

If hatching is to be used to demarcate an area this shall include a polygon feature enclosing the hatching and shall not only be the hatching itself.

Examples of these are shown in the sketches below.
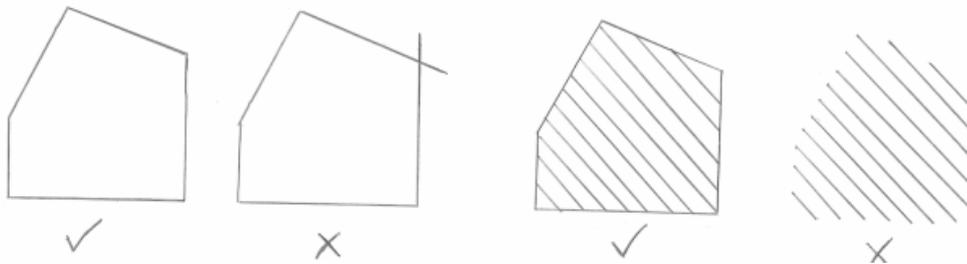
3.5 Points, point symbols and lines at point symbols

CAD operators and designers can continue using their own standard symbols for features such as poles, manholes, signs etc, as these are not imported into the GIS. However, it is beneficial if a point is placed at the centre or origin of the symbol. This point is imported into the GIS and used as the origin for a symbol placed by the GIS. If a feature falls on a line e.g. a manhole on a pipe, a valve on a pipe, a pole on a cable etc, it is important that the point lies exactly on the line as shown in the figure below.

As far as possible, single lines shall be used to denote linear features such as pipes, kerb lines etc. Lines shall be continuous i.e. they shall meet at the centre of a manhole and not stop at the perimeter as illustrated below.
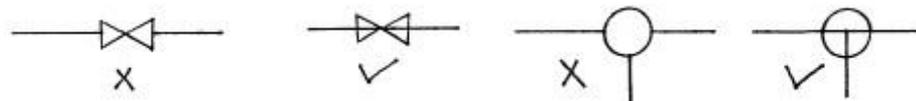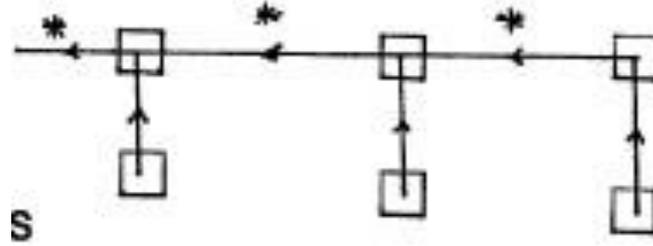

Where possible, separate lines shall be drawn between features such as valves, tees, crosses, manholes etc even if these features are on a straight line. This is illustrated below.

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3.6 Text on layers and text in tables

Typically text information extends to items such as manhole numbers; manhole levels; valve types; pipe diameters; cable types; road centreline levels, finishing details etc.

Any text placed on a CAD drawing shall be placed as close as possible to the object to which it refers. The practise of placing text at some distance from the object and using arrows to indicate the object shall be avoided as far as possible. This practise shall assist the GIS conversion processes by easing the population of the GIS attribute database with the text on the CAD drawing.

Should text consist of more than one line, it shall be input as a single text entity with line breaks rather than multiple text entries and thus shall only have single placement point.

The figure below illustrates good practise when placing layers on a water main CAD drawing.
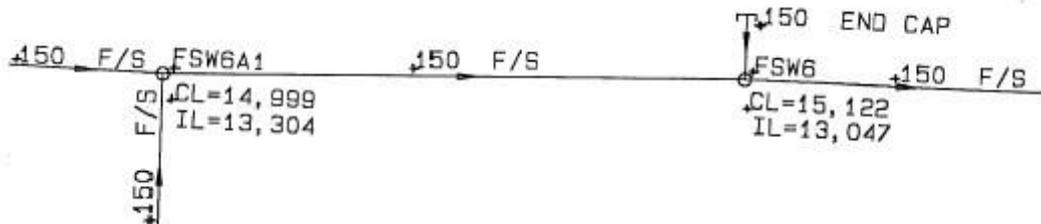
If tables are used to place text on a drawing these shall be well referenced to the features to which they refer.

