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John C. Stennis Space Center Creo Model Based Computer-Aided Design Standard

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1.0 SCOPE/PURPOSE

This document establishes the requirements and procedures for the creation and modification of Creo Parametric® design software Computer-Aided Design (CAD) models and drawings for use at National Aeronautics and Space Administration (NASA) John C. Stennis Space Center (SSC). The goal is to produce robust models that relate correct dimensional data. This document identifies modeling methodology so that all design groups produce consistent electronic deliverables within SSC.

1.1 Application

- 1.1.1 This document applies to all NASA SSC organizations, contractors, and sub-contractors involved with the preparation of Creo Parametric models that will be integrated into SSC designs.
- 1.1.2 All Creo Parametric objects created at SSC shall adhere to the practices described within this document, except legacy models. Test facility models will adhere to the practices within this document as resources permit.
- 1.1.3 The solid geometry in the CAD model shall be the authority, supplemented by 2-Dimensional (2D) drawings.
- 1.1.4 The drawing and Bill of Materials (BOM) shall be used to define the notes, Geometric Dimensioning and Tolerancing (GD&T), and other information necessary to fully define the configuration.
- 1.1.4 Information regarding the Design and Data Management System (DDMS) Windchill® can be found at the following website:
<https://sscddms.ndc.nasa.gov/Windchill/ssc/portal/portal.jsp>. In the absence of an applicable SSC DI, ED-CAD-DI-001, *Workspace Use and Troubleshooting*, may be used for additional information.
- 1.1.6 Instructions provide specific information on implementation techniques for certain requirements within the SSTD and are listed in Section 2.0. These [Marshall Space Flight Center \(MSFC\) Desktop Instruction \(DI\)](#) may be found in DDMS Reference Documents.

2.0 REFERENCE AND APPLICABLE DOCUMENTS

Referenced documents shall be the latest version unless otherwise specified.

ASME Y14.100 – 2000, *Engineering Drawing Practices*
ASME Y14.41 – 2003, *Digital Product Definition Data Practices*
ASME Y14.5M – 1994, *Dimensioning and Tolerancing*

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NASA-STD-(I)-0007, *NASA Computer-Aided Design Interoperability*
 SOI-8080-0007, *Test Site Drawings*
 SOI-8080-0015, *Configuration Control of Technical Systems*
 SPR 1440.1, *Records Management Program Requirements*
 SSTD-8070-0001-CONFIG, *SSC Facilities Engineering Documentation Standard*
 SSTD-8070-0002-CONFIG, *Facilities Drafting Manual*
 SSTD-8070-0005-CONFIG, *Preparation, Review, Approval and Release of
 SSC Standards*

Desktop Instructions:

SSC-issued Desktop Instructions for SSC Model Based CAD Design are under review. Until such time as SSC-issued Desktop Instructions are created, the following MSFC DIs may be used as references. Within these Desktop Instructions, Integrated Collaborate Environment (ICE) is referenced. It is MSFC's Design and Data Management (DDMS) equivalent.

Desktop Instruction ED-CAD-DI-001, *Workspace Use and Troubleshooting*
 Desktop Instruction ED-CAD-DI-002, *Naming and Renaming Files in ICE Windchill*
 Desktop Instruction ED-CAD-DI-003, *Library Components*
 Desktop Instruction ED-CAD-DI-004, *Standard Drawing Notes*
 Desktop Instruction ED-CAD-DI-005, *Simplified Representation Creation
 and Maintenance*
 Desktop Instruction ED-CAD-DI-006, *Creation of Skeleton Files*
 Desktop Instruction ED-CAD-DI-007, *Standard Symbols*
 Desktop Instruction ED-CAD-DI-008, *Updating Drawing Formats*
 Desktop Instruction ED-CAD-DI-009, *MOD File Creation*
 Desktop Instruction ED-CAD-DI-010, *Shrink-wrap Creation*
 Desktop Instruction ED-CAD-DI-011, *Data Transfer*
 Desktop Instruction ED-CAD-DI-014, *Cable Routing*
 Desktop Instruction ED-CAD-DI-015, *Piping*
 Desktop Instruction ED-CAD-DI-016, *Related Companion Files*
 Desktop Instruction ED-CAD-DI-017, *Creating Standard Layers*
 Desktop Instruction ED-CAD-DI-018, *Sheet Metal Parts*
 Desktop Instruction ED-CAD-DI-019, *Adding Materials and Generating Mass
 Properties*
 Desktop Instruction ED-CAD-DI-020, *User-Defined Features*
 Desktop Instruction ED-CAD-DI-022, *Vendor Item Modeling*
 Desktop Instruction ED-CAD-DI-023, *Exploded Views*
 Desktop Instruction ED-CAD-DI-024, *Tables and Tabulated Drawings*
 Desktop Instruction ED-CAD-DI-025, *Bulk Items*
 Desktop Instruction ED-CAD-DI-026, *Verifying 3-Dimensional CAD Models*
 Desktop Instruction ED-CAD-DI-027, *Revising CAD Documents and WT Parts*
 Desktop Instruction ED-CAD-DI-030, *Gathering Released Data in ICE Windchill*

