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DRAFTING/CAD GUIDELINES AND STANDARDS	May 30, 2014	Mechanical Engineering Division
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The purpose of this Engineering Standard is to establish guidelines for the preparation and approval of drawings used for fabrication, installation, or repair. It applies to drawings that are generated by both the Central CAD Design Group (CCDG), and by individuals or groups outside of the CCDG. This standard is also used to establish guidelines for the preparation of manual drawings and drawings created by CAD software.

INTRODUCTION:

This document along with procedure ENG-010 defines and establishes the standards, practices and policies to be followed by PPPL and Sub-contract personnel in the preparation and subsequent control of engineering drawings and design data. PPPL Projects and Departments are responsible to apply the standards to assure the quality and uniformity of documentation and control of engineering designs and specifications. The various locations, where Design/Drafting activities are performed, plus the wide interchange of drawings necessitates standardization in Design/Drafting practices to promote correct interpretation of drawings. A glossary of special terms and abbreviations is found below.

REFERENCE DOCUMENTS:

- PPPL Procedure ENG-010, Control of Drawings, Software, and Firmware
- ASME Y14.5- Engineering Standard for Geometric Dimensioning and Tolerancing
- ISO 2553:1992
- ITER CAD MANUAL Section 09 – Drawing Best Practices ITER D 24SNC9
- ITER CAD MANUAL Section 05 – Design Data Management ITER D 249WSM
- ITER CAD MANUAL Section 01 – Introduction ITER D 249WLQ
- Drawing Management Procedure- US D 227FU8
- Design Change Procedure- US D 22M5G7
- Design Change Request (DCR) Users Guide- US D 22YCFM
- Document Review and Approval Procedure- US D 223LSJ
- Document Review and Approval Procedure Matrix- US D 22J4DV
- WBS- Complete Dictionary ITER D 22G73N
- ITER Plant Breakdown Structure (PBS)

ACRONYMS

Following is a partial listing of the abbreviations, acronyms, and mnemonics used in this Standard:

ANSI	American National Standards Institute
AWS	American Welding Society
B/M	Bill of Material
CAD	Computer Aided Drafting
CATIA	Computer Aided 3-D Interactive Application (Software)
CCDG	Central CAD Design Group
DA	Domestic Agency
DCC	Document Control Center
DCR	Design Change Request
DDNRS	Document and Drawing Number Reservation System
DNS	Drawing Numbering System
ECN	Engineering Change Notice
Enovia	PLM Software (Catia Data Management)
EP	Electrical Parts List
IEEE	Institute of Electrical and Electronic Engineers
IO	ITER Organization
ITER	International Thermonuclear Experimental Reactor
NCR	Non-Conformance Report
PBS	Plant Breakdown Structure

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RE	Responsible Engineer
SME	Subject Matter Expert
TL	Team Lead
WBS	Work Breakdown Structure
WP	Work Planning Form

NATIONAL DRAFTING STANDARDS

All American National Standards Institute (ANSI), Institute of Electrical and Electronic Engineers (IEEE), National Fire Protection Association (NFPA) and National Electrical Code (NEC) standards apply unless superseded elsewhere in this document. Dimensioning and tolerancing of drawings are controlled by ANSI Y14.5-2009. Copies of these standards are available in PPPL CADD room.

INTERNATIONAL DRAFTING STANDARDS

TABLE OF CONTENTS

1.0 DRAWING PREPARATION
1.1 Drawings Preparation by Groups/ Individuals Outside of CCDG
1.2 Drawings Preparation by Central CAD Design Group (CCDG)

2.0 DRAWING FORMATS
2.1 General Drawing Layout
2.2 Title Block
2.3 Standard Drawing Size
2.4 Geometric Dimensioning and Tolerancing
2.5 Bill of Material
2.6 Zoning of Drawings
2.7 Tables

3.0 DRAWING NUMBERS
3.1 Engineering Drawing Numbers
3.2 Drawing Number Identification
3.3 Part, Item and Device Number
3.4 Drawing Number Preservation
3.5 Multi-Sheet Drawings
3.6 Vendor Drawings
3.7 Revision of Vendor Drawings
3.8 Revision of PPPL Generated Drawings
3.9 Prior PPPL Drawing Numbers

4.0 TYPES OF DRAWINGS
4.1 Layout Drawings
4.2 Sketch Drawings
4.3 Engineering Drawings (CAD or Manual)

5.0 WELDING DRAWINGS
5.1 Welding Symbols
5.2 Welding and Brazing Notes on Drawings
5.3 Welding Review and Approval

6.0 CHECKING OF DRAWINGS
6.1 Responsibility of Checker
6.2 Job Information for Checker
6.3 Check Print Markings (Recommended)

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7.0 APPROVAL OF DRAWINGS
7.1 Drawings Produced Outside the CCDG
7.2 Drawings Produced By the CCDG
7.3 Electrical Drawings and/or Mechanical Drawings Generated by AutoCAD
7.4 Mechanical Drawings Generated by Pro-Engineer (CREO)

8.0 CHANGES OR REVISIONS TO DRAWINGS

9.0 CATIA (ITER) DRAWING REQUIREMENTS
9.1 Drawing Preparation:
9.2 Drawing Format
9.3 Drawing Numbers
9.4 Types of Drawings
9.5 Welding Drawings
9.6 Checking of Drawings
9.7 Approval of Drawings

10.0 VIEWING DATA BASE DRAWINGS
10.1 Viewing Project Drawings in PDF Format
10.2 DELETE

APPENDIX A: DRAWING FORMATS

APPENDIX B: ELECTRICAL DRAWING EXAMPLES

APPENDIX C: GEOMETRIC SYMBOLS USED IN DIMENSIONING AND TOLERANCING

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GENERAL REQUIREMENTS

1.0 DRAWING PREPARATION

Drawings may be created by the Central CAD Design Group (CCDG) or by individuals and/or groups outside of the CCDG. They may be produced manually or using computer CAD design software. In either case, preparation of the drawing must meet requirements that will ensure that the drawing produced has the correct and sufficient information or data that will allow it to be shared by all parties.

1.1 Drawing Preparation by Groups/Individuals Outside of CCDG

Requirements for drawings produced outside of the CCDG are generally not as stringent as those generated in the CCDG. Drawings (mechanical or electrical) that are generated outside of the CCDG can be either hand drawn or created by using MAC or PC CAD software packages. However, certain criteria must be met for the drawing to be acceptable. All drawings either CADD or hand generated MUST follow the guidelines described in sections 1.13 thru 1.16.

1.1.1 Software for Electrical CAD Generated Drawings:

It is recommended and encouraged that **ALL** electrical CAD generated drawings be created using AutoCAD software. For Printed Circuit Boards the recommended software is PADS.

1.1.2 Software for Mechanical CAD Generated Drawings:

It is recommended that mechanical CAD generated drawings be created using one of the following software packages: Pro-Engineer, CATIA, SOLIDWORKS, AutoCAD, Vector Works or Claris-CAD. Pro-Engineer is the primary Mechanical CAD Design software. CATIA is the desired Mechanical CAD Design software incorporated on the ITER Project.

1.1.3 All drawings shall be drawn on a standard PPPL drawing format. (See section 2.0)

1.1.3.1 For hand generated drawings, hard copies of the PPPL format can be obtained from the CCDG supervisor. For those drawings not originally generated on a PPPL format; the original drawing can be mounted directly onto the correct format.

1.1.3.2 For MAC or PC generated drawings, copies of the format can be downloaded from the Engineering Web site using the following steps:

- Go to the PPPL Employee Home Page
- Click on the link for Engineering
- Click on the link for the Mechanical Engineering Division
- Click on the link Drawing Formats
- Select your format for either MAC or PC.

1.1.4 Mandatory Information Required on Drawings

1.1.4.1 Sufficient information shall be placed on the drawing to allow for the part or assembly to be fabricated in the future with little chance of misinterpretation. No assumptions or verbal instructions are permitted.

1.1.4.2 Information, which shall be clearly identified, on each drawing includes:

- Dimensions: Either decimal or fractional format is acceptable, depending upon tolerance requirements.

- Tolerances: these are generally identified on the bottom of the standard PPPL format and can be either in decimal or fractional form depending upon the dimensional format used. If decimal, the number of places in the dimensions dictates the tolerance (±.005, ± 0.030 or ± 0.100). Some dimensions may require special tolerances from the general tolerance of the standard PPPL format; these special tolerances shall be noted alongside the dimension to which it applies.

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- Bill of Material (B/M): If multiple parts are used, a B/M shall be provided clearly identifying all parts of the assembly. In electrical drawings, only assembly drawings have a B/M on the drawing; all other materials are handled as a list "bill of materials". (See section 2.4)

- Material type: Be specific- note the grade and applicable standard of steel, copper, aluminum, G-10 etc. (ex. A240, 304L)

- Catalog parts should include product number and manufacturer.

- Weld symbols and notes shall be clearly called out. (See section 5.0)

- Manufacturing notes that are needed to satisfactorily complete the part or assembly shall be clearly spelled out.

1.1.2 Checking:
See section 6.0.

1.1.3 Approval of Drawings Prepared Outside the CCDG:
See section 7.0

1.2 Drawing Preparation by Central CAD Design Group (CCDG)
Generally, drawings produced in the CCDG have a higher level of conformity with drafting standards. For drawings requiring preparation by the CCDG, a CAD designer will be assigned whose duties shall be to prepare the necessary models or drawing package under normal supervision of CCDG. The requestor shall provide the designer with as much information as possible to generate the models and/or drawings. This information shall be written and could include text, calculations, sketches, schematics, and vendor catalogs. A brief meeting between the Cognizant engineer, CAD Room administrator and CAD Designer is desirable. It is also recommended that whenever possible the CAD designer participate/attend all pertinent design reviews.

1.2.1 Applicable nationally recognized drafting/CAD practices and standards shall be used in the preparation of the drawings.

1.2.2 All drawings shall be prepared on a PPPL standard drawing format as described in section 4.0.

1.2.3 Monitoring progress: The CCDG Administrator or group leader shall review the work of the designer or draftsperson to ensure that drawing development is progressing in conformance with design criteria and requirements. However, it is the responsibility of the Cognizant Individual to ensure that the technical information shown on the drawing is correct.

1.2.4 When, in the judgment of the CAD designer and cognizant engineer, the drawings have been completed they shall be submitted to the CCDG Administrator for review and independent checking. The Cognizant engineer and CCDG Administrator shall select the independent checker. See section 6.0.

1.2.5 Distribution of Preliminary Drawings: When the drawing has developed to a preliminary state, prints or PDF's may be circulated to other involved disciplines for comments concerning interface and interferences. In addition, preliminary un-checked and un-approved drawings may be sent to internal shops for purpose of gaining information as to availability of material, preliminary cost to manufacture, vendor interest and the like. Preliminary drawings must have a legally issued drawing number and title and must have the following note either as part of the standard PPPL format or across the main body of the drawing:

"PRELIMINARY ISSUE – FOR REFERENCE ONLY"

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2.0 DRAWING FORMAT

2.1 General Drawing Layout

The right hand side of a single sheet drawing shall be reserved for all notes (General and Reference), the Bill of Material and future revisions. This information shall also appear on Sheet 1 of a multi-sheet drawing. A reference note shall be added above the Title Block on ALL subsequent sheets of a multi-sheet drawing that states **"FOR NOTES AND BILL OF MATERIAL SEE SHEET 1"**. (See Appendix A for Drawing Formats)

2.2 Title Block

A standard NSTX Title Block is shown in Figure 1. Any and all standard format Title Blocks shall include important information necessary to fabricate or assemble the component. The Title Block shall include as a minimum:

2.2.1 Project:
Identifies the project that the drawing is associated with (NSTX, NCSX, etc)

2.2.2 Descriptive Title:
The drawing title shall typically consist of three lines. These three lines shall conform to the Work Breakdown Structure (WBS) of the associated project. Line three shall be the name, either a noun or noun phrase, by which the part or assembly shall be known.

2.2.3 Designer: (Printed name and signature area)
Cognizant person who is responsible for generating/ creating the drawing

2.2.4 Engineer: (Printed name and signature area)
Cognizant person who is responsible for the contents of the drawing

2.2.5 Checker: (Printed name and signature area)
This is the name of the individual who has checked the drawing for accuracy, content, etc. See section 6.0 for more information on checker.

2.2.6 CCDG Supervisor: (Printed name and signature area)
Last signature on drawing, verifying that drawing meets requirements outlined in section 1.0

2.2.7 Date:
Month, Day and Year drawing was approved.

2.2.8 Drawing Number: (Assigned by CCDG Supervisor)
See section 3.0

2.2.9 Revision Number area:
Indicate the latest version/change of that drawing. All revisions are identified numerically beginning with 0 (zero) for the initial release.

2.2.10 Signature area for Welding Engineer: (See section 5.0)

2.2.11 Bill of Material: (See section 2.5)
2.2.11.1 Assembly and /or Part Number
2.2.11.2 Drawing Number
2.2.11.3 Nomenclature or Description
2.2.11.4 Material
2.2.11.5 Quantity Required

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2.2.12 Tolerance requirements: (Standard)
See section 2.4

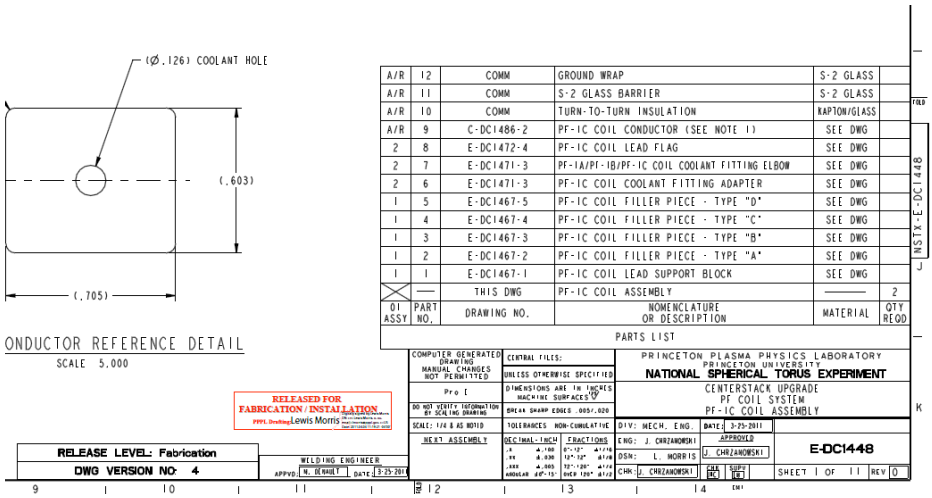

Figure 1- Sample Title Block (NSTX Project)

2.3 Standard Drawing Sizes:

Table number 1 identifies the Standard English drawing sizes that are used at PPPL.
Table number 2 identifies the standard metric drawing sizes that are used for ITER.

Table 1 – STANDARD (English Units) FINISHED SHEET SIZES

Letter Size	Width (inches)	Length (inches)
A	8.5	11
B	11	17
C	17	22
D	22	34
E	34	44

Table 2 – STANDARD (Metric Units) FINISHED SHEET SIZES

	Width (mm)	Length (mm)
A4	297	210
A3	297	420
A2	420	594
A1	594	841
A0	841	1189

2.4 Geometric Dimensioning and Tolerancing:

Geometric Dimensioning and Tolerancing shall be applied whenever possible to CCDG generated drawings using the principals of the American National Standard's Institute's Y14.5 Standard (ANSI Y14.5). A listing of the recommended Geometric Symbols used in dimensioning and Tolerancing applications for the ASME Y14.5 and ISO standards are located Appendix B of this document.

2.4.1 Tolerances:

Tolerances are identified on the bottom of the standard PPPL format (Title block area) and can be either in decimal or fractional form depending upon tolerance requirements. If decimal, the number of places in the dimensions dictates the tolerance (±.010, ± 0.03 or ± 0.1). Unless a tolerance is specified, the tolerances outlined in the drawing Title Box shall be used.

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2.4.2 Dimensions/Scales on Drawings:
Each project may decide whether the English or metric system will be used in dimensioning their drawings. Unless otherwise noted, the general recommended dimensioning system is:

2.4.2.1 The English System, expressed in inches, is the preferred system for dimensioning mechanical engineering drawings. The International System Units (SI) of length (meter and millimeter) may be used as a primary or secondary dimension (see 2.5.8 below) when appropriate.

2.4.2.2 Only the scales indicated in Table 2, below, shall be used in the generation of mechanical engineering drawings employing the English linear unit of measure.

