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Chapter 8 - ELECTRONIC DELIVERY

CADD Production Criteria Handbook

8.1 GENERAL

The Electronic Delivery process is centered on the preparation and use of secured project deliveries.

Note *See Chapter 1.6 Glossary of Terms in the Handbook for definitions of terms used in this chapter.*

8.2 PROJECT DATA SET CONTRASTED TO THE BID SET

As defined in the CADD Manual, the Project dataset includes all files used or produced during the course of production and delivered in the Electronic Delivery folder structure. This differs from the Bid Set, which is used to advertise the project for letting.

The Bid Set is a subset of the Project dataset files and differs depending upon if the Classical, or Digital Delivery is performed.

Classical Electronic Delivery Bid Set	***Digital Delivery Bid Set***
Project.pdf represents the plans and is retained in the project \root folder. Individual sheet image files are created for each sheet in the plans and signed and sealed individually.	*fpid*-PLANS[-].pdf is a composite of all plan sheets and delivered separate from the project folder structure. This file is signed and sealed with Digital Signature. Revisions to this file are named *fpid*-PLANS-REV##[-].PDF.
The Specifications file is named *fpid*.pdf and retained in the \Specs subfolder of the project.	The Specifications file is named *fpid*-SPECS[-].pdf and delivered separate from the project folder structure. The Supplemental Specifications file is named *fpid*-SPECS-SUPP##[-].PDF. This file is signed and sealed with Digital Signature.
Does not include CADD Data or Engineering data files	Includes a ZIP file (*fpid*-CADD[-].ZIP) of the Project Directory structure containing the CADD (Native DGN's or DWG's of the platform used to design the project) and supporting data files. This file is the only file delivered outside and separate from the project folder structure. This file is not signed and sealed. See more on this file later in this Chapter.
SetMaker is used to create this Bid Set from the Project dataset.	Bid Set for *fpid*-CADD[-].ZIP is created manually.
Comp Book is not delivered to the contractor with the Bid Set.	Comp Book is delivered to the contractor and is named *fpid*-COMPBOOK.PDF. Delivered separate from the project folder structure. Revisions to the Compbook are named *fpid*-COMPBOOK-REV##.PDF.

Note *The fpid-CADD[-].ZIP will be made available to contractor for bidding. The existing naming convention standards and directory structure in the CPCH will be preserved in the delivered fpid-CADD[-].ZIP for Bid Sets. Empty project folders/directories will be removed from project directory structure. Files that are redacted by the designer that he/she does not deem useful to the contractor for creating an accurate bid, or necessary for constructing the project are not included in fpid-CADD[-].ZIP. The goal is to provide the data to empower Automated Machine Guidance in construction. Advertising projects with the Engineering Data (i.e. LandXML of the route geometrics [points, alignments, and profiles], and models [surfaces of the pre-construction Existing Ground, and the as-designed proposed Surfaces]) is desired.*

The Bid Set retains the same folder structure as the Project dataset for those folders containing files (all empty folders are automatically removed by the SetMaker application designed for this task).

Note *Please refer to Chapter 24, Specifications Standards - regarding the handling and inclusion of Technical Special Provisions (TSPs) in the Bid Set.*

- **Production of *fpid*-CADD[-].ZIP**

The Bid Set for Digital Delivery projects that the contractor receives will include *fpid*-PLANS[-].PDF, fpid-SPECS[-].PDF, *fpid*-CompBook.PDF and *fpid*-CADD[-].ZIP. The *fpid*-CADD[-].ZIP file contains the Project directory structure; however the files listed below have been redacted:

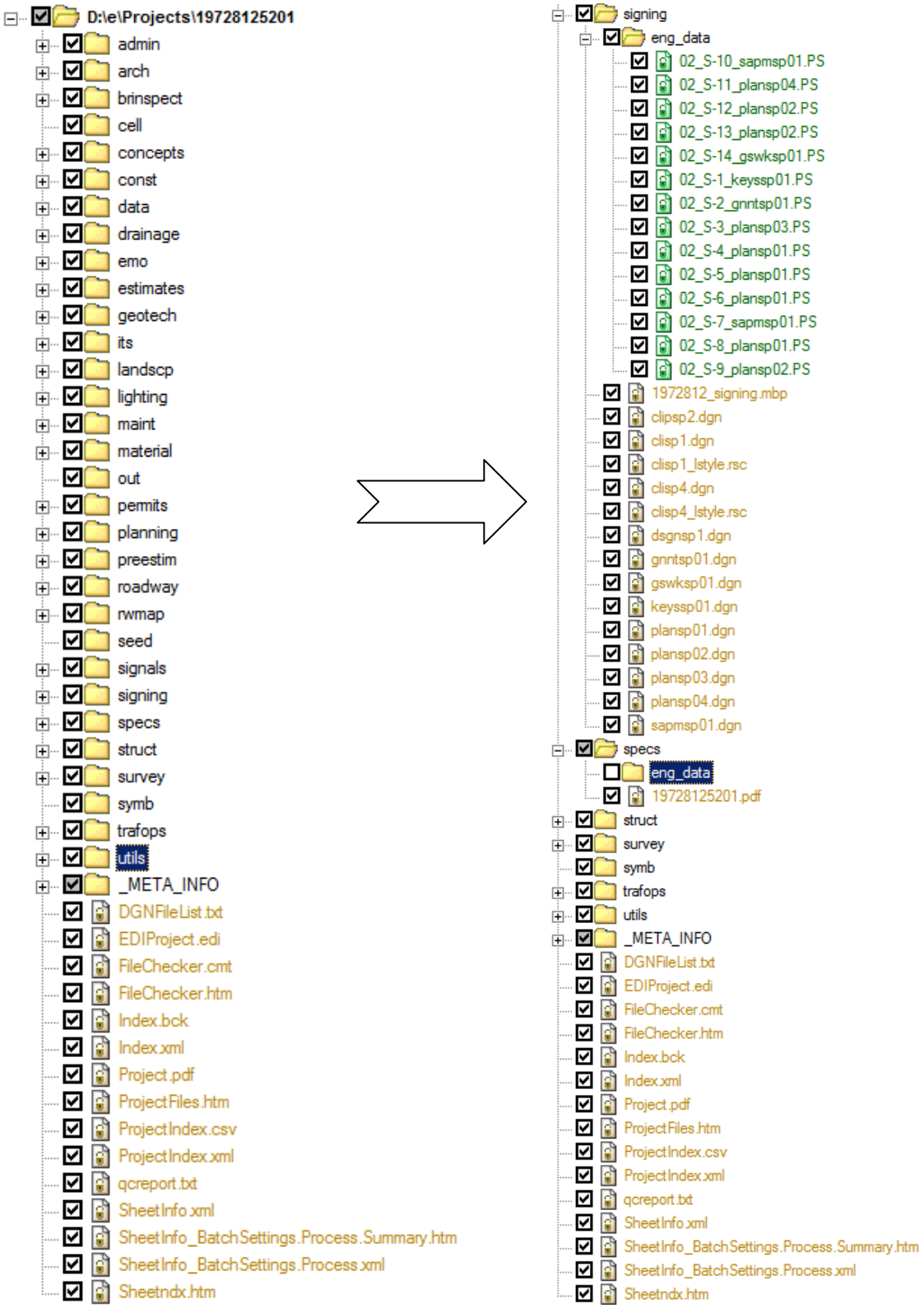
- *fpid*-PLANS[-].PDF (typically located in the \root of the Project Directory folder)
- *fpid*-SPECS[-].PDF (typically located in the \Specs Project sub-directory folder)
- *fpid*-COMPBOOK.PDF (typically located in the \Roadway Project sub-directory folder)
- Any other files the designer does not deem the contractor needs to bid or build the job.