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3.0 ACRONYMS/DEFINITIONS

3.1 Acronyms

2D	2-Dimensional
3D	3-Dimensional
ACT	Activation
ASM	Assembly Model
ASME	American Society of Mechanical Engineers
BOM	Bill of Materials
CAD	Computer-Aided Design
CDR	Critical Design Review
CM	Configuration Management
CSYS	Coordinate System
DDMS	Design and Data Management System
DI	Desktop Instruction
ECR	Engineering Change Request
EMI	Engineering Modification Instruction
EO	Engineering Order
FAC	Facility
GD&T	Geometric Dimensioning and Tolerancing
ICD	Interface Control Document or Interface Control Drawing
ICE	Integrated Collaborative Environment
IDR	Intermediate Design Review
MBD	Model Based Definition
MPA	Modular Product Architecture
MSFC	Marshall Space Flight Center
MSK	Mechanical Sketch
NASA	National Aeronautics and Space Administration
OML	Outer Mold Line
PDR	Preliminary Design Review
PLM	Product Lifecycle Management
PM	Project Manager
PS	Pipe Supports
PSK	Piping Sketch
PUR	Purge
RMB	Right Mouse Button

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SAE	Society of Automotive Engineering
SBU	Sensitive But Unclassified
SOI	Stennis Organizational Instruction
SPR	Stennis Procedural Requirement
SSC	John C. Stennis Space Center
SSTD	Stennis Standard
STE	Special Test Equipment
STRU	Structure
TA	Test Article
TS	Test Stand
UDF	User-Defined Feature
US	Upper Stage
WT	Windchill Type

3.2 Definitions

As-Designed	State of an approved drawing prior to its release.
Baseline	See DDMS Windchill Baseline.
Bill of Materials (BOM)	A listing of all parts for an assembly.
Bottom-Up Design Methodology	Design of individual components independent of external references or controls.
Bulk Item	Any item with a quantity of “As Required” on the BOM.
CAD Document	(Also known as CAD object.) A version-controlled object on DDMS Windchill that can contain one primary CAD file, as well as other secondary reference files.
CAD File	A file used within the Creo Parametric design software which includes CAD parts, assemblies, drawings, formats, sketches, layouts, etc. (.prt, .asm, .drw, etc.)
CAD Model Structure	The relationships between models and where those models are used or referenced.
Common Parts	Those items listed on the Common Parts List; can be standard parts and vendor parts.

