

HARVARD UNIVERSITY



UNIVERSITY PLANNING OFFICE

CAD and Image Standards for Construction Documentation

Holyoke Center Suite 573 · 1350 Massachusetts Avenue · Cambridge, MA 02138
t 617.496.4434 · *e*: upo_library@harvard.edu
www.upo.harvard.edu

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i. INTRODUCTION

This document outlines how to produce and deliver CAD drawings and raster images of as-built construction drawings. For purposes of this document image files refer to the TIF format. The University Planning Office revised this standard in January 2009. Prior versions were published in 2006, 2002, 1999, 1996 and 1994. The revisions in this edition focus on file naming conventions and image policies.

The purpose of this document is to serve as a tight specification for producing and delivering CAD drawings and image files that document as-built conditions for construction projects. The guidelines are intended to ensure consistency of materials and to maximize both short and long term usability of construction documentation.

Before a capital project can be closed out and final payment from Harvard University rendered, all specified materials must be submitted to the appropriate Harvard project manager or representative in accordance with production standards and special instructions described throughout this document. See also the publication [Capital Projects Closeout Construction Documentation Requirements](#) - Guidelines for Architects, Contractors, and Project Managers (available at <http://upo.harvard.edu>) for the list of closeout requirements.

A signed copy of the [Electronic File Quality Assurance Checklist](#) (Template 3) in the Closeout Requirements must also be submitted with CAD drawings and image files being delivered during the closeout phase of construction projects. In signing and submitting an Electronic Quality Assurance Checklist, the vendor (architect, engineer, contractor, etc.) is assuring that all materials adhere to the standards and guidelines set forth in this document.

This standard complies with the layering standard found in the AIA CAD Layer Guidelines found in the *United States National CAD Standard – Version 4*. The file naming convention is based on the sheet identification format and also complies with the U.S. National CAD Standard. The layering standard outlined herein was derived from the 1997 American Institute of Architects' *CAD Layer Guidelines*. For additional detail beyond what is outlined herein, please refer to the U.S. National CAD Standard for guidance. A copy of the current National CAD Standard may be obtained from <http://www.buildingsmartalliance.org/ncs/>.

Standards for CAD drawings documenting space, for import in a space management system, are in a separate document – [Harvard University Space Documentation CAD Standard](#).

Please direct any questions or comments about this document to the address below.

Harvard University Planning Office

573 Holyoke Center

1350 Massachusetts Avenue

Cambridge, MA 02138.

tel: 617-496-4434

email: upo_library@harvard.edu and james_nelson@harvard.edu

1. CAD DRAWING PRODUCTION

1.1 FILE FORMAT and SETUP

1.1.1 Electronic File Format

As-built construction project drawings must be submitted to Harvard University in full compliance with the most recent or prior version of AutoCAD® software at the time of submission (file extension = .DWG).

1.1.2 Scale, Unit, and Tolerances

All CAD drawing models should be drafted at full scale in architectural units, such that one drawing unit equals one inch. Tolerances for construction drawings are implicit within professional service contracts.

1.1.3 Fonts & Text Styles

Text styles and fonts may vary, but the use of font ROMANS.shx for most applications is desirable. Special fonts which are not packaged with AutoCAD® are **not** allowed. Dimensions, labels and notes, should be not less than 1/8" height on printed drawings

1.1.4 Blocks

Harvard is currently not imposing the use of any particular block definitions or block libraries. However, Harvard requires that the following general rules be employed when handling block entities:

1. All entities within a block must be created on layer 0.
2. Drawing entities translated into blocks from non-AutoCAD® systems must revert to layer 0 when exploded.
3. File translation from other systems which result in wall blocks within the .DWG file are unacceptable.

1.1.5 Title Blocks

Each CAD file submitted to Harvard should have only one title block. If using paper space, the title block should be placed with its lower left hand corner point inserted at a coordinate location of (0,0,0). Depending on the purpose of the drawing, facility documentation or construction, the drawing's title block should contain certain essential information that Harvard needs to store and retrieve each drawing in its library.

Title Blocks for Construction Drawings

Consulting architects and engineers must use the Harvard University title block template or a modified version provided by your Harvard client.

List of Faculties/Departments title blocks available at upo.harvard.edu/campusprojects/standards.html:

- Harvard University - generic title block
- Allston Development Group

At minimum, these title blocks should contain all of the information listed below.

Project Information:

- Firm Name - representing the drawing author
- Project Name - as specified by Harvard
- Building Number - as specified by Harvard

- Building Name - specify only if the project name does not include this information already, and the project is building specific
- Project Number - assigned by the Vendor

Sheet Information:

- Drawing Title - indicating the drawing content, e.g. floor plan, section, detail, etc.
- Sheet Identification – Must follow the Sheet Naming Convention in Section 3
- Date of Drawing - Date of final revision of the record drawing
- Drawing Scale - representing the intended plot scale of the drawing with title block
- North Arrow

1.1.6 Policy on External Reference Files (XREFs)

Harvard will **not** accept the submission of any CAD drawing deliverable which contains unbound references to external source drawing files. All externally referenced data sources that were used during the CAD drawing production phase should be inserted and retained as a block within a single drawing file, including the title block, upon project completion and prior to drawing delivery to Harvard. The resulting self-contained drawing file is an acceptable deliverable to Harvard.

1.1.7 Policy on Image Files (JPGs, BMPs, PNGs)

Harvard will **not** accept the submission of referenced images either. All images included in a drawing must be cut and pasted into the drawing so that they are embedded within the CAD file. Referenced images will be discarded and therefore might cause incomplete drawings. Please be aware of this when creating your CAD files. If it is not possible to embed the images please contact Property Information Resource Center (PIRC) staff to determine an alternative.