Table 2- Engineering Scale (English Units)

Scale Ratio	Fraction of Full Size
1200 Inches = 12 Inches	100X
120 Inches = 12 Inches	10X
48 Inches = 12 Inches	4X
24 Inches = 12 Inches	2X
12 Inches = 12 Inches	1/1 or Full
6 Inches = 12 Inches	1/2
3 Inches = 12 Inches	1/4
1.5 Inches = 12 Inches	1/8
0.75 Inches = 12 Inches	1/16
Not to Scale	None

2.4.2.3 Engineering and/or project drawings may be made to the **METRIC SYSTEM** with all of the dimensions expressed in millimeters. (Tolerance reference in Title box must correspond to the metric system)

2.4.2.4 Only the scales indicated in Table 3, below, shall be used in the generation of mechanical engineering drawings employing metric units of measure.

Table 3- Engineering Scale (Metric Units)

Scale Ratio	Fraction of Full Size
1000 Millimeters= 1 Meter	10X
5000 Millimeter = 1 Meter	5X
2000 Millimeter = 1 Meter	2X
1000 Millimeter = 1 Meter	1:1
500 Millimeter = 1 Meter	1:2
200 Millimeter = 1 Meter	1:5
100 Millimeter = 1 Meter	1:10
50 Millimeter = 1 Meter	1:20
20 Millimeter = 1 Meter	1:50
10 Millimeter = 1 Meter	1:100
5 Millimeter = 1 Meter	1:200
2 Millimeter = 1 Meter	1:500
1 Millimeter = 1 Meter	1:1000
NOT TO SCALE	NONE

2.4.2.5 **FRACTIONAL** dimensioning, expressed in feet and inches, is the preferred form for use in the preparation of all Architectural building/facilities, structural, electrical plans and piping system drawings.

2.4.2.6 Diagram drawings such as schematics, flow charts and isometric or perspective views do not require dimensioning.

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2.4.2.7 Use of the scales listed in Table 4, below, are restricted to the generation of architectural, electrical, structural and piping drawings employing English units of measure.

Table 4 Architectural Scale (English Units)

Scale Ratio	Fraction of Full Size
12 Inches = 1 Foot	1/1 or Full
6 Inches = 1 Foot	1/2
3 Inches = 1 Foot	1/8
1 Inch = 1 Foot	1/12
3/4Inch = 1 Foot	1/16
1/2 Inch = 1 Foot	1/24
3/8 Inch= 1 Foot	1/32
1/4 Inch= 1 Foot	1/48
3/16 Inch= 1 Foot	1/64
1/8 Inch = 1 Foot	1/96
3/32 Inch = 1 Foot	1/128
NOT TO SCALE	NONE

2.4.2.8 Some PPPL drawings may require a dual dimensioning system, when working on a foreign collaboration, for example. The preference is for the decimal system expressed in inches to be primary with the metric system expressed in millimeters as secondary information. The dimensions shown in millimeters will be enclosed in parentheses (XXX). A note is required on the drawing stating:

"DIMENSIONS ENCLOSED IN PARENTHESES ARE IN MILLIMETERS"

When the collaboration customer requires metric dimensions as primary, the inch equivalent shall be shown in parentheses with a note on the drawing stating:

"PRIMARY DIMENSIONS ARE SI UNITS. DIMENSIONS ENCLOSED IN PARENTHESES ARE IN INCHES"

2.4.2.9 PPPL drawings created for the ITER Project require metric dimensions only and are primarily expressed in millimeters. Dimensions expressed in inches are not required.

2.4.2.10 Dual dimensioning of some drawings within a drawing set or unit is strictly forbidden. Instead, all the drawings pertaining to the same drawing set or unit will be presented employing one common dimensioning system throughout.

2.5 Bill of Material:

A Bill of Material (B/M) is a list of all parts (items), materials, subordinate assemblies, manufacturer and referenced data required to fabricate, assemble or install the parts shown on the drawing to which the bill of material applies.

The Bill of Material usually appears on the drawing to which it applies, whereas other lists (e.g. Electrical parts, Piping and Values) appear in separate documents that refer to the drawings on which the parts (items) are depicted.

2.5.1 Assembly drawings:

A Bill of Material may pertain to more than one assembly if more than one assembly is shown on the same drawing.

2.5.2 Multi-detail drawing:

A Bill of Material may pertain to more than one tabulated part of an assembly shown on the same drawing sheet.

2.5.3 Tabulated Drawing:

A Bill of Material may pertain to more than one tabulated part of assembly shown on the same drawing sheet.

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2.5.4 Listing Preference:

The initial Bill of Material list should normally be displayed above the title block, with the items appearing on the drawing in the order illustrated. Since the first entry is at the bottom of the list as seen on the drawing, entries shown here are made in the reverse order, beginning with Assembly Drawings and continuing upward.

Hardware-(Called out per ANSI or other Standards) from smallest to largest in size
Procured Commercial Parts – (Catalog items without vendor drawings) PPPL Detail Drawings in numerical order
PPPL Assembly Drawings in numerical order

The B/M list will have preference over notes in the allocation of space. On manually generated drawings with space permitting, gaps should be provided between each grouping of parts for future expansion (addition) to the Bill of Material List. CAD software permits moving and insertion of additional B/M parts.

2.5.5 Balloon Cross-reference:

The Bill of Material part (item) numbers should agree with the part numbers identified on the drawing proper using the balloon method.

2.5.6 Special situations:

- Weldment Using One Structural Material Size: Only when the entire individual weldment consists of a single structural material size throughout (e.g. 2x2x1/4 angle), is the quantity in the drawing Bill of Materials list to indicate the total length of material required. This does not apply to any weldment drawing consisting of various parts made from one material plate size or thickness.
- Exhausted Space, Single Sheet: Situations will arise where no space on a drawing sheet is available to continue the original B/M listing at its preferred location. In such cases, any open area on the same drawing sheet may be used to continue the B/M list. A statement should be inscribed at the end of the initial B/M indicating:

  "B/M CONTINUED AT ZONE_____" [Include the cross-reference zone location]
- Exhausted Space, Multi-sheets: The term multi-sheets apply to two or more drawing sheets of the same size that are applicable to the same item or assembly. B/M listings on multi-sheet drawings may be continued or carried over onto the next sheet of the same drawing set. The initial sheet together with the other sheets comprising a set should be cross reference with statement at the end and beginning of each B/M list indicating:

  "B/M CONTINUED ON DRAWING_____" or

  "B/M CONTINUED FROM DRAWING_____"
- Extensive B/M List, multi-sheet: Situations may arise where a B/M listing may consist of an unusually large number of parts. In such cases, a separate drawing of the same sheet size as the multi-sheet drawing set may be used. If this option is exercised, the separate B/M must be either the first or last drawing of the set.

2.6 Zoning of Drawings

The standard "D" and "E" size drawing forms are zoned to establish reference areas for use in location changes, dimensions, or other features on complex drawings. For zone identification, use the drawing alphanumeric coordinates.

2.7 Tables

Various types of tables may be used on a drawing to supply additional information which may be presented more clearly than through pictorial or word description methods.

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2.7.1 Table Location: Any area not occupied by the drawing proper, including sections and views, may be used to present data in table form. No tables are permitted in areas reserved for revisions, general notes and bill of material list.

2.7.2 Table Identification: All tables will be identified using Roman Numerals for future cross-reference purposes in correspondence.

2.7.3 When fabrication/operation notes appear on the same drawing that has a table, the notes shall be identified using Arabic numbers.

3.0 DRAWING NUMBERS:

The number system described in this section will be for all new internal PPPL drawings. Existing drawing numbers for projects will not be changed. Requests for the issue of all drawing numbers will be handled through CCDG. Issuing, documentation, and maintaining all laboratory engineering drawing numbers using the PPPL Drawing Numbering System is the responsibility of CCDG.

3.1 Engineering Drawing Number

All PPPL engineering drawings produced by either the CCDG or by an individual outside of the CCDG shall be identified with a drawing number from a master series made available by the CCDG: Layout drawings are included under this numbering system.

3.1.1 Sketch Drawing Number Identification: The **use of sketch drawings for the manufacture of equipment or hardware incorporated into any PPPL device, machine or experiment is prohibited.** Sketch drawings are therefore not considered engineering type drawings that require documentation and filing in the CCDG file rooms. The originator has sole responsibility for their preparation, numbering and storage.

3.1.2 Engineering Drawing Number Request: Blocks of numbers will be assigned to authorized drafting groups and individuals. These numbers will be issued in sequential order and listed on a Drawing Numbering Form. Large blocks of numbers will be issued only in cases where a Drawing Tree listing drawing titles and sheet sizes is presented.

3.1.3 Assignment of Additional Blocks: The assignment of additional blocks of drawing numbers is contingent on prompt processing of manually or CAD produced drawings corresponding to previously assigned drawing numbers. For manually generated drawings, the individual or group must forward to the CCDG the original drawing of the previous block of assigned numbers to CCDG for scanning. Upon completion of the scanning, the original tracings will either be placed into the CCDG drawing files or may be signed out to the group or individual generating the drawings and a copy kept in the CCDG files. For CAD generated drawings, the individual or group must forward to the CCDG the CAD file of the generated drawings for processing.

3.2 Drawing Number Identification

Drawing numbers are based upon the Work Breakdown Structure (WBS) principal established for a specific project. A complete drawing number consists of groups of letters and numbers that, together, create a unique identification of a single drawing sheet. The drawing number consists of a base number and a two-part suffix. The following example identifies the essential information required to establish the complete drawing number. Example: **E – 9 D 1 9 8 6** (mechanical drawings only)

3.2.1 **E**- defines the drawing size

3.2.2 **9D1**- 9D defines the 1st and 2nd WBS number. The 1 defines the 3rd WBS level or a sub-system assigned number (These numbers are taken from the WBS listing of a project)

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3.2.3 **001-** Drawing number (Drawing numbers 001 through 009 are retained for top assembly numbers; 010 through 999 are taken in order, mixing both parts and assemblies). Some series of numbers are more prevalent than others. This may exhaust the 3-digit drawing numbers and dictate the use of a 4-digit drawing number.

3.2.4 Electrical Drawings:

3.2.4.1 For electrical drawings the creation of the drawing number is the same as for mechanical drawings. Example: **D – 5 G A 5 0 5**

3.2.4.2 For electrical Connection Wiring Diagrams (CWD's), Schematics, Parts Lists and Bills of Material, artwork positive and negatives, the first part of their suffixes contain a two – letter symbol (the symbols for these drawings types) and the second part of each may contain a sheet number (up to five digits). **These are the only drawing types for which sheet numbers are permitted in the drawing identification number.**

3.3 Part, Item and Device Numbers

3.3.1 Part Number: On drawings with a Bill of Material (B/M) and Parts List (PL), the part number is the identification number assigned to each part (or assembly) that is shown on the drawing. Balloons encircling these numbers are utilized to identify the particular detail on the field of the drawing for the "Item Number" and "Device Number". On Electrical Parts (EP) type drawings, the data provided for a given item number includes a list of identical components, each of which is identified by a Device Number that is unique with that electrical parts list "EP".

3.4 Part, Item and Device Numbers

3.4.1 Part Number: On drawings with a Bill of Material (B/M) and Parts List (PL), the part number is the identification number assigned to each part (or assembly) that is shown on the drawing. Balloons encircling these numbers are utilized to identify the particular detail on the field of the drawing for the "Item Number" and "Device Number". On Electrical Parts (EP) type drawings, the data provided for a given item number includes a list of identical components, each of which is identified by a Device Number that is unique with that electrical parts list "EP".

3.4.2 Item Number: The item number also includes a description of the component and shows the quantity required.

3.4.3 Device number: The device number, generated during the preparation of the schematic diagram (type "SC" drawing) from which the "EP" is derived, identifies a single (solitary) device on the "SC". All devices that are identical to each other will appear on the "EP" under the same item number.

3.5 Drawing Number Preservation

Once a drawing number has been assigned it shall not be changed under any circumstances, unless there was a transposition error at the time of assignment. In that case, the correction will be made and all affected groups notified of the error and its correction.

3.5.1 Re-drawing-Same Size Sheet: When re-drawing, if possible, use the same drawing size thereby retaining the original drawing number.

3.5.2 Re-drawing-Different Sheet Size: When revisions to a drawing cannot be completed due to drawing size constraints, the drawing can be re-generated using a larger format size while retaining the original drawing number.

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3.5.3 Drawing Number Reuse: Drawing number reuse is strictly forbidden.

3.6 Multi-Sheet Drawings

Multi-sheet mechanical and electrical drawings will have a base drawing number with sheet numbers issued in sequential order.

3.7 Vendor Drawings:

The following procedures and actions will be adhered to upon receipt of a drawing produced by vendors or by any other group not conforming to the PPPL Drawing Numbering System.

3.7.1 Number Assignment: Drawings produced by outside vendors for use by PPPL require re-identification in accordance with the PPPL Drawing Numbering System. The CCDG (Mechanical and Electrical) will affix a vendor drawing sticker onto the drawing (Figure 2). A PPPL drawing number, utilizing the EMDRAC numbering system, will then be assigned and written onto the vendor drawing sticker in the block identified as DWG. No. The EMDRAC System is comprised of two series of numbers: 6426- and 6782-. These numbers are issued sequentially and assigned to new Vendor drawings as they are received.

3.7.2 Scanned Copies: The CCDG will then scan as a PDF and file the vendor drawing promptly after the vendor drawings are processed as described above. The PDF will also be archived and posted to the PPPL Web page.

3.7.3 Re-identification Drawing –Use of: Once a PPPL drawing number has been assigned to a vendor generated drawing, all correspondence, print requests and the like will refer to the newly assigned PPPL drawing number.

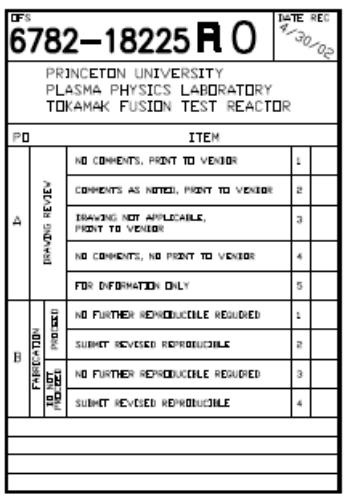

Figure No. 2 Vendor Drawing Sticker (EMDRAC)

3.8 Revision of Vendor Drawings

Changes or revisions to vendor drawings that have become a PPPL 'record' drawing shall follow procedure ENG-010 "Control of Drawings, Software and Firmware".

3.9 Revision of PPPL Generated Drawings

Changes or revisions to PPPL generated drawings shall follow procedure ENG-010 "Control of Drawings, Preparing and Processing a Software and Firmware".

3.9.1 Revision of Multi-Sheet Drawings

When revisions are made to a multi sheet drawing, the same revision number will be identified on all sheets of that drawing.

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3.9.2 Revision Block

Each revision to an approved (signed-off) individual drawing sheet shall be recorded in the revision block in accordance with the following. (Figure 3- One Type of Revision Block)

13 14 15

NO.	REVISION	BY	CH	SUP	APPROVED	DATE
1	REVISED PER ECN-6923	LM	KT	LM	K. TRESEMER	6-20-2012

A

Figure 3- One Type of Revision Block (NSTX Project) on Standard Format

- Revision Number:
  The identifying revision number pertaining to the particular revision being recorded is entered in the number column of the drawing revision block. Revision numbers are sequential, beginning with the numeral "1".
- Description: Enter the identifying number of the Approved Engineering Change Notice (ECN) and when possible a brief description of the change within the drawing revision block, including the cross-reference zone locations (coordinates).
- Except for describing the addition of parts, the identification number of the Approved ECN will suffice.
- Approvals: Signatures and dates of approval of the revision are entered in the approval columns of the revision block. Written initials are permitted for signatures. A revision is not approved unless it has been checked.

3.9.3 Voided Drawings

Conditions dictated by a new design may necessitate voiding the original drawing and replacing it with an entirely new drawing. When this occurs, the voided drawing has the following notation (together with the name of the CAD designer, the name of the person approving the change, the identity number of the approved Change Package and the date) entered as near the title block as possible:

"VOIDED –REPLACED BY DRAWING_____"

3.9.4 Redrawn Drawings

On all approved (signed-off) drawings re-drawn either manually or by CAD, the original title, names, dates and drawing numbers will be maintained.

- Re-drawn Without Change: All previous revision notations are omitted from the newly created drawing. The revision block of the new drawing shows only the revision number next in sequence. A notation **'RE-DRAWN WITHOUT CHANGE'** is entered into the new drawings revision description block, and the previous drawing's list revision number is entered in the number space. The revision block is approved by signature and dated.

  In addition, the previous drawing (original drawing sheet) has notation (together with the name of the draftsperson, the name of the person approving the change and the date) entered as near to the title block approving the change and the date entered as near to the title block as possible stating: **"RE-DRAWN-DO NOT USE"**

  If the original drawing was generated on paper or Mylar, scan and archive the drawing for future record once the **"RE-DRAWN-DO NOT USE"** stamp is in place. Then discard the original drawing.