The *fpid*-CADD[-].ZIP is delivered as a separate file outside of the Project Directory where the remaining files for the project are found. This is to avoid unnecessary duplication of data within the Project Directory. Beyond the files listed in the bullets above, the designer should determine what files should remain to support the plans and facilitate the contractor constructing the project through automated means. As a minimum, the *fpid*-CADD[-].ZIP should include:

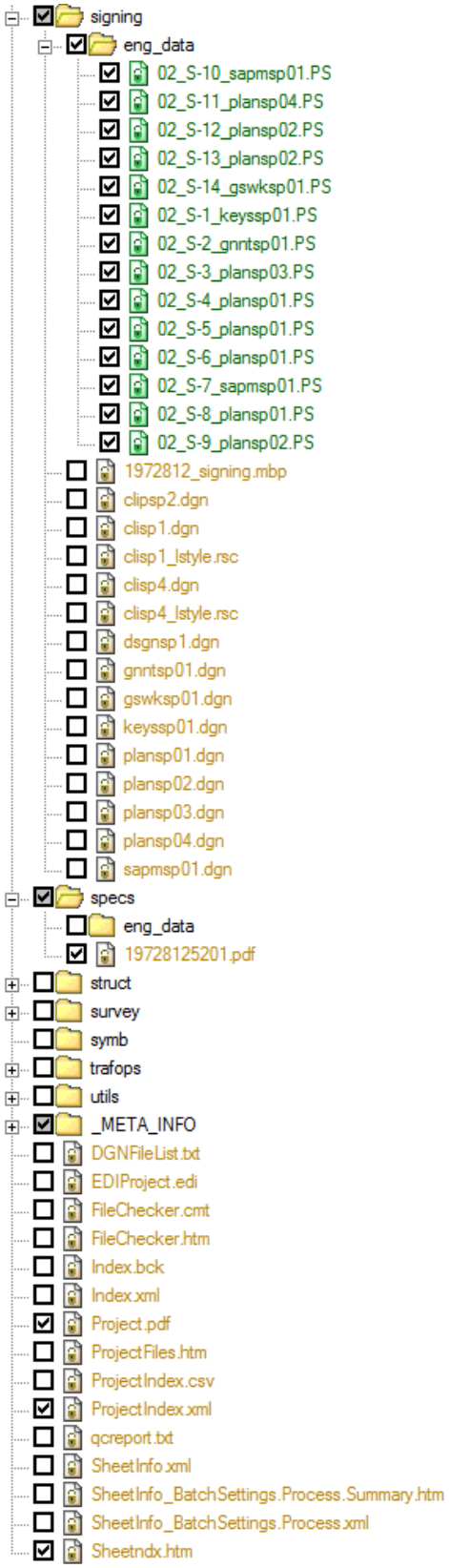
- CADD drawing files
- Engineering data files described in Section 8.7.1 below
- Summary of Quantity Sheet backups, such as, shapes, points, and area identifications

8.3 PROJECT DIRECTORY / BID SET EXAMPLES

The following images are taken from the SetMaker application. A Project dataset directory structure is shown on the left hand side. The right hand image expands the directory structure and shows files for Classical Electronic Delivery that would be included in the Project dataset delivery.



The following image shows the selection from the *SetMaker* application which defines the files (boxes checked) that are to be included in the Bid Set for a Classical Electronic Delivery. Many files that are not necessary for the advertisement; nor folders that do not contain data for the Classical Electronic Delivery Bid Set are not included.



8.4 FILE NAME CONVENTIONS FOR ELECTRONIC DELIVERY

8.4.1 CLASSICAL ELECTRONIC DELIVERY PROJECTS

For Classical Electronic Delivery the following table illustrates the file names used in each successive revision:

Original Delivery	***Revision 1/ Supplement1***	***Revision 2/ Supplement1***	***Revision 3/ Supplement2***
ProjectIndex.XML	ProjectIndex.XML	ProjectIndex.XML	ProjectIndex.XML
Project.PDF	Project1.PDF	Project2.PDF	Project3.PDF
Sheetndx.HTM	Sheetndx1.HTM	Sheetndx2.HTM	Sheetndx3.HTM
	Deltandx1.HTM	Deltandx2.HTM	Deltandx3.HTM
	Revison1.PDF	Revision2.PDF	Revision3.PDF
ProjectFiles.HTM	ProjectFiles.HTM	ProjectFiles.HTM	ProjectFiles.HTM
fpid.PDF TSP1.PDF, TSP2.PDF…	*fpid*SUPP01.PDF	*fpid*SUPP01.PDF	*fpid*SUPP02.PDF

Note *Multiple TSP files may exist in the delivery.*

8.4.2 DIGITAL DELIVERY PROJECTS

For Digital Delivery the following table illustrates the file names used for each successive revision (for the Bid Set):

Original Delivery	***Revision 1/ Supplement1***	***Revision 2/ Supplement1***
fpid-CADD[-].ZIP	*fpid*-CADD-REV01[-].ZIP	*fpid*-CADD-REV02[-].ZIP
fpid-PLANS[-].PDF	*fpid*-PLANS-REV01[-].PDF	*fpid*-PLANS-REV02[-].PDF
fpid-COMPBOOK.PDF	*fpid*-COMPBOOK-REV01.PDF	*fpid*-COMPBOOK-REV02.PDF
fpid-SPECS[-].PDF *fpid*-SPECS-TSP[BOE#][-].PDF	*fpid*-SPECS-SUPP01[-].PDF *fpid*-SPECS-TSP[BOE#]-SUPP01[-].PDF	*fpid*-SPECS-SUPP01[-].PDF *fpid*-SPECS-TSP[BOE#]-SUPP01[-].PDF

Note *Comp Book revisions may not be required with every plans revision, such as, the case with Signing and Marking revision plans where quantities are tabulated in Tabulation of Quantities sheets.*

Listed below are sample file names using the Digital Delivery naming convention shown above:

Original Delivery	*Revision 1/ Supplement1*	*Revision 2/ Supplement1*
12345678901-CADD.zip	12345678901-CADD-REV01.zip	12345678901-CADD-REV02.zip
12345678901-CADD-ConsultA.zip	12345678901-CADD-REV01-ConsultA.zip	12345678901-CADD-REV02-ConsultA.zip
12345678901-CADD-ConsultB.zip	12345678901-CADD-REV01-ConsultB.zip	12345678901-CADD-REV02-ConsultB.zip
12345678901-PLANS.pdf	12345678901-PLANS-REV01.pdf	12345678901-PLANS-REV02.pdf
12345678901-PLANS-ROADWAY.pdf	12345678901-PLANS-REV01-ROADWAY.pdf	12345678901-PLANS-REV02-ROADWAY.pdf
12345678901-PLANS-SIGNING.pdf	12345678901-PLANS-REV01-SIGNING.pdf	12345678901-PLANS-REV02-SIGNING.pdf
12345678901-COMPBOOK.pdf	12345678901-COMPBOOK-REV01.pdf	12345678901-COMPBOOK-REV02.pdf
12345678901-SPECS.pdf	12345678901-SPECS-SUPP01.pdf	12345678901-SPECS-SUPP01.pdf
12345678901-SPECS-TSP560-A.pdf	12345678901-SPECS-TSP560-SUPP01-A.pdf	12345678901-SPECS-TSP560-SUPP01-A.pdf

Name the files starting with more general information on the left and move to the more specific on the right.

For example; begin with the *fpid* number, entering all 11 digits without dashes; then the item description (PLANS, SPECS, ASBUILT, etc.), then revision or supplement number (REV## or SUPP##), and finally any naming [-] specific to the project *(optional)*.

This file naming convention allows project files to collate as they are sorted and combined in a single folder. Text, numbers and dashes are allowed. Characters that interfere with operating system path specifications or XML paths must be excluded, such as underline and spaces along with (/ \ . : , < & # >).

8.5 PRE-PRODUCTION

Pre-Production involves creation of a “seed” project to provide an environment for meeting CADD standards. Activities include the creation of the project directory structure. The project must begin correctly so FDOT standards for Electronic Delivery can be met.

The Electronic Delivery software contains several tools to create a project directory structure with the appropriate project information. This newly generated project, referred to as the “seed project”.

Note *In-house projects are managed through the TIMS project management software, and the district will define the method by which they will initialize in-house projects.*

The *Professionals Electronic Data Delivery System (PEDDS)* application has a module that is used to enter key financial, administrative and location data into the project as project identification information. This project identification information is contained in an XML file format (ProjectID.xml) in the \eng_data sub-folder of the project. It is the FDOT’s responsibility to provide much of this information to the consultant. PEDDS should also be used to secure the seed project prior to handoff to the prime consultant or from the prime to his sub-consultant.

8.6 PRODUCTION

During the production phase, several tasks must be performed prior to the creation of the media to deliver the data meeting FDOT Electronic Delivery requirements specified here and in the CADD Manual. Prior approval should be obtained for any alternate media, besides CR-ROM or DVD-ROM, to be used for delivery of the data to FDOT.

A summary of General tasks during the Production Phase include:

- Understand and follow the directory structure and file naming requirements for Electronic Delivery.
- Draw CADD design files to FDOT Standards as defined in this Handbook, using the workspaces and resources provided. Deliver any non-standard user created CADD resources, such as custom created cell libraries, etc. in appropriate folders and document their use.
- Document all approved deviations from FDOT standards in the project journal file(s) including documenting important methods used and decisions made during design.
- Create required engineering data and quantity output files.
- Generate Quality Control (QC) Reports for all design files using the CADD QC tools provided. These reports indicate compliance to file naming and CADD element symbology standards.
- Merge any external project files into the project directory structure, including all files from sub-consultants, external reference files, scanned images for sheets (if any) and specifications documents.
- Bundle any non-standard graphics dependent resource files into the project sub-directory **\symb** (to include user created fonts and/or line styles)
    - **\cell** (to include project specific / user created cell or block libraries).
- Check for any duplication of files and resolve (documenting reasons for duplications). Remove non-essential file duplication. Remove non-essential “junk” files.
- Review the project for completeness and accuracy. The application FileChecker is provided to help assist with this task.

8.6.1 CLASSICAL ELECTRONIC DELIVERY PROJECTS

For Classical Electronic Delivery projects, the Designer will create and maintain the project Index and journal files.

A summary of Classical Electronic Delivery tasks in addition to the General tasks during the Production Phase include:

- Use the Sheet Navigator application in MicroStation to test that each design file containing sheets is properly identified and tagged with sheet administrative data. Every sheet should be accounted for by this application, unless the source of the sheet is external to MicroStation (i.e. a scanned file). Likewise the Sheet Set Organizer is used to accomplish a similar function in AutoCAD Civil 3D.
- Create final plot images files from graphics design files containing the sheets for Classical Electronic Delivery projects.
- For Classical Electronic Delivery projects use the Electronic Deliver Indexer (EDI) or Sheet Set Organizer (SSO) to create the indexes of plan sheets and files. EDI and SSO are also used to batch plot sheets to image files.
- For Classical Electronic Delivery projects use EDI or SSO to create final versions of the Index reports, including an HTML format version for use in the letting.

- For Classical Electronic Delivery projects, if it is a revision, create the Revision Report (Deltandx#.htm) using the ProjectDelta.
- For Classical Electronic Delivery projects, use EDI or SSO to create the composite Acrobat file (Project#.PDF) of all the plan sheets. Likewise, if the project represents a revision, create the revision PDF (Revision#.pdf) containing those sheets that were revised.
- Electronically sign and/or sign and seal files (plan sheets and specifications files, engineering reports, etc.), as required, using PEDDS.
- Secure the entire project dataset with PEDDS for secure delivery of all project data to FDOT.
- Create the Secured Project CD-ROM (or DVD-ROM) with the appropriate labels and the required checklist (include PEDDS documents if Electronic Signing and Sealing was used).
- For Classical Electronic Delivery and if required by the District, create the Bid Set dataset using the SetMaker application.
- For Classical Electronic Delivery projects and if the project is a Strung Project, use the Strung Project application to create the Strung Data Set from Bid Set data sets created in the previous step. Secure the Strung Project delivery with PEDDS.
- Create Bid Set CD-ROM, as required, with the appropriate labels and PEDDS documents for Classical Electronic Delivery Projects.
- Authenticate hardcopy media (CD-ROM, DVD-ROM, etc) with PEDDS to ensure the data is readable and represents the secured project delivery.

8.6.2 DIGITAL DELIVERY PROJECTS

Digital Delivery does not require an Index or the use of the tools used to maintain the Index, but requires *fpid*PLANS.PDF file(s) to be produced.