1.1.8 Policy on Model Space and Paper Layout Space

Harvard requires that each CAD file submitted as a project deliverable contains *only one drawing model with one title block*, using either of the following setup methods. Note that some Harvard clients may express a preference for one method to be used instead of another. In this case, please see your Harvard client representative for specific preferences.

Method #1 -- *Model Space Only*. Both the drawing model and the drawing's title block are contained in the same model space environment within a single CAD file. The paper space environment is not used.

Method #2 -- *Model Space and Paper Space Combined*. Each CAD file is set up to contain only one title block in paper space which references the building model contained in model space.

1.1.9 Use Disclaimer

All construction documents **must** include the following disclaimer (already placed on the Harvard border template): "Warning: This document may contain sensitive and/or proprietary information and therefore must be treated as a confidential document. Acceptance of this document constitutes an agreement that this document and the information contained herein shall be maintained and transmitted in a confidential manner. No part of this document shall be reproduced, released or distributed without the express written permission of Harvard University and any distribution to non-Harvard entities or persons must be subject to a written confidentiality agreement."

1.2 LAYERING

Harvard has adopted most of the layer name and use rules recommended by the *CAD Layer Guidelines* published in 1997 by the American Institute of Architects (AIA). Where noted, Harvard has supplemented the AIA guidelines with its own rules and standards, as necessary. The layering standard complies with the AIA CAD Layer Guidelines as found in the *United States National CAD Standard - Version 4*. For additional detail, beyond what is outlined herein, please refer to the National CAD Standard for guidance. A copy of the National CAD Standard may be obtained from <http://www.buildingsmartalliance.org/ncs/>.

1.2.1 Layer Name Formatting

Layer names may be as short as six characters (discipline code + major group) or as long as fourteen characters (discipline code + major group + minor group + status). Here are the four examples of acceptable formula variations, with explanations of formula variables found below:

Layer Name Formatting								
# 1	A-WALL	=	Discipline Code	+	Major Group			
# 2	A-WALL-FULL	=	Discipline Code	+	Major Group	+	Minor Group	
# 3	A-WALL-DEMO	=	Discipline Code	+	Major Group	+	Status Code	
# 4	A-WALL-FULL-E	=	Discipline Code	+	Major Group	+	Minor Group	+ Status Code

Discipline Code:

The discipline code is one or two character field with a designator from the table below and if necessary an optional second character (a user defined modifier) followed by a hyphen. The Discipline designators are the same for both layer names and file names.

Discipline Designator			
A	Architectural	O	Operations
B	Geotechnical	P	Plumbing
C	Civil	Q	Equipment
D	Process	R	Resource
E	Electrical	S	Structural
F	Fire Protection	T	Telecommunications
G	General	U	University (HU defined)
H	Hazardous Materials	V	Survey/Mapping
I	Interiors	X	Other Disciplines
L	Landscape	Z	Contractor / Shop Drawings
M	Mechanical		

Major Group:

The major group designation is a four-character field that identifies the building system, such as doors, walls, windows, etc. Although most major groups are logically associated with specific discipline codes, it is possible to combine major group codes with any of the discipline codes. For example, A-WALL or I-WALL.

Minor Group:

This is an optional, four-character field for further differentiation of major groups. For example, partial height walls (A-WALL-PART) might be differentiated from full height walls (A-WALL-FULL). The following common modifiers defined by the AIA can also be used in the minor group field:

IDEN	identification tags	example: A-DOOR-IDEN
PATT	cross hatching, poche	example: A-WALL-PATT

If necessary, the minor group field may also be defined by the user, allowing additional layers to be added to accommodate special project requirements. However, this should only be done after checking the National CAD Standard to see if any of the predefined layer names in that list would meet the special project requirements.

Status Field:

The status field is an optional one-character designator that indicates work status or construction phase. Since drawings submitted at close-out are as-built, this field should be used to differentiate new construction from existing or phases of work that must be differentiated. The status field is always the last character of the layer name. See also the Status Field / Dominant Phase Rule below. Examples of values defined for this field, by the AIA, are as follows:

Status Field Codes			
E	Existing to Remain	X	Not in Contract
N	New Work	0-9	Phase Numbers

1.2.2 General Rules about Names and Uses

Layer uses are generally implied by the layer name. However, the following explanation of certain layer use rules should be noted.

Status Field / Dominant Phase Rule:

This rule pertains to the use of the status field in naming layers for construction projects. Layers representing the dominant phase of a project can be represented without a status field. For example, in a small remodeling project, N would indicate new construction, while layers without status fields would indicate parts of the existing building to remain. Conversely, a remodeling project consisting of mostly new construction might use E to indicate “existing to remain” building systems while all layers without a status field designator would represent new construction.

Annotation and Title Blocks:

These rules also come from the 1997 AIA *CAD Layer Guidelines*, which define annotation as comprising text, dimensions, title block and sheet borders, detail references and other elements on CAD drawings that do not represent physical aspects of a building. Annotation is designated by the major group ANNO, which can be combined with any discipline code. Types of annotation are designated below (asterisk represents any discipline code):

- *-ANNO-DIMS dimensions
- *-ANNO-KEYN keynotes
- *-ANNO-LEGN legends and schedules
- *-ANNO-NOTE notes
- *-ANNO-NPLT construction lines, nonplotting information, viewports
- *-ANNO-REDL redlines
- *-ANNO-REVS revisions
- *-ANNO-SYMB symbols
- *-ANNO-TEXT text
- *-ANNO-TTLB title blocks and sheet borders

Annotation can be placed in both model space and paper space (see *Policy on Model Space and Paper Space* on p. 5 of this document). Dimensions, symbols and keynotes would typically be placed in model space. Legends, schedules, title blocks, and sheet borders would typically be placed in paper space. The same layer names would be used in both cases.

