

UNITED STATES NATIONAL CAD STANDARD®

Version 4.0

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1090 Vermont Avenue, NW, Suite 700
Washington, D.C. 20005-4905

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United States

National CAD Standard® - Version 4.0

A Consensus Standard Incorporating Industry Publications



The National Institute of Building Sciences (NIBS) is a non-governmental, non-profit organization, authorized by Congress to encourage a more rational building regulatory environment and to accelerate the introduction of existing and new technology into the building process.

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National Institute of Building Sciences
Publications Department
1090 Vermont Avenue, NW, Suite 700
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ph: 202-289-7800
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wb: www.nationalcadstandard.org

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Foreword

Thank you for purchasing the United States National CAD Standard® (NCS or Standard). This standard is an important first step in coordinating the efforts of the building design and construction industry. By classifying electronic building design CAD data consistently, communication among design and construction project teams can be streamlined, resulting in cost savings and greater efficiency in the design and construction process. By adopting this Standard, you are making a wise choice for the future of your company or organization. Broad implementation of this Standard will significantly improve building design and construction service delivery to all clients.

Recognizing the evolving nature of computer technology, the National CAD Standard Project Committee (NCS Project Committee) is committed to the continuous growth and development of the Standard to keep pace with technology as it develops. The evolution of the Standard is dependent upon the participation of a broad cross-section of industry professionals. You are invited to contribute to the development of the Standard by joining the NCS Project Committee. For further information, visit the NCS web site at: <http://www.nationalcadstandard.org>.

This Standard is intended as a foundation for information sharing. Undoubtedly, it will not meet the needs of all users in all cases. To the extent possible, we urge you to classify your basic data according to the Standard, augmenting it only in those cases where your data cannot be sufficiently classified, organized or represented according to it. In this way, you can ensure that a baseline of your construction data can be freely exchanged with others who adopt the Standard. Moreover, the task of educating others about your particular customized data-classification or organizational system for CAD can be minimized.

Note on Version 4.0: To denote changes from Version 3.0/3.1, we have placed in the left margin a delta (Δ) where material has been deleted or a change bar (|) where material has been added or revised. In the AIA CAD Layer Guidelines we have placed a bullet (●) in the “New” column, where new Layers have been added, a change bar (|) where Layers have been revised and a delta (Δ) where material has been deleted.

We would greatly appreciate feedback on any problems you encounter. Please use the form in Appendix H to record your comments.

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Introduction

An Overview

The National Institute of Building Sciences (NIBS) Facility Information Council (FIC) (formerly the CADD Council) facilitated the development of the United States National CAD Standard® (NCS), and will continue to support its evolution in the future. The Standard is comprised of three documents previously published by member organizations of the FIC and the report of the NIBS NCS Project Committee. The NIBS report includes this Introduction, Administration, and Appendixes, with amendments to the constituent documents as approved by the committee. The report describes how the constituent documents are related to one another, resolves discrepancies between them, and ensures the full integration of the previously independent parts. The constituent documents include:

- **AIA CAD Layer Guidelines**, The American Institute of Architects;
- **Uniform Drawing System**, Modules 1-8, The Construction Specifications Institute; and
- **Plotting Guidelines**.

The origins of the NCS (see *A Brief History* below) can be traced to a Memorandum of Understanding (see Appendix C) signed by the above publishing organizations as well as the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) and the United States General Services Administration (GSA). Broad building design and construction industry support is evidenced by the membership of the NIBS FIC Board of Direction (see Appendix G), under whose auspices the NCS Project Committee operates.

The constituent documents have undergone a thorough review and comment process by the NCS Project Committee, the body formed by the FIC to review and comment on the existing publications that comprise the Standard. The Committee followed the NIBS Consensus Process in conducting its work. This process ensures broad, democratic participation by all interested persons and organizations. It provides a framework for the coordination and integration of the previously independent parts. Additionally it establishes a mechanism for revising the constituent documents to meet the needs of the broadest possible spectrum of users.

This Overview is intended to provide you with a brief history of the development of the NCS and to inform you of the process for its future evolution and development. The remainder of the Introduction is organized according to the following topics:

- Adoption and Implementation:
How Vision Becomes Reality
- Implementation:
The Role of Design Professionals
The Role of Building Owners
The Role of Building Design Software Developers
- Benefits:
Why Should You Adopt the United States National CAD Standard?
Benefits for Building Design Professionals
Benefits for the General Contractor and related Sub-contractors
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- The United States National CAD Standard:
One Element of a Larger Framework
A Brief History
- The Facility Information Council:
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- The United States National CAD Standard NCS Project Committee:
How You Can Participate

Adoption and Implementation:

How Vision Becomes Reality

Adoption of the NCS by the building design and construction industry is voluntary. The success of the Standard in achieving its intended purpose of streamlining and simplifying the exchange of building design and construction data will be measured by the number of participants in the building design and construction industry who choose to adopt it. The decision to adopt the Standard will be made by thousands of individuals and organizations on the basis of whether or not the Standard adequately addresses this critical industry need.

Implementation:

The Role of Design Professionals

As a building design and construction industry professional and as representative of a company, organization, or association, you are an integral part of this process. We urge you to adopt the Standard throughout your business enterprise and to participate in its ongoing development to ensure a Standard that reflects the broadest possible spectrum of viewpoints from throughout the industry.

