भारतीय मानक

कम्प्यूटर एडिड डिजाइन (सी ए डी) तकनीक — संरचना ड्राइंग तैयार करने के लिए कम्प्यूटरों का उपयोग

Indian Standard

COMPUTER-AIDED DESIGN (CAD) TECHNIQUE — USE OF COMPUTERS FOR THE PREPARATION OF CONSTRUCTION DRAWINGS

ICS : 01.100.30; 35.240.10

BUREAU OF INDIAN STANDARDS
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NATIONAL FOREWORD

This Indian Standard which is identical with ISO/TR 10127 : 1990 'Computer-Aided Design (CAD) Technique — Use of computers for the preparation of construction drawings' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendation of Drawings Sectional Committee and approval of the Basic and Production Engineering Division Council.

This standard will identify major differences between the manual drawing practice and the CAD Technique in the construction industry.

The text of ISO Standard has been approved as suitable for publication as Indian Standard without deviations. In this adopted standard, certain terminology and conventions are not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear, referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a full point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards in 'Bibliography' for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their place are listed below along with their degree of equivalence for the editions indicated :

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 2382-1:1984 (Superseded by ISO/IEC 2382-1 : 1993)	IS 14692 (Part 1):1999 Information technology — Vocabulary: Part 1 Fundamental terms	Identical
ISO 2382-4:1987	IS 13557 (Part 4):1993 Information processing systems — Vocabulary : Part 4 Organization of data	do
ISO 2382-5:1989	IS 13557 (Part 5):1993 Information processing systems — Vocabulary: Part 5 Representation of data	do
ISO 7498 : 1984	IS 12373 (Part 1):1987 Basic reference model of open systems interconnection for information processing systems: Part 1	do
ISO 7942:1985	IS 12369:1987 Specification for graphical Kernel system for computer graphics	do
ISO 9179-1:1988	IS/ISO 9179-1:1988 Technical drawings — Numerically controlled draughting machines: Part 1 Vocabulary	do

The concerned Sectional Committee has reviewed the provisions of the following ISO Standards referred in this adopted standard and has decided that they are acceptable for use in conjunction with this standard:

International Standard	*Title*
ISO 2382-9:1984	Data processing — Vocabulary — Part 09: Data communication
ISO 2382-12:1988	Information processing systems — Vocabulary — Part 12: Peripheral equipment

(*Continued on third cover*)

Indian Standard

COMPUTER-AIDED DESIGN (CAD) TECHNIQUE — USE OF COMPUTERS FOR THE PREPARATION OF CONSTRUCTION DRAWINGS

1 Definition of Drawings

Design documentation, including drawings, is the information required to produce a product; in the construction industry this is a building project or a civil work. A drawing is conventionally viewed as an analogical presentation of information; normally a graphical two-dimensional representation in plan and elevation view of a product. There are various levels of abstraction for the product starting at the concept drawings and proceeding to drawings for designing, production, manufacturing, construction, administration , maintenance, etc. In addition to the graphical information (lines) in the form of drawings are the related alphanumeric data (words) in the form of specifications and a wide accumulation of discipline knowledge consisting of codes, company standards, discipline conventions, and design and site changes. These may or may not be represented in the design documentation. In many countries, the specifications, or written part of the construction documentation, take precedent over the "drawings" or graphical part. Therefore one cannot conceive of drawings as simply the graphical representation but must also include all the information necessary to produce a product.

In most countries, it is generally accepted that concept drawings and working drawings serve the function of testing design concepts and recording design decisions, respectively, and that drawings for production and manufacturing are a communication tool used to transfer information from the designer to the constructor and to the fabricator. Drawings are recording devices and information transfer tools; therefore one must not view drawings as an end in themselves, but rather as a growing information base of design and site decisions used in the process of building a product.

In the manual world it is extremely difficult to imagine a static drawing as a growing information base; a major dilemma with paper, erasers, and pens. The existing drawings are always supplemented by additional information: specifications, detail lists, manufacturers guides, codes, and associated standards; all of which augment the information provided on a set of drawings. This information also includes updates to the drawings, new drawings, revisions, design change orders, site change orders, and fabrication drawings; all of these forming part of the ever growing information database. In the past, this information has been handled reasonably well by the construction industry; although an awkward procedure, it has served the construction industry well over the past millenia

There are, however, two major problem areas with these methods that take an inordinate amount of time: cross-referring information and updating information. This is where the CAD Technique will provide a valuable tool for the designer, fabricator, and the constructor, not to mention the initiator and final recipient in the design-build cycle, the owner.