Elevations, Sections, and Three-Dimensional Drawings:

Per the 1997 AIA *CAD Layer Guidelines*, special groups of layers within each discipline are defined for elevations, section, details, and three-dimensional views. Defined layer groups are as follows (asterisk represents any discipline code):

*-ELEV	elevations
*-ELEV-IDEN	component identification numbers
*-ELEV-OTLN	building outlines
*-ELEV-PATT	textures and hatch patterns
*-SECT	sections
*-SECT-MBND	materials beyond section cut
*-SECT-MCUT	materials cut by section
*-SECT-PATT	textures and hatch patterns
*-SECT-IDEN	component identification numbers
*-DETL	details
*-DETL-IDEN	component identification numbers
*-DETL-MBND	material beyond section cut
*-DETL-MCUT	material cut by section
*-DETL-PATT	textures and hatch patterns

AIA guidelines further recommend that the minor group ELEV can be added to any major group layer (A-WALL-ELEV, A-DOOR-ELEV, etc.) to identify information only seen in 3D views. This facilitates integrating three-dimensional CAD models with two-dimensional plans, as shown by this example:

A-WALL	walls in plan view
A-WALL-ELEV	wall surfaces in 3D view

Harvard Defined Layers and Discipline Category:

Harvard has defined a short list of layers designated for space management uses which should be employed in conjunction with space documentation projects. These layers need not be used for construction projects. All Harvard defined layers can be found appended to the partial AIA layer list included with this document under the discipline code U (for University).

1.2.3 Standard Layer Listing

If additional names are needed for construction drafting purposes, please refer to the AIA CAD Layer Guidelines found in the *United States National CAD Standard*. If that layer list is not sufficient, new layer names may be added using the formatting rules described in this section.

LAYER		ATTRIBUTE	
Name	Description	Color	Linetype
Architectural			
A-ANNO-TEXT	General Text	4-cyan	continuous
A-ANNO-REDL	Redlines	1-red	continuous
A-ANNO-SYMB	Symbols	4-cyan	continuous
A-ANNO-LEGN	Legends and schedules	4-cyan	continuous
A-ANNO-DIMS	Dimensions	4-cyan	continuous
A-ANNO-TTLB	Border and Title Block	7-white	continuous
A-ANNO-NOTE	Job Notes	4-cyan	continuous
A-ANNO-NPLT	Construction lines, nonplotting information, viewports		continuous
A-ANNO-KEYN	Key notes	4-cyan	continuous
A-AREA	Area calculation boundary lines		continuous
A-AREA-IDEN	Room numbers, tenant identifications, area calcs		continuous

A-AREA-OCCP	Occupant or employee names		continuous
A-AREA-PATT	Area cross hatching		continuous
A-CLNG	Ceiling information		continuous
A-CLNG-GRID	Ceiling grid		continuous
A-CLNG-PATT	Ceiling patterns		continuous
A-CLNG-SUSP	Suspended elements		continuous
A-DOOR	Doors	2-yellow	continuous
A-DOOR-IDEN	Door number, hardware group, etc.		continuous
A-EQPM	Equipment - built in	1-red	continuous
A-EQPM-CLNG	Ceiling-mounted or suspended equipment		continuous
A-EQPM-FIXD	Fixed equipment		continuous
A-EQPM-IDEN	Equipment identification numbers	4-cyan	continuous
A-EQPM-MOVE	Moveable equipment		continuous
A-FLOR	Floor information		continuous
A-FLOR-CASE	Casework (manufactured cabinets)		continuous
A-FLOR-EVTR	Elevator cars and equipment	2-yellow	continuous
A-FLOR-HRAL	Stair and balcony handrails, guard rails		continuous
A-FLOR-IDEN	Room numbers, names, targets, etc.	4-cyan	continuous
A-FLOR-LEVL	Level changes, ramps, pits, depressions		continuous
A-FLOR-PATT	Paving, tile, carpet patterns		continuous
A-FLOR-SIGN	Signage		continuous
A-FLOR-SPCL	Architectural specialties (accessories, etc.)		continuous
A-FLOR-STRS	Stair treads, escalators, ladders	2-yellow	continuous
A-FLOR-TPTN	Toilet partitions		continuous
A-FLOR-WDWK	Architectural woodwork (field-built cabs/counters)		continuous
A-GLAZ	Windows, curtain walls, glazed partitions	2-yellow	continuous
A-GLAZ-FULL	Full-height glazed walls and partitions		continuous
A-GLAZ-IDEN	Window number	4-cyan	continuous
A-GLAZ-PHRT	Windows and partial-height glazed partitions		continuous
A-GLAZ-SILL	Window sills		continuous
A-ROOF	Roof	1-red	continuous
A-ROOF-LEVL	Level changes		continuous
A-ROOF-OTLN	Roof outline		continuous
A-ROOF-PATT	Roof surface patterns, hatching		continuous
A-WALL	Walls – general		continuous
A-WALL-INTR	Interior Building Wall	9-lt grey	continuous
A-WALL-FIRE	Fire wall patterning		continuous
A-WALL-FULL	Full-height walls, stairs and shaft walls		continuous
A-WALL-EXTR	Exterior Building Wall	7-white	continuous
A-WALL-HEAD	Door / window headers (on reflected ceiling plans)		continuous
A-WALL-JAMB	Door / window jambs (on floor plans only)		continuous
A-WALL-MOVE	Moveable partitions		continuous
A-WALL-PATT	Wall insulation, hatching and fill		continuous
A-WALL-PRHT	Partial-height walls (on floor plans only)	2-yellow	continuous
Civil			
C-ANNO-DIMS	Dimensions	4-cyan	
C-ANNO-LEGN	Legends and schedules	7-white	continuous
C-ANNO-NOTE	Notes	4-cyan	continuous
C-ANNO-SYMB	Symbols	4-cyan	continuous
C-ANNO-TEXT	General Text	4-cyan	continuous
C-ANNO-TTLB	Border and Title Block	7-white	continuous
C-BLDG	Proposed building footprints		continuous
C-COMM	Site communication/telephone poles, boxes, towers		continuous
C-FIRE	Fire protection-hydrants, connections		continuous
C-NGAS	Natural gas-manholes, meters, storage tanks		continuous