How does the NCS enhance the business prospects of building industry professionals? There are three principal advantages. First, a common language of data classification and organization for CAD will improve communication and data transfer among building design and construction teams, helping to streamline the building design and construction process. Secondly, a national CAD standard will provide one component of a coherent and consistent electronic database, or “information model,” which can be made available throughout the life-cycle of the building, for purposes other than the original construction. A single, nation-wide data classification and organization system for CAD will simplify the transfer of building data from the original building design CAD applications to facility management (FM) applications. A streamlined building design and construction process and a corresponding information model, with a life span equal to the building it represents, results in a higher quality of service to both building owners and facility managers, who are the clients of the design and construction teams. Finally, a “common language” of data classification and organization for CAD will reduce the need for training of

staff and development and maintenance of office standards, enabling building design and construction organizations to devote valuable personnel resources to revenue-generating tasks.

Beyond the immediately tangible benefits, a common language for the classification and organization of electronic data for CAD will create new opportunities for building design professionals to develop additional sources of revenue by offering a broader range of value-added services to building owners and facility managers. It suggests the redefinition of the roles and the traditional relationships from independent, single project contracts to long-term, service-oriented relationships. A national CAD standard for classifying electronic building data facilitates the development of these new business models.

The Role of Building Owners

Large-scale building owners, a group that includes corporations, government agencies, and educational or health care institutions, have a key role and interest in the full-scale implementation of the NCS. As high-volume consumers of building design and construction services, most large-scale building owners have developed company CAD standards that are required of all A/E firms providing them with building design services. By adopting the NCS, the burden of maintaining a proprietary standard is eliminated, and the maintenance of building information models is greatly streamlined and enhanced. Moreover, because large building owners represent a significant share of the building design and construction market, their adoption of the NCS is likely to have a singular impact on the entire building design and construction industry.

The Role of Building Design Software Developers

Incorporation of the NCS into the software products that practitioners use on a daily basis is a vital element in the promulgation of the Standard. For example, software tools such as macros can be developed to automatically create CAD data file names or CAD data file layer names in the NCS format. Templates could be included in applications to automatically create drawing file sheets in the NCS graphic format. Incorporation of such tools will become a vital feature of future CAD, Facilities Management, and other building design, construction and maintenance applications. Software developers who develop such tools will enjoy a significant competitive advantage in the marketplace.

The NCS Business Management Group intends to license software companies to implement the NCS in their products.

Benefits:

Why Should You Adopt the United States National CAD Standard?

For anyone faced with organizing (or simply understanding the organization of) electronic building design data for CAD produced in a multitude of formats, the value of organizing the data in a consistent format is immediately apparent. In the absence of a single national CAD standard, many companies and organizations have developed internal “office standards” as a way of consistently organizing their own electronic CAD data. The value of such office standards is limited to their realm of influence. For design firms, that realm may not extend beyond the firm itself, except in cases where design sub-consultants can be compelled to adopt it. Large building and property owners may require adoption of a “company standard” as a condition for providing design services to them, and thus influence a realm well beyond their immediate organizations. However, the effort required to develop office standards is a now an unnecessary cost of doing business, and the duplication of effort required to develop multiple office standards is a gross and blatant inefficiency.

Computerization of the building design process was intended to result in increased efficiency and lower costs. The lack of a single, comprehensive, consistent data classification and organizational system for the exchange of electronic building design CAD data seriously hampers that goal. The NCS will benefit all participants in the building design and construction process. Particular benefits for particular players are outlined below.

Benefits for building design professionals

- Consistent classification, organization and representation of CAD data for all projects, regardless of the project type or client.
- Seamless transfer of information between architects, engineers, and other design team members.
- Reduced preparation time for translation of electronic data files between different proprietary software file formats; predictable file translation results.
- Reduced data file formatting and set-up time as a result of adoption of the Standard by software application vendors.
- Greatly reduced staff training time to teach multiple “office standards.”

- Streamlined process for checking drawings for references, omissions, etc.
- Automated updating of data files as the Standard evolves.
- New opportunities for expanded services and revenue beyond building design.
- New marketing opportunity; design firms complying with the Standard can feature compliance as a benefit to prospective clients.

Benefits for the general contractor and related sub-contractors

- Consistent organization of CAD data for all projects, from all sources.
- Consistent drawing sheet order and sheet organization; information appears in the same place in all drawing sets, regardless of the source.
- Reduction of discrepancies, reducing the potential for errors, change orders, and construction delays.
- Consistent detail reference system.

Benefits for the client/building owner

- Consistent organization of data for all projects, from all sources.
- Greater clarity of communication of design intent to the client.
- Streamlined electronic data management of facility management data.
- Enhanced potential for automated document storage and retrieval.
- Streamlined construction document checking process.

Benefits for the entire building design and construction industry

- Reduced costs for training resulting from the common language of data classification and organization for CAD.
- Improved preparation and training of prospective employees at undergraduate and graduate institutions of higher learning.
- Enhanced potential for automated training and distance learning.

- Elimination or reduction of a major barrier to the free exchange of building construction data, creating an opportunity to improve quality, improve efficiency and reduce costs in the building design, construction and maintenance process.