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- Re-drawn With Change: When a drawing is re-drawn with a change, the next sequential revision number shall be placed in the number column of the superseding (new) drawing and the identifying number of the Approved Change Package entered in the revision description column.

  "RE-DRAWN WITH CHANGE PER ECN #_____"

  The change shall be approved in the same manner as is required for a normal drawing change. The following notation (together with the name of the CADD Designer, the name of the person approving the change and the date) shall be entered as near to the previous drawing's (original drawing sheet) title block as possible.

  "RE-DRAWN WITH CHANGE-DO NOT USE"

  If the original drawing was generated on paper or Mylar, scan and archive the drawing for future record once the **"RE-DRAWN-DO NOT USE"** stamp is in place. Then discard the original drawing.

3.10 Prior PPPL Drawing Numbers:

Over the years, detailed drafting standards were adopted independently by various drafting groups. These are superseded by this PPPL Drafting Standards Document which takes precedence. The reference table below identifies those past projects and codes used prior to the new drawing numbering system.

Table 5- Project Codes for Prior Major Projects

Project Code	Mnemonic	Name of Project
5300	LSP1	Levitated Spherator
5328	FMI	Floating Multi-pole
5450	ST	Symmetric Tokamak
5601	ATC	Adiabatic Toroidal Compressor
5602	PLT	Princeton Large Torus
5605	PDX	Princeton Divertor Experiment
5612	PLTU	Princeton Large Torus Upgrade
5620	PBX	Princeton Beta Experiment
6000	TFTR	Tokamak Fusion Test Reactor
6003	S1	Spheromak (S-1)

4.0 TYPES OF DRAWINGS

Categories of drawings which may be prepared consist of layouts, sketches and engineering drawings. This includes drawings that are either manually produced (pencil/board) or computer aided drawings (CAD).

4.1 Layout Drawings:

A layout is generated during the origination and development of a design. It may begin with a few tentative outlines, overlays, marked prints, templates or other devices and ends with an accurately made to scale drawing showing all the elements of the design.

4.2 Sketch Drawings:

A sketch drawing is primarily intended to pictorially present, exchange, or clarify information between interested parties. They are to be used to convey general information but should not be used as the primary document for fabricating components.

4.2.1 Sketches are not permanent record drawings and **will not** be used during any phase of manufacture, construction or assembly of a major device or equipment.

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4.2.2 Sketches shall be prepared in the most efficient manner but must include all required information to sufficiently clarify the part so that the users of the sketch may proceed without additional information.

4.2.3 Sketch numbers: Since sketches are not permanent record drawings, sketch numbers are not issued by the CCDG. The Cognizant individual or group will generate identifying numbers for these documents, as needed.

4.3 Engineering Drawings (CAD or Manual)

An engineering drawing is a document that discloses by means of pictorial, schematic or textual presentation or combination thereof, the physical and/or functional engineering end product requirement.

4.3.1 Function:

Its primary function is to present the design requirements for the required part or assembly. The drawing should contain delineation, dimensions, and tolerances, performance requirements, notes, and references as required, in sufficient clarity and detail to insure correct interpretation by the customer, contractor, vendor, agency, or any manufacturer that may have the need for its content or use.

4.3.2 All engineering drawings should provide maximum latitude in the choice of manufacturing methods, processes and procurement, consistent with the engineering requirements. References to specific methods of ordering parts and material, detailed methods of manufacture or assembly or inspection processes are better satisfied through the use of a PPPL specification document. Reference to applicable specification is to be included in the notes area on the drawings.

4.3.3 Mechanical Engineering Drawing Types:

Any one of the following types of drawings will be considered engineering drawings.

4.3.3.1 Arrangement Drawing:

- An arrangement drawing depicts, with or without controlling dimensions, the relationships between the major units, as shown in any projection or perspective.
- This drawing shall show sufficient views of the item(s) so that a general understanding of the configuration and location of the major units are conveyed.
- Overall, locating and other general dimensions necessary to define the configuration are shown. All major units shall be identified. This drawing shall always be drawn to scale.

4.3.3.2 Installation Drawing:

- An installation drawing is an outline drawing that shows general configuration and complete information necessary to install an item relative to its supporting structure or to other associated items.
- This drawing shall include overall and principal dimensions in sufficient detail to establish the limits of space in all directions required for installation, operation and servicing.
- Also to be included is the amount of clearance required to permit the opening of doors or removal of units, or other access area requirements.
- Clearance for travel or rotation of any moving parts shall be shown, including the centers of rotation, angles of travel in azimuth, elevation and depression, and radii from each pivot point to the end of each rotating element involved.

4.3.3.3 Assembly Drawing:

An assembly drawing is a drawing that depicts the assembled relationship of:

- Two or more parts

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- A combination of parts and subordinate assemblies

- A group of assemblies required forming an assembly of higher order

- A component (such as a Weldment), consisting of two or more parts joined together constituting a single unit. Weldments will always be considered assemblies and will be presented employing a format applicable to assembly drawings.

4.3.3.4 Detail Drawing:

- A detail drawing includes complete engineering requirements for the individual part delineated thereon. A detail drawing shall completely define all features of the part depicted, including where applicable; configuration, dimensions, tolerances, materials, mandatory processes, surface finishes, protective coatings, symbols, etc.

- Additional documentation such as specifications, required to supplement the drawing in stating end product requirements of the part shall be identified on the drawing in notes.

4.3.3.5 Tabulation Drawing:

- As many tabulated parts as practical will be drawn on a single drawing sheet. A tabulated detail may also be incorporated onto a multi-detail sheet drawing. Tabulated assemblies are only to appear on a tabulated type assembly or multi-assembly drawings.

4.3.3.6 Diagram:

- A diagram drawing delineates the features and relationship of parts forming an assembly by means of symbols and lines. A diagram drawing is a graphic explanation of the manner by which an installation system or assembly performs its function, (e.g. mechanical, hydraulic, pneumatic and fluid schematic or flow diagrams).

- The diagram may be shown in isometric, perspective or drawn as if all features are in a single plane.

4.3.3.7 Document Lists:

- These lists are considered design criteria and will be generated by the responsible Cognizant Engineer and provided to the CCDG Supervisor prior to beginning the work assignments

- These lists are primarily used to identify lines, symbols and tag numbers required in the production of Engineering Diagram type drawings.

- Types of Document Lists
  Piping Line List
  Valve List
  Instrument List

- List Identification Number
  A document list will be identified with a drawing number compatible with those numbers assigned the group of originated drawings.

- Diagram Symbols
  Diagram symbols will not be defined in this document.

4.3.3.8 Source Control Drawing:

A source control drawing is a procurement document for a commercial or vendor type item in existence, new, or to be developed, specifying thereon engineering requirements to the extent necessary to ensure re-procurement of the item delineated, without disclosing details of manufacture. Source control drawings are used when it is desired to limit the source of the available item because of proven reliability of the item to be ordered, the

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re-installation or assembly into identical existing units or due to the manufacturer being the sole source. Use of Source Control Drawings must be coordinated with Procurement to ensure compliance with Procurement regulations.

4.3.3.9 Tooling Drawing:
A tooling drawing may be a detail or assembly type drawing generated for use as a special tool, drill jig, fixture, handling frame, gage, template or die used in the manufacturing, handling installation or checking of parts and assemblies.
Some of the major factors for the use of tooling drawings are:

- To protect or hold part(s) during manufacture, handling, or installation
- To check dimensional accuracy
- To provide or to ensure interchangeability
- To provide template for use in shop layout work
- To provide for checking or repeatability of physical shape or dimensions.
- Tooling drawings should be prepared by a mechanical designer with considerable experience in tolerancing, inspection procedures, drafting and manufacturing practices.
- Part Identification: A note shall be added to the tooling drawing that "All tools are to include the entire drawing number metal stamped, engraved, etched, tagged, bagged, or painted in reasonable height on/or attached permanently to the tool for future identification".
  Gages should be further dimensionally identified with their go, no-go dimension limits on the tool proper.
- Tooling Drawing Titles: On tooling drawings the name and type of tool should comprise the title which will appear in the drawing title block. Examples are:

  -Flat plug gage for Bevel Gear.

  -Lifting frame for NB enclosure.
- The tool designer should strive to design tools that are simple as possible with a minimum of parts, thereby reducing the possibilities for error.
- Representation, Other Drawings:
  Any detail or assembly type of tooling shown on other types of engineering drawings will be depicted (drawn) with a phantom outline.
- Safety: Safety features of all tools are very important. Tools must be designed so as to prevent injury to the operator.

4.3.3.10 Drawing Tree:
A Drawing Tree (Figure 4) tabulates all engineering drawings and documents pertaining to a top "assembly", followed by a hierarchy of subordinate assemblies and details. Drawing trees are to be created in the initial planning stages of the design/drafting task. When the anticipated quantity of drawings required exceed 15, a formal family drawing tree will be created listing all drawings for the particular task. When the quantity of drawings are 14 or less for a particular task the use of the "next assembly" area of the drawings title block will suffice for tracking master and subordinate drawings within the task.

- General Format:
  A drawing tree may be presented in a single line or block diagram form, with lines connecting the top assembly to subordinate assemblies, and with relevant drawing number shown

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- Hierarchy:
  The top assembly should be a predominant drawing (e.g. a master assembly, plot plan, single line, or lead schematic diagram) that is most suited to be the "top" point of reference. Subassemblies branch out from the above, and out of them subordinate assemblies are referenced.

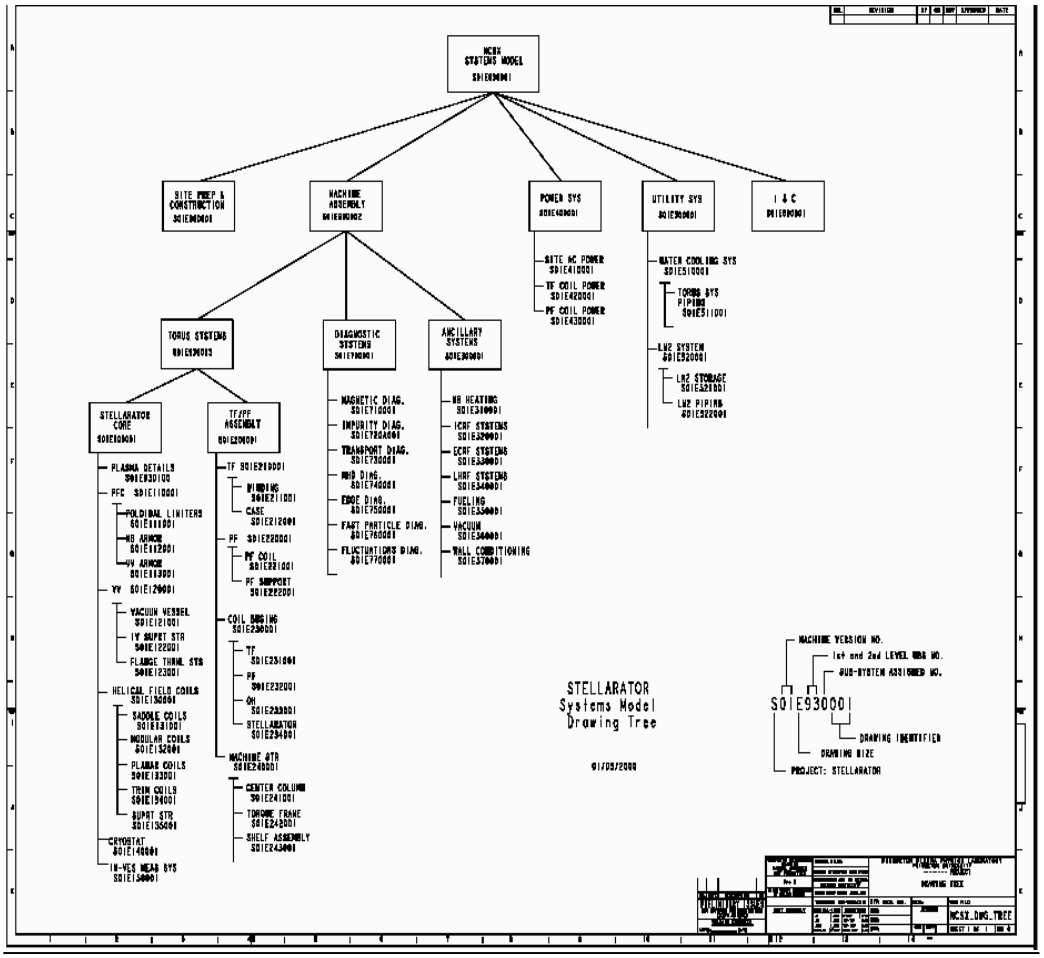

Figure 4- Typical Drawing Tree

4.3.4 Electrical Engineering Drawing Types:

Any one of the following type (s) of drawings will be considered electrical engineering drawings.

4.3.4.1 Block Diagram:

- A block diagram gives a conceptual presentation of a system, indicating the flow of electricity or signals. It shows the main elements or stages indicating function, primarily in block form.

- General Format: The signal path preferably flows from left to right. The inputs preferably should be at the upper left-hand and the outputs at the lower right hand.

- Symbols: Although standard symbols may be used in block diagram, blocks (usually squares or rectangles, occasionally triangles) are used to symbolize the various stages of the circuit; a single line with an arrow is used to show the signal train and flow from block to block.

- Reference Drawings: When applicable, drawing numbers of schematics are included in respective blocks; when applicable, part number of connector is included.

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- Titles or Brief Descriptions: Titles or brief descriptions of components or stages represented are places within the blocks.

4.3.4.2 Interconnection (Cabling) Diagrams:

- Interconnection diagrams are cabling diagrams that show routing of system cables, indicating types and sizes.

- Usage: Interconnection diagrams are made for large system planning, and to facilitate overall system view.

- Symbols: The equipment to be connected is shown as a rectangle, with its label and relevant wiring diagrams. The cables are shown as elongated balloons with the cable number inside the balloon.

- Cables Groupings: Cables routed between pieces of equipment are grouped according to type and/or size.

- Plugs and Jacks: As required, plugs and jacks are shown on cabling diagrams.

4.3.4.3 Connection Wiring Diagram: "CWD"

- A connection wiring diagram is a wiring diagram which primarily shows external connections between unit assemblies and/or equipment. The internal connections of the unit assemblies or equipment are usually omitted when schematic drawings of the equipment exist.

- The connection wiring diagram is optimum for showing connections between "Black box" units (e.g., vendor-supplied units). For equipment built at PPPL, where wiring diagrams show the interconnections, the connection wiring diagram is unnecessary, unless required by project.

- Cable numbers: To eliminate duplication of cable numbers each CWD is assigned a unique cable number. (Number assignments are based on the drawing number. The specific utilization of the drawing number in the creation of a cable number is determined by the project.) Each cable shown on a CWD is marked with a unique letter or letter pair. It is understood that a complete cable number is the base number followed by its letter suffix.

- References: All "Black boxes" are referenced to their respective wiring diagrams.

4.3.4.4 Schematic (Elementary) Diagram:

A schematic diagram shows, by means of graphic symbols, the electrical connections and functions of a specific circuit. A schematic diagram depicts the circuit and its functions without regard to the actual physical size, shape, or locations of the component device. A schematic diagram is sometimes referred to as an elementary diagram.

- General Format:

  A typical power or control circuit schematic diagram is organized so that the flow of current (from source to load) or sequence of operations is either from left to right or top to bottom. The preferred format is left to right.

  The left to right format is depicted by two horizontal parallel lines with devices between. It is preferred, when convenient, that the circuit be drawn so that the most positive (or highest ac) potential is at the top, and the most negative (or ac neutral) potential is at the bottom.

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Operational sequence reads like a book, set up so that the first component that is apt to be operated or activated is on the far left side, while the last that is apt to be operated is on the far right.

If top to bottom format is used, it is identical to left to right format except transposed by 90 degrees, with source at the top and with its most positive or highest ac potential on the left. The operational sequence in this configuration is such that the first component to be activated is on the top while the last that is apt to be operated is at the bottom.

It is preferred that the incoming signals enter a circuit from the left and output signals exit to the right, and that incoming signals enter from the top and output signals exit from the bottom.