C-NGAS-UNDR	Natural gas-underground lines		continuous
C-PKNG	Parking lots		continuous
C-PKNG-ISLD	Parking islands		continuous
C-PKNG-STRP	Parking lot striping, handicapped symbol		continuous
C-PROP	Property lines, survey benchmarks		continuous
C-PROP-BRNG	Bearings and distance labels		continuous
C-PROP-CONS	Construction controls		continuous
C-PROP-ESMT	Easements, rights-of-way, setback lines		continuous
C-ROAD	Roadways		continuous
C-ROAD-CNTR	Center lines		continuous
C-ROAD-CURB	Curbs		continuous
C-SSWR	Sanitary sewer-manholes, pumping stations		continuous
C-SSWR-UNDR	Sanitary sewer-underground lines		continuous
C-STRM	Storm drainage catch basins, manholes		continuous
C-STRM-UNDR	Storm drainage pipe-underground		continuous
C-TOPO	Proposed contour lines and elevations		continuous
C-TOPO-RTWL	Retaining wall		continuous
C-TOPO-SPOT	Spot elevations		continuous
C-WATR	Domestic water- manholes, pumping, storage		continuous
C-WATR-UNDR	Domestic water-underground lines		continuous
Electrical			
E-ANNO-TEXT	General Text	4-cyan	continuous
E-ANNO-SYMB	Symbols	4-cyan	continuous
E-ANNO-LEGN	Legends and schedules	4-cyan	continuous
E-ANNO-DIMS	Dimensions	4-cyan	continuous
E-ANNO-TTLB	Border and Title Block	7-white	continuous
E-ANNO-NOTE	Job Notes	4-cyan	continuous
E-ILIN	One-line diagrams		continuous
E-ALRM	Miscellaneous alarm system		continuous
E-AUXL	Auxiliary systems		continuous
E-CCTV	Closed-circuit TV		continuous
E-COMM	Telephone, communications outlets		continuous
E-CTRL	Electric control system		continuous
E-CTRL-DEVC	Control system devices		continuous
E-CTRL-WIRE	Control system wiring		continuous
E-INTC	Intercom system		continuous
E-LITE	Lighting	2-yellow	continuous
E-LITE-CIRC	Lighting circuits		continuous
E-LITE-CLNG	Ceiling-mounted lighting		continuous
E-LITE-EMER	Emergency lighting		continuous
E-LITE-EXIT	Exit lighting		continuous
E-LITE-FLOR	Floor-mounted lighting		continuous
E-LITE-IDEN	Luminaire identification and text	4-cyan	continuous
E-LITE-JBOX	Junction box		continuous
E-LITE-NUMB	Lighting circuit numbers		continuous
E-LITE-ROOF	Roof lighting		continuous
E-LITE-SPCL	Special lighting		continuous
E-LITE-SWCH	Lighting-switches		continuous
E-LITE-WALL	Wall-mounted lighting		continuous
E-POWR	Power	5-blue	continuous
E-POWR-BUSW	Busways		continuous
E-POWR-CABL	Cable trays		continuous
E-POWR-CIRC	Power circuits		continuous
E-POWR-CLNG	Power-ceiling receptacles and devices		continuous
E-POWR-EQPM	Power equipment		continuous