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Configuration Item	An aggregate of hardware, firmware, software, or any of its discrete portions, which satisfies an end-use function and is designated for Configuration Management (CM). Configuration Items may vary widely in complexity, size, and type. The following are typically designated as Configuration Items: Top assemblies, main assemblies, components with specifications, spares units, and orbital/logistics replacement units.
Creo Parametric Layout	Type of file used to create and modify models based on parameters and/or relations. Serves as a vital communication tool that controls all corresponding geometry in one central location, pictorially reflecting what each parameter drives and how.
DDMS Windchill Baseline	A list of a particular collection of models at a certain point in time within DDMS Windchill. This does not mean under configuration control. Referred as Managed Baseline within DDMS Windchill.
Design Layout Drawing	Type of drawing created to define the overall configuration of a design; serves as an engineering work sheet from which engineering drawings are made; is not used for procurement or inspection.
Design Release	Approved design that is ready for implementation/construction.
Effectivity	Defines the usage of a specific as-designed configuration for an event or range of events – flight(s), mission(s), test(s), etc. – by use of alpha-numeric values. It is NOT equivalent to as-built serial numbers, lot numbers, or calendar dates. Effectivity for subordinate components of an assembly must be equal to or greater than each applicable assembly effectivity where the component is used.
End Item	A type of Windchill Type (WT) Part that represents a Configuration Item. Effectivity can be designated against End Item WT Parts in DDMS Windchill.
Inseparable Assembly	An assembly whose piece parts cannot be separated and still retain its original form.
Modular Product Architecture	A type of Top-Down Design Methodology which focuses on the explicit identification and control of the physical/mechanical interfaces and/or their location in the design through the use of skeletons, but does not control the overall geometry of the design.

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Mono-detail Drawing Part

Drawing of only one part or assembly.

- 1) A physical representation of a component or assembly as defined in the Bill of Material.
- 2) A Creo Parametric design software model file with a .prt suffix

Parent-Child Relationship

Creating a direct dependency between components in an assembly without using a skeleton.

Promotion Notice

Also called a Promotion Request. Enables the designer to set the state of one or more items to a new lifecycle state with a selection of review processes; allows the designer to promote objects to an Approved state using the Design Review Approval process.

Release

Configuration control of a file.

Reps

Short term for simplified representations.

Skeleton

The standard Skeleton Model is a part model that contains some combination of features (datums, sketches, copied geometry, etc.) to drive design intent (component placement, etc.) of one or more assemblies.

Standard Parts

Those items governed by a national (e.g., National Aerospace Standard) or international (e.g., SAE Aerospace) standard; a non-vendor item part.

Start Assembly

Template used to standardize assembly creation.

Start Part

Template used to standardize part creation.

Top-Down Design Methodology

Method of placing critical information in a high-level location and communicating that information to the lower levels of the product structure.

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4.0 GENERAL REQUIREMENTS

4.1 Default Settings

4.1.1 Start Part

- 4.1.1.1 English and metric start part files shall be used in the creation of all parts.
- 4.1.1.2 If English parts are to be modeled, the English start part file shall be used.
- 4.1.1.3 It is recommended that the use of metric hardware be avoided where possible.
- 4.1.1.4 If metric parts are to be modeled, the metric start part file shall be used.
- 4.1.1.5 These start parts are located on a controlled server and maintained by the DDMS Administrator. The files are as follows:
 - a. nasa_startpart_english – This default start part shall be used on all English units designs. This part contains standard views, parameters, relations, datum planes, layers, simplified representations, and a coordinate system.
 - b. nasa_startprt_metric – This default start part shall be used on all metric designs. This part contains all standard views, parameters, relations, datum planes, and a coordinate system.

4.1.2 Start Assembly

- 4.1.2.1 English and metric start assembly files shall be used in the creation of all assemblies.
- 4.1.2.2 If English assemblies are to be modeled, the English start assembly file shall be used.
- 4.1.2.3 If metric assemblies are to be modeled, the metric start assembly file shall be used.
- 4.1.2.4 These start assemblies are located on a controlled server and maintained by the DDMS Administrator. The files are as follows:
 - a. nasa_startassy_english – This default start assembly shall be used on all English units. This assembly contains all standard views, parameters, relations, datum planes, and a coordinate system.

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- b. nasa_startasy_metric – This is the default start assembly to be used on all metric designs. This assembly contains all standard views, parameters, relations, datum planes, and a coordinate system.