The word "drawing" was derived from "withdrawing" as in "withdrawing information", so "drawing" could mean both the graphical and associated alphanumeric information; this has considerable more meaning and importance when dealing with computers. Specifically, computer-aided design draughting has precipitated a new question regarding the word "drawing": - can a database be a drawing, or the reverse, is a drawing a database?

Computer technology has also introduced new definition problems with terms such as: Computer-Aided Design (CAD), Geometric Modelling, Computer-Aided Design Draughting (CADD), and Computer-Aided Engineering (CAE).

Computers have introduced new parameters to the design process: a dynamic ability to rapidly access and change information and a possibility to cross-reference related pieces of information in an easy manner. These are not new features recently introduced by CAD, but rather new opportunities to deal with drawings in the conventional definition. In addition, the CAD technique will introduce different ways to access building information and will develop new techniques for using the information, many of which are unknown at this time.

To assist in the explanation of these concepts, Figure 1 has been developed to outline the layout of a drawing system using the CAD Technique. This has an analogy to conventional draughting practice: the database is the design representation in the mind of the designer(s), the filters are the manual tasks to produce specific information needed for evaluation or bidding procedures, the drawings are the output product of the design cycle.

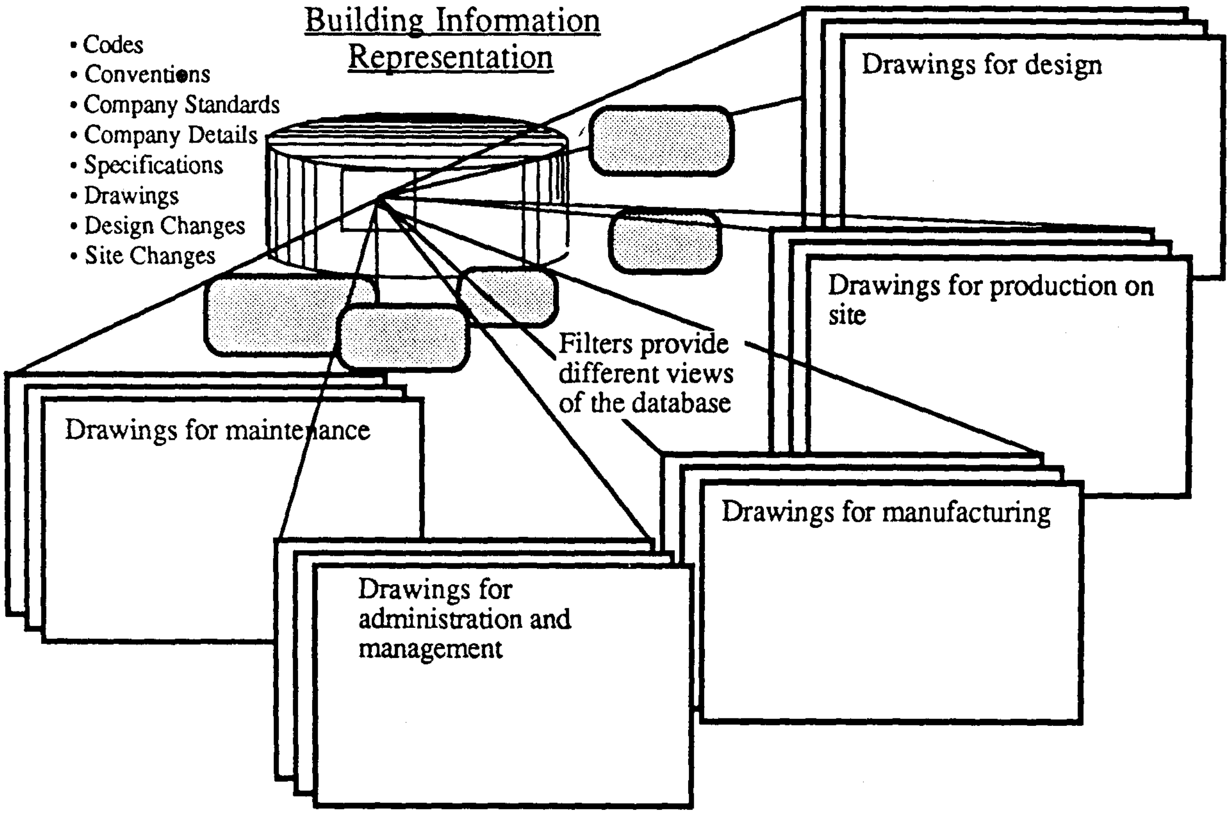

Figure 1

2 CADD Paradox

2.1 Limitations of the CAD Techniques

The limitations of the CAD Technique fall into three categories: display and resolution deficiencies, programming limitations, and functionality uncertainty. This is not intended to be an exhaustive list, but one that identifies major limitations. These will be overcome in the near or intermediate future by technological advancements.