When producing the *fpid*PLANS.PDF, there are important considerations to be made:

- File size of the PDF files being produced must be considered. The larger the PDF files get, the more difficult they are to manage, particularly if they have to be transmitted over the Internet (as when the advertisement takes place).
- Produce *fpid*-PLANS[-].PDF in Black and White, unless color hardcopy printing is required from that file. Production of the PDF in color enlarges the file size considerably.
- The number of plan sheets also effects file size. If the overall plans set will exceed 700 sheets, then strongly consider breaking up *fpid*-PLANS[-].PDF into smaller sections by Plans Component. For example: *fpid*-PLANS-Roadway.PDF, *fpid*-PLANS-Signalization.PDF, etc., where the Component name is appended to the PDF that contains that Key Sheet and Component sheets. Not only will the resulting files be smaller, but each of these separate component files of the plans will Digitally Sign and Seal faster and be easier to administer Signatories, if multiple ones are involved in the Signing and Sealing process.

A summary of additional Digital Delivery tasks during the Production Phase include:

- For Digital Delivery projects, create *fpid*-PLANS[-].PDF for the original delivery, and *fpid*-PLANS-REV##[-].PDF for revisions.
- Digital Delivery projects will use certificate based Digital Signature.
- Digital Delivery project files and data must be put together manually to create the Bid Set.For Digital Delivery, each “Lead” and “Goes-with” Project dataset and Bid Set data is delivered separately. The application StrungProject is not used for Digital Delivery.

8.6.3 ENGINEERING DATA

In addition to the delivery of all files used or produced during the course of the Project CD deliverable, the ***FDOT CADD Manual*** requires the inclusion of certain engineering *data files* for critical geometrics in the design. These include the alignments, profiles, cross sections, and surfaces. Critical geometric items like the centerline and profile of the proposed mainline roadway, side streets, special ditches, utilities, etc., are included.

- **Delivery Standards for Engineering Data**

The required formats for engineering data files for a project as part of the electronic delivery includes LandXML, which covers basic route geometry element types, and is readable by FDOT software systems, such as GEOPAK and Civil3D. FDOT utilizes LandXML for one means of delivering critical geometrics, and is readable by known construction AMG equipment and software.

The LandXML format defines a data exchange format for:

Point data	Profiles
Curve data (circular arcs)	Cross Sections
Spiral data	Terrain Model Surfaces
Chains (with station equations)	Hydrology and Hydraulics.

LandXML is also widely supported by many other civil engineering software.

- **Cross Sections**

Although LandXML defines a specification for the exchange of cross section data, FDOT has legacy systems (Multiline) that do not support LandXML cross sections (and functional sections within FDOT that do not use contemporary CADD software). The designer shall also create and deliver cross sections in a text file format called a Multi-line GEN file. These include existing ground terrain, bottom of the proposed template, etc. to define those materials defined in the FDOT Design Standards Indexes 500 and 505. Users are strongly encouraged to reference the Multiline application training posted on the ECSO website.

The *Multi-Line General File format* can represent cross section shots, alignment station equations, horizontal offsets and limits. The ASCII text file format of a Multi-line GEN file is documented in the following pages.

❖ Comments Section of a GEN File

This section of the surface definition contains records that are comment in nature. The information that should be included in these comments is:

- Definition of what each Limits Table represents
- Definition of what the surface or surface feature code represents
- Definition of the Alignment and Profile (if applicable) that is referenced by the Cross Section data. The geometry of the alignment is not contained in the .GEN file, so adequate description needs to be documented so an end-user of the data can establish the proper relationships.

➢ Example of Comments section of a GEN file:

```
$ These are cross sections for Centerline US9A
$ This data is in ENGLISH units
$ Limits Table A is Federal Aid Participation limits
$ Surface EXIST is Pre-Construction Existing Ground
$ Horizontal Alignment is CHAIN SR9A1 found in US9A.XML
$ Feature of Surface EXIST is feature code EXIST
```

Notes on the format above:

- Keyword "$" precedes any remarks needed
- Description of any included Limits Tables
- Description of any surfaces included (i.e. Surface EXIST)
- Alignment referenced by the cross section data
- Feature code assignments
- Other comments as necessary

❖ Station Equation Section of a GEN File

If station equations are present in the cross sections, an **EQUATIONS table** must be present defining the region over which those equations apply. A new station equation region is started when a station equation is introduced into the alignment, where the ahead stationing differs from the back stationing at the given cross section where the equation is introduced.

➢ Example of Equations section:

```
EQUATIONS
EQ R1 23+50.000   23+10.000
EQ R2 24+76.000   24+90.000
EQ R3 53+22.000   53+55.250
END EQUATIONS
```

Notes on the format above:

- Keyword "**EQUATIONS**" to start station equation section
- 1st station equation region "1" begins at station 23+50 back, 23+10 ahead
- 2nd station equation region "2" begins at station 24+76 back, 24+90 ahead
- 3rd station equation region "3" begins at station 53+33 back, 53+55 ahead
- Keyword "**END EQUATIONS**" to end station equation section

❖ Limits Table Section of a GEN File

If the project has lateral limits represented in the cross sections (such as excavation limits, construction limits, R/W, etc.), these limits will be represented in a **LIMITS table**. The **LIMITS** table represents a pair of offsets at a particular cross section where a limit or pair of limits exists. A new **LIMITS** table will be included for each set of limits produced for a particular cross section or set of cross sections.

➢ Example of Limits section:

```
LIMITS TABLE A
LI  23+00.000          -42.000     39.000
LI  24+00.000 R1       -46.000     34.000
LI  25+00.000 R2       -46.000     34.000
LI  54+00.000 R3       -50.000     30.000
END LIMITS
```

Notes on the format above:

- Keyword "**LIMITS TABLE**" to indicate offset limits
- Limits are defined with keyword "**LI**" followed by **station** and **region**. The leftmost offset is first (negative if left of centerline, positive if right) and rightmost is next. If more than one set of limits are needed per station, a second limits table (In this case "LIMITS TABLE B") may be required.
- Keyword "**END LIMITS**" indicates the end of the end of limits table.

- Cross Section Data of a GEN File

The cross section for each surface represented is introduced with the command **GROUND** followed by the surface definition. For each type of surface (i.e. Existing Ground, Proposed Template, Subsoil Excavation, etc.), a **GROUND** section will appear in the format covering the station range for which that surface applies.

Standard Surface Descriptions	Line type
Roadway Sub-Design Template	A
Original Borrow Terrain	B
Tolerance Line	C
Original Channel Terrain	D
Extra Depth Subsoil	E
Final Roadway	F
Final Subsoil	G
High	H
Final Borrow	J
Final Channel	K
Low	L
Channel Template	O
Pre-Construction Roadway Terrain	P
Roadway Template Bottom of Base	R
Roadway Template Top of Surface	S
Original Roadway Terrain	T
Unassigned	I, M, N, Q, U, V, W, X , Y

For a given station on a particular surface, the station, the region that the station falls in and the points on the cross section (represented by offset-elevation pairs) are entered on a line.