4.1.3 Start Drawing/Drawing Template

- 4.1.3.1 Drawing templates shall be utilized to assist users in quickly beginning a drawing.
- 4.1.3.2 The start parts, start assemblies, and drawing templates have parameters that shall control various fields in the title block.
- 4.1.3.3 These fields shall NOT be overridden by text such that the parameter is no longer controlling them.
- 4.1.3.4 The following drawing templates shall be used:
 - a. SSC_B_SIZE_PRO-E_DRW_TEMPLATE
 - b. SSC_C_SIZE_PRO-E_DRW_TEMPLATE
 - c. SSC_D_SIZE_PRO-E_DRW_TEMPLATE
 - d. SSC_F_SIZE_PRO-E_DRW_TEMPLATE

4.1.4 Dimensional and Angular Tolerances

- 4.1.4.1 All SSC English start parts and assemblies shall have the following default tolerance values:
 - a. Linear X.X +/- 0.1
 - b. Linear X.XX +/- .03
 - c. Linear X.XXX +/- .010
 - d. Angular X.X +/- 0.5

These values control the default tolerance for all dimensional values whose tolerance is not otherwise explicitly displayed on the drawing.

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- 4.1.4.2 If the entire drawing requires tolerances other than tolerances in the drawing format title block, the new tolerances shall be defined by a general note which will override the format title block tolerances.
- 4.1.4.3 The drawing title block fields for default tolerances shall NOT be manually overridden.

4.1.5 Systems of Units

The units of the start parts/assemblies are as follows:

- Inch lbm Second for nasa_startpart_english and nasa_startassy_english. This is the Creo Parametric default.
- millimeter Kilogram Second (mmKS) for nasa_startprt_metric and nasa_startasy_metric.

4.1.6 Part Accuracy

- 4.1.6.1 SSC default start parts shall use an absolute accuracy of 0.0005 inches for English start parts and 0.0127 millimeters for metric start parts. The default value may be increased if geometry errors are produced with this value. After changing the accuracy, the model must be regenerated.
- 4.1.6.2 Relative accuracy shall NOT be used.
- 4.1.6.3 See Appendix D for additional information.

4.2 Model and Drawing Integrity

- 4.2.1 ModelCHECK™ is an integrated application that runs transparently within Creo Parametric. ModelCHECK™ uses a configurable list of design standards and best modeling practices. It can be configured to run interactively as well as automatically when the designer regenerates or saves a model.
- 4.2.2 All designers shall run ModelCHECK™ interactively at the following points, at a minimum:
- Prior to submittal for Preliminary (30%) Design Review (PDR), Intermediate (60%) Design Review (IDR), and Critical (90%) Design Review (CDR).
 - Prior to submittal for CM Release

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4.2.3 It is recommended that all designers run ModelCHECK™ interactively at the following points, at a minimum:

- a. At regular intervals throughout the design activity
- b. After creating Primary, Secondary, and Tertiary features for parts. Refer to Section 12.0 for additional information.
- c. At initial check-in for external or vendor parts

4.2.4 Errors found by ModelCHECK™ shall be resolved prior to check-in to DDMS Windchill when changing state to design, for creation of a baseline, Engineering Release, and As-Built Released. In the absence of an applicable SSC Desktop Instruction (DI), ED-CAD-DI-026, *Verifying 3-Dimensional CAD Models*, may be used for information for acceptable occurrences of modeling techniques that ModelCHECK™ lists as an error.

Warnings shall be evaluated and resolved where possible. In the absence of an applicable SSC DI, ED-CAD-DI-026, *Verifying 3-Dimensional CAD Models*, may be used for information on running ModelCHECK™ and resolving resulting errors and warnings.

4.2.5 See Appendix D for additional information.

4.3 General Drafting Requirements

4.3.1 Drawings shall be prepared in accordance with SOI-8080-0007, *SSC Test Site Drawings*, and SSTD-8070-0002-CONFIG, *Facilities Drafting Manual*.

4.3.2 The BOMs shall be generated from the model.

4.3.3 When preparing a drawing utilizing Creo Parametric design software, the following requirements apply:

4.3.3.1 All views and dimensions shall be derived from the model, except as allowed in Paragraph 14.3.10.

4.3.3.2 Sketching in of model geometry and overriding of dimensions shall NOT be allowed.

4.3.3.3 Notes on drawings shall come from the Standard Notes List (Refer to Subsection 7.2) when an appropriate note is available. Other notes not covered in the standard notes list may be added to the drawing as required.