- Line weights: Main power lines are drawn using very heavy lines. Minor power lines are medium heavy or standard weight, and instrumentation and control lines are standard weight.
- Numbering Devices: Devices should be numbered consecutively, in accordance with circuit logic. Devices, symbolized as entities, although consisting of two or more components in a series and/or parallel network, are designated as an entity with only the total effective rating indicated. They will be defined on a detail schematic, or in a note form on a drawing, or in an "EP" electrical parts list. Device numbers assigned from "one-line" diagrams are not changed when the device is placed on a schematic diagram or vice versa.
- Device Number assignments: Device number assignments will be coordinated with the lead designer and the engineer. The device identification prefix uses standard PPPL device designations. Suffixes for device numbers are assigned in blocks to each schematic diagram (e.g. 1-100, 101-130, etc.) Mnemonic designations can be used instead of conventional device identifications in special circumstances as, for example, relay control ladders, where mnemonics conveys relay information. Similarly, devices for switchgear operation and control may be identified according to "IEEE Device Numbers and Functions for Switchgear Applications", prefixed with the particular switchgear device label and suffixed with the particular phase (e.g., Q5B2 50A), instead of using conventional identifications.

  Device number assignments should be recorded in the appropriate "Wire, Device, and Cable Number Log" in the CCDG room, if required by engineering.

- Wire (Node) Number:
  A "wire number" as used on schematic diagrams distinguishes a particular electrical point or node.

  Wire numbers must be used on nodes that appear on two or more schematic diagrams.

  Wire numbers are also for labeling conductors, while eliminating the need for showing terminals on the schematic. Every physical wire that is part of a particular node, regardless of size or type, is labeled with the same wire number. It begins with a numeral.

  Exceptions to this are positive or negative busses that may be prefixed with a "P" or "N", or instances where they are part of modularized subsystems that are identified with letters, and then a respective letter may prefix their wires.

- Wire Number Series:
  To eliminate duplication of wire number, every schematic diagram for a particular system is assigned a different wire number series. The blocks of wire number assignments is coordinated with the lead designer and is recorded in the appropriate "Wire, Device, and Cable Number Log".

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In selecting wire numbers, when adding devices in an existing circuit already numbered, use an existing wire number from the immediate area in which the devices will be inserted, suffixed with a letter (e.g., 22A, 22B, 22C, etc.). Neutral wire numbers should begin with an "N".

- Terminal Designations:
  All schematics without wire number must show terminal numbers where connections are made between depicted subassemblies, and units.

  Terminal designations used in conjunction with wire number are shown in parentheses in order to reduce the chance of confusing terminal numbers with wire numbers.
- Device Arrangement:
  Devices within a circuit are arranged in operational sequence from left to right and/or top to bottom.
- Information Duplication:
  Information shall not be duplicated on two or more schematic diagrams. Each component is shown once on a schematic diagram. No redundant information is permitted unless it is required to facilitate understanding, and then it is shown in phantom line, clearly marked: **"FOR REFERENCE ONLY".**
- Cross-References:
  Whenever elements of a component (such as a relay coil or its contact) appear on different schematic diagrams, they are cross-referenced with appropriate drawing numbers.
- Physical Location and Wiring Diagram Reference:
  The physical location and wiring diagram reference of every component appearing on a schematic diagram is indicated by note or legend unless "IEEE Reference Designation for Electrical and Electronic Parts and Equipment Standards (ANSI Y32.16) are used.
- Origins and Destinations of All Incoming and Outgoing Lines:
  The origins and destinations of all incoming and outgoing lines must be specified and reference with an appropriate drawing number. Arrows are used pointing away from power or signal source.
- No Extraneous Information:
  When a schematic diagram is used in conjunction with a wiring diagram or parts list, no extraneous information, such as wire type or component manufacturer should appear on the schematic unless it is pertinent to the understanding of the schematic (e.g., co-axial cable, having certain impedance, or the like).
- Cross and Right Angle Lines will be held to a minimum
- All "Black Box" units are referenced with the schematic diagram number of units.
- All components, branch circuits and their components are shown. When a complete circuit is not shown, clearly identify with notes that the section is not completed and is missing components or circuits.

4.3.4.5 Key Interlock Schematic:
A Key Interlock Schematic indicates and describes the operation of a key interlock system. Interlock systems may be provided to guide or assure specific operational sequences, frequently to augment safety.

- General Format:
  The general arrangement of devices and areas matches their approximate geographical location. Power line and devices are shown in a skeletal format in the area in which they are physically located. The schematic drawings that show the complete circuit are referenced. It shall be clear that the electrical circuit shown is incomplete and is only for illustrative purposes.

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- Symbols and Coding:
  Symbols and coding are identical to that used by "Kirk".

- Line Weights:
  Power lines are shown heavy. Key Interlock Symbols are shown in normal weight lines. Direction of key transfer is shown in a medium weight dashed line with arrows indicating direction.

- Electrical Device Numbers:
  Electrical device numbers appear adjacent to their respective symbol and are referenced to their respective one-line and/or schematic diagrams.

- Item Numbers:
  Item numbers may be used, located in small hexagons adjacent to each key interlock. If used, they must be listed and described on the Bill of Material of the "KI" schematic.

- Key Numbers:
  Key numbers, when available, are indicated adjacent to "Key Transfer Lines".

- Description of Operation:
  This is required in lieu of an Access Procedures document. The operation is described in steps, identified by number. These numbers are placed in small circles adjacent to the arrows of respective "Key Transfer Lines".

4.3.4.6 Logic Ladder Diagram:
A Logic Ladder Diagram (Figure 5) shows control logic of a system using conventional control devices, i.e., pushbuttons, relays, etc., in conjunction with a programmable or process controller or similar device.

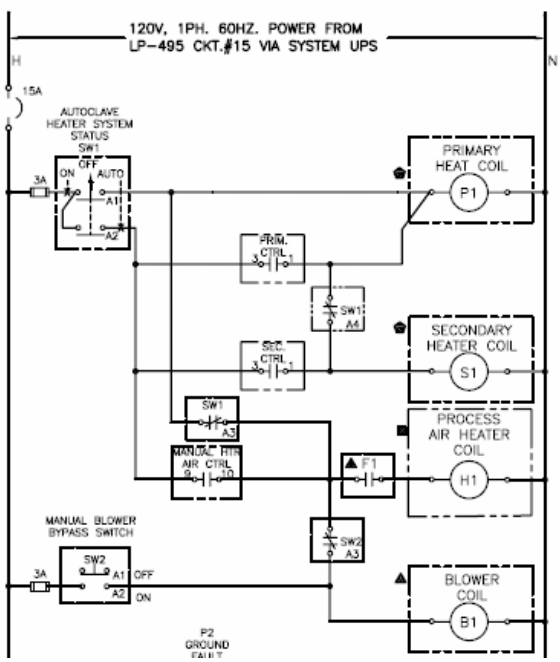

Figure 5- Example Logic Ladder Diagram

- General Format:
  The general format is similar to that of a conventional control ladder diagram. The preferred arrangement is horizontal, i.e., represented as two parallel horizontal lines with components connected between them by vertical lines.

- Logic Symbols: Logic Symbols are the representation of the aggregate of all the devices implementing a logic diagram in which the interconnections between symbols are shown on the drawing by lines.

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- Graphic Symbols on electrical or electronic drawings represent the functional character of a device in the circuit.
- Device Number:
  Device numbers must be closely coordinated with the respective schematic diagram which "establishes" the device number series. Identification of relays may be mnemonic.
- Cross-Reference:
  When elements of a component (such as a relay coil and its contact) appear on different schematic or logic diagrams, they are cross-referenced with appropriate drawing numbers.
- No Extraneous Information:
  Wire numbers, polarity marks, power sources, device descriptions, or any other data extraneous to the logic of the system do not appear on a Logic Ladder Program.

4.3.4.7 One-Line Diagram:
A one-line (or single-line) diagram shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices used therein. The one-line diagram conveys basic information about the operation of the system, but omits much of the detailed information usually shown on schematic or connection diagrams. This form of presentation lends itself to simplified diagrams of complex circuits and to diagrammatic representation of power systems in which a single line represents power circuit.

A One-Line Diagram gives a general presentation of power flow, instrumentation, voltages, components values, cables (when required), and power capacity of a system. It depicts the overall system. It is usually generated during the preliminary stages of a project.

- General Format:
  Single lines represent single phase or multi-phase power and control lines. Points of diminishing potential should be shown progressing from top to bottom or from left to right.
- Graphic Symbols on electrical or electronic drawings represent the functional character of a device in the circuit.
- Line Weights:
  Main power lines are shown as very heavy lines. Minor powers, instrumentation, and control lines are shown standard weight.
- Numbering Components:
  Components should be numbered according to power flow, from left to right and/or bottom.
- Device Functions:
  Device functions on AC Power, one-line diagrams are codified by ASA device functions numbers (e.g., 51, AC time over current relay) and are defined in notes or legend on each single-line diagram on which they appear. (See Section 7/E)

4.3.4.8 Panel Assembly:
The panel assembly gives a physical description of the size and position of components on console panels and control station mounting boards.

- Component Layout:
  The component layout should present a front view of the panel or board involved and need not specify mounting dimensions. It should include: outline dimensions, component centerline dimension, nameplate designations, and device numbers in parentheses ( ). Electrical connection will not be shown.

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4.3.4.9 Electrical Parts List:
Parts lists for electrical devices and assemblies include item number, device number, description and quantity of devices indicated on referenced assembly drawings or schematic diagrams.

4.3.4.10 Bill of Materials: (B/M)

- Parts lists for mechanical components and assemblies are described in Section 2.4.

4.3.4.11 Wiring Diagram:
Wiring Diagrams show the electrical connections of electrical components.

- Graphic Symbols:
  Use Electrical and Electronic IEEE standards
- Cable Numbers:
  To eliminate duplication of cable numbers, all wiring diagrams are assigned a distinct cable series unless cable numbers are assigned from a Cabling Diagram, Connection Wiring Diagram (CWD) or other formal documents. The cable number series and the last cable number are located in the center and at the bottom of the wiring diagram. The cable number series assignments will be coordinated with the group leader or drafting supervisor and the engineer and must be recorded in the appropriate "Wire, Device, and Cable Number Log".
- Cable or Wire Loom Code:
  Documentation of cable connections to terminals normally is accomplished by assigning an arbitrary code number or letters in a circle or an ellipse to each cable or wire loom (e.g., 1,2,A) placing it at the end of the short line representing the wire connected to a terminal and at the cable itself.

  The preferred method of coding wire looms or groups within a particular piece of equipment, such as control rack (if the panels or shelves are labeled with letters), is to use a letter on each panel in the circle or ellipse. For example, for those wires of the same type going from Panel "C" to Panel "E", it would be CE. If there are two or more types of wire going between panels, numbers are to be used to suffix loom labels (e.g., CE1)

  The symbols of large components are drawn to larger scale than symbols of smaller components.
- Wire Numbers on Terminal Strips:
  Wire numbers on terminal strips should be in chronological order from top to bottom or from left to right. (They do not have to be grouped according to cabling).
- Wire Closest to Ground Potential:
  Wires closest to ground potential should, whenever possible, be arranged to be at the bottom of a component (when mounted vertically) or on the right-hand scale side of the component (when mounted horizontally).
- Component Arrangement:
  The component arrangement is established by two criteria:

  -Operation sequence (i.e., from left to right and top to bottom), similar to a control panel.

  -Numerical order (i.e., from left to right and top to bottom), similar to a relay rack.
- Wire-Cable Types and Wire Sizes:
  Wire-cable types and wires sizes are indicated on all wiring diagrams for internal wiring, as well as wiring and cables leaving unit.
- Maximum Number of Wires on a Terminal:
  The preferred maximum of wires on a terminal is two when codes permit.

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- Arrangement:
  Wiring Diagrams, other than pictorial types, show devices arranged in their general geographic location as seen by the wireman.
- Orientation of a Wiring Diagram:
  The orientation of section views must be stated. (e.g., front view, rear view, etc.).
- Internal Wiring of Components:
  Internal wiring of components may be omitted on wiring diagrams if they are shown elsewhere and are referenced.
- Simplified Type Wiring Diagrams
  PPPL's preferred types of wiring diagram show only short lines representing wires at terminals on components with appropriate wire numbers. When "daisy – chaining: (connecting many common points together), the specific routing of wires is left to the wireman. If specific wiring configurations are desired for components, these should be indicated.
- Zone Type Wiring Diagrams:
  Zone type wiring diagrams have zones assigned to all electrical components, identified alphanumerically. Zones have nothing to do with component types. They are simply identifications assigned to a geographical area reserved for particular components. In general, they are assigned consecutively in the order of left to right and top to bottom. This type is normally used for large and complex wiring diagrams.
  The Zone Labels are prefixed with a letter or letters (e.g., A, B, AA, BB, CC, etc., without duplicating prefixes on the same equipment) and suffixed by numbers. The labels are assigned per panel, rack, or shelf. All terminal strips will have their prefixes end with "T" (e.g. AT, BT). The numerical suffixes begin with numeral 1 in the upper left section of the Wiring Diagram, and will continue consecutively. When they are added in an area where no zone numbers exist, it has the same number as the nearest zone, but suffixed with a letter.

  Wires connected to terminals on a device are shown with a short line, referenced with wire number on one side and the zone to which the other end terminates on the other side. If more than one wire terminates on a terminal, only one wire is shown, but both zones are indicated. In addition, if the zone to which a particular wire terminates is located on another drawing, then the wire has a codes circle at its end. The legend or cable listing indicates either the drawing on which the wire is continued or the cable of which it is part.
- Pictorial Type:
  Pictorial type wring diagrams show physical components to scale, with wires shown in exact physical locations. This type of drawing, being made to scale, may also serve as an assembly drawing, including dimensions, details, and bill of materials list for devices such as brackets, standoffs, etc., which do not appear on the electrical parts list.

4.3.4.12 Plan View, Elevations and Details:
These drawings are used extensively in electrical design. This is the mechanical element to install and document electrical equipment and their location. They can be used individually or concurrently.

A Plan View is a MAP that shows an electrician where electrical items are located and routes that trays and conduits follow that connect these items. You are looking down on the area from a point above the floor. Plan Views are Elevation specific. With several floors or one floor; you need a Plan View at the floor elevation to map what is existing or a future installation.

Elevation drawings are pictures letting you look at an installation. It is at eye level - so you can develop and plan an installation as you would look at it. You can see if you have space to work with. Elevation is specific only to the floor elevation.

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Detail drawings are specific items that require particular attention by the electrician. This assists the electrician by defining an assembly sequence or to provide additional information that cannot be shown in a plan view or elevation drawings.

Dimensions are shown on all of these drawings to assist with any aspect of design. Estimating, maintenance and planning are key aspects where dimensions are routinely used.

4.3.4.13 Electronic, Logic and Printed Circuit Board Drawings:
Electronic and Circuit Board drawings are a unique set of drawings. They are specific in nature as they are purpose/ equipment oriented. The several categories that define these drawings are:

- Symbolic Logic Circuitry: the use of logic statements/ expressions (that include connectives: AND, OR, NAND, NOR) to develop electronic circuitry.
- Circuit Board Artwork: for the manufacture of simple and multi-layer printed circuit boards and the discrete component orientation and layout.
- Schematics: that show signal names and their state being received and emanated by the circuit components along with a path on the circuit board. Also shown is the Signal/ Component Pin number orientation and connections.

5.0 WELDING DRAWINGS

It is essential to have an accurate method of showing on drawings the exact types, sizes, and locations of welds desired by the Cognizant Engineer.

5.1 Welding Symbols:

Use standard weld symbols and notes to specify the type of weld, its size, and other processing and finishing information on drawings. A complete set of symbols is given in a standard published by the American National Standards Institute and the American Welding Society:

ANSI/AWS A2.4, Symbols for Welding and Nondestructive Testing

5.2 Welding and Brazing Notes on Drawings:

The following note shall be added to all PPPL drawings that identify welding or brazing as a process for fabrication.

5.2.1 General Welding Note: "Welding (and Brazing, if applicable) shall be performed in accordance with the requirements of (insert applicable code here). Welding (and Brazing, if applicable) performed on-site shall also meet the requirements of PPPL Procedure Number ENG-037. Visual weld inspection shall be performed in accordance with the acceptance criteria of (insert applicable code here)." Applicable codes to be determined by table below:

5.2.2 Examination and Testing Note: Where applicable, additional nondestructive examination and testing requirements, e.g. helium leak testing, 8x visual examination, liquid penetrant examination, specific Code references, brazing criteria, etc., shall also be noted on fabrication drawings, in addition to the required materials of construction, welding process(es), procedure(s), weld joint details, and sizes.