The United States National CAD Standard:

One Element of a Larger Framework

Why should there be a national standard for the organization of CAD data? While the primary purpose is to establish a common basis for the classification and organization of electronic CAD data throughout the building design industry, the broader objective is to improve communication throughout the entire construction industry, including contractors, building product manufacturers, CAD software developers, and facility managers.

The NCS is only one of a number of ongoing efforts aimed at integrating electronic information. Other efforts include the International Alliance for Interoperability (IAI), Overall Construction Classification System (OCCS) hosted by CSI, STEP activities of the National Institute of Standards and Technology (NIST), Manufacturing Information Management Open Systems Alliance (MIMOSA), the Construction Operations Building Information Exchange (COBIE), the National Building Information Model Standard (NBIMS), the buildingSMART® Alliance, and the International Standards Organization (ISO), to name just a few.

The scope of the NCS is limited to the classification and organization of electronic data within CAD data files. It addresses issues such as layer names, discipline designators, line weights, pen assignments, and the graphic organization of construction drawing sheets. While facilitating the exchange of data between current CAD software, it does not yet address the more complex issues of electronic data file format compatibility between software applications using object-oriented programming, which is the focus of IAI Industry Foundation Classes (IFC).

The OCCS will be a hierarchical classification system addressing information “disconnects” in the building lifecycle process and outlines a vision, or specification, for an integrated electronic model. The IAI aecXML effort is coordinating the development of standards to facilitate the exchange of web-based data. NIBS has developed an XML standard to allow equipment manufacturers to deliver electronic operations and maintenance manuals that plug right in to computerized maintenance management systems (CMMS). This XML XSD schema was contributed to and is now incorporated into the IAI IFC.

While these efforts began separately and are independent, they are not mutually exclusive. In an ideal world, no barrier of any kind, either at the application code level, the data classification and organization level, or at the process level would obstruct the free flow of building design and construction information. All of the current efforts are intended to accomplish that same goal.

One might ask why the current efforts are independent of each other. Two principal reasons are that the work is very complex and it makes sense to begin with what you know. Different elements of the problem can be addressed most effectively by different groups with each group focusing its unique expertise on the appropriate aspect of the challenge. As an example, the development of data classification and organizational standards can be done by an informed group of CAD users, independently of software programming considerations, and can be implemented across a broad array of software applications. Meanwhile, the challenge of interoperability, that is, the ability to transfer electronic data files seamlessly from one software application to another, can be addressed by software application programmers, in close consultation with CAD users. Concurrently, a vision of an integrated information model can be developed in collaboration with software vendors, CAD users, building owners and facility managers, general practitioners and other building team members.

Many of the independent efforts have reached a level of maturity that makes it increasingly important to collaborate on related activities. The NIBS buildingSMART® Alliance www.iai-na.org/bsmart has emerged as a focal point for improving communication within the industry, as well as a forum for structuring various collaboration activities. The North American Chapter of the International Alliance for Interoperability (IAI-NA), a NIBS Council since 2002, moved in 2006 to increase recognition of the buildingSMART® concept, standing for both the technology of seamless facility information exchange, and a broader consumer focus.

A Brief History

In 1990, the American Institute of Architects (AIA) published the 1st Edition of *CAD Layer Guidelines*. This was the first effort in the building design industry to develop a data classification system for organizing electronic building data specifically addressing the names of CAD data files and the names of layers within CAD data files.

In 1990, the Construction Specifications Institute (CSI) published a technical document entitled *Standard Reference Symbols* and in 1994 began formal development of the *Uniform Drawing System* (UDS), an organizational standard and system for drawings. CSI's *MasterFormat*™, the industry standard classification system for building product data and building construction

specifications, provides uniformity for written building design information. UDS provides uniformity for graphical building design information in drawings. CSI established a comprehensive long-range plan for the UDS to address all facets of construction drawing organization, including the naming of layers in CAD data files. Since a layer guideline already existed, CSI decided, in the best interest of the industry, to work cooperatively with the AIA to revise CAD Layer Guidelines in lieu of creating a new document. The 2nd Edition of ***CAD Layer Guidelines*** was published by the AIA in 1997 and with amendments was a part of the NCS Version 1.0.

In 1997, CSI published the first three modules of the UDS. These modules, with amendments, were part of Version 1.0 of the NCS. In June 1999, Modules 4 – 6 of the UDS, Drafting Conventions, Terms and Abbreviations, and Symbols, were published. The following year Modules 7 and 8 of the UDS, Notations and Code Conventions, were published. All the UDS modules were subsequently submitted to the NIBS Consensus Process and incorporated in Version 2.0 of the NCS.

In January 2005, NIBS released NCS 3.1. It included republication of all UDS modules to incorporate *MasterFormat*™ 2004 and amendments from the NCS Project Committee.