- The points are ordered left-most offset to right-most offset as read left to right along the line.
- White space separates the offset and elevation and the adjacent offset/elevation pairs (other points on the cross section).
- Offsets left of centerline are indicated by a minus sign "-" in front of the offset. Offsets right of centerline are unsigned.
- A zero offset point (centerline) is not necessary, but is highly recommended, as that would leave no confusion concerning how to interpolate the centerline elevation.
- The maximum line-length is 132 characters, so multiple lines may be used to include all of the points necessary for a given surface on a particular cross section.
- Each surface definition must be provided in the complete format as shown. Only station equations and limits tables' sections may be omitted from a surface definition if they do not exist for the given cross sections.

- Example of Cross Section Data (in this case existing Ground sections):

```
GROUND EXISTING GROUND SURFACE
XS 23+00.000     -60.000 21.300  .000 18.300   50.000 16.700
XS 24+00.000 R1  -50.000 17.000  .000 16.300   30.000 14.000
XS 24+00.000 R1   50.000 22.000
XS 25+00.000 R2  -50.000 17.000  .000 15.800   30.000 14.300
XS 26+00.000 R2  -50.000 17.000  .000 15.600   30.000 14.600
XS 27+00.000 R2  -50.000 17.000  .000 15.900   30.000 14.800
XS 28+00.000 R2  -50.000 17.000  .000 16.300   30.000 15.100
XS 28+00.000 R2   50.000 19.000   75.000 16.300
XS 28+50.000 R2  -50.000 17.000  .000 16.500   30.000 15.400
XS 29+00.000 R2  -50.000 17.000  .000 16.800   30.000 14.800
XS 30+00.000 R2  -50.000 17.000  .000 16.300   30.000 14.500
XS 31+00.000 R2  -50.000 17.000  .000 16.100   30.000 14.300
XS 32+00.000 R2  -50.000 17.000  .000 15.800   30.000 14.700
XS 33+00.000 R2  -50.000 17.000  .000 15.600   30.000 14.300
END GROUND
```

Notes on the format above:

- Each surface defined in the cross section will have its own set of data in the format as shown.
- Keyword "**GROUND"** shall be followed by comments identifying the surface.
- Keyword "**XS**" followed by station, region, and offset, elevation pairs (up to 132 characters per line)
- Keyword "**END GROUND**" indicating end of cross sections

Other GROUND sections should be included for the finish surface of the proposed roadway, as well as the bottom of the base, sub grade, and any other soil layers that must be excavated (A4, A6, A8, etc). Other Ground Sections might start like the following, indicating the surface being represented by the data:

```
GROUND MULTILINE DATA LINE TYPE R   ← Roadway Template Bottom of Base
GROUND MULTILINE DATA LINE TYPE T   ← Original Terrain
```

- **Quantity Files**

Engineering data supporting quantity calculations will be delivered according to the guidelines and formats defined by Final Estimates in the Computation Methods for Design, Construction and Final Estimates Handbook found here:

http://www.dot.state.fl.us/construction/Manuals/finalest/newcompbook/NewSampleCompbook.shtm

8.6.4 DATA FOR MACHINE CONTROL IN CONSTRUCTION

FDOT strongly encourages 3D design and modeling for all projects to facilitate contractor use of Automated Machine Guidance (AMG), also known as machine control. AMG technology can reduce time and cost of construction because of greater productivity by equipment operators, fewer grade checks needed, greener construction, greater safety, less rework, and less survey staking. Contractors invest in AMG for safety, productivity, and to stay competitive. AMG technology is now an industry standard and contractors will be increasingly dependent on electronic design data for bidding and construction. Providing electronic design data during project advertisement allows contractors to produce estimates faster and consider different staging scenarios. Contractors claim this reduces their risk and should produce better bids.

AMG uses positioning devices such as Global Positioning Satellite navigation systems (GPS), total stations, or survey grade rotating laser levels to determine real time X, Y, and Z positions of construction equipment and compares the position against a digital model of the proposed design. The model can include horizontal alignments, profiles, cross-sections, two dimensional (2D) and three dimensional (3D) graphics data which include original ground and proposed design surfaces. This model data can be exported to the formats need by the AMG equipment by the contractor. A computer display on the construction equipment shows the equipment operator several perspectives and delta values of his position compared to the design surface model and other entities in the data.

In general, projects characterized by the following are the best candidates for modeling and AMG:

- Projects with large amounts of earthwork or paving, including new corridors or significant reconstruction.
- Projects with a good GPS environment for receiving satellite signals, or enough line of sight for using total station and laser controlled systems.
- Projects with designs based on an accurate existing ground Digital Terrain Models (DTM).

Designing using a 3D workflow must start at the beginning of the project to create the needed files, and is contingent upon data being tied to an AMG field usable coordinate system and datum. The overall reduction of design and construction costs by modeling and AMG will be realized. The 3D workflow enables the project development team to visualize potential impacts and promote intense collaboration during the planning and design process. Discovering design errors by inspection of the 3D models will reduce costly change orders during construction.

The use of modeling will require conversion of CADD data to AMG formats. This conversion is the responsibility of the contractor, as the contractor may have special needs that the designer may not anticipate. However the formats of Electronic Delivery data prescribed by this Handbook should enable a successful translation.

The electronic files delivered with the design are provided as a courtesy to the contractor. The Contracts Administration Office releases this CADD data with accompanying exculpatory language stating the contractor cannot use the data as a basis for claims. Contractors will be completely responsible for any digital data converted or derived from model data provided by design. Post-design services may employ the designer to convert model data to needed AMG formats. Since the intention of the FDOT is to encourage 3D modeling and AMG in construction, means for accountability and certification of 3D models will be forthcoming.

Types of modeling data needed:

- **Control**

The field monument survey control for the design of the project needs to be clearly transmitted to the contractor, including the coordinate system and datum of that control. This is important because the contractor must calibrate his AMG equipment to that control.

- **Alignments/PGLs**

Already described in Section 8.6.1; LandXML files of the controlling alignments and profiles that represent the controlling geometry of the project may be used or can be extracted from other CADD files delivered. These tie all other data provided directly to the contract plans set. The data must be in the coordinate system of the control that can resolve to the field and congruent to all the other data that will be provided.

- **Surfaces**

Surfaces created during design using CADD software indicate the designer's intent. Surfaces from the original terrain survey represent the existing conditions at the time of the design. As a minimum, the pre-design existing (Ground) surface, as well as the finished construction (Top) surface will be delivered. LandXML should typically be delivered for the surfaces on most projects and same surfaces also delivered as 3D graphics files in the native CADD systems (corridor surfaces in DGN or DWG). Surfaces represented by LandXML files can become unwieldy for larger projects (surfaces should be represented in LandXML files of less than 500 MB per surface-file), so it may be necessary to subdivide a project's surface data into logical sections when delivering large LandXML surface files.