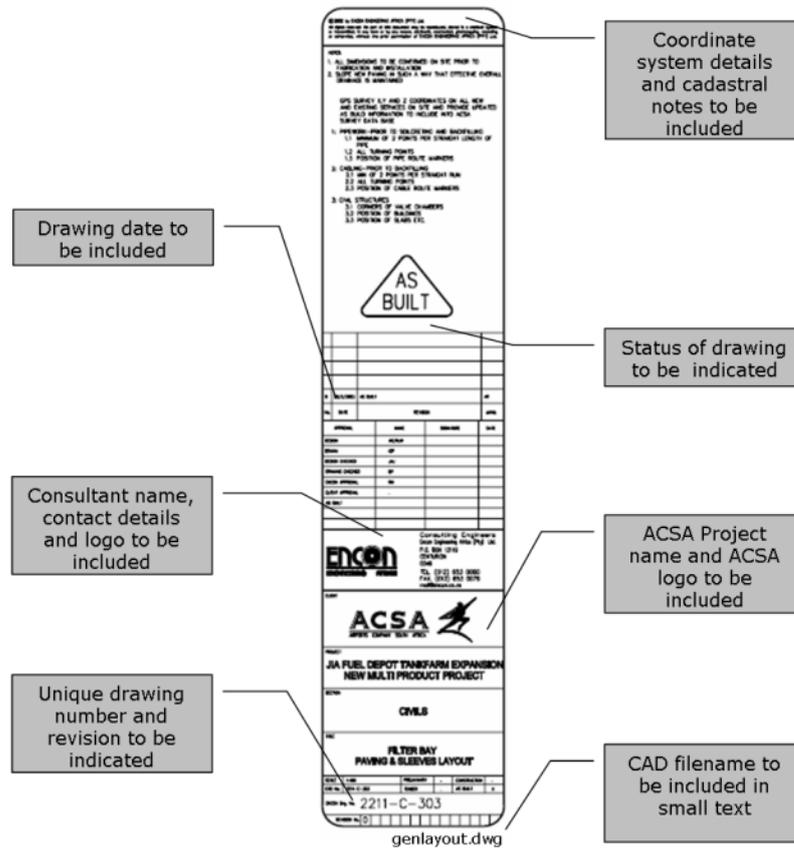*UNCONTROLLED COPY WHEN PRINTED*

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4.   DETAIL – SETTING UP OF DRAWINGS

4.1.   Example of a compliant drawing and drawing frame

The figures below show the correct way to set up a drawing and shows the minimum details that shall be included.

Figure 3 – Drawing correctly set up with frame and details

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Figure 4 – Minimum requirement for details on drawing frame

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5. DETAIL – SUBMISSION TO THE COMPANY

5.1 Design cycle and submission of drawings

It is essential that CAD drawings be submitted to the Company correctly and formally. These submissions shall be done at logical points in the development of a Company project and shall be submitted in logical batches, identified by the Company project name. The project process below illustrates typical drawing submission point, but this may vary due to the nature of different projects.
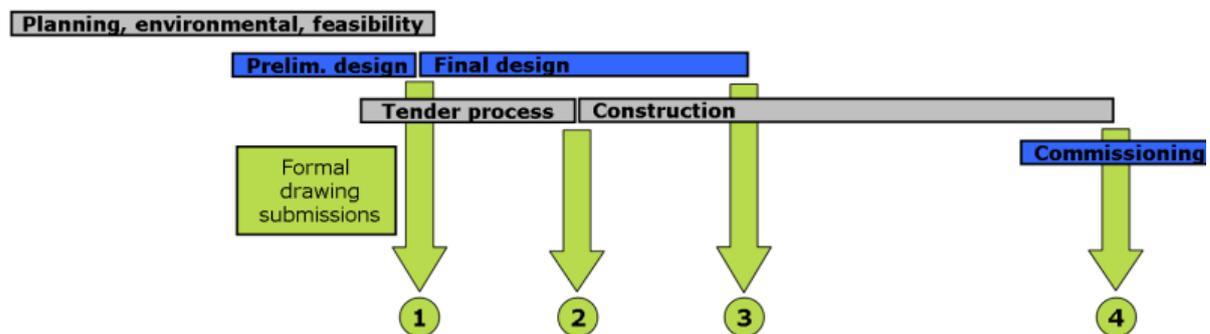
1. Final planning, feasibility and preliminary design drawings to be submitted.