The United States Department of Defense (DOD) has also played a significant role in the development of CAD standards. In 1993, DOD formed what is now known as the CADD/GIS Technology Center, headquartered in Vicksburg, MS, the former site of the Army Corps of Engineers CADD Center. The CADD Center was created in an effort to develop a single “office CAD standard” for the Army, Navy, and Air Force, which, until that time (and reflecting the state of the industry as a whole), employed many organizational systems throughout their building design and construction operations. As a large consumer of building design and construction services, DOD’s efforts had the effect of bringing some semblance of order to data classification for a significant segment of the industry. In 1994, Secretary of Defense Perry strongly promoted the adoption of private sector standards by DOD and further promoted the involvement of DOD in the development of such standards. As a result, the CAD standards developed by the CADD Center were based strongly on the ***CAD Layer Guidelines*** and the ***Uniform Drawing System***. The CADD/GIS Technology Center continues to be actively involved in the development of the NCS.

In 1997, key building design and construction industry organizations with an interest in the development of a national CAD standard signed a **Memorandum of Understanding** that formed the basis of a cooperative, collaborative relationship for the development of the United States

National CAD Standard. Signatories included NIBS, AIA, CSI, the DOD CADD/GIS Technology Center, the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), the United States Coast Guard, and the United States General Services Administration (GSA).

The publishing signatories, AIA, CSI, the CADD/GIS Technology Center and the Coast Guard, agreed to contribute their documents to a consensus process facilitated and financed by NIBS and the FIC with the anticipated outcome of a national CAD standard. Each organization retains full ownership, including copyright, of its respective documents.

Most importantly, the publishing signatories agreed to maintain, revise and support the continued publication of their documents in cooperation with the NIBS NCS Project Committee. The Memorandum of Understanding is an agreement for cooperation and collaboration that is unprecedented in the building design and construction industry and has no equal in the computer industry.

The Facility Information Council:

History, Mission, Governance

The United States Congress authorized NIBS to assemble, store and disseminate technical data and other information directly related to its technological and regulatory responsibilities. The NIBS FIC fulfills a part of that responsibility by providing an industry-wide forum for the standardization and integration of facility information throughout the entire life-cycle of buildings, from design, construction, and maintenance, through re-use or retirement.

The need for an integrated system for storing electronic building design and construction data has been recognized since the 1960s, when the commercial use of computers in the construction industry first began. During this period, several individuals and organizations published research papers and developed organizational plans for integrated computer systems for the building industry. The limitations of early computer systems, the rapidly evolving nature of computer technology and the rapid obsolescence of contemporaneous computer systems rendered these data-organization efforts impractical.

With its introduction in 1982, the personal computer emerged as the platform of choice for business computing. The building design industry shifted rapidly from manual production to a

computer-based process. Today, nearly all design and documentation in the building construction industry is accomplished using CADD. Computer-aided design and drafting software applications have evolved to a point of maturity that now makes a single, coherent system for classification of building design and construction data possible. It is now incumbent on the industry to harness this computer technology to maintain national competence and assert United States resourcefulness to successfully compete in the global marketplace.

The Computer Aided Design and Drafting (CADD) Council was established by NIBS in 1994. The inaugural meeting was held on June 23rd of that year in conjunction with the A/E/C SYSTEMS show in Washington, D.C. In 1999, the name of the Council was changed to the Facility Information Council (FIC) to more fully reflect its charter as well as to better align its mission with the strategic goals of NIBS.

The purpose of the FIC is to improve the performance of the life-cycle of facilities including design, engineering, construction, operations, maintenance and retirement by fostering:

- A common integrated life-cycle “information model” for the A/E/C industry.
- Standards that allow for the free flow of graphic and non-graphic information throughout the information model.
- Communication and interaction between the United States and the International Standards Organization (ISO) on CADD related efforts.

In September 2005, the FIC established a second project committee to develop a complex standard addressing building information models, or BIMs. The new FIC project committee began developing a National Building Information Modeling Standard (NBIMS). The NBIMS is a set of interoperable standards for exchange of facility and infrastructure data through the life-cycle of a project. The first draft document of the BIM Standard delivered by the NBIMS Project Committee in March of 2007 entitled *National BIM Standard, Version 1, Part 1 - Overview, Principles and Methodologies*, establishes the NCS as the minimum base requirement to meet the new 3-D, object-based environment represented by NBIMS and buildingSMART®.

Membership on the FIC is open to all individuals and organizations with an interest in and commitment to the FIC’s purposes. The FIC meets annually. The FIC’s Board of Direction is comprised of representatives from industry organizations and associations, private software developers and vendors, governmental agencies, and the public. A complete roster of the membership of the FIC Board of Direction can be found in Appendix G.

The National CAD Standard Project Committee:

How You Can Participate

The key to success and longevity of a standard is long-term care and feeding. The NIBS FIC will continue to facilitate the evolution of the NCS. Likewise, the major contributing organizations are committed to supporting the development of their constituent documents.

With publication of Version 1.0 of the NCS in July of 1999, the NCS Project Committee accomplished its original mission. Immediately thereafter, the FIC re-opened membership on the NCS Project Committee to all persons with interest in developing Version 2.0 of the NCS. Beginning with the start of work on Version 3.0 the NCS Project Committee became a standing committee open to new applicants at any time.

The first three committees operated under the NIBS Consensus Process. In 2004, the NIBS NCS Project Committee adopted new governance rules described in Appendix F. Members who attend project committee meetings do so at their own expense or at the expense of their sponsoring organizations. The majority of meetings are held at the NIBS offices in Washington, D.C. To the maximum extent possible, the work of the NCS Project Committee and its task teams is conducted via the internet and conference calls.