Note *For example, a relatively small TIN surface (32,208 points, 63,462 triangles) can be represented as LandXML file of 4.99 MB. So a LandXML file of approximately 100 times this data volume could be manageable as LandXML. Since LandXML is text, it will compress significantly when creating a ZIP to deliver the data (for example, a 50 Megabyte LandXML file of a TIN surface will ZIP down to approximately 10 Megabytes for delivery).*

Surfaces should also be delivered in contemporary MicroStation DGN or AutoCAD DWG 3D graphics formats (meeting FDOT CADD standards for symbology), and are most usable when each surface is separated into their own drawing file.

Note *Points and Break lines should be contained in the surface files described above.*

Note *If the native to CADD system used to produce those surfaces mentioned above stores surface data in alternative formats, as such the case with GEOPAK .TIN, a GEOPAK .DAT, an InROADS / GEOPAK Roadway Modeler .DTM, then those files must also be delivered.*

- **Breaklines**

Hard surface breaks must be respected during construction (i.e. edges of pavement, shoulder breaks, ditch profiles, etc.) and need to be provided to enhance the surface data. These aid the field AMG equipment operator during grading and string-less staking operations by preventing the "shaving" that could occur as the equipment transitions the break.

8.6.5 MAXIMUM CORRIDOR FREQUENCY INTERVAL SPACING

Design software used by FDOT samples the 3D corridor models at user defined intervals in order to create surfaces. To ensure reasonable accuracy in surface models for AMG operations, maximum interval is described below.

Note *The designer may sample more frequently to more accurately represent his design model in the exported surface files, although there is limiting return (larger files and poorer computer performance) if sampling too frequently.*

Corridor Model Geometrics	Facility Design Speed	Maximum Interval
Horizontal or Vertical Curves	Less Than or Equal To 45 mph	5 feet spacing maximum
Horizontal or Vertical Curves	Greater Than 45 mph	25 feet spacing maximum
Horizontal or Vertical Alignment in Tangency	All Speeds	25 feet spacing maximum

Additional sampling intervals may be needed at critical horizontal geometry points (i.e. PC's, PT's), superelevation transition points, profile geometry points (i.e. PVC's, PVT's), and profile high/low points.

The designer must also add sampling at other critical points along the corridor, such as change of typical section, critical drainage locations, approach and interior to intersections, median crossovers, etc.

8.6.6 MERGING EXTERNAL PROJECT FILES

Files must be merged into the main project directory structure prior to securing the project for delivery. These include CADD System dependency files, and files provided from outside sources, such as those produced by sub-consultants.

- **CADD System Dependency Files**

Certain CADD System files that are used, or referenced, might reside external to the project directory during the production phase. Before delivery to FDOT, these files must be placed in the appropriate locations within the FDOT project directory structure. It is highly recommended that these files be included in the project directory structure early on in the project development and verified that referencing functions work properly. Reference files must also be attached without the "save full path" option, and should be located by their relative paths from the root project directory.

For printing purposes, any user created custom line style / type, font resource, and cell / block library files used for the project must be included with the project in the sub-directory **\symb**. In addition, any external design files that are referenced, such as sheet border files, must be copied to the project directory. This allows future customers of the data the ability to view or recreate prints matching the original delivery.

Note *The designer does not need to include the FDOT standard CADD resources delivered by the FDOT CADD Software (MicroStation or AutoCAD resources). However, the FDOT CADD Software version information must be provided in the project journal.*

- **Files from Outside Sources**

Files that come from an outside source include files produced by a sub-consultant. Files from sub-consultants shall be delivered to the primary consultant, or the FDOT designer, following the same requirements for Electronic Delivery.

8.6.7 REVIEWING THE PROJECT

A baseline checklist found in the Electronic Delivery software and in Section 8.6.12 of this Handbook may be employed to help the producer consider critical items in this important review. Note that some FDOT districts have their own supplemental checklists which provide additional detail. Note there are tools in the FDOT CADD Software Suite (including QC and FileChecker) to ensure quality control which helps enable a successful review.

Note *Contact your District Project Manager for specific District Supplemental Electronic Delivery requirements.*

For example, a start of items to review might include:

- Take particular care to look for missing sheets, gaps in the numbering, or duplicate sheet numbering, etc.
- Make certain the Electronic Plan Note appears on all plan sheets indicating the source of the official record (Sheet Navigator can assist with the placement of this note).
- If Sheet Navigator indicates all sheets are accounted for, the project should be further reviewed with the Electronic Delivery Indexer (EDI) for Classical Electronic Delivery.
- Ascertain whether an image file (.PS, .PDF, or .TIF format) is available for each sheet in the electronic plans for Classical Electronic Delivery, or that *fpid*-PLANS[-].PDF contains all sheets, in order, and rotated properly for Digital Delivery.
- It is also important to review the Comments about particular files using the Electronic Delivery Indexer (Classical Electronic Delivery). These comments should supplement the documentation in your project Journal(s).
- Double-check that the Journal(s) for the project is complete and accurate.

FileChecker can be used to find multiple files in the project directory structure with the same file name, but different content. Likewise, it can find files with the same content, but different filenames. These tools should be used to find and resolve potential file naming problems. Remember that FileChecker is only a tool to aid the producer find potential issues in their Electronic Delivery! Using FileChecker doesn't excuse the producer from performing a thorough review.

Once the producer is certain all components of the project are accurate, correct and complete, PEDDS will be used for Signing and Sealing Classical Electronic Deliveries, or certificate based Digital Signature will be used for Digital Delivery. PEDDS will be used to secure the Project CD data set before delivery to FDOT.

8.6.8 SIGN AND SEAL PROJECT FILES

8.6.8.1 CLASSICAL ELECTRONIC DELIVERY WITH PEDDS

The requirements for signing and sealing information stored in electronic files have been defined by the Boards of Professional Regulation and Volume I, Chapter 19 of the FDOT Plans Preparation Manual. For each professional in responsible charge who signs and seals files in a project, the PEDDS program generates:

- A Signature file, which defines the files that are being signed and sealed (this is an XML format file found in the *_meta_info* directory of the project). The signature file identifies files signed by the professional Signatory - including the file's SHA-1 hash code, and any qualifiers (conditions) the signatory placed on the signing of a particular file.
- A Signature Document (a report) generated after a signatory elects to sign and seal selected files. This document is printed, signed, dated, and sealed with a seal approved by the respective Board of Professional Regulation. This document secures the files signed and sealed by the professional, using the SHA-1 hash code computed for the signature file itself. If a non-licensed signatory selects files to sign (typically using his/her driver's license number), then the signature document is printed, signed and dated, but is not sealed with an impression seal.