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Weld in Accordance With: TABLE 7	Visual Inspection Criteria:
ASME Section VIII Division 1 (Welding and Brazing of Pressure Vessels)	ASME B31.3 Category D
ASME Section I (Welding and Brazing of Power Boiler Components)	ASME B31.3 Category D
ASME B31.1 (Welding and Brazing of Power Piping)	ASME B31.1
ASME B31.3 (Weld Joints in Low Pressure Process and Vacuum System Piping and Tubing)	ASME B31.3 Category D
ASME B31.9 (Welding and Brazing of Building Piping Services)	ASME B31.9
AWS D1.1 (Welding of Structural Carbon and Low Alloy Steel)	AWS D1.1
AWS D1.2 (Welding of Structural Aluminum)	AWS D1.2
AWS D1.3 (Welding of Structural Sheet Steel)	AWS D1.3
AWS D1.6 (Welding of Structural Austenitic Stainless Steel)	AWS D1.6
AWS D9.1 (Welding of Non-Structural Sheet Metal)	AWS D9.1
AWWA D100 (Welding of Water Storage Tanks)	AWWA D100

5.2.3 Welding/Brazing of Pressure Vessels: (Stainless Steel with leak rate requirement)

NOTE:

1. Welders must be certified to section IX of ASME Code.
2. Weld procedures must be in accordance with section IX of ASME code.
3. Visual inspection shall be performed in accordance with acceptance criteria of AWS D1.6
4. Note orientation of all welded parts.
5. Leak rate shall not exceed 1 X 10-5 Torr-L/sec. (Specify leak rate as required)

5.3 Welding Review and Approval:

If welding or brazing is required, a PPPL Weld Engineer or designated backup must review the drawing for correct use of symbols and weld notations. On manually created drawings he/she must then sign the appropriate space provided on the drawing format for weld engineer approval. If an electronic signature is required follow the steps outlined in section 7.3 and/or 7.4 as applicable. The Weld Engineer's signature is required on Sheet 1 of a multi-sheet drawing.

6.0 CHECKING OF DRAWINGS

Once a drawing has been completed, it is necessary to check or verify that the dimensions, details, etc. are correct prior to approving the drawing. Checking will use a graded approach where it is the responsibility of the Project to determine the degree of checking that is required. In the case of independent individuals generating their own drawings, it is the responsibility of the Responsible Line Manager (RLM) to determine the degree of checking required. This section outlines the responsibilities of the checker and recommended checking practices.

6.1 Responsibility of Checker:

An individual when assigned as checker will review the drawing relating to quality, accuracy, manufacturability and conformance to standards. The degree of checking required is to be determined by the Project or Cognizant individual responsible for the drawing.

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6.1.1 The checker is responsible for ensuring the accuracy and completeness of the drawings submitted to him/her, taking into account the design requirements, and assuring compliance with PPPL Drafting/ CAD Guidelines and Standards plus other applicable standards.

6.1.2 The checkers duties include: Examining detail, layout, assembly and installation drawings for practicality of design; accuracy and conformity to the design criteria and/or existing specification and standards. He/she shall apply knowledge of mechanical and/or electrical design methods; of manufacture/assembly; and drafting techniques/procedures.

6.1.3 The checker must be familiar with the function and criteria of the drawings to be checked, but should not have been an active participant in preparing this material.

6.1.4 The checker shall discuss required changes with Cognizant Individual and/or Designer and shall coordinate and check corrections.

6.2 Job Information for Checker:

The following information should be supplied, together with check prints and drawing originals (manually produced drawings only):

- Job Title, Job Number Work Package
- Cost Center Responsible Engineer's Name
- Responsible Designer's Name
- Drawing Tree or list of drawings to be checked
- ECN document (if changes are being made to original drawing)
- Applicable specifications

6.3 Check Print Markings (Recommended):

Prints of all drawings and documents submitted to checking will be marked employing the following conventions.

6.3.1 All items or features correctly presented on a drawing/document will be marked over, crossed out or encircled using a "Green" marker/pencil.

6.3.2 Items deleted from the drawing/document will be marked over or crossed out using a "Yellow" marker/pencil.

6.4 Changes or additions to the drawing/document will be written using a "Red" marker/pencil.

6.4.1 Questions or suggestions used in support of the checking assignment to clarify information, calculations, reference material, etc., and not requiring changes to the drawing/document will be expressed with a "Black" marker/pencil.

7.0 DRAWING APPROVALS

7.1 Drawings Produced Outside the CCDG:

New drawing approval signatures for drawings produced outside of the CCDG shall follow procedure ENG-010 "Control of Drawings, Software and Firmware". In addition:

7.1.1 Prior to proceeding with approval, completed drawings (manually generated or CAD generated) shall be first reviewed by the Central CADD Design Group Supervisor for completeness to ensure that all of the information referred to in Section 1.1.4 has been provided. Note: This brief review will not verify the technical content or accuracy of the drawings. That is the purview of the assigned Checker.

7.1.2 Once the initial CCDG review has been completed as noted above, follow procedure ENG-010 "Control of Drawings, Software and Firmware" for the approvals.

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7.1.3 CAD Generated Drawings: All CAD drawings which are generated outside of the Central CADD Design Group must be generated utilizing one of the recommended CAD software packages referenced in Section 1.1.2 in this standard. A PDF of the drawing which has been approved shall be digitally signed by the interested parties. The signed PDF must be submitted to the CCDG Supervisor for his/her Fabrication Stamp and digital signature. He will then archive the stamped PDF's for future reference and posting to the PPPL Web page. In addition, an electronic copy of each CAD drawing file must be forwarded to the CCDG Supervisor for archiving.

7.2 Drawings Produced By the CCDG:

New drawings that are produced by the CCDG shall follow procedure ENG-010 "Control of Drawings, Software and Firmware". Drawings produced by the CCDG shall also be generated utilizing the following software packages: Mechanical drawings shall be generated using Pro-Engineer (CREO), CATIA or AutoCAD. Electrical drawings shall be generated using AutoCAD.

7.3 Electrical Drawings and/or Mechanical Drawings Generated by AutoCAD:

The approval of AutoCAD generated drawings can be completed either electronically or manually by making a paper copy of the drawing and manually approving the document. The approval method to be used will be the decision of each project and the type of drawing involved. The following steps are a recommended guideline if electronic signatures are used. It is preferred to use the electronic method of approval, i.e.; electronic signature.

7.3.1 Electronic signatures are done with the use of the most recent version of Adobe Acrobat software available at PPPL on PDF's generated by same.

7.3.2 All individuals who must sign the drawing are required to establish their own password-protected electronic signature. This process is defined in the Adobe Acrobat software package. Once established, they shall e-mail the validated certificates to the CCDG Supervisor who maintains the list of validated certificates (called fingerprints in Adobe Acrobat).

7.3.3 The individual who generates the drawing shall generate a PDF of that drawing file. The PDF shall then be forwarded to all interested parties (Checker, Cog Engineer, Weld Engineer if required) who, in turn, shall sign the document utilizing their password protected electronic signature.

7.3.4 Once all signatures have been placed on the drawing, the CCDG Supervisor shall verify the authenticity of the signatures, sign and place an electronic "For Fabrication" stamp on the PDF indicating that the drawing may be used for fabrication or installation. (See ENG-010) The CCDG Supervisor will then place the stamped PDF into the archive folders and post to the PPPL Web page.

7.4 Mechanical Drawings Generated by Pro-Engineer (CREO):

The approval of CAD drawings generated by Pro-Engineer (CREO) shall conform to the following procedure with approvals controlled by Windchill (a PTC Database Manager Product).

7.4.1 Perform "HIDE LAYER" and "SAVE STATUS" on drawings and associated models. Make certain that datum's, axes, points and coordinate systems reside on corresponding layers. For any items that do not reside on a layer use "Layer Properties" function in the Layer Tree to assign the item(s) to its corresponding layer. It is NOT PERMISSIBLE to blank the layers by using the menu icon tools.

7.4.2 All models (parts and assemblies) and drawings shall have valid and active descriptions associated to them.

7.4.3 Complete the title block with your name (Designer), the Checker, the Cog Engineer, the current date and the initials of the Checker and Supervisor in the appropriate blocks. Verify that the correct revision number appears in the Revision Block, beginning with 0 (zero) for the initial drawing release. File the drawing and associated models and "Check In" to the appropriate folder in Windchill. NOTE: The drawings and associated models (parts, assemblies) MUST be located in the appropriate folder. Drawings and models which are being elevated to Fabrication **MUST NOT** be placed in a sketch folder. If you are uncertain where the files should be located, see the CADD Group Supervisor for guidance.

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7.4.4 If there are welds specified on the drawing, leave the Weld Engineer's name and date blocks blank. The Weld Engineer will electronically sign an approved pdf file. If there are **NO WELDS** on the drawing, fill in the Weld Engineer Block with "N/A". **DO NOT LEAVE BLANK**. (NOTE: Prior to submitting the drawing(s) for promotion to Fabrication, in the interest of expediency, forward a copy or pdf of the drawing(s) to the Weld Engineer for his comments/approval. This will minimize errors and the need to re-submit for promotion.)

7.4.5 Mark the appropriate "Magnetic Permeability Requirement" block (Yes or No) with an "X". A nice bold "X" can be created by selecting "Font Filled" with a text height of ½".If there are magnetic permeability requirements, a corresponding note shall be added to the drawing. It is the Cognizant Engineer's responsibility to make certain the correct values are designated on the drawing.

7.4.6 Follow the **Windchill** procedure to issue a Promotion Request.

7.4.6.1 In Common-space, select the drawing(s) that will be promoted to fabrication status.

7.4.6.2 A pop-up window will appear with the heading "New Promotion Request." In this window there are six steps to follow in sequence. Each step must be completed to proceed to the next step:

Step 1: Set attributes. Enter descriptive information about the promotion request. This can include the drawing(s) title(s) and/or number(s) or, in the case of revisions, an ECN number.

Step 2: Collect objects. Gather the objects related to the promotion request. Under the "Configuration" tab select the "Required" option. This will populate the window with all related objects required to generate the drawing(s) being promoted (approved). You must then go through the list in its entirety making certain to exclude ALL library parts, formats and any other objects which may already be in the Fabrication state.

Step 3: Edit object list. Select only those objects that you want to be promoted. Check through the list to make certain that you have excluded any objects that may already be in fabrication. Once you are satisfied that this requirement has been met, activate the promote block to include all objects.

Step 4: Select state for promotion. Select the state to which you want the objects promoted. There are six states from which to choose: "Preliminary Design", "Conceptual", "Prototype", "Final Design", "Fabrication" and "As Built". Typically, we use only "Fabrication" to promote from "WIP".

Step 5: Select process. Select the promotion process you want the objects to follow. Select "Promotion Request Approval Process".

Step 6: Define participants. Select users to participate in the promotion process. Select from the "Participants" column those approvers whose name(s) appear on the drawing(s) being promoted. Select "Finish" to complete and close the process. An automatic e-mail notification is sent out to each selected participant to let them know they have been included in a promotion request.

7.4.7 After the Promotion Request has been approved by the appropriate parties, you can then add to your Workspace the latest approved drawing(s) and verify that the "Release Level" block on the format has changed to "FABRICATION" and that the "Version No." block reflects the latest version as shown in Common space. (On the rare occasion that these blocks do not reflect the correct info you will have to manually edit the field(s). Please note that you will NOT be able to file the drawing since it will already be in the "FABRICATION" mode and locked by the system. This is an acceptable solution.)

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7.4.8 Upon completion of the above steps, create a pdf file of the drawing(s). To create a proper pdf for stamping and signing, select the "MONOCHROME" and "STROKE ALL FONTS" settings. If the Weld Engineer's electronic signature is required, forward the pdf to him for his digital signature with a request to return the signed pdf to you so you can forward it to the CADD Group Supervisor. The CADD Group Supervisor will then add the Fabrication stamp and his electronic signature to the pdf. The pdf shall then be archived and posted to the PPPL Web Page.

8.0 CHANGES OR REVISIONS TO DRAWINGS

Changes or revisions to drawings shall follow procedure ENG-010 "Control of Drawings, Software and Firmware".

9.0 CATIA (ITER) DRAWING REQUIREMENTS

This section describes how to create ITER drawings using CATIA.

9.1 Drawing Preparation

Drawings may be created by the Central CAD Design Group (CCDG) or by individuals and/or groups outside of the CCDG. They may be produced by using the recommended CADD software. In either case, preparation of the drawing must meet requirements that will ensure that the drawing produced has the correct and sufficient information or data that will allow it to be shared by all parties. See Drawing Management Procedure US D 227FU8.

9.1.1 Drawing Preparation by Groups/Individuals Outside of CCDG:
See section 7.1

9.1.2 Software for Mechanical CAD Generated Drawings:
See Section 1.1.1

9.1.3 All drawings shall be drawn on a standard ITER drawing format:
See Section 9.2 and APPENDIX A

9.1.4 Mandatory Information Required on Drawings:
See section 1.1.4.

9.1.5 Checking:
See Section 9.6

9.1.6 Drawing Preparation by Central CAD Design Group (CCDG):
See section 1.2

9.1.6.1 Monitoring Progress See Section 1.2.3

9.1.6.2 Applicable ISO drafting/CAD practices and standards shall be used in the preparation of the drawing.

9.1.6.3 Add required ITER properties to models before beginning FTB.
(See ITER 'CAD Manual 05 - Design Data Management 249WSM)

Figure 6- FTB Manager (ITER Project)

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9.1.6.4 All drawings shall be prepared on an ITER standard drawing format as described in section 9.2.

9.1.6.5 For PC generated drawings, copies of the format can be accessed from CATIA/ENOVIA using 'FTB Manager' (Automated software Figure 6). Select the appropriate sheet style that meets the requirements (Figure 7).

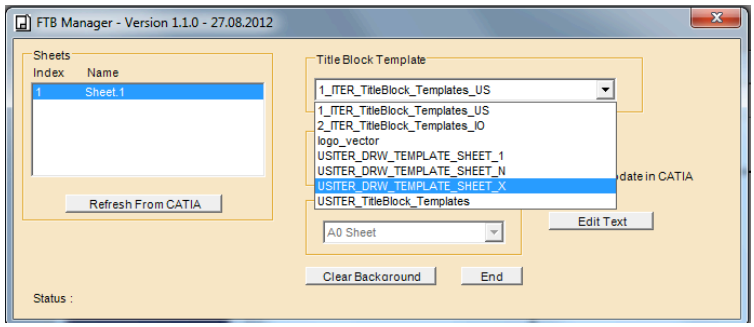

Figure 7- FTB Manager (Sheet style ITER Project)

9.1.6.6 Distribution of Preliminary Drawings: When the drawing has developed to a preliminary state, prints or PDF's may be circulated to other involved disciplines for comments concerning interface and interferences. In addition, preliminary un-checked and un-approved drawings may be sent to internal shops for purpose of gaining information as to availability of material, preliminary cost to manufacture, vendor interest and the like. Preliminary drawings must have a legally issued drawing number and title and must have the following note either as part of the standard ITER format or across the main body of the drawing: "PRELIMINARY FOR INFORMATION ONLY NOT FOR CONSTRUCTION". See Drawing Management Procedure US D 227FU8.

9.1.6.7 Use of Preliminary Drawings: Preliminary drawings should only be used for fabrication for special purposes, such as 'Proof of Concept' (See Drawing Management Procedure US D 227FU8 to determine the suitability of the manufacturing process, etc. They should not be used to produce parts for actual use.

9.2 Drawing Format

9.2.1 General Drawing Layout:

The right hand side of a single sheet drawing shall be reserved for the Bill of Material and future revisions. The upper left shall be reserved for all notes (General and Reference). This information shall also appear on sheet 1 of a multi-sheet drawing. A reference note shall be added above the Title Block on ALL subsequent sheets of a multi-sheet drawing that states "FOR NOTES AND BILL OF MATERIAL SEE SHEET 1".

9.2.2 Title Block:

A sample standard ITER Title Block is shown in Figure 8. Any and all standard format Title Blocks shall include important information necessary to fabricate or assemble the component. The Title Block shall include as a minimum:

9.2.2.1 Project:
Identifies the project that the drawing is associated (ITER).

9.2.2.2 Descriptive Title:
The drawing title shall typically consist of three lines. Line one shall be the name, either a noun or noun phrase, by which the part or assembly shall be known. Line one is a direct link to Catia Document name in. Line two consists of US-ITER WBS title referencing WBS Complete Dictionary 22G73N. Line three shall be additional descriptive information.

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9.2.2.3 Designer (DRW): (Hand signature and date, Printed name entered by hand)
Cognizant person, responsible individual for generating/creating the drawing

9.2.2.4 Responsible Engineer: (Printed name entered by hand)
Cognizant person, for the contents of the drawing

9.2.2.5 Checker: (Printed name and Initials entered by hand)
This is the name of the individual who has checked the drawing for accuracy, content, etc. See section 6.0 for more information on checker.

9.2.2.6 SME (Subject Matter Expert): (Printed name and Initials entered by hand) Last signature on drawing, verifying that drawing meets requirements outlined in section 1.0

9.2.2.7 Date:
Month, Day and Year drawing was approved.

9.2.2.8 Drawing Number: (Assigned by ENOVIA)
See section 9.3.

9.2.2.9 Revision Number area:
This indicates the most recent version of the drawing. All revisions are identified numerically beginning with 0 (zero) for the initial release. All Preliminary revisions are identified alphabetical beginning with 'A' until 'Certified for Construction'. All 'Certified for Construction' revisions begin with 1 for the initial release.