E-POWR-FEED	Feeders		continuous
E-POWR-IDEN	Power identification, text		continuous
E-POWR-JBOX	Junction box		continuous
E-POWR-NUMB	Power circuit numbers		continuous
E-POWR-OTLN	Power outline for backgrounds		continuous
E-POWR-PANL	Power panels		continuous
E-POWR-SWBD	Power switchboards		continuous
E-POWR-URAC	Underfloor raceways		continuous
E-POWR-WALL	Power wall outlets and receptacles		continuous
E-RISR	Riser diagram		continuous
E-SOUN	Sound/PA system		continuous
Fire Protection			
F-ANNO-TEXT	General Text	4-cyan	continuous
F-ANNO-SYMB	Symbols	4-cyan	continuous
F-ANNO-LEGN	Legends and schedules	4-cyan	continuous
F-ANNO-DIMS	Dimensions	4-cyan	continuous
F-ANNO-TTLB	Border and Title Block	7-white	continuous
F-ANNO-NOTE	Job Notes	4-cyan	continuous
F-CO2S	CO2 system		continuous
F-CO2S-EQPM	CO2 equipment		continuous
F-CO2S-PIPE	CO2 sprinkler piping		continuous
F-HALN	Halon		continuous
F-HALN-EQPM	Halon equipment		continuous
F-HALN-PIPE	Halon Piping		continuous
F-IGAS	Inert gas		continuous
F-IGAS-EQPM	Inert gas equipment		continuous
F-IGAS-PIPE	Inert gas piping		continuous
F-PROT	Fire protection systems		continuous
F-PROT-ALRM	Fire alarm		continuous
F-PROT-EQPM	Fire system equipment (hose cabinet/extinguishers)		continuous
F-PROT-SMOK	Smoke detectors/heat sensors		continuous
F-SPRN	Fire protection sprinkler system		continuous
F-SPRN-CLHD	Sprinkler head-ceiling		continuous
F-SPRN-OTHD	Sprinkler head-other		continuous
F-SPRN-PIPE	Sprinkler piping		continuous
F-SPRN-STAN	Sprinkler system standpipe		continuous
F-STAN	Fire protection standpipe system		continuous
Interior			
I-ANNO-TEXT	General Text	4-cyan	continuous
I-ANNO-SYMB	Symbols	4-cyan	continuous
I-ANNO-LEGN	Legends and schedules	4-cyan	continuous
I-ANNO-DIMS	Dimensions	4-cyan	continuous
I-ANNO-TTLB	Border and Title Block	7-white	continuous
I-ANNO-NOTE	Job Notes	4-cyan	continuous
I-EQPM	Equipment		continuous
I-EQPM-MOVE	Moveable equipment		continuous
I-FURN	Furniture	1-red	continuous
I-FURN-CASE	Cabinetry / casement	1-red	continuous
I-FURN-CHAR	Chairs and other seating		continuous
I-FURN-FILE	File cabinets		continuous
I-FURN-FREE	Furniture - freestanding (desks, credenzas, etc.)		continuous
I-FURN-IDEN	Furniture numbers	4-cyan	continuous
I-FURN-PLNT	Plants		continuous
I-FURN-PNLS	Furniture system panels		continuous

I-FURN-POWR	Furniture system-power designation		continuous
I-FURN-WKSF	Furniture system work surface components		continuous
Landscaping			
L-ANNO-TEXT	General Text	4-cyan	continuous
L-ANNO-SYMB	Symbols	4-cyan	continuous
L-ANNO-LEGN	Legends and schedules	4-cyan	continuous
L-ANNO-TTLB	Border and Title Block	7-white	continuous
L-ANNO-NOTE	Job Notes	4-cyan	continuous
L-PLNT	Plant and landscape materials		continuous
L-PLNT-BEDS	Rock, bark, and other landscaping beds		continuous
L-PLNT-GRND	Ground cover and vines		continuous
L-PLNT-PLAN	Planting plants		continuous
L-PLNT-TREE	Trees		continuous
L-PLNT-TURF	Lawn areas		continuous
L-SITE	Site improvements		continuous
L-SITE-BRDG	Bridges		continuous
L-SITE-DECK	Decks		continuous
L-SITE-FENC	Fencing		continuous
L-SITE-FURN	Site furnishings		continuous
L-SITE-PLAY	Play structures		continuous
L-SITE-POOL	Pools and spas		continuous
L-SITE-SPRT	Sports fields		continuous
L-SITE-STEP	Steps		continuous
L-SITE-WALL	Walls		continuous
L-WALK	Walks and steps		continuous
L-WALK-PATT	Walks and steps-cross-hatch patterns		continuous
Mechanical			
M-ANNO-TEXT	General Text	4-cyan	continuous
M-ANNO-SYMB	Symbols	4-cyan	continuous
M-ANNO-LEGN	Legends and schedules	4-cyan	continuous
M-ANNO-TTLB	Border and Title Block	7-white	continuous
M-ANNO-NOTE	Job Notes	4-cyan	continuous
M-CMPA	Compressed air systems		continuous
M-CMPA-CEQP	Compressed air equipment		continuous
M-CMPA-CPIP	Compressed air piping		continuous
M-CMPA-PEQP	Process air equipment		continuous
M-CMPA-PPIP	Process air piping		continuous
M-CONT	Controls and instrumentation		continuous
M-CONT-THER	Thermostats		continuous
M-CONT-WIRE	Low voltage wiring		continuous
M-CWTR	Chilled water systems		continuous
M-CWTR-EQPM	Chilled water equipment		continuous
M-CWTR-PIPE	Chilled water piping		continuous
M-EXHS	Exhaust system		continuous
M-EXHS-DUCT	Exhaust system ductwork		continuous
M-EXHS-EQPM	Exhaust system equipment		continuous
M-EXHS-RFEQ	Rooftop exhaust equipment		continuous
M-FUME-EQPM	Fume hoods		continuous
M-FUME-EXHS	Fume hood exhaust system		continuous
M-HOTW	Hot water heating system		continuous
M-HOTW-EQPM	Hot water equipment		continuous
M-HOTW-PIPE	Hot water piping		continuous
M-HVAC	HVAC system	5-blue	continuous
M-HVAC-CDFF	HVAC ceiling diffusers		continuous