Important: The signature document must be preserved and protected and must never be lost or separated from the data it is associated with. Without this document the associated data cannot be truly authenticated and thus, cannot be considered a legal record.

Note *Finished sheets that will imminently become Signed and Sealed (electronically) shall bear the electronic signature note as shown in the FDOT Plans Preparation Manual exhibits. The note should not be applied to sheets during the early course of plans preparation to minimize the potential for confusion by a recipient that a sheet may be signed and sealed. The note must be applied at final delivery.*

8.6.8.2 DIGITAL DELIVERY WITH DIGITAL SIGNATURE

Digital Signatures used for signing FDOT documents must comply with Florida Administrative Code governing the specific discipline for the professional signing those documents. Digital Delivery project designers will use Digital Signature instead of PEDDS.

In compliance with the above, an Access Certificates for Electronics Services (ACES) digital certificate shall be use to ensure authenticity and accountability in citizen-to-government, business-to-government, and government-to-government electronic transactions. An ACES digital certificate is an electronic identity issued by a Certification Authority that establishes an individual's identity per the Federal Government Services Administration (GSA) standards when using electronic transactions, and there are several 3rd party Certificate Authorities that issue such certificates.

When applying Digital Signatures, many software applications allow the signature to have an "appearance." As a minimum, use a visible signature, with the text name of the Signatory (not an image), and the date-time stamp at the instant of signing. Do not include any watermark or overlay, unless it is an image of the "wet ink" signature of the Signatory. Do not include company logos, or other images within the Digital Signature appearance. The reason for signing may be placed in a text block where there is more space available and the reason is not restricted.

Note *Finished sheets that will imminently become Signed and Sealed (digitally) shall bear the electronic signature note as shown in the FDOT Plans Preparation Manual exhibits. The note should not be applied to sheets during the early course of plans preparation to minimize the potential for confusion by a recipient that a sheet may be signed and sealed. The note must be applied at final delivery.*

8.6.9 SECURING THE PROJECT FOR DELIVERY

PEDDS includes a process to secure the complete project directory, including all contained files for delivery. This securing process is run after all the project files are finished (and for electronic signature after all signature files have been created, printed, and the Signature Documents are signed, dated, and sealed).

The process of securing a project for delivery creates a Manifest Document containing the computed hash code of the Manifest File (Manifest.XML - which lists all files in the project with their individual hashes), thus securing ALL the files in the project directory. The Manifest Document is printed, signed, and dated (but is not sealed), by a project manager (or data manager), and delivered to FDOT along with the media containing the complete project submittal.

Note *Digital Signature secures each file signed separately. PEDDS is still used to secure a Project CD deliverable where Digital Signature was used to sign and seal files.*

8.6.10 AUTHENTICATION OF A DELIVERY

PEDDS and its paper reports received with the project will be used by FDOT to authenticate a project. The Authentication Report generated by the authentication process in PEDDS will be compared against the Manifest and Signature documents submitted with the delivery. If the project submitted is found to generate the same hash codes, the delivery will be considered authenticated.

8.6.11 MEDIA REQUIREMENTS FOR DELIVERY

All electronic projects submitted to FDOT will be on write protected physical media (CD-ROM or DVD-ROM) unless otherwise approved by the FDOT Project Manager. If the project is too large to fit on one CD/DVD, then the process for delivery to FDOT must be reviewed with the FDOT Project Manager before splitting the project on multiple CD/DVDs or choosing an alternate media. All Project CD's must have a Project Identification Label with the required information shown below:

- Financial Project ID Number of Project:
- Project Description *(including County and State Road numbers, local road designation):*
- Firm or District Performing the Work
- Name of FDOT and Consultant Project Manager(s)
- Creation Date of the Media
- Disk (#) of (Total #) *(if multiple ROMs are needed)*
- Delivery Type Label *(Project CD, Bid Set CD, etc.)*
- Anticipated Letting Date for the Project

Note *After burning project data to a ROM, or other media for delivery to the FDOT, that media should be authenticated with PEDDS to ensure no changes were introduced during the media production process prior to submission to FDOT.*

With the cost of USB memory drives (thumb drives) and corresponding increase of capacity, this media will be grow in popularity for delivery. If such a drive is delivered, it shall be labeled as a minimum with the *fpid* number and district.

8.6.12 COMPLIANCE CERTIFICATION

All Electronic Deliveries for FDOT Projects are to be delivered to the FDOT Project Manager, unless an alternate agreement is reached. A Compliance Certification (or similar document), as provided on the following page should accompany the documents in all FDOT Project deliveries.

Note *Districts may use a more comprehensive form in their Quality Assurance processes than the one shown on the following page. FDOT is working toward a single version meeting the needs of all Districts.*

The Compliance Certification Checklist Report shown on the following page contains a baseline checklist of items that should be checked before a final submittal.

Compliance Certification Checklist Report

All electronic data submittals are to be transmitted to the FDOT Project Manager. The following questions shall be addressed before submittal, and this or similar report given to the Project Manager along with the submittal.

- ☐ 1. Have project journal(s) been created containing all necessary project information?
- ☐ 2. Is the listing of the software packages and versions used to create all delivered files included in the journal?
- ☐ 3. Are all the native files generated by the CADD/Design software in checklist item 2 included in the delivery package?
- ☐ 4. Are design graphics files compliant with the FDOT CADD standards for directory structure, file naming, and element symbology?
- ☐ 5. Does the submittal include all user-created CADD System resource files (line styles, fonts, etc.) that may have been used with the project?
- ☐ 6. Has the QC software been run against the graphics design files? Are the resultant QC Reports of compliance included in the delivery submittal? Has FileChecker been run to verify directory structure, file naming standard, etc.?
- ☐ 7. Have the prescribed engineering data files been created and submitted for the alignments, profiles, and surfaces in the formats described in the CADD Production Criteria Handbook? Is this information stored in the appropriate directories?
- ☐ 8. Have Multi-line general file format files been created and included for the surfaces represented in the cross sections?
- ☐ 9. Have images for the plans been been checked and included for all sheets in the plan set? PDF format? Checked for Sheet size, Scale, Rotation/Orientation?
- ☐ 10. Are the files representing the plans, referenced by Chapter 19 of the FDOT Plans Preparation Manual, signed and sealed? Is the Electronic Plan Note on each sheet?
- ☐ 11. Has the entire delivery been secured with PEDDS? Has the resulting Manifest Document been signed?
- ☐ 12. If Electronic Signature used, are hardcopy reports of the PEDDS documents included, printed and signed? This includes the signed and initialed Manifest Documents and all signed Signatory Documents. If Digital Signature used, are the correct files signed with the appropriate Digital Certificate and independently validated? Does FDOT have the root certificate installed for the certificate Authority used?
- ☐ 13. Has the final media for submission been properly labeled and re-checked to make sure the data is readable and can be authenticated?
- ☐ 14. For Classical Electronic Delivery, has a Project.PDF file been included that contains all sheets that are defined by the delivery's index?
- ☐ 15. For Classical Electronic Delivery, has an index report SheetNDX.htm file been included that links all sheets that are defined by the delivery's index for the plans?