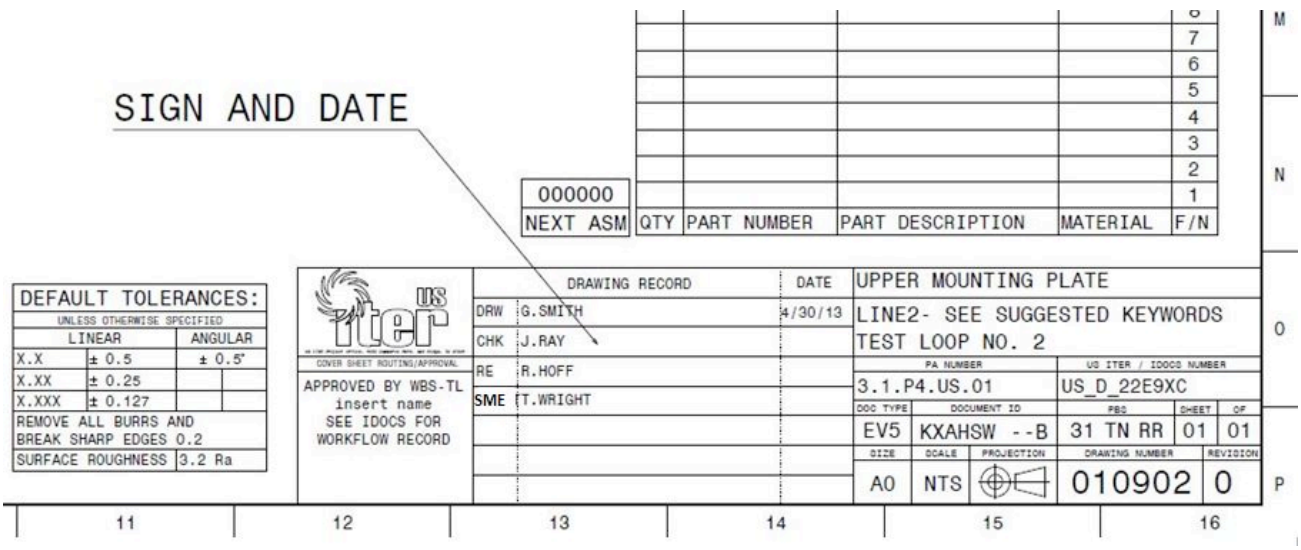

Figure8- Sample Title Block (ITER Project)

9.2.2.10 Signature area for Welding Engineer:
See section 9.5

9.2.2.11 Bill of Material:
- Assembly and /or Part Number
- Description
- Material
- Quantity Required

9.2.2.12 Assembly and /or Part Number

9.2.2.13 Tolerance requirements (Standard)
See section 9.2.2.20

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9.2.2.14 US ITER/ IDOCS Number
6 character Alpha/numeric assigned by DCC

9.2.2.15 PBS
See IO document **ITER PLANT BREAKDOWN STRUCTURE (PBS) 28WB2P or IDF 2 FBMWF**

9.2.2.16 Document ID:
Enovia generated ID including 3 characters Versioning (revision)

9.2.2.17 PA Number (Procurement Agreement):
See USDA RE

9.2.2.18 Standard Drawing Size:
Table number 8 identifies the standard metric drawing sizes that are used for ITER.

Table 8 – **STANDARD (Metric Units) FINISHED SHEET SIZES**

	Width (mm)	Length (mm)
A4	297	210
A3	297	420
A2	420	594
A1	594	841
A0	841	1189

9.2.2.19 Tolerances:
Tolerances are identified on the bottom of the standard PPPL format (Title block area) and can be either in decimal or fractional form depending upon tolerance requirements. If decimal, the number of places in the dimensions dictates the tolerance (±0.5, ± 0.25 or ± 0.127). Unless a tolerance is specified, the tolerances outlined in the drawing Title Box shall be used.

9.2.2.20 Dimensions/Scales on Drawings:
Each project may decide whether the English or metric system will be used in dimensioning their drawings. Unless otherwise noted, the general recommended dimensioning system is: **ITER CAD MANUAL Section 9 – Drawing Best Practice 24SNC9**

9.2.2.21 Zoning of Drawings:
The standard "A1" and "A0" size drawing forms are zoned to establish reference areas for use in location changes, dimensions, or other features on complex drawings. For zone identification, use the drawing alphanumeric coordinates.

9.2.2.22 US ITER TITLE BLOCK
Approved by the WBS TL/ Not all drawings require WBS TL approval. See document Review and Approval Procedure- US D 227FU8 Section 6.3.:

9.3 Drawing Numbers

Refer to document US ITER 16000-PR0001-R03 Document and Drawing Numbering Procedure

9.3.1 Vendor Drawings:
This document has yet to be determined by ITER.

9.3.2 Revision of Vendor Drawings:
This document has yet to be determined by ITER.

9.3.3 Revision of PPPL Generated Drawings:
Changes or revisions are made to a multi-sheet drawing, the same revision number will be identified on all sheets.

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9.3.3.1 Revision of Multi-Sheet Drawings:
When revisions are made to a multi-sheet drawing, the same revision number will be identified on all sheets.

9.3.3.2 Revision Block:
Each revision to an approved (signed-off) individual drawing sheet shall be recorded in the revision block in accordance with the following. (Figure 3- One Type of Revision Block)

DRAWING REVISION HISTORY		
REV	DESCRIPTION	DATE
0	CERTIFIED FOR CONSTRUCTION	04/30/13
I	REVISED PER DCR #	

Figure 9- Revision of a Certified for Construction Revision Block (ITER Project) standard format

DRAWING REVISION HISTORY						
REV	DESCRIPTION	RE	CHK	STRCT		DATE
	COMMENT PRINT					01/15/13
	REVISED PER C.B. COMMENTS					02/15/13
A	ISSUED FOR COMMENT	RH	JR	HW		04/30/13
B	ISSUED FOR PRELIM DESIGN REVIEW	RH	JR	HW		06/25/13

Figure 10- Preliminary Release Revision Block (ITER Project) standard format

- Revision Number: The identifying revision number pertaining to the particular revision being recorded is entered in the number column of the drawing revision block. Revision numbers are sequential, beginning with the numeral "1". (Figure 3)
- Revision Letter Preliminary Release: The identifying revision letter pertaining to the particular revision being recorded is entered in the REV column of the drawing revision block. Revision letters are alphabetically, beginning with letter "A". (Figure 4)
- Description: Enter the identifying number of the Design Change Request approved (DCR) and when possible a brief description of the change within the drawing revision block, including the cross-reference zone locations (coordinates). See Design Change Procedure- US D 22M5G7 and Design Change Request (DCR) Users Guide- US D 22YCFM-v1.1.
- Identification Number: Except for describing the addition of parts, the identification number of the Approved DCR will suffice.
- Approvals: Handwritten signatures and dates of approval of the revision are entered in the approval columns of the title-block. A revision is not approved unless it has been checked.

9.4 Types of Drawings:
An engineering drawing is a document that discloses by means of pictorial, schematic or textual presentation or combination thereof, the physical and/or functional engineering end product requirement.

9.4.1 Layout Drawings:
See section 4.1

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9.4.2 Vendor Drawings:

9.4.3 Sketch Drawings:
N/A

9.4.4 TITLE:
See section 4.3

9.4.5 Mechanical Engineering Drawing Types:
See section 4.1.for the various types of drawings considered to be engineering drawings.
See Drawing Management Procedure- US D 227FU8.

9.4.5.1 Function:
See section 4.1.1

9.4.5.2 All engineering drawings (mechanical and electrical) should provide maximum latitude in the choice of manufacturing methods, processes and procurement, consistent with the engineering requirements. References to specific methods of ordering parts and material, detailed methods of manufacture or assembly or inspection processes are better satisfied through the use of a PPPL specification document. Reference to applicable specification is to be included in the notes area on the drawings.

9.5 Welding Drawings

9.5.1 Welding Symbols:
Use standard weld symbols and notes to specify the type of weld, its size, and other processing and finishing information on drawings. A complete set of symbols is given in a standard published by the American National Standards Institute and the American Welding Society: **(Weld Per ISO 2553:1992)**

9.5.2 Welding Review and Approval:
If welding or brazing is required, a PPPL Weld Engineer or designated individual must review the drawing for correct use of symbols and weld notations. On ITER created drawings he/she must then hand sign the appropriate space provided on the drawing format for weld engineer approval.

ANSI/AWS A2.4, Symbols for Welding and Nondestructive Testing.

9.6 Checking of Drawings:

See section 6.0

9.6.1 Function: The checker is responsible for ensuring the accuracy and completeness of the drawings submitted to him/her, taking into account the design requirements, and assuring compliance with PPPL Drafting Standard Section 9.0 and CAD Guidelines ITER CAD Manual 01 – Introduction ITER_D_249WLQ and Standards plus other applicable standards.

9.7 Approval of Drawings:

9.7.1 Drawings Produced Outside the CCDG:
TBD

9.7.2 Drawings Produced By the CCDG:
New drawings that are produced by the CCDG shall follow procedure Document Review and Approval Procedure 'US ITER 16000-PR0005-R02' and Document Review and Approval Procedure Matrix 'US ITER 16100-PR0006-R05'

9.7.2.1 Perform "HIDE/SHOW" on all model geometrical entities not associated to drawing.

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9.7.2.2 Apply appropriate drawing level stamp.

9.7.2.3 Perform a data clean using CATDUA.

9.7.2.4 Run ITER data standardization checking software Q-checker.

9.7.2.5 Print for hand signatures for approval.

9.7.2.6 Scan signed print for distribution.

9.7.2.7 Add names and dates to corresponding locations on drawing.

9.7.2.8 Complete the title block with your name (**Drw**), the Checker, the **Responsible Engineer** Cog Engineer, **SME** along with the current date. Verify that the correct revision number appears in the Revision Block, beginning with 0 (zero) for the **Certified for Construction** initial drawing release. If you are uncertain where the files should be located, see the CADD Group Supervisor for guidance.

9.7.2.9 Drawings and associated models need to be upgraded from 'In-Work' to 'Da-Draft' status in Enovia.

10.0 VIEWING DATA BASE DRAWINGS

This section describes how to view drawings (in PDF format) that have been approved for fabrication and have been archived in the PPPL data base.

10.1.1 Viewing Project Drawings in PDF Format:

This viewing system is an internet browser based program that enables personnel to easily access and copy CAD files in the PDF format to their desktop. This viewing system is relatively new and will continue to be updated as additional drawings are added to the system.

10.1.2 Instructions for viewing Project Drawings in PDF Format:

10.1.2.1 Open the **PPPL Local Home Page** on your browser.

10.1.2.2 Under "**Services by Organization**", choose **"Engineering". (**An alternate path would be to select **"Project Engineering Drawings"** under the **"Information and Services by Function"** header. Skip 9.1.1.3 and 9.1.1.4. Continue at 9.1.1.5.)

10.1.2.3 On the **"Engineering"** page, choose **"Mechanical Engineering Division"**.

10.1.2.4 On the "**Mechanical Engineering Division**" page, choose **"View Project Engineering Drawings".**

10.1.2.5 Click on the desired **Project Name** [ex. NSTX, MRX…etc.]**.**

10.1.2.6 Click on the desired highlighted **Group Code.**

10.1.2.7 To locate the desired drawing, you may scroll up and down the current page, or you may do the following:

- Click **"EDIT"** at the top of your browser window and choose **"Find** (on this page)" from the drop-down menu.
- In the **"FIND"** window, enter a word or phrase that might be in the drawing title, or you may enter a drawing number or even the drawing file name if you know it.
- Click **"FIND NEXT"** to begin the search and if necessary, continue clicking **"FIND NEXT"** until you locate the desired drawing.

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- Click on the highlighted **"FILE NAME"** to open the drawing file in PDF format and view the drawing.

- You can now copy the drawing file to your desktop or create a print out for your reference and/or use.

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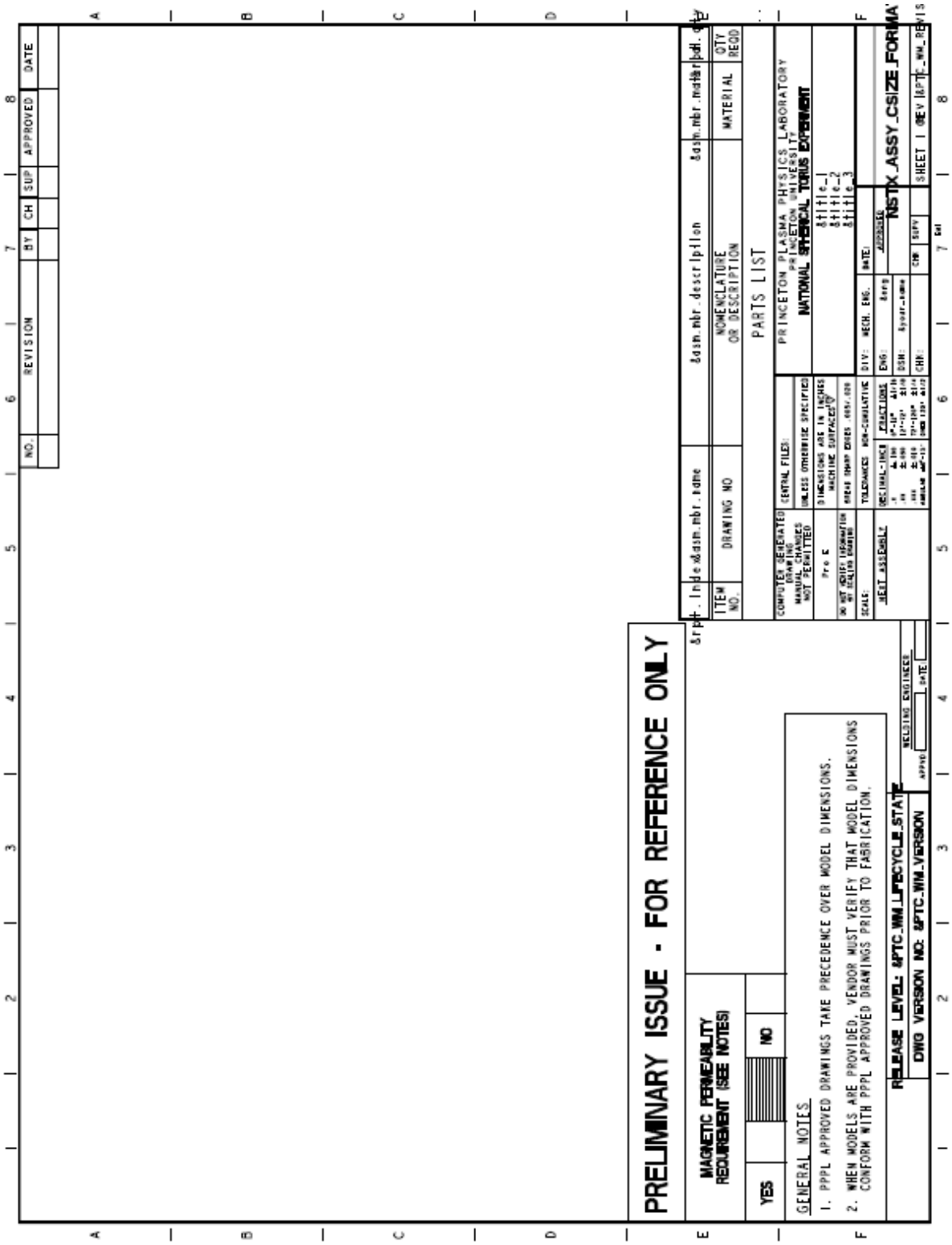
APPENDIX A- DRAWING FORMATS