M-HVAC-DUCT	HVAC ductwork		continuous
M-HVAC-EQPM	HVAC equipment		continuous
M-HVAC-ODFF	HVAC other diffusers		continuous
M-HVAC-RDFF	Return air diffusers		continuous
M-HVAC-SDFF	Supply diffusers		continuous
M-MDGS	Medical gas systems		continuous
M-MDGS-EQPM	Medical gas equipment		continuous
M-MDGS-PIPE	Medical gas piping		continuous
M-SPCL	Special systems		continuous
M-SPCL-EQPM	Special equipment		continuous
M-SPCL-PIPE	Special piping		continuous
M-STEM	Steam systems		continuous
M-STEM-CONP	Steam systems condensate piping		continuous
M-STEM-EQPM	Steam systems equipment		continuous
M-STEM-HPIP	High pressure steam piping		continuous
M-STEM-LPIP	Low pressure steam piping		continuous
M-STEM-MPIP	Medium pressure steam piping		continuous
Plumbing			
P-ANNO-TEXT	General Text	4-cyan	continuous
P-ANNO-SYMB	Symbols	4-cyan	continuous
P-ANNO-LEGN	Legends and schedules	4-cyan	continuous
P-ANNO-TTLB	Border and Title Block	7-white	continuous
P-ANNO-NOTE	Job Notes	4-cyan	continuous
P-ACID	Acid, alkaline, oil waste systems		continuous
P-ACID-PIPE	Acid, alkaline, oil waste piping		continuous
P-DOMW	Domestic hot and cold water systems		continuous
P-DOMW-CPIP	Domestic cold water piping		continuous
P-DOMW-EQPM	Domestic hot and cold water equipment		continuous
P-DOMW-HPIP	Domestic hot water piping		continuous
P-DOMW-RISR	Domestic hot and cold water risers		continuous
P-EQPM	Plumbing - miscellaneous equipment		continuous
P-FIXT	Plumbing fixtures, toilets, sinks	3-green	continuous
P-SANR	Sanitary drainage		continuous
P-SANR-EQPM	Sanitary equipment		continuous
P-SANR-FIXT	Plumbing fixtures		continuous
P-SANR-FLDR	Floor drains		continuous
P-SANR-PIPE	Sanitary piping		continuous
P-SANR-RISR	Sanitary risers		continuous
P-STRM	Storm drainage system		continuous
P-STRM-PIPE	Storm drain piping		continuous
P-STRM-RFDR	Roof drains		continuous
P-STRM-RISR	Storm drain risers		continuous
Structural			
S-ANNO-TEXT	General Text	4-cyan	continuous
S-ANNO-SYMB	Symbols	4-cyan	continuous
S-ANNO-LEGN	Legends and schedules	4-cyan	continuous
S-ANNO-DIMS	Dimensions	4-cyan	continuous
S-ANNO-TTLB	Border and Title Block	7-white	continuous
S-ANNO-NOTE	Job Notes		continuous
S-BEAM	Beams		continuous
S-COLS	Columns	6-magenta	continuous
S-FNDN	Foundation		continuous
S-FNDN-PILE	Piles, drilled piers		continuous
S-FNDN-RBAR	Foundation reinforcing		continuous

S-GRID	Column grid	6-magenta	continuous
S-GRID-DIMS	Column grid dimensions		continuous
S-GRID-EXTR	Column grid outside building		continuous
S-GRID-IDEN	Column grid tags	4-cyan	continuous
S-GRID-INTR	Column grid inside building		continuous
S-WALL	Structural bearing or shear walls		continuous
Telecomm			
T-ANNO-TEXT	General Text	4-cyan	continuous
T-ANNO-SYMB	Symbols	4-cyan	continuous
T-ANNO-LEGN	Legends and schedules	4-cyan	continuous
T-ANNO-TTLB	Border and Title Block	7-white	continuous
T-ANNO-NOTE	Job Notes	4-cyan	continuous
T-CABL	Cable plan		continuous
T-DIAG	Diagram		continuous
T-EQPM	Equipment plan		continuous
T-JACK	Data/telephone jacks		continuous
University			
U-ANNO-TEXT	General Text	4-cyan	continuous
U-ANNO-REDL	Redlines	1-red	continuous
U-ANNO-SYMB	Symbols	4-cyan	continuous
U-ANNO-LEGN	Legends and schedules	4-cyan	continuous
U-ANNO-DIMS	Dimensions	4-cyan	continuous
U-ANNO-TTLB	Border and University Title Block	7-white	continuous
U-ANNO-NOTE	Job Notes	4-cyan	continuous
U-ANNO-NPLT	Construction lines, nonplotting information, viewports	7-white	continuous
U-ANNO-KEYN	Key notes	4-cyan	continuous
U-SPAC-ROOM	Net room area boundaries (polylines)	4-cyan	continuous
U-SPAC-RMNO	Signed or unsigned room number	4-cyan	continuous
U-SPAC-RMID	Space management control number for room polylines	5-blue	continuous
U-SPAC-GROS	Gross floor area boundaries (polylines)	6-magenta	continuous
U-SPAC-FLID	Space management control number for floor polylines	5-blue	continuous
U-SPAC-PATT	Area Hatching		continuous

1.2.4 Attributes (Colors, Linetypes, Pens)

Many of the layers found in the partial AIA layer list in the *Standard Layer Listing* on p. 8 of this document have been assigned specific attribute values by Harvard according to the following categories: color, pen weight, and linetype. Attributes that have not been pre-defined by Harvard may be assigned at the discretion of the user.

Colors

Harvard recommends the use of specific colors for the layers and annotation layers most often used to assist space documentation. The color assignment of these layers can be found in the *Standard Layer Listing*. All other layers may have their colors assigned at the discretion of the client.

As a general rule for all projects, drawing entities should assume the color property of the layer on which they reside. This means that the color of individual entities should be assigned 'by layer' as opposed to 'by entity.' Entities which have been translated from other systems may fail to meet this requirement.

Linetypes

The default linetype of each layer is typically CONTINUOUS unless otherwise specified.

Pen Weight

The following chart shows pen weight assignments which should maximize the printed clarity of drawings conforming to the color assignments of Harvard's core layers. Other pen weights may be assigned at the discretion of the client.