Display Deficiencies: The manual drawing process has an advantage over the automated with respect to the amount of information displayable at one time. Five sheets of A0 drawings can be placed on a table and the information on all can be scanned and cross-referred. The automated system only permits one small portion of one drawing to be displayed on the screen at one time. This disadvantage is temporal; with the advent of better user interface techniques, faster disks, better software design, and larger computer memory and disk space, this will eliminate the existing restrictions in one or two generations of hardware and software (3 to 5 years).

Resolution Deficiencies: Manual draughting displays all information at the same resolution: different scales are used on the drawings to present smaller details, but all the information is readable by the "average" reader, normally ± 0,1 mm on the drawing. The CAD Technique permits the information to be displayed at different scaling factors. Therefore, one can zoom into the drawing to obtain more information. The closer one is, the more detailed is the data, however, there is a loss of information display because the overall picture is not there at that small scale.

Programming Limitations: Not <u>all</u> of the functionality currently possible with the CAD Technique can be made available in <u>all</u> CAD systems at <u>any</u> point in time. There is now enough information about automated draughting to know what is required for most production draughting operations. CAD systems will evolve to meet the new specifications of the designers, so the existing problem is temporal. All CAD software producers will try to make all of the required features available on their machine (or they will not succeed financially).

Functionality Uncertainty: This is a new medium - the refinement of which may take several years. How machines will be used or what will be the best way of performing specific draughting or design functions will not be known until several generations of hardware implementations and software programs have been tested and refined. An example is a graphical input device - a primary function for any graphical system; various input devices were used for decades in research and practice before the digitizing tablet and the mouse were accepted as a universal default for simple graphical entry. This brings forth a major dilemma, how can one standardize before a technology has matured?

2.2 Limitations of the manual system

In the manual system the drawing was the database and standards were developed according to accepted conventional practice. Computer technology has rendered some standards obsolete, but has also introduced the need for more standardization, such as data transfer between different CAD systems. The manual system with its associated standards do not address the complex information world of the CAD Technique and the standards will have to be augmented.

In the conventional manual system the overall structure of the information for any construction project is in the mind of the designer and the user. At times the various information components are held together in a few documents, but there is not an integrated database of information. Computers must deal with information in an ordered, logical fashion, therefore there must be a structure for this construction data. The manual system works fine as is, but if this loosely related system of information is applied to the CAD Technique the automated system may not perform as well as its manual counterpart.

The teaching of a designer and draughtsman is a pure heuristic function, this learning evolves over time and with experience in the construction industry. Many of the opportunities can not be duplicated in a school setting and must be acquired through the trial and error process. Computers have advantages over the manual system in that the system can hold the rules and the knowledge for the user and the user can supply the facts and details. This could greatly reduce the time required to assimilate the knowledge essential for producing technical drawings, thereby producing better designers and buildings.

2.3 Similarities of both systems, manual and automated

All technical innovations alter in a small way the conventional technology. In some way the application of the CAD Technique to technical drawings is no different from the introduction of quill pens, french curves, dry transfers, or micro-filming for construction drawings. It optimizes some operations and makes the overall product more efficient. It produces the same results in a different process, format, or time frame. The product is virtually the same for technical drawings: design and fabrication documentation to assist in the construction of buildings or civil works. The main difference with the CAD Technique is the process by which the information is entered and recorded. Experience in the CAD industry has shown the output product of this new technology should duplicate the output of existing technologies.

2.4 Differences

The CAD Technique is not only the automation of the manual process, but it also provides the opportunity to do operations in new ways that were previously impossible or cost restrictive. Solids modelling is one clear example, another is interference checking.