MECHANICAL ASSEMBLY SIZE "C" FORMAT



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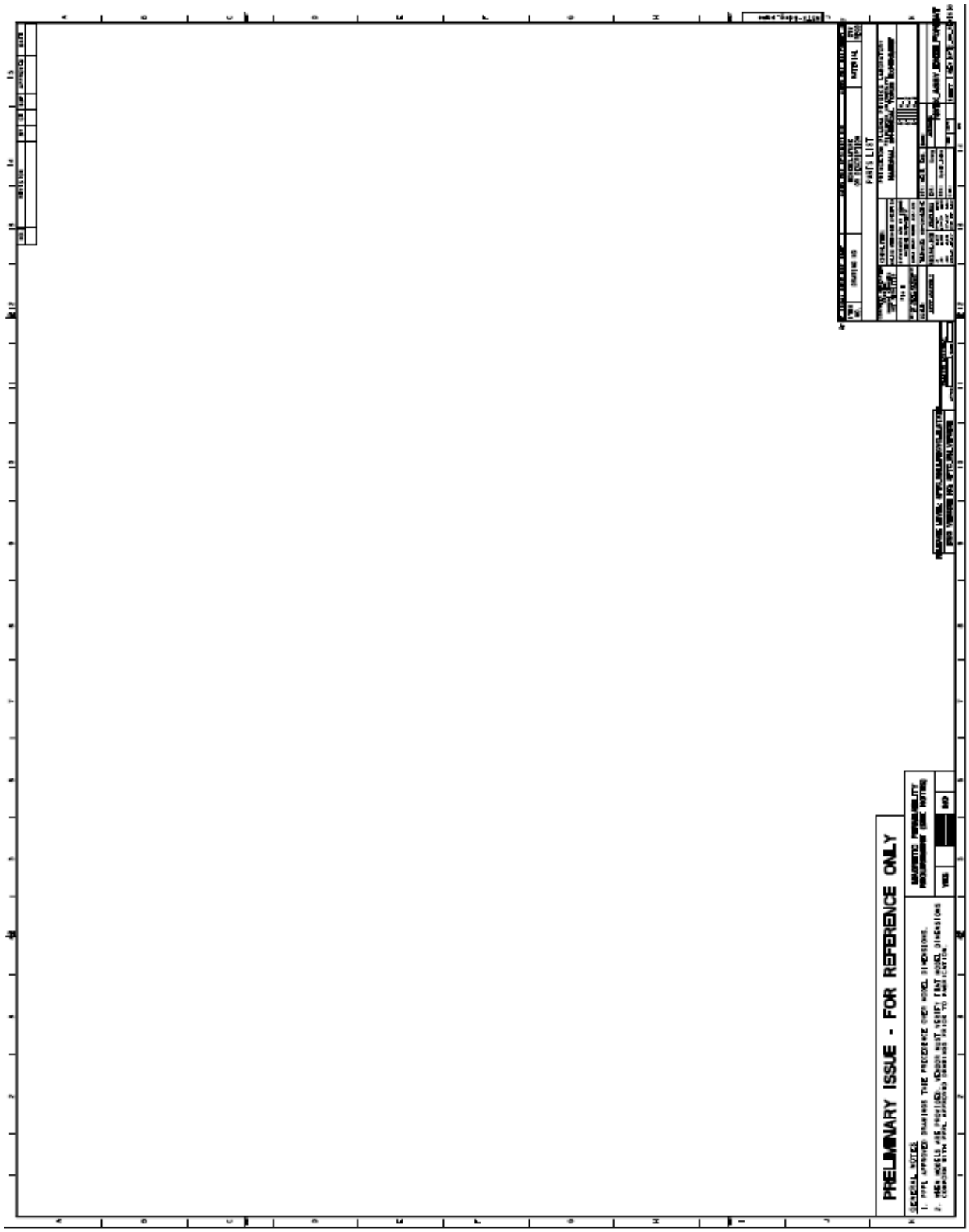
APPENDIX A- DRAWING FORMATS

MECHANICAL ASSEMBLY SIZE "E" FORMAT



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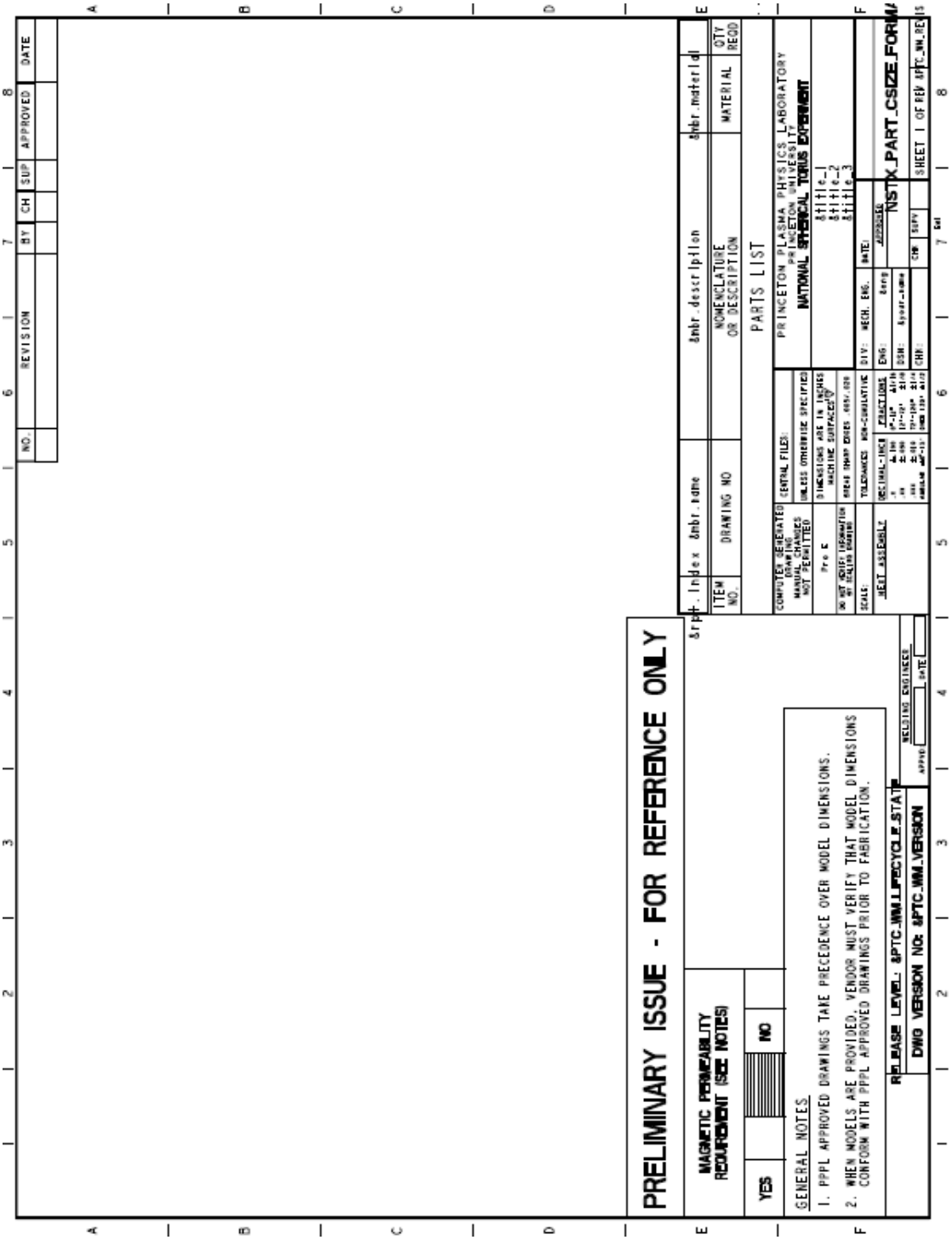
APPENDIX A- DRAWING FORMATS

MECHANICAL PART SIZE "C" FORMAT



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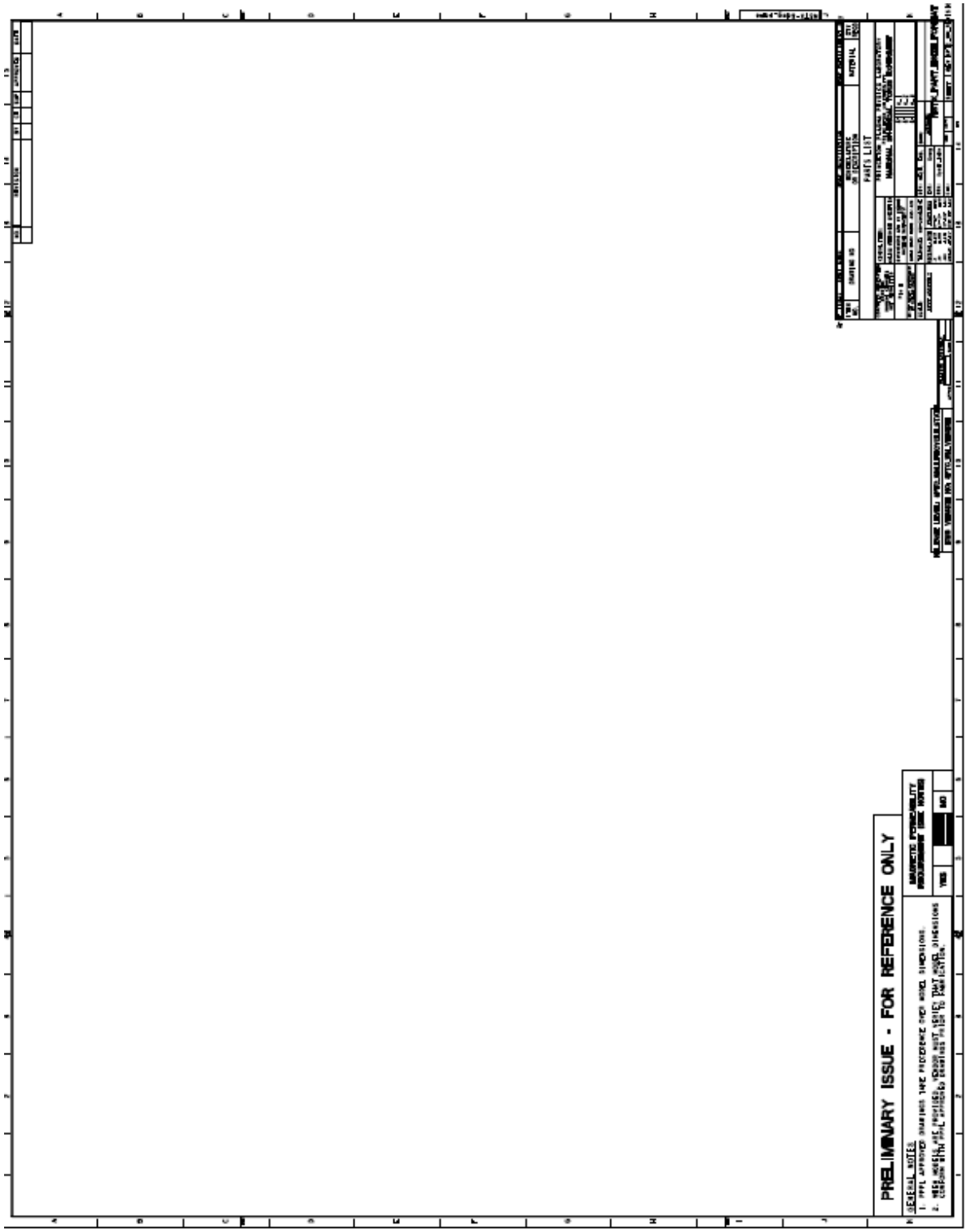
APPENDIX A- DRAWING FORMATS

MECHANICAL PART SIZE "E" FORMAT



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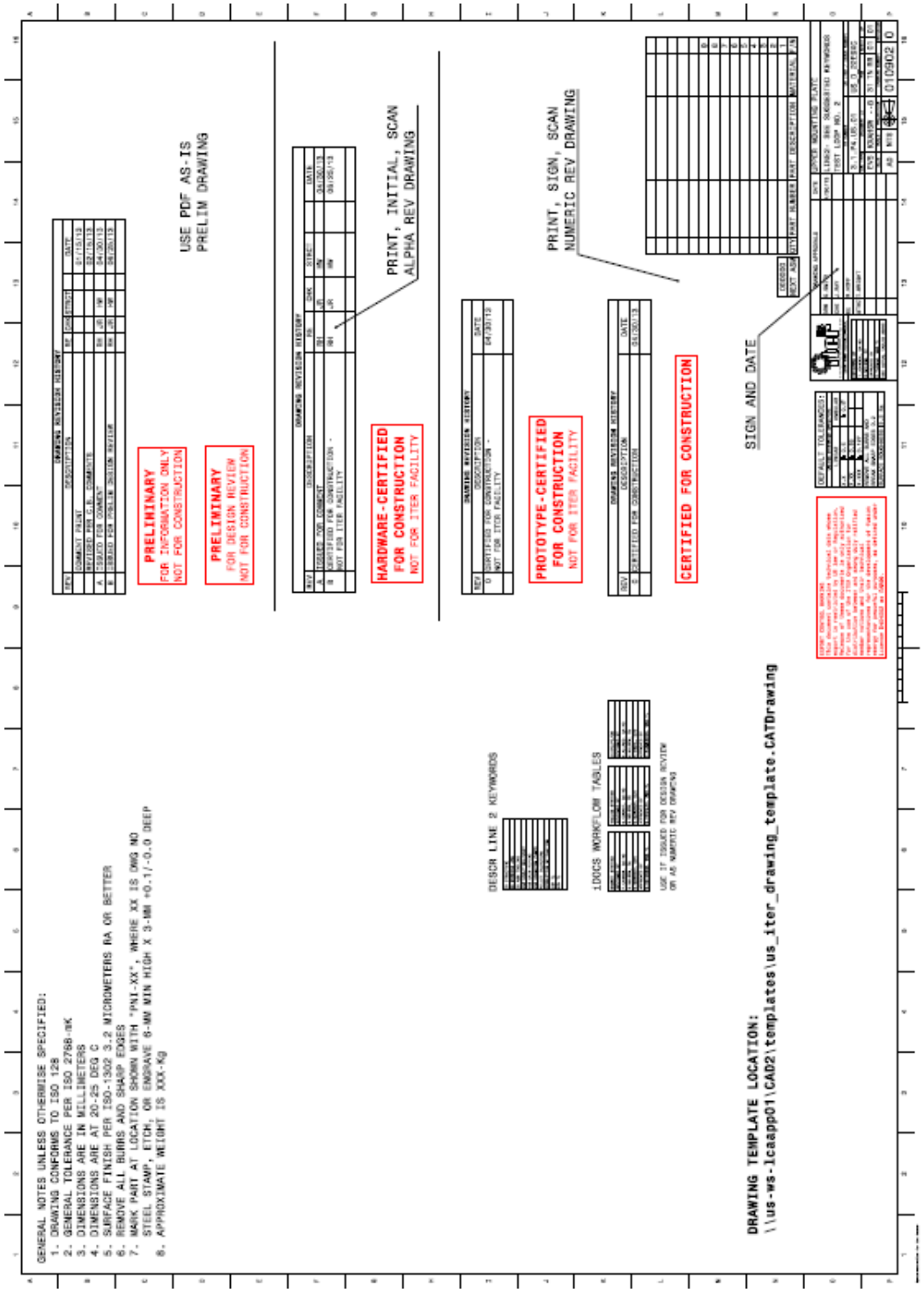
APPENDIX A- DRAWING FORMATS

US ITER DRAWING FORMAT



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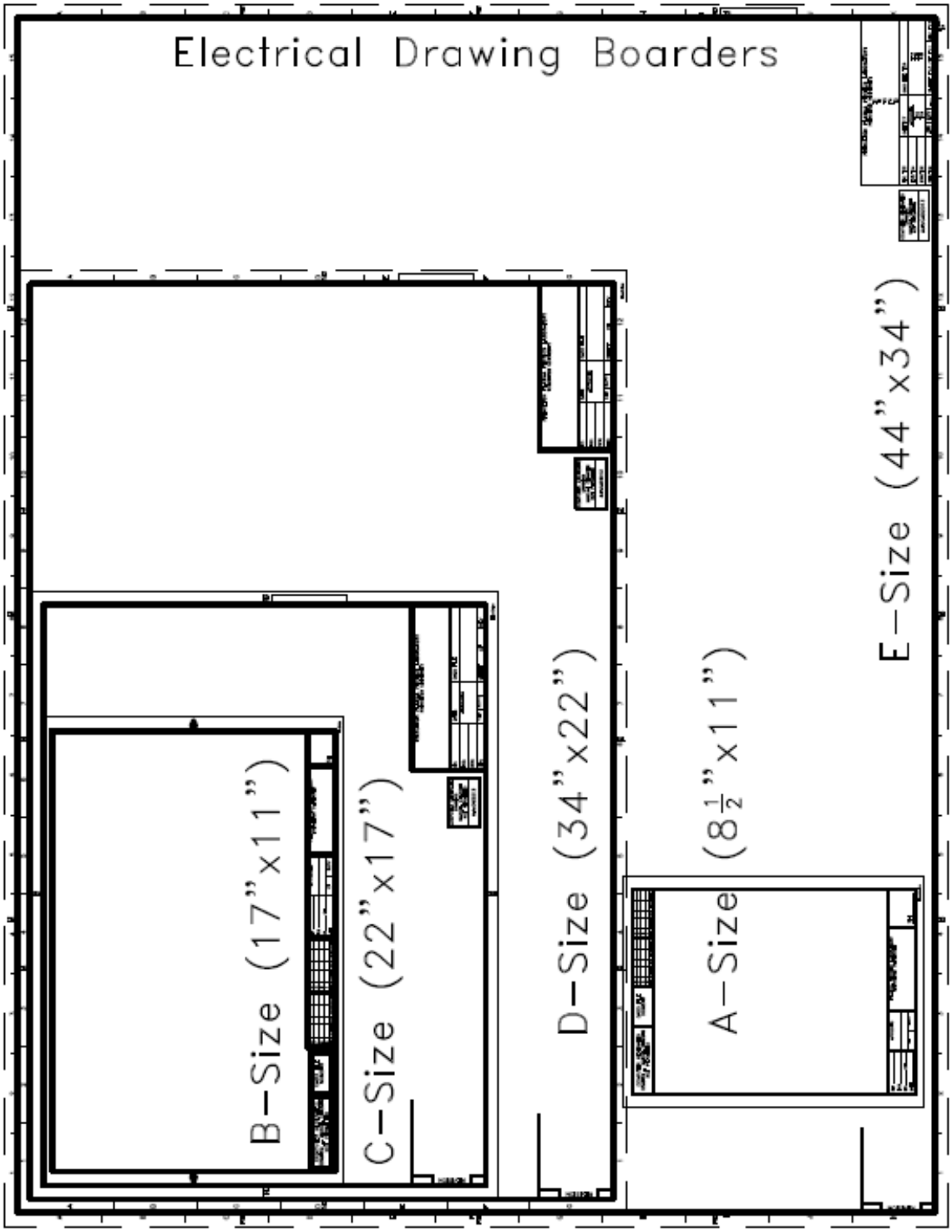
APPENDIX A- DRAWING FORMATS