4.3.4 Detailed Drawing Guidelines are given in Section 14.0.

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5.0 NAMING CONVENTION

5.1 Initial CAD Identification

5.1.1 Initial Creo Parametric CAD Name, Common Name, and File Name

The naming requirements in Table 1 shall be used when creating a Creo Parametric object prior to official SSC numbers being assigned. Figure 1 shows the Creo Parametric interface where the identification is entered. If SSC numbers have already been assigned, the SSC numbers may be used in accordance with Subsection 5.3.1.

Table 1. Creo Parametric CAD Initial Naming Requirements	
Creo Parametric Field Name	3D CAD Model or 2D CAD Drawing
Name (File Name) (User entered)	Utilize Project CAD Naming Convention described in Section 5.0 of this SSTD. NOTE: A file suffix .prt, .asm, or .drw is automatically added to the Name field value to create the file name based on the type of file selected.
Common Name (User entered)	Assign name using all CAPS in a format specified by the drawing title requirements of GDRM Section 8.0 Procedures or ASME Y 14.100 Section 5.0/Appendix C. (See Paragraph 6.5.3.)
File Name (System generated)	Software completes the file name from the Creo Parametric Name field by adding the file suffix .prt, .asm, or .drw.

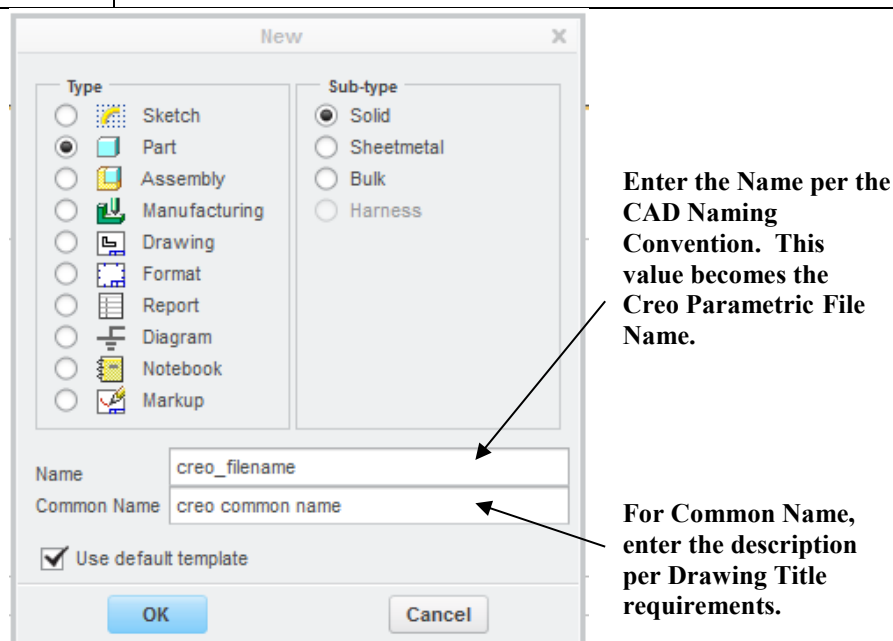


Figure 1. Creo Parametric Name Entry Interface

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5.1.2 Initial DDMS Windchill CAD Number, Name, and File Name

The naming requirements in Table 2 shall be used when creating a DDMS Windchill CAD Document prior to official SSC numbers being assigned. Figure 2 shows how the Creo Parametric naming maps to the DDMS Windchill CAD model fields. If SSC numbers have already been assigned, the SSC numbers may be used in accordance with Subsection 5.3.1.