Another difference between the manual and the automated world is the framework of existing computer systems and computer standards that are currently available internationally. This includes the Initial Graphics Exchange Specification (IGES), Graphical Kernel System (GKS), Programmers Hierarchical Interactive Graphics System (PHIGS) and the Open Systems Interconnection (OSI). In the automated world all of the parts of the computer system must fit together properly, in the manual world many of the parts could exist by themselves. Any standard developed using the CAD Technique will have to relate to existing standards, specifically IGES, GKS, PHIGS, and OSI. Anyone purchasing CAD systems will have to base their purchase in some way on these standards, as a major feature of a CAD system is the ability to upgrade information and capabilities and to transfer data from one CAD system to another and from one designer to another. This provides compatibility with other systems and reduces obsolescence of systems purchased. With current CAD technology it would be foolhardy to purchase an orphan CAD system, running on an orphan machine with an orphan operating system and no data transfer mechanism. In the future this will be even more foolhardy.

Other differences between the two include updates and revisions to plans and drawings on a computer database. This is one that directly affects the technical drawing disciplines. The information provided by the CAD systems can be obtained faster and more accurately by users. This enables designers, contractors, and fabricators to access data in new, innovative ways to date untried. Information access can be considered as instantaneous, thereby providing the users with unlimited access to correct, cross-referred data.

New methods and standards for archiving information will also be required with the CAD Technique. Many questions arise: How long will the data on a disk stay current, will one be able to edit the data in 10 years, what will the cost be of keeping this information up-to-date, etc.? These problems have been addressed with micro-filming standards, but will have to be addressed again with the advent of the CAD Technique.

2.5 Correlation between existing manual drawing practice and CAD

There is a strong correlation between the two methods specifically the output product and the information entry. The current CAD systems rely heavily on the *status quo* for the entry of information into the CAD system and for the output product. It may be decades before the method of presentation of information for technical drawings will be changed drastically. Research into the relationships of data for buildings information is currently on-going and it may be years before a unified structure for building information will be available. Other similarities exist in both the manual and the CAD Technique system: the two produce designs for product fabrication, provide working models for development of design schemes, enable the designer to compare alternatives in an easy, orderly fashion, and provide a working tool for others to access and modify. It is hoped that the advantages of the computer systems will eliminate some manual disadvantages and that the disadvantages of the CAD Technique discussed in the previous sections will be overcome by technological innovations.

2.6 Dilemma

The discussions of the limitations of both the manual and CAD systems in addition to the presentation of the differences and similarities of the two and the correlation between the two has provided insight into the dilemma of the CAD Technique. These deficiencies and conflicts can be clearly identified as the following:

- Computer technology has limitations: display and resolution
- Programming and functionality limitations exist with the CAD Technique
- There is a need for the maturing of CAD Techniques
- Manual recording methods and devices do not take advantage of the newer, faster, more efficient computer technology
- Manual standards need updating
- There is a lack of strong structures in manual presentation of information
- Heuristic nature of learning manual system is slow and time consuming
- Common formats are needed for presentation of information: "drawings"
- Similar data entry methods needed for CAD systems
- There is a need for relationships with other computer standards
- New opportunities are provided by CAD Technique (3D, databases, etc)
- There is an ability to transfer CAD data between different designers/firms
- Easy updates of information exist with the CAD Technique
- Strong cross-referring is possible with CAD information

This is clearly a dilemma for designers and professionals in the construction industry, but these points also affect standards organizations. The new technology has not matured to a point where all of the potential methods and techniques have been clearly identified. In general, the key dilemmas with respect to ISO/TC 10/SC 8 and its WG 12 appear to be:

- How does ISO/TC 10/SC 8 or its WG 12 fit into the CAD picture?
- How can the industry optimize the CAD Technique when not everything is known about all aspects of the technology?
- How can the industry and ISO replace outdated methods with the newer technologies?
- How can the industry structure construction data in a better form now that the CAD Technique is available?
- How does or can ISO/TC 10/WG 4 and ISO/TC 10/SC 8/WG 12 relate to other standards such as IGES, STEP, PHIGS, OSI, or GKS ?
- How can ISO/TC 10/SC 8/WG 12 accommodate, encourage, or direct CAD Technique development and advancement through standardization?

3 Proposed Course of Action

The CAD Technique offers many new opportunities for technical drawing. It will drastically change the presentation of information in the upcoming decades. It may create new professions or alter existing ones. Standardization must follow the lead in specific fields or lead the way in others.