ELECTRICAL DRAWING FORMATS



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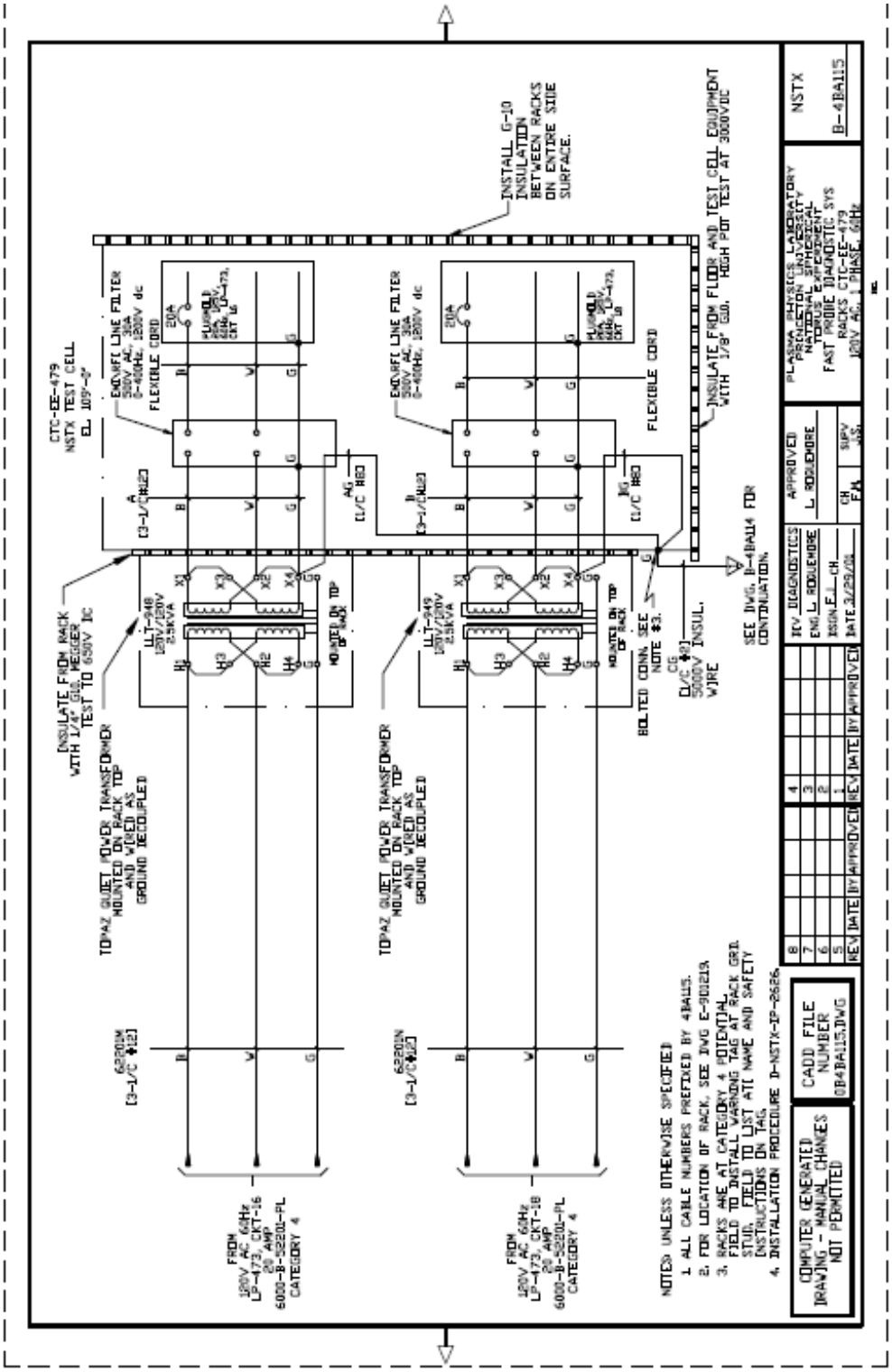
APPENDIX B- ELECTRICAL DRAWING EXAMPLES

CONTROL WIRING DIAGRAM



Control Wiring Diagram (CWD) Example

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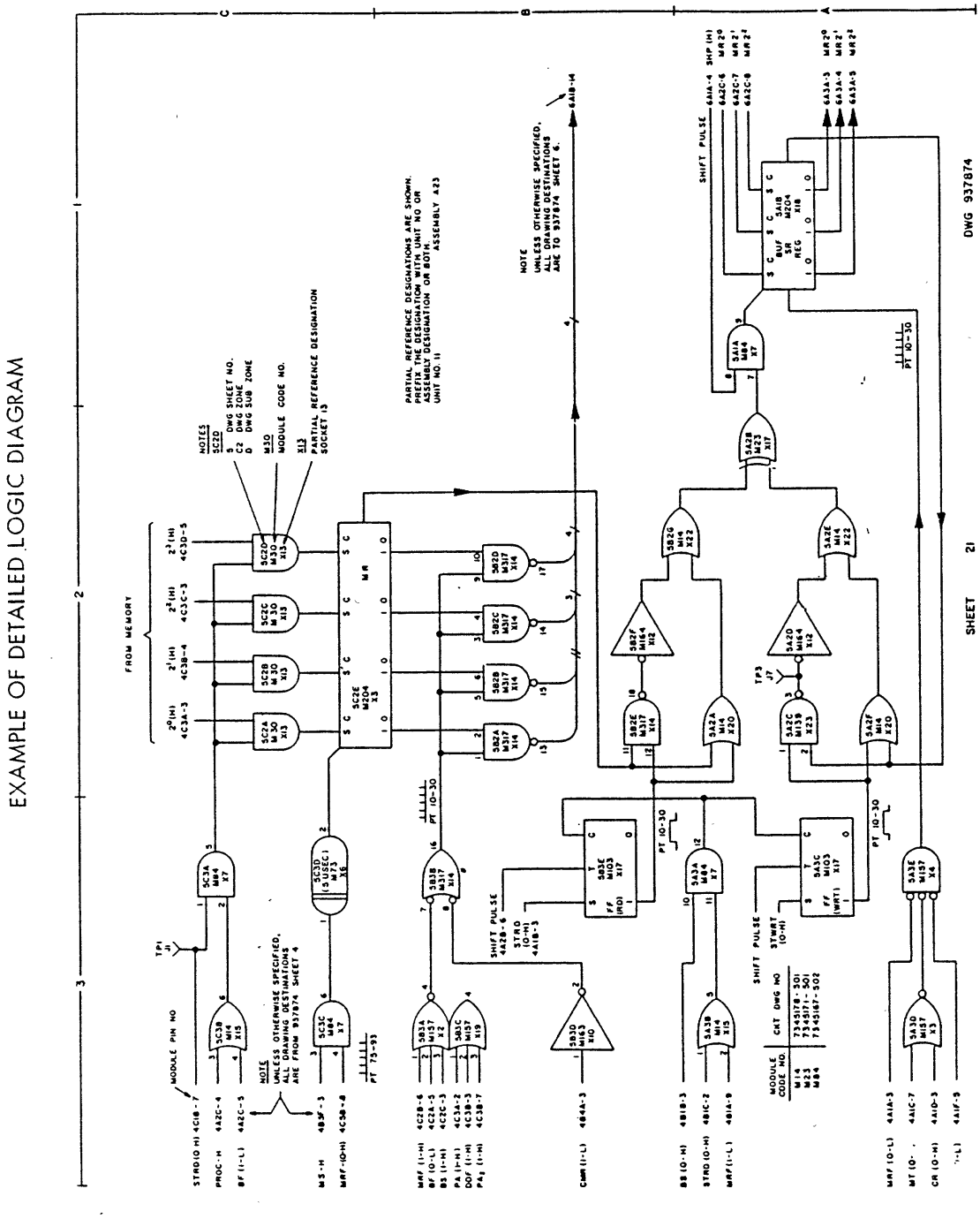
APPENDIX B- ELECTRICAL DRAWING EXAMPLES

ELECTRICAL- LOGIC DRAWING



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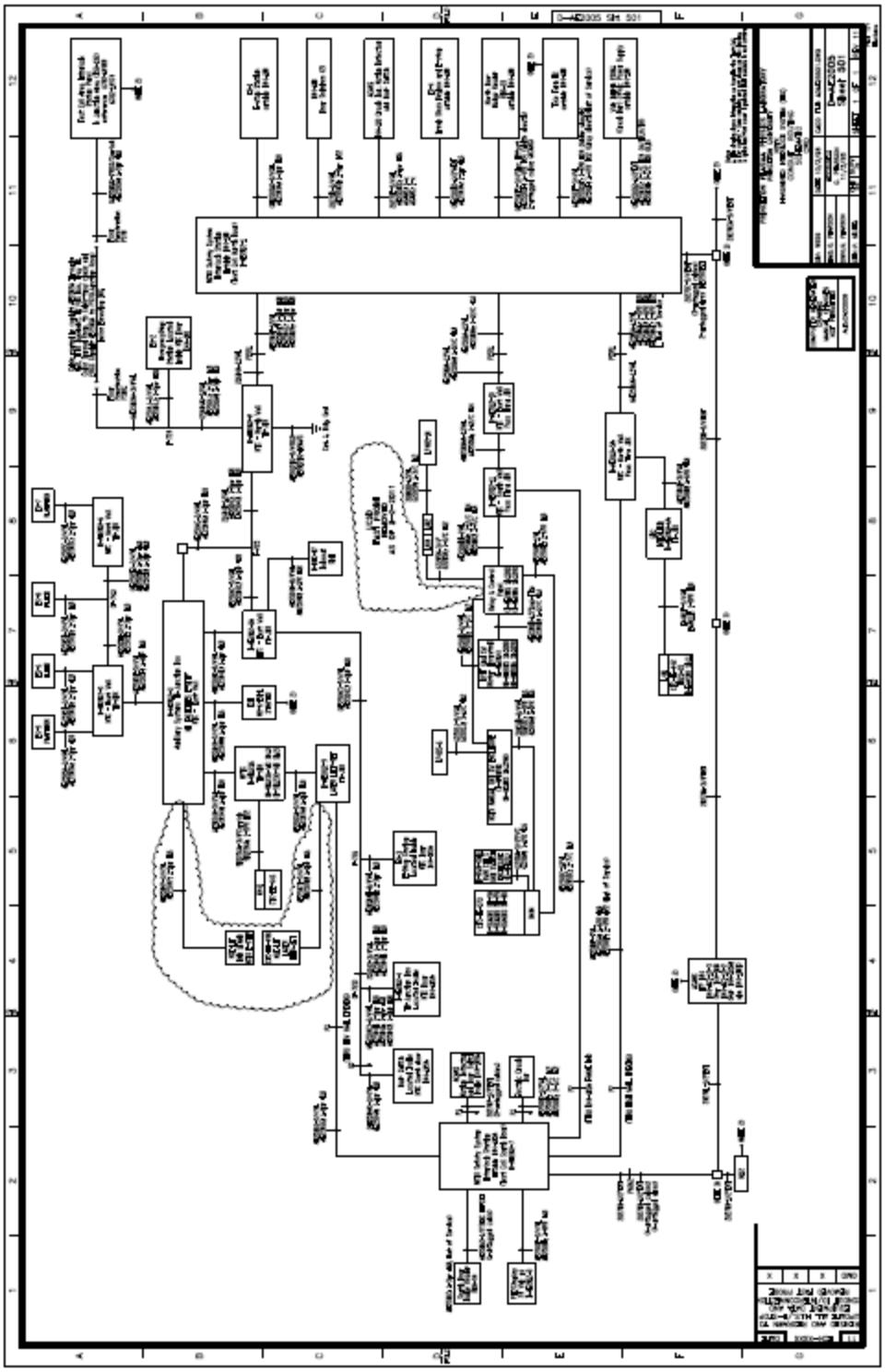
APPENDIX B- ELECTRICAL DRAWING EXAMPLES

ELECTRICAL- INTERCONNECTION DIAGRAM



Interconnection Diagram Example

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APPENDIX C

GEOMETRIC SYMBOLS USED IN DIMENSIONING AND TOLERANCING

ASME Y14.5-2009

Fig. C-6 Comparison of Symbols

SYMBOL FOR:	ASME Y14.5	ISO
STRAIGHTNESS	—	—
FLATNESS	⏥	⏥
CIRCULARITY	○	○
CYLINDRICITY	//	//
PROFILE OF A LINE	⌒	⌒
PROFILE OF A SURFACE	⌓	⌓
ALL AROUND	⌒⊖	⌒⊖
ALL OVER	⌓⊖	⌓⊖ (proposed)
ANGULARITY	∠	∠
PERPENDICULARITY	⊥	⊥
PARALLELISM	//	//
POSITION	⌖	⌖
CONCENTRICITY (Concentricity and Coaxiality in ISO)	◎	◎
SYMMETRY	⌯	⌯
CIRCULAR RUNOUT	*↗	*↗
TOTAL RUNOUT	*⌰	*⌰
AT MAXIMUM MATERIAL CONDITION	Ⓜ	Ⓜ
AT MAXIMUM MATERIAL BOUNDARY	Ⓜ	NONE
AT LEAST MATERIAL CONDITION	Ⓛ	Ⓛ
AT LEAST MATERIAL BOUNDARY	Ⓛ	NONE
PROJECTED TOLERANCE ZONE	Ⓟ	Ⓟ
TANGENT PLANE	Ⓣ	NONE
FREE STATE	Ⓕ	Ⓕ
UNEQUALLY DISPOSED PROFILE	Ⓤ	UZ (proposed)
TRANSLATION	▷	NONE
DIAMETER	⌀	⌀
BASIC DIMENSION (Theoretically Exact Dimension in ISO)	50	50
REFERENCE DIMENSION (Auxiliary Dimension in ISO)	(50)	(50)
DATUM FEATURE	* A	* or * A
* May be filled or not filled		

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APPENDIX C

GEOMETRIC SYMBOLS USED IN DIMENSIONING AND TOLERANCING

ASME Y14.5-2009

Fig. C-7 Comparison of Other Symbols

SYMBOL FOR:	ASME Y14.5	ISO
DIMENSION ORIGIN		
FEATURE CONTROL FRAME	⌖ Ø0.5Ⓜ A B C	⌖ Ø0.5Ⓜ A B C
CONICAL TAPER		
SLOPE		
COUNTERBORE	⌴	NONE
SPOTFACE	SF	NONE
COUNTERSINK	∨	NONE
DEPTH/DEEP	↧	NONE
SQUARE	□	□
DIMENSION NOT TO SCALE	15	15
NUMBER OF PLACES	8X	8X
ARC LENGTH	⌒105	⌒105
RADIUS	R	R
SPHERICAL RADIUS	SR	SR
SPHERICAL DIAMETER	SØ	SØ
CONTROLLED RADIUS	CR	NONE
BETWEEN	* ↔	↔ (proposed)
STATISTICAL TOLERANCE	ST	NONE
CONTINUOUS FEATURE	CF	NONE
DATUM TARGET	Ø6 A1 or A1 Ø6	Ø6 A1 or A1 Ø6
MOVABLE DATUM TARGET	A1	A1 (proposed)
TARGET POINT	×	×

* May be filled or not filled

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