Table 2. DDMS Windchill CAD Initial Numbering/Naming Requirements	
DDMS Windchill Field Name	3D CAD Model or 2D CAD Drawing
Number	Utilize Project CAD Numbering Convention described in Section 5.0 of this SSTD. (NOTE: When Creo Parametric is uploaded to DDMS Windchill, this value is automatically mapped from the Creo Parametric Name (File Name) field including the file suffix .prt, .asm, or drw.
Name	Assign name using all CAPS in a format specified by the GDRM Section 8.0 Procedures or ASME Y 14.100 Section 5.0/Appendix C. (NOTE: When Creo Parametric is uploaded to DDMS Windchill, this field value is automatically mapped from the Creo Parametric Common Name field.)
File Name	Utilize Project CAD Numbering Convention described in Section 5.0. (NOTE: When Creo Parametric is saved to DDMS Windchill workspace, this field value displays the Creo Parametric Name (File Name) field with file suffix .prt, .asm, or drw.)

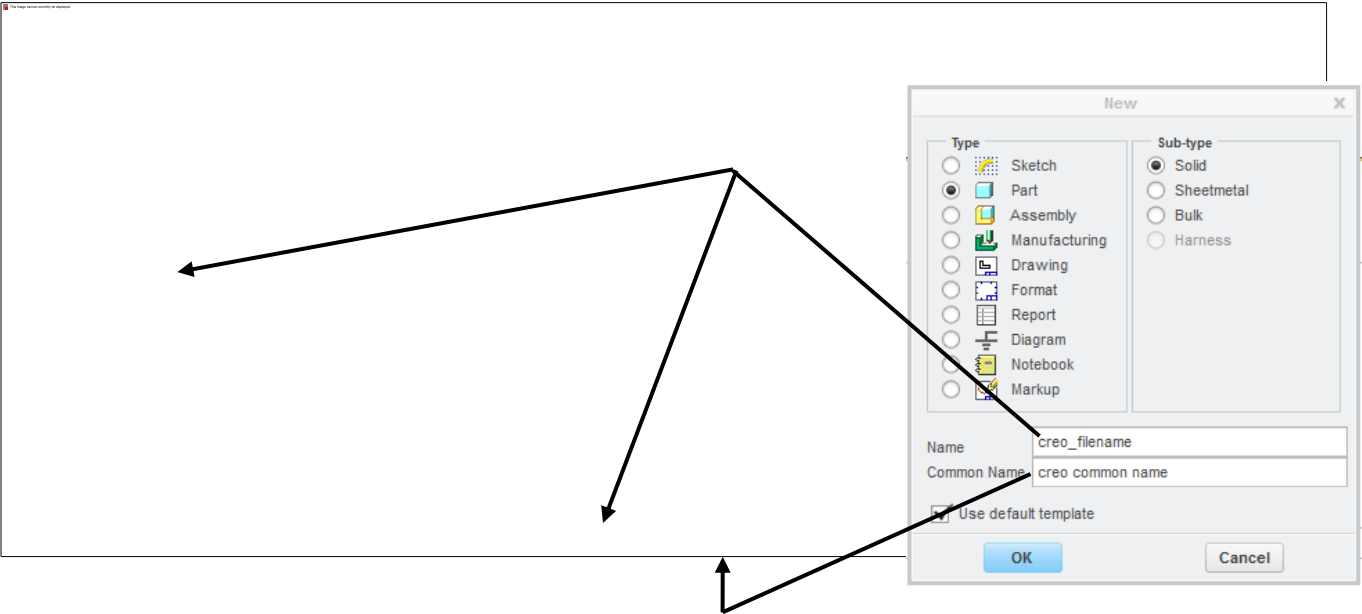


Figure 2. DDMS Windchill Name Entry Interface

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5.2 Initial CAD File Name

5.2.1 If SSC numbers have already been assigned, the SSC numbers may be used in accordance with Subsection 5.3.1. Otherwise, it is recommended that the initial CAD file name be a logical name that is descriptive of the file. The file name **shall** be limited to 31 characters, which is the allowable limit within Creo Parametric.