Pen #	Color	Weight	Space documentation drawing elements (including, but not limited to):
1	red	0.01	furniture, casement, fixed/moveable equipment
2	yellow	0.01	stairs details, doors, windows & glazing, elevator cars, toilet partitions, partial height walls
3	green	0.012	toilets
4	cyan	0.012	text, dimensions, legends, etc, Harvard room polylines
5	blue	0.004	Harvard space tracking room numbers
6	magenta	0.016	structural columns, Harvard gross floor polylines
7	white	0.026	walls, exterior
8	dk grey	0.012	
9	lt grey	0.016	walls, interior (except partial height walls)
30	orange	0.025	
50	tan	0.035	

1.3 POLICY on CAD FILE TRANSLATION

1.3.1 Error-free AutoCAD® Drawing Deliverables

Harvard University recognizes that many of its construction firms do not use the same version of AutoCAD®. However, the University expects that service providers who work with other file formats will submit DWG formatted CAD files upon project closeout that are fully compliant with all of the standards outlined herein, and which have no significant loss of drawing entities or project data that can result from standard CAD file translation procedures.

All DWG files and CAD drawing entities submitted at the end of a project must be able to be manipulated using standard AutoCAD® drafting procedures. Non-compliance with this policy may result in the rejection of CAD files submitted at project closeout in addition to delayed rendering of final project payment. DXF files will not be accepted at project closeout as a substitution for DWG CAD file deliverables.

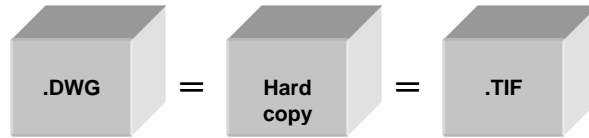
1.3.2 Translation Testing Recommended

For firms translating their native CAD file format into DWG format concerned about delivering error-free CAD files to Harvard upon project closeout, it is strongly recommended that thorough file translation testing be conducted **before** the drawing development phase of the project. This will assure early detection of file conversion issues, if any, and allow for corrective measures to be taken before the project closeout period.

2. IMAGE FILE PRODUCTION

2.1 OVERVIEW

The intent of this standard is to receive an image file of sufficient detail to recreate 100% of the information contained in the hard copy original, without creating an excessively large digital file. Every sheet in the record set of construction drawings needs to have a corresponding (1:1) image file. The image may be produced directly from the CAD application or scanned from the hard copy. Regardless of production method, **the image file must match the content of the CAD file and hard copy for each sheet submitted.** All images must follow these image production requirements and be listed in the electronic file index (Section 3).



2.2 IMAGE PRODUCTION

2.2.1 Content

The image is a duplicate of the hard copy so it must contain all content outlined in the CAD Drawing Production requirements stated in Section 1 with regard to Scale, Tolerances, Fonts, Text styles, Title Blocks and the Use Disclaimer.

2.2.2 Electronic File Format

Construction project drawing images must be submitted to Harvard University in TIF format. The files may be uncompressed or compressed using LZW lossless data compression. Formats other than TIF will not be accepted.

2.2.3 Resolution

All TIF images should be created at a resolution of 300ppi. A 24"x36" original will result in an image 7,200 pixels by 10,800 pixels. Higher resolution may be used if 300ppi will not accurately reproduce all content on a sheet. Do not adjust paper settings to achieve 300ppi.

2.2.4 Bit Depth

No image should be created with a bit depth greater than 8-bit, unless prior arrangements have been made with the Property Information Resource Center.

Bit Depth		
Black and White	1-bit	May not be used for images created by scanning hard copy, only to be used in circumstances where there will be no loss of information.
Grayscale	8-bit	Sheets in which no color is used.
Color	8-bit	Sheets in which color is used to differentiate content.

2.3 TIF CREATION AND CONVERSION

2.3.1 AutoCAD® TIF Creation

Autodesk confirms that, as of August 2009, current **AutoCAD software is unable to directly convert .DWG files to .TIF files meeting [Harvard's requirements](#)**. Acceptable options are outlined below.

Note: Due to the many variables in AutoCAD software version and file specifics, it is not possible to provide detailed instructions in this document. Contact either Autodesk and/or the [Property Information Resource Center](#) for more information.

1. **Internal AutoCAD solution:** Create either a DWF or PDF file from the Plot module in AutoCAD 2010. Once in the DWF or PDF, use a viewer to generate a TIFF image meeting Harvard requirements.
2. **External AutoCAD solution:** Use a third-party software to transfer .DWG to .TIF files. Some options suggested by Autodesk:

PDF-Xchange

<http://pdf-xchange.software.informer.com/3.0/>

PDF-XChange Viewer 2.0422

http://download.cnet.com/PDF-XChange-Viewer/3000-10743_4-10598377.html

Bluebeam PDF Revu CAD Edition

<http://www.bluebeam.com/web07/us/products/revu/cad/features.asp>

Universal Document Converter

http://www.print-driver.com/howto/convert_autocad_to_tiff.html

TIFF Image Printer 8.0

<http://www.peernet.com/tiff/autocad-to-tiff.html>

3. **Non-AutoCAD solution:** Generate TIF files by scanning the hard copy drawing. Setting bit-depth to 8 and selecting black and white options will help keep file sizes down, but TIF files will be very large. JPG and PDF files will not be accepted **in place of** TIF files.

2.3.2. Conversion to TIF from Other File Formats

For firms converting to TIF from other image file formats, the format being converted from must be a lossless format like PNG or GIF. Firms should not convert from a file format that uses lossy compression, for example .JPEG, due to degradation of the image. Nor should the image be resampled in order to increase resolution to 300ppi.

3. SHEET IDENTIFICATION AND DELIVERY

3.1 SHEET AND FILE NAMING CONVENTION

Harvard requires that for each Sheet submitted as a project deliverable there is a corresponding DWG and image file (i.e. TIF). The sheet and the digital files all follow the same naming convention.