The only requirement for participation is that applicants submit a membership application form and be in possession of the latest version of the NCS.

If you wish to participate, please visit the United States National CAD Standard web site at <http://www.nationalcadstandard.org> and complete the on-line application for the project committee and specific task teams.

In conclusion and on behalf of the FIC we would like to thank all who have participated in the development of Versions 4.0, 3.1, 3.0, 2.0, and 1.0 of the NCS. Their names are listed in Appendix D. As the tag line in the title indicates, the NCS is a “Consensus Standard Incorporating Industry Publications.” This would not have been possible without industry-wide participation. Many individuals and organizations have contributed countless hours toward development of the constituent publications and the establishment of a United States National CAD Standard. The benefit of these efforts will be appreciated by many users.

David A. Jordani, FAIA
Chair, NCS Project Committee
Vice Chair – Board of Direction, Facility Information Council;
National Institute of Building Sciences
President, Jordani Consulting Group

Dominique Fernandez
NCS Project Committee, Facility Information Council
Director, Technical Programs
National Institute of Building Sciences

Richard L. Hayes, PhD, AIA
Managing Director, AIA Knowledge Resources
American Institute of Architects

Aaron Titus
Member, Board of Direction, Facility Information Council;
National Institute of Building Sciences
Technical Program Manager
Construction Specifications Institute

Washington, DC
November 2007

Administration

Admin-1: Title

1.1 This document is known as the United States National CAD Standard®, and is referred to herein as “The United States National CAD Standard for Architecture, Engineering, and Construction (A/E/C),” “United States National CAD Standard,” “NCS,” or “the Standard.”

Admin-2: Current Version

2.1 Version 4.0 of the NCS published in November 2007.

Admin-3: Intent

3.1 The intent of the NCS is to assist in classifying electronic design data consistently, to streamline and simplify the exchange of data within the design and construction industry, and to illustrate the appropriate presentation of two-dimensional graphic standards.

3.2 During design, use of the NCS is intended to speed the transfer of information between owner, designer, consultants, and contractors/subcontractors.

3.3 During construction, use of the NCS is intended to reduce time in finding and referencing information between owner, designer, consultants, product suppliers, and manufacturers.

3.4 After occupancy, use of the NCS is intended to facilitate continued use of archived construction documents.

Admin-4: Scope

4.1 Data Organization: The NCS assists in classifying and organizing electronic data within CAD data files. It addresses issues such as layer names, discipline designators, line weights, pen assignments, and the graphic organization of construction drawing sheets.

4.2 Data Exchange: Implementation of the NCS by users and software vendors is intended to facilitate the exchange of data between current and future CAD software and to help guarantee the future utility of today's CAD data files.

Admin-5: Implementation by CAD Users

5.1 Voluntary Implementation: Implementation of the NCS in whole or in part is voluntary. Each organization shall determine its degree of conformance with the NCS. (The agreement between owner and design professional or between design professional and consultant may specify degree of conformance required.)

5.2 Disclosure Statement: Projects claiming substantial or partial conformance with the NCS shall include an NCS Statement of Substantial Conformance. (See Appendix A)

Admin-6: Publishers of Software and Electronic Building Data

6.1 Registration: Any software vendor, manufacturer, material supplier, or other organization, commercial or non-profit, may apply to the National Institute of Building Sciences (NIBS) to be registered as a "Publisher of Electronic Data." Upon acceptance of registration application, agreement with the terms and conditions, and payment of the yearly registration fee, the publisher may state that his or her product is in full or partial conformance with the NCS.

6.2 Disclosure Statement: Publishers claiming substantial or partial conformance with the NCS shall include an NCS Statement of Substantial Conformance with their product and also make the Statement readily available at no charge directly from the publisher.

Admin-7: Assumptions

7.1 Type of Construction: The NCS is for use in organizing CAD documents for all types of construction, even though the examples in the NCS are shown primarily for building construction.

7.2 Type of Documents: The NCS assumes that the final construction document product will consist of one or more sheets of graphic images (plans, elevations, sections, details, perspectives, isometrics) and applicable text as projected on a static two-dimensional surface. Such images may be viewed on a computer monitor or printed on a sheet of paper. (Note: Standards for three-dimensional computer models – produced by object-oriented programs – are not currently part of the NCS.)

7.3 Options: It is anticipated that users will implement a sub-set of the NCS, depending on the size and type of project. Portions of the NCS are labeled “optional” or “recommended” and substantial conformance with the NCS would not necessarily require use of all or any of these items.

7.4 Minor Variations: It is not expected that project documents will fully conform to the NCS in every respect and detail. Most projects will include several minor variations from the NCS. Provided these minor variations are listed as part of the Statement of Substantial Conformance, the project will then be considered in Substantial Conformance.

Δ Admin-8: (Reserved for future use)

Admin-9: Definitions

CAD: Computer-Aided Design (or Drawing).

CAD file: An electronic computer file, containing CAD data entities, which can be changed and manipulated by a CAD software program.

Drawing: Graphic and pictorial portions of the documents showing the design, location, and dimensions of the project, generally including plans, elevations, sections, details, schedules, and diagrams.