FPID: _____

Date of Scope: _____

Certified by EOR: _____

8.7 POST-PRODUCTION

The "Post-Production Phase" involves the review and acceptance of an Electronic Delivery, and making that delivery available to FDOT internal services for posting. Functions include the receipt and authentication of the delivery media, and placement of the project data into systems designed for general access to the data.

Upon receipt of the secured Electronic Delivery package and the accompanying documents, it may be authenticated using PEDDS by FDOT's designated representative for accepting project data. The electronic submittal checklist(s) will also be reviewed for completion.

Following the requirements in this Handbook does not guarantee an acceptable work product, as this Handbook does not address the quality of the engineering or survey work performed.

Once the electronic submittal is accepted, the electronic project will be imported into FDOT file management systems for subsequent use. Copies of the submittal media may be distributed among various stakeholders, such as Construction and Maintenance.

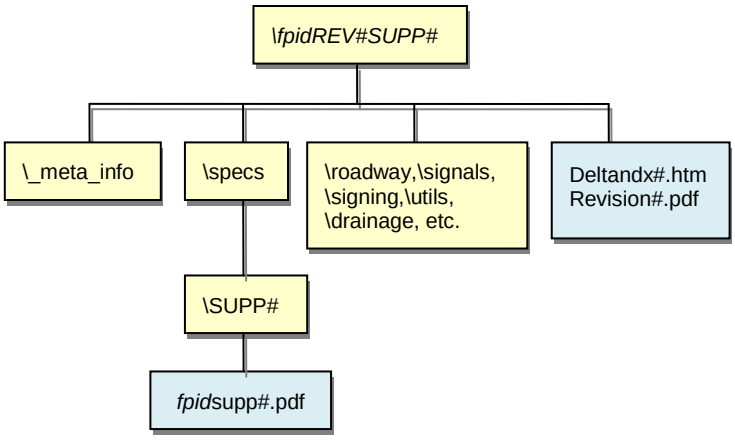
8.8 REVISIONS

8.8.1 CLASSICAL ELECTRONIC DELIVERY

Revisions are modifications after the Electronic Delivery has been accepted by Project Review. Central Office or District plans processing units require the revised "Bid Set" data submittal to use a specific directory naming convention for revisions and / or supplements for Classical Electronic Delivery. This convention can be created with the SetMaker tool, but the user must be aware of the conventions (it's not automatic).

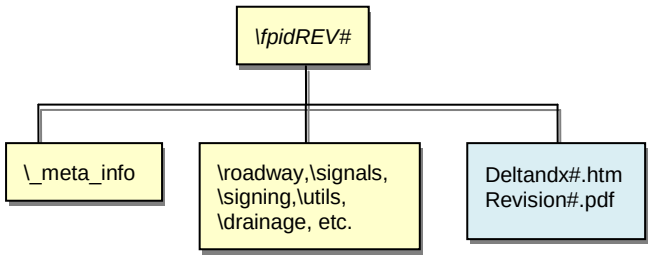
Note *Project root folder renaming does not apply for the "Project CD" submissions (that directory name NEVER changes, regardless of which revision); only the subsets created for revisions and/or supplements ("Bid Set CD") have their root folders renamed.*

When both a plans revision and specifications changes (called a supplement) are needed, the directory structure (and content) for the "Bid Set" subset for the revision 1 and supplement 1 is shown below:

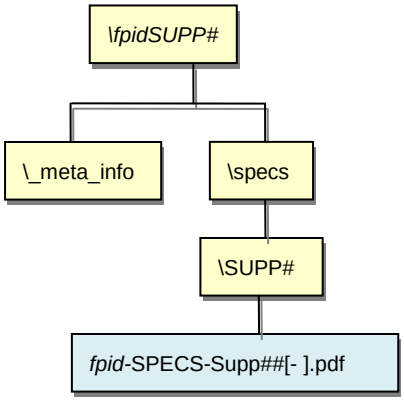


Note *A complete "Project CD" deliverable, named the original project name, is usually required to be submitted with each contemporary revision to the project. The directory naming conventions shown in these diagrams apply only to "Bid Set" subsets extracted from those revised "Project CD" submissions on Classical Electronic Delivery projects.*

If there are **plans revisions only** to a Classical Electronic Delivery, the following directory structure would be used:



If there are specifications only, the following directory structure would be used:



The *root directory name* for "Bid Set CD" data sets created for a revision and/or supplement are then:

Event	*Project CD*	*Plans & Specs (Revision) CD*
Original Delivery	*fpid*	*fpid*
Revision 1	*fpid*	*fpid*REV1
Supplement 1	*fpid*	*fpid*SUPP1
Revision 2	*fpid*	*fpid*REV2
Revision 3 and Supplement 2	*fpid*	*fpid*REV3SUPP2

Important: When preparing the revision, do not over plot any signed and sealed file from an earlier delivery – doing so will make the Signatory of those files not Authenticate in PEDDS.

8.8.2 DIGITAL DELIVERY

Digital Delivery Bid Sets do not require the directory structure as previously shown. The Bid Set for Digital Delivery is the set of files described in Section 8.2 through Section 8.4.

8.9 STRUNG PROJECTS

Classical Electronic Delivery of “strung projects” involves the act of combining two or more independent and secured project data sub-sets (Bid Sets) together. Stringing projects involves combining the data in a way that the end-user of the data (typically a contractor) can reasonably navigate “lead” and “goes-with” sub-project data comprising the strung project.

Users must be familiar with the process of creating “Bid Set” data sub-sets from “Project” data sets. These must be created prior to project stringing. An application named StrungProject is included in the Electronic Delivery software suite for this operation.

Digital Deliveries differ, in that each “lead” and “goes-with” project is delivered as separate data sets, and never combined or intermingled. The StrungProject application is not needed for Digital Deliveries.

8.10 RE-LET PROJECTS AND ROLL BACK REVISIONS

In rare cases, projects must be re-let. If no revisions have occurred to the project that must be re-Let, FDOT will simply re-advertise and Let the project with the submitted Project CD or Bid Set CD data. However if a revision has been applied to the project to be re-Let, then the revision is no longer germane and the re-Let project is essentially an original Letting all over again. In this case, the data producer may be asked to roll back the revision indexing as if the delivery was an original delivery. This could involve updating the plan sheets to remove the revision enumerations - potentially removing the notations a revision has even occurred.

Note *The changes to plans that were once identified as a revision are now considered simply a plan change.*

8.11 DESIGN BUILD PROJECTS

The scope defines the deliverable FDOT receives from the design build contractor.