5.2.2 See Appendix A for an example of project specific initial CAD file naming details and examples.

5.3 Final CAD Identification for “As-Designed” Model

5.3.1 Final DDMS Windchill and Creo Parametric CAD Identification

5.3.1.1 The numbering and naming convention in Table 3 shall be assigned to DDMS Windchill Objects prior to release. It is recommended that this naming convention is utilized as soon as official SSC numbers have been assigned:

Table 3. DDMS Windchill CAD Final Numbering/Naming Requirements		
DDMS Windchill Field Name	3D CAD Model	2D CAD Drawing
File Name	Part number plus file suffix assigned by CAD package (e.g., .prt or .asm for Creo Parametric files)	a. The shown part number for drawings with a shown and opposite configuration; or b. The drawing number with no dash number for other drawings such as tabulated or non-part drawings (e.g., schematics); or c. The same as the part number for all other drawings.
Number	Same as File Name.	Same as File Name.
Name	Assign name from Drawing Title.	Assign name from Drawing.

5.3.1.2 Final drawing numbers shall be assigned by Engineering, based on the next available number within DDMS.

5.3.1.3 Drawing numbers shall NOT be re-used. If a drawing number is assigned and a change deletes that part, then that drawing number is discarded and not ever used.

5.3.1.4 Files shall be renamed from the initial CAD file name to the final CAD file name when the TPS is completed by the CM team.

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5.4 Companion CAD File Identification

- 5.4.1 If applicable, the appropriate companion file suffix (as defined in Table 4) preceded by an underscore () and followed by a three-digit sequential number shall be added to the Windchill Number (e.g., number_mod001.prt).
- 5.4.2 If a CAD model falls under more than one category as defined in Table 4, all the applicable companion file suffixes shall be added to the Windchill Number in alphabetical order, separated by underscores () (e.g., number_gen_mod001.prt).

Table 4. Companion File Suffixes	
Suffix	Description
ALT	Models created to provide an alternate representation of the active CAD model such as simplified substitutes.
CVA	Convenience assemblies (do not use; not for new design).
BLK	Any modeled bulk items, such as spray-on pipe insulation.
DGA	Drawing assemblies (do not use; not for new design).
DEP	Deployed models.
DYN	Dynamics models (mechanism models).
ENV	Envelope part models, accurately represent the Outer Mold Line (OML) of an assembly as a single part.
FLT	Flat state sheet metal parts or flat pattern cable parts.
GEN	Generics of family tabled parts or assemblies.
HRN	Harness subassembly models.
ICD	Interface Control Document (ICD) skeleton models.
LAY	Layout models (not notebooks).
MFG	Models created to support manufacturing (typically capture intermediate manufacturing states of a part).
MOD	Modified representations of a part or assembly design such as an “As-Installed” model.
MSS	Mass properties models.
MVA	Model View Assembly facilitates copying geometry from simplified reps.
NTB	Notebooks.
PIP	Pipe subassembly models.
PKG	Package subassembly models.
PSN	Alternate Position model (e.g., extended, retracted).
PTL	Partial assemblies used in large file management.

Continued on next page.

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Table 4. Companion File Suffixes	
Suffix	Description
REL	Related model assembly used for creation of drawings for large assemblies, used for installation/integration drawings.
SIM	Model created to support an analysis or simulation.
SKL	Skeleton models used for design (not interface or locator skeletons).
SWR	Shrinkwrap models.
TRD	Trade Study models.

5.5 CAD File Name for Vendor Parts

- 5.5.1 The CAD file name for vendor parts shall match the vendor part number. The vendor file name shall NOT exceed 25 characters and shall be followed by an underscore (_) and the SSC 2-character identifier of MS; for example NAS1351N3-6_MS. Refer to NASA-STD-(I)-0007 for additional information.
- 5.5.2 When vendor part numbers include characters that are not allowed, such as a slash (/), an underscore (_) shall be substituted for such characters.
- 5.5.3 The relation PART_NUMBER=REL_MODEL_NAME must be deleted for vendor parts. The exact part number shall then be entered using the Part_Number parameter without the _MS identifier.

5.6 WT Part Identification

Prior to release, WT Parts shall be identified in accordance with Table 5.

Table 5. DDMS Windchill WT Part Identification Requirements	
DDMS Windchill Field Name	WT Part
Number	Part number
Name	Assign name using the Drawing Title requirements.

6.0 STANDARD PRACTICES FOR CREO

6.1 Layers

6.1.1 Layer Usage

- 6.1.1.1 All non-solid items shall be placed on a layer.