Based on the above discussions, ISO/TC 10/SC 8/WG 12 has identified the following as principal concerns for standards in technical drawings:

- Adopt existing manual draughting practice and standards
- Update manual standards to reflect CAD Techniques

- Work closely with existing automated standards
- Contribute to standards through the development of application CAD Techniques standards
- Create Data Structure needed for the Construction Industry
- Permit area for growth of CAD Technique and standards data in a better form now that the CAD Technique is available.

4 Work Needed that can be Addressed by ISO/TC 10/SC 8/WG 12

4.1 Develop Vocabulary for CAD Techniques

A vocabulary has been developed by ISO/TC 10/SC 8/WG 12 based on the work from the Canadian, draft British, and existing ISO standards. This could be augmented by the vocabulary developed by ISO/TC 10/WG 4 and ISO/TC 10/WG 5.

4.2 Allocate Categories to drawings (e.g. layers, etc.)

This would outline methods for the structuring of CAD information. To date there has been no standardization of the assignment of layers to CAD drawings nationally or internationally. Layering is a common technique used by the majority of CAD systems and has been in usage for over 20 years in the construction industry, although not standardized. Allocation of categories to drawings would be the first step in the development of a structure for construction information.

4.3 Develop Data Structure for CAD Information for the Construction Industry

There is a need for the proper definition of the mandatory structuring of information for construction CAD data. This should reflect the requirements of the construction industry, should be easy to use, should be easy to maintain, should be portable, and should assist the designer and the building owner in their tasks.

The operative words for the definition of the database at this time are:

Structured...... hierarchic with relational ties .... centralized.

The plan is as follows:

- Find out more information from practitioners and collect more practical experience (Canada, Denmark, Finland, France, Germany F.R., Norway, Sweden, UK, USA, etc.)
- Study existing CAD database systems ---- wait one year
- Suggest Generic Data Structure

4.4 Data Interchange standards

Standards such as IGES, STEP, GKS and PHIGS have a direct impact on the use of application standards and *visa versa*. It is then necessary to follow development in other ISO and National Committees by having representation on:

- ISO/TC 10/WG 4 (Technical Drawings, CAD Technique)
- ANSI Y 14.26M (IGES)
- ISO/TC 184 (STEP)
- ANSC X3H3.1 (PHIGS) and ISO/TC 97 (GKS)

4.5 Check use of existing categories of systems

Owing to the close association between the work of Congress International du Bâtiment (CIB) W 74, Working Group in construction information, and that of ISO/TC 10 - Technical Drawings, it has been deemed important to investigate and compare systems to identify commonalties, overlaps, and conflicts.

Glossary of Terms

Note: The following terms and their description should be understood for explanation of the context of this Technical Report only.

Alphanumeric Code
A code according to which data are represented using an alphabetic character set [a numeric character set] [an alphanumeric character set] (ISO 2382/4)

CAD (abbreviation)[1]
Computer-Aided Design
CADD (abbreviation)
Computer-Aided Design Draughting
CAE (abbreviation)
Computer-Aided Engineering

Data
A representation of facts, concepts, or instructions in a formalized manner suitable for communication, interpretation, or processing by humans or by automatic means. (ISO 2382/1)

Database
A set of data, part or the whole of another set of data and consisting of at least one file, that is sufficient for a given purpose or for a given data processing system.(ISO 2382/4)

Data Transfer
Moving data from one computer process to another in an ordered form.

(to) Digitize
To express or represent in a digital form data that are not discrete data.
Example: To obtain a digital representation of the magnitude of a physical quantity from an analog representation of the magnitude. (ISO 2382/5)

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1 Abbreviations such as CAD, CAE, CAM, CADD have not been defined owing to their specific definitions in the various technical disciplines. As a result the terms can be interpreted as meaning the Use of Computers in the Design, Engineering, Manufacturing, or Design Draughting disciplines.

Digitizing Tablet
(or Tablet)
A special flat surface with a mechanism for indicating positions thereon, normally used as a locator (ISO 2382/13).

(magnetic) Disk
A flat circular plate with a magnetizable surface layer on which data can be stored by magnetic recording. (ISO 2382/12)

Graphical Kernel System (GKS)
ISO 7942-1985 Information Processing Systems - Computer Graphics - Graphical Kernel System - Functional Description: The standard provides a set of functions for computer graphics programming. GKS defines a graphics nucleus of a graphics system. It provides a functional interface between an application program and a configuration of graphical input and output devices.