Guidelines: Required. Part of the United States National CAD Standard.

Optional: Not required. If item is left out, documents will still be in Substantial Conformance with NCS. If included, however, must follow NCS guidelines. (See Appendix B)

Recommended: Not required, suggested method only. (See Appendix B) Other consistent methods, if listed on the NCS Statement of Substantial Conformance, are equally acceptable in order for documents to be in Substantial Conformance with NCS. (See Appendix A)

Required: Items to be followed if claiming Substantial Conformance with NCS.

Plot file: An electronic computer file containing information necessary to print one drawing sheet formatted for output to a printing or plotting devices no longer stored in its native CAD file format.

Admin-10: Copyright, Trademark, and License

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AIA CAD Layer Guidelines

United States National CAD Standard® - Version 4.0

**The American Institute of Architects
1735 New York Avenue, NW
Washington, DC 20006-5292**

(800) 242-3837

www.aia.org

www.nationalcadstandard.org

The American Institute of Architects
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Introduction

Overview

Virtually all vector-based CAD systems support the concept of layers. This function allows building design information to be organized in a systematic fashion, facilitates the visual display of the information on a computer screen, and allows the information to be efficiently converted to the conventional print media of drawings. Efficient use of layers can reduce document preparation time and improve document coordination. Organizing data by layers allows a single CAD file to contain a wealth of information about a building or facility. By turning selected layers on or off, data can be created, reviewed and edited according to a hierarchy that simulates the physical organization of building systems, the relative position of building elements, or the sequence of construction.

A Brief History of CAD Layer Guidelines

The American Institute of Architects (AIA) published the first edition of *CAD Layer Guidelines* in 1990. The early success of the first edition and rapidly evolving technology resulted in the second edition being published in 1997. The most significant change between the first and second editions was the elimination of the “short” layer name format and the adoption of the long layer name format as a single standard. The second edition also included additional layer field codes for remodeling projects, added new discipline designations for interiors, telecommunications, and other disciplines, and improved the method of organizing drawing annotation.

In July 1997, the AIA agreed to incorporate *CAD Layer Guidelines* into the emerging *United States National CAD Standard*® (NCS), a project of the National Institute of Building Sciences (NIBS). The AIA and NIBS were joined in that effort by the Construction Specifications Institute (CSI) and what is now known as the CADD/GIS Technology Center of the U.S. Army Corps of Engineers. CSI and CADD/GIS Technology Center agreed to incorporate their own publications, the *Uniform Drawing System* and the *Plotting Guidelines*, respectively, into the NCS. These four constituent publishers, as they came to be known, were joined by a number of building design and construction industry organizations in developing and publishing the NCS.

In March 1999, the U.S. National CAD Standard Project Committee (NCS Project Committee) formally accepted *CAD Layer Guidelines, Second Edition* (with minor amendments) as a constituent document of the NCS Version 1.0, published in July 1999. The NCS Project Committee immediately set to work on publication of Version 2.0, which was published in 2002.

Considerable confusion resulted from the lack of “alignment” between the “Second Edition” of *CAD Layer Guidelines* and “Version 1.0” of the NCS. Because *CAD Layer Guidelines, Second Edition* was published before, and later incorporated into, the NCS Version 1.0, this could not be avoided. With publication of the NCS Version 2.0, this problem was corrected by giving the constituent document an entirely new name. For the first time, "AIA" became part of the title of the publication, and the numbered “editions” were abandoned. As a result, this publication became known as *AIA CAD Layer Guidelines: U.S. National CAD Standard - Version 2.0*. Subsequent editions of the NCS adopted the same nomenclature.

Version 2.0

AIA CAD Layer Guidelines, Version 2.0, was designed and formatted to match its companion document, CSI's Uniform Drawing System. It was also carefully coordinated with that document, so that the two function as a whole.

Additions and improvements to Version 2.0 of *AIA CAD Layer Guidelines*:

- Incorporation of NCS V1.0 amendments, including the change from a four-character to a single character Status field.
- An expanded Layer Format that includes a two-character discipline designator and a second optional Minor Group.
- An expanded Drawing View Layer List for users with a need to organize data by drawing type rather than by building system.
- Expanded Layer Lists for Civil, Structural, Mechanical, Plumbing, and Telecommunications Disciplines.
- New Discipline Designators for Survey/Mapping, Geotechnical, Civil Works, Process, and Operations Disciplines.
- An entirely new Layer List for the Survey/Mapping Discipline.

- New Annotation Minor Groups, and a new “free agent” rule permitting Annotation Minor Groups to modify any Major Group.
- Clarification of the existing “free agent” rule, emphasizing that any reasonable combination of Discipline Designator, Major Group and Minor Group is permitted.
- New rules and a detailed Commentary to facilitate conformance with the ISO CAD Standard.

Version 3.0/3.1

Highlights of revisions and additions to Version 3.0/3.1 include the following:

- User-defined Minor Group field codes may now be four alphabetic and/or numeric characters (0–9) and/or “~”.
- Additions to the Process Layer List allow users to define layers by individual systems or groups of systems.
- Expanded the Landscape Layer List.
- New Major and Minor Groups added to the Equipment, Mechanical, and Interior Layer Lists.
- Equipment layer added to the Fire Protection Layer List.