2. Set of tender drawings to be submitted.

3. Final design drawings to be submitted. Can be submitted in logical batches per phase of the project completed. Revisions of design drawings to be submitted during the course of design and construction period to be submitted as required.

4. Final As built drawings to be submitted. ***These are the most valuable submission to Company and all projects* shall *be concluded with a formal submission of these as built drawings.***

Any drawings sent to the Company staff informally during the course of a project, usually by email and with special relevance to preliminary drawings used for discussion shall not be considered as a formal submission. Final versions of these drawings shall be included in one of the above formal project CAD drawing submissions to the Company.

All formal submissions shall be made per project on a single set of CD's or DVD. See 5.4 for example CD/DVD Label.

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5.2 PDF electronic hard copy

Each submission shall include a PDF electronic hard copy of each drawing set up in paper or viewport space.

Naming of the PDF electronic hard copies shall be the drawing no and the revision number. *E.g. C0920-ACSA-NORTH PIER-001_REV0.pdf*

The electronic hard copies shall be printed as close to full size as possible, but with to a minimum paper size of A3. At the same time file sizes of the PDFs are not to exceed 500kB as far as possible. PDF printer resolutions shall be set to ensure that this file size is not exceeded.

Most modern CAD packages have built in PDF printers but shall this not be the case these can be obtained freely off the internet at the following sources.

Adobe Acrobat PDF Printer – www.adobe.com
Cute PDF Printer – www.cutepdf.com

6. SUBMISSION

A submission form shall accompany any batch of drawings submitted to the Company. A pro-forma of the submission form is show below. The standard for the submission for is in Microsoft Excel if at all possible.

COMPANY CAD DRAWING SUBMISSION FORM		
AIRPORT:-	OR Tambo International Airport	
PROJECT NAME:-	Echo Apron Extension	
SUBMITTED BY:-	ENCON Engineers	
CONTACT NO:-	011 – 555 5555	
CONTACT NAME:-	Joe Soap	
SUBMISSION STATUS:	Final Design	
PDF Filename	CAD file name	Drawing Title
C0920-NORTH PIER-001_REV0.pdf	genlayout.dwg	Northern elevation of pier
C0920-NORTH PIER-002_REV0.pdf	genlayout.dwg	Drainage details on second floor
C0920-NORTH PIER-003_REV0.pdf	genlayout.dwg	Reinforcing of roof
C0920-NORTH PIER-004_REV0.pdf	genlayout.dwg	Layout of air-bridges
C0920-NORTH PIER-005_REV0.pdf	mainmodel.dwg	Window and door schedule
C0920-NORTH PIER-006_REV0.pdf	mainmodel.dwg	Eastern layout
C0920-NORTH PIER-007_REV0.pdf	mainmodel.dwg	Western layout
Etc.		

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6.1 CD/DVD submission labelling

The mock-up below shows the minimum labelling on CDs/DVDs submitted to the Company.

6.2 CAD drawing format and reference files

All CAD drawings submitted shall be in an approved CAD format. This extends to the following formats:
- AutoCAD – DWG extension
- Bentley Microstation – DGN extension
- Drawing Exchange format – DXF extension

CAD drawings that make use of reference files referenced into the CAD model from different files (E.g. Contour lines may be referenced into a road design drawing from different survey model contained a different file.) shall be merged into the model before submission. **Final CAD files submitted** shall *be self-contained and* shall *not contain references to any file of any type.*

If the aforementioned reference files are large (E.g. the abovementioned contour lines may extend over an entire metropole or province), these shall be clipped to the extent required for the drawing in question, in order to reduce the file size of the file to be submitted.

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