Hierarchic
A tree-structured organization of data where each record is associated with a parent record.

Information
The meaning that humans assign to data by means of the conventions used in their representation. (ISO 2382/1)

Initial Graphics Exchange Specification (IGES)
United States standard (ANSI Y14.26) for the transfer of CAD data from one application program to another.

Interface
A shared boundary between two functional units, defined by functional characteristics, common physical interconnection characteristics, signal characteristics, and other characteristics, as appropriate.
NOTE - The concept involves the application of two devices having different functions. (ISO 2382/9)

Layer
A self-contained group of data that can be manipulated or displayed individually.

Layering

The use of layers in computer-aided design draughting.

Mouse

A hand held locator operated by moving it on a surface. (ISO 2382/13)

(adjective) Modelling

The representation of a real-life situation with an analog model. In the CAD Technique, geometric modelling is the physical representation of objects using computer graphics techniques.

Open Systems Interconnection (OSI)

ISO 7498-1984 Information processing systems - Open Systems Interconnection - Basic reference model for the integration of the seven levels of computer systems architecture.

Programmers Hierarchical Interactive Graphics System (PHIGS) - ISO/IEC 9592

PHIGS provides a set of functions for definition, display, and modification of 2D or 3D graphical data, definition, display, and manipulation of geometrically related objects, modification of graphical data, and the relationships between the graphical data.

Relational Database

A pointer-based database permitting the independent cross referring of data fields with other characters, data, or databases.

(screen) Resolution

The display accuracy of an output device such as a screen, printer, or plotter; normally identified as the number of addressable points per unit length on an output device.

Software

Computer programs, procedures, rules, and any associated documentation concerned with the operation of a data processing system. (ISO 2382/1)

Solids Modelling

A mode of representation and display showing the solid properties of a three-dimensional object.

User Interface

The management routines of a data processing system that controls the method, devices, and management of the input and output of data, normally handled by the application package or the operating system.

Zooming

Progressively scaling the entire (screen) display to give the visual impression of movement of all or part of the display group toward or away from an observer.
Note - The scaling value should be the same in all directions. (ISO 2382/13)

Bibliography

ISO 2382-1 : 1984, *Data processing — Vocabulary — Part 01: Fundamental terms.*

ISO 2382-4 : 1987, *Information processing systems — Vocabulary — Part 04: Organization of data.*

ISO 2382-5 : 1989, *Information processing systems — Vocabulary — Part 05: Representation of data.*

ISO 2382-9 : 1984, *Data processing — Vocabulary — Part 09: Data communication.*

ISO 2382-12 : 1988, *Information processing systems — Vocabulary — Part 12: Peripheral equipment.*

ISO 2382-13 : 1984, *Data processing — Vocabulary — Part 13: Computer graphics.*

ISO 7498 : 1984, *Information processing systems — Open Systems Interconnection — Basic Reference Model.*

ISO 7942 : 1985, *Information processing systems — Computer graphics — Graphical Kernal System (GKS) functional description.*

ISO 9179-1 : 1988, *Technical drawings — Numerically controlled draughting machines — Part 1: Vocabulary.*

ISO/IEC 9592-1 : 1989, *Information processing systems — Computer graphics — Programmer's Hierarchical Interactive Graphics System (PHIGS) — Part 1: Functional description.*

ISO/IEC 9592-2 : 1989, *Information processing systems — Computer graphics — Programmer's Hierarchical Interactive Graphics System (PHIGS) — Part 2: Archive file format.*

ISO/IEC 9592-3 : 1989, *Information processing systems — Computer graphics — Programmer's Hierarchical Interactive Graphics System (PHIGS) — Part 3: Clear-text encoding of archive file.*

(*Continued from second cover*)

International Standard	*Title*
ISO 2382-13:1984	Data processing — Vocabulary — Part 13: Computer graphics
ISO/IEC 9592-1:1989	Information processing systems — Computer graphics — Programmer's Hierarchical Interactive Graphics System (PHIGS) — Part 1: Functional description
ISO/IEC 9592-2:1989	Information processing systems — Computer graphics — Programmer's Hierarchical Interactive Graphics System (PHIGS): Part 2 Archive file format
ISO/IEC 9592-3:1989	Information processing systems — Computer graphics — Programmer's Hierarchical Interactive Graphics System (PHIGS) : Part 3 Clear-text encoding of archive file

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