New in Version 4.0

- Appendix A added with all groups and fields alphabetized into one easy to read list.
- Disciplines and lists alphabetized.
- Telecommunications discipline contains new items as well as many that were moved from the Electrical discipline.
- Major and Minor group definitions made more generic to allow broader usage.
- Major and Minor group abbreviations coordinated with the UDS section of NCS.
- Civil Works discipline deleted.
- Misleading examples from Version 3.0/3.1 deleted.

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Layer Name Format

Hierarchy of Data Fields

The layer name format is organized as a hierarchy. This arrangement allows users to select from a number of options for naming layers according to the level of detailed information desired. Layer names consist of distinct data fields separated from one another by dashes. A detailed list of abbreviations, or field codes, is prescribed to define the content of layers. Most field codes are mnemonic English abbreviations of construction terminology that are easy to remember.

There are four defined layer name data fields: **Discipline Designator**, **Major Group**, two **Minor Groups**, and **Status**. The Discipline Designator and Major Group fields are mandatory. The Minor Group and Status fields are optional. Each data field is separated from adjacent fields by a dash (“-”) for clarity.

The complete U.S. NCS layer name format, showing the Discipline Designator, the Major Group, two Minor Groups, and the Status fields.

A	I	-	W	A	L	L	-	F	U	L	L	-	D	I	M	S	-	N
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Before You Begin

The NCS allows you to select from a number of format options for creating layer names. It is recommended that you select the options that you wish to use for layer names on a given project, and then apply the resulting format consistently for all layer names on that project.

Note that for *conceptual conformance* to ISO 13567, *Organization and Naming of Layers for CAD*, the layer name format and length must be the same for all layers on a given project. See “Commentary: NCS and ISO 13567” (CLG-81) at the end of *AIA CAD Layer Guidelines* for detailed information about ISO conformance.

A typical layer name showing the required data fields only.

Note that only the mandatory discipline character is shown, creating a Level 1 Discipline Designator.

A - WALL

Discipline Designator, Level 1

The Discipline Designator denotes the category of subject matter contained on the specified layer. The Discipline Designator is a two-character field. The first character is the discipline character, and the second character is an optional modifier. The Discipline Designator is described in greater detail on page UDS-01.10. For a complete list of Discipline Designators see Appendix A beginning on page CLG-89 and Appendix A of Drawing Set Organization beginning on page UDS-01.29.

LEVEL 1 DISCIPLINE DESIGNATORS	
A	Architectural
B	Geotechnical
C	Civil
D	Process
E	Electrical
F	Fire Protection
G	General
H	Hazardous Materials
I	Interiors
L	Landscape
M	Mechanical
O	Operations
P	Plumbing
Q	Equipment
R	Resource
S	Structural
T	Telecommunications
V	Survey / Mapping
X	Other Disciplines
Z	Contractor / Shop Drawings

Discipline Designator, Level 2

The optional second character is used to further define the discipline character. As an example, the Level 2 Discipline Designators for Architectural are shown:

A typical layer name showing the required data fields only.

Note that the mandatory Level 1 discipline character is supplemented by the optional discipline modifier to create a Level 2 Discipline Designator.

AD - WALL

Designator	Description	New
A	Architectural	
AD	Architectural Demolition	
AE	Architectural Elements	
AF	Architectural Finishes	
AG	Architectural Graphics	
AI	Architectural Interiors	
AJ	User Defined	
AK	User Defined	
AS	Architectural Site	

For a complete list of Discipline Designators see Appendix A of *AIA CAD Layer Guidelines* beginning on page CLG-89 and Appendix A of UDS Drawing Set Organization beginning on page UDS-01.29.

A typical layer name showing the required data fields only.

The mandatory Major Group field is highlighted:

A - WALL

A typical layer name showing one optional Minor Group field:

A - WALL - FULL

A typical layer name showing two optional Minor Group fields:

A - WALL - FULL - TEXT

Major Group

The major group is a four-character field that identifies a major building system. The prescribed Major Group field codes (four-character abbreviations) shown on the Layer List are logically grouped with specific discipline designators. However, any Major Group may be combined with any prescribed Discipline Designator, provided that the definition of the Major Group remains unchanged. Therefore, any reasonable combination of the prescribed Discipline Designators and Major Groups is permitted.

NOTE: User-defined Major Group field codes are not permitted.

NOTE: For *conceptual conformance* to ISO 13567, *Organization and Naming of Layers for CAD*, the use of the Major Group “ANNO” is not permitted. See “Commentary: NCS and ISO 13567” (CLG-81) at the end of *AIA CAD Layer Guidelines* for detailed information about ISO conformance.

Minor Group

This is an optional, four-character field to further define the Major Groups. For example, *A-WALL-FULL* denotes *Architectural, Wall, Full-height*. A second minor group may be used for still further delineation of the data contained on a layer. For example, *A-WALL-FULL TEXT* indicates *Architectural, Wall, Full-height, Text*.

The prescribed Minor Group field codes (four-character abbreviations) shown on the Layer List are logically grouped with specific Major Groups. However, any Minor Group may be used to modify any Major Group, provided that the definition of the Minor Group remains unchanged. Therefore, any reasonable combination of the prescribed Major and Minor Groups is permitted.