3.1.1 Naming Construction Drawings

The file naming convention follows the Sheet Identification section of the *United States National CAD Standard - Version 4.0*.

3.1.2 Sheet Identification

The sheet identification format is a consistent format that contains five alphanumeric characters in a specific sequence conveying meaningful information to both the drawing creator and user. The sheet identifier consists of three components: the discipline designator, the sheet type designator, and the sheet sequence number followed by the drawing extension, i.e. .TIF or .DWG.

Discipline Designator					Sheet Type Designator					Sheet Sequence Number				
A	A	N	N	N	A	A	N	N	N	A	A	N	N	N

Discipline Designator - Consists of one alphabetical character and a hyphen or two alphabetical characters. The codes used for the discipline designator are listed in the *Layer Naming Convention* on page 6. The discipline designator identifies the sheet as a member of a particular genre of drawings. The discipline designator can be either one or two characters long. For more specific genres, such as security (TS) or audio visual (TA) drawings, creators can use a two character designator: the first letter indicating the genre and the second letter indicating the subset of that genre. If a discipline designator is only one character long, a hyphen is a required place holder to ensure the consistent length of the sheet identifier. Not all type designators are required. The standard also does not prohibit combining different types of drawings onto the same sheet.

Sheet Type Designator – Consists of one numeric character. The sheet type designator refers to the type of information displayed in the drawing.

Sheet Type Designators		
0	General	symbols, legends, notes, etc.
1	Plans	horizontal views
2	Elevations	vertical views
3	Sections	sectional views, wall sections
4	Large-Scale Views	plans, elevations, stair sections, or sections that are not details
5	Details	
6	Schedules and Diagrams	
7	User Defined	
8	User Defined	
9	3D Representation	isometrics, perspectives, photographs

Sheet Sequence Number – Consists of two numeric characters. The sheet sequence number, which is a series of sequential numbers from 01 through 99. The use of 00 is not allowed.

APPENDICES

(see following pages)

A. Electronic File Quality Assurance Checklist

B. Electronic File Index

APPENDIX A

A. ELECTRONIC FILE QUALITY ASSURANCE CHECKLIST

CAD drawings and image (TIF) files delivered at closeout of a capital project must be accompanied by this checklist. When a checklist has been signed and submitted, the vendor (architect, engineer, contractor, etc.) is assuring that all materials adhere to the standards and guidelines set forth in the University Planning Office's *CAD and Image Standards for Construction Documentation* publication.

FILE FORMAT AND SETUP

- Electronic File Format
- Scale, Units, & Tolerances
- Fonts and Text Styles
- Blocks
- Title Blocks
- Policy on Model Space and Paper Space
- Policy on External Reference Files (XREFs)

LAYERING

- Standard Layer List
- Layer Name Formatting
- General Rules about Naming and Uses
- Layer Attributes (Colors, Pen weights, Linetypes)

CAD & TIF NAMING CONVENTIONS

- Building and Floor Identification Codes
- Discipline Identification Codes
- Drawing Type Codes
- Drawing Numbers

POLICY ON CAD FILE TRANSLATION

- Full AutoCAD® Compliance
- Translation Testing Procedures (if applicable)

POLICY ON TIF TRANSLATION

- Produce at 300 ppi at hard copy dimensions
- Files must be uncompressed

 Name of Accountable Vendor Representative
 (please print)
 Phone number: _____

 Signature of Accountable Vendor Representative
 Date: _____

APPENDIX B

B. ELECTRONIC FILE INDEX

All electronic materials (CAD files, TIF files, index table files, etc.) must be delivered on CD-ROM or DVD, formatted using Windows 2000 or higher.

Indices for files must be submitted in both paper format and electronically in Microsoft Excel (version 5.0 or later). A blank template of this form is available on the UPO website at <http://upo.harvard.edu/CampusProjects/standards.html>. Images files must be created at a resolution of 300ppi at hard copy dimensions, please refer to the *CAD and Image Standards for Construction Documentation* publication. Indices must contain the following information:

1. File Name
2. Title of Drawing
3. Horizontal Paper Size - measured in inches, indicate the width of the original paper drawing at its widest horizontal dimension
4. Vertical Paper Size - measured in inches, indicate the length of the original paper drawing at its widest vertical dimension
5. Scale - indicate the scale of the original drawing (examples: 1"=20' or NTS)
6. Pixel Depth - indicate color, grayscale, bi-tonal

Sample Electronic File Index

PROJECT INFORMATION								
Project Manager:	Kate Loosian							
Name of Project:	Hemenway Gym Conversion							
CAPS Project #:	FAS 05-012							
CAPS Building #:	854							
ELECTRONIC FILE INFORMATION								
DRAWING INFORMATION		CAD FILE INFORMATION		TIF INFORMATION				
Drawing Title	Architect's Drawing Number	CAD file name	File Version	TIF file name	Horizontal Dimension	Vertical Dimension	Scale	Pixel Depth
Title Sheet	T-001	T-1.dwg	2000	T-001.tif	30"	42"	1' = 20'	Grayscale
First Floor Demolition Plan	DT-001	D-1.dwg	2000	DT-001.tif	30"	42"	1' = 20'	Grayscale
Second and Third Floor Demolition Plan	D-002	D-2.dwg	2000	D-001.tif	30"	42"	1' = 20'	Grayscale
Second and Third Floor Plan	A-001	A-2.dwg	2000	A-001.tif	30"	42"	1' = 20'	Grayscale
Elevations	A-002	A-3.dwg	2007	A-001.tif	30"	42"	1' = 20'	Grayscale
Second and Third Enlarged Stair Plan	A-003	A-4.dwg	2007	A-001.tif	30"	42"	1' = 20'	Grayscale