NOTE: User-defined Minor Group field codes are permitted. They must contain four alphabetic and/or numeric characters and/or “~”, and must be fully documented on the NCS Compliance Disclosure Statement for the project on which they are used.

NOTE: For *conceptual conformance* to ISO 13567, *Organization and Naming of Layers for CAD*, the use of certain Minor Group field codes is restricted. See “Commentary: NCS and ISO 13567” (CLG-81) at the end of *AIA CAD Layer Guidelines* for detailed information about ISO conformance.

A typical layer name showing the location of the optional Status field:

A - WALL - FULL - TEXT - N

Status (Phase)

The status field is an optional single-character field that distinguishes the data contained on the layer according to the status of the work or the construction phase. The prescribed field codes for this field are as follows:

STATUS FIELD CODES	
D	Existing to demolish
E	Existing to remain
F	Future work
M	Items to be moved
N	New work
T	Temporary work
X	Not in contract
1-9	Phase numbers

Note that for *conceptual conformance* to ISO 13567, *Organization and Naming of Layers for CAD*, this field may be used to denote either “Status” OR “Phase,” but not BOTH. See “Commentary: NCS and ISO 13567” (CLG-81) at the end of *AIA CAD Layer Guidelines* for detailed information about ISO conformance.

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Drawing View Layer List

Drawing View Field Codes

The Drawing View field codes are specialized codes for layers that are organized primarily by drawing type, rather than by major building system. The field codes DETL, ELEV, and SECT may also be used as Minor Group field codes to modify a major building system.

For data sets that are organized by drawing type, an optional alphanumeric Minor Group field code, ANNN, is prescribed to further distinguish drawings within a single CAD file. This Minor Group may be used ONLY to modify the prescribed Drawing View Major Groups; it may not be used to modify any other Major Group. The format of ANNN is also prescribed. It must consist of a single alphabetic character followed by a three-digit number between 001 and 999. The definition of ANNN is not prescribed; it must be defined by the user. The definition must be documented on the NCS Compliance Disclosure Statement for the project on which it is used.

The Minor Group field codes IDEN, MBND, MCUT, OTLN, and PATT may be used to modify any Major or Minor Group in the Layer List. The definitions of these prescribed field codes cannot be changed. See page CLG-8 for rules and options governing the use of field codes.

Drawing View Layer Names

Layer Name	Description	New
□□-DETL	Detail	
□□-ELEV	Elevation	
□□-SECT	Section	
□□-□□□□-ANNN	Drawing View Major Group: optional number (A = letter, NNN = number between 001 and 999)	
□□-□□□□-ANNN-IDEN	Drawing View Major Group: optional number: identification tags	
□□-□□□□-ANNN-MBND	Drawing View Major Group: optional number: material beyond cut	
□□-□□□□-ANNN-MCUT	Drawing View Major Group: optional number: material cut by the view	
□□-□□□□-ANNN-OTLN	Drawing View Major Group: optional number: outline	
□□-□□□□-ANNN-PATT	Drawing View Major Group: optional number: textures and hatch patterns	

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Annotation Layer List

Annotation Field Codes

Annotation consists of text, dimensions, notes, sheet borders, detail references and other elements on CAD drawings that do not represent physical aspects of a building. Use of the Major Group ANNO allows all annotation to be placed in a defined group of layers.

The Layer Names shown below provide examples for the use of Minor Group field codes for annotation. **These Minor Groups may be used to modify any Major or Minor Group in the Layer List.** See page CLG-8 for complete rules and options governing the use of Major and Minor Group field codes.

Annotation Layer Names

Layer Name	Description	New
□□-ANNO	Annotation	
□□-□□□□-BRNG	Bearings and distance labels (survey coordinates)	
□□-□□□□-DIMS	Dimensions	
□□-□□□□-IDEN	Identification tags	
□□-□□□□-KEYN	Keynotes	
□□-□□□□-LABL	Labels	
□□-□□□□-LEGN	Legends, symbol keys	
□□-□□□□-LOGO	Company logo	●
□□-□□□□-MARK	Markers, break marks, leaders	
□□-□□□□-MATC	Match lines	
□□-□□□□-NOTE	Notes	
□□-□□□□-NPLT	Non-plotting graphic information	
□□-□□□□-PROS	Date/Time/File name stamp	●
□□-□□□□-RDME	Read-me layer (not plotted)	

Layer Name	Description	New
□□-□□□□-REDL	Redlines	
□□-□□□□-REFR	Reference, external files	
□□-□□□□-REVC	Revision clouds	
□□-□□□□-REVS	Revisions	
□□-□□□□-SCHD	Schedules	
□□-□□□□-STMP	Professional stamps	●
□□-□□□□-SYMB	Reference symbols	
□□-□□□□-TABL	Data tables	
□□-□□□□-TEXT	Text	
□□-□□□□-TITL	Drawing or detail titles	
□□-□□□□-TTLB	Border and title block	

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Example Layer Lists

The following lists of layers present the most commonly used layers for each Discipline. The definitive list of Discipline Designators, Major and Minor Groups, and Status Fields is in Appendix A on page CLG-89.

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