INTERNATIONAL STANDARD

ISO/IEC 9592-1

First edition
1989-04-01

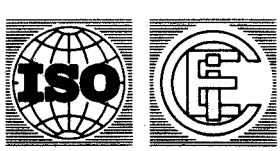
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Information processing systems — Computer graphics — Programmer's Hierarchical Interactive Graphics System (PHIGS) —

Part 1 :
Functional description

Systèmes de traitement de l'information — Infographie — Interface de programmation du système graphique hiérarchisé (PHIGS) —

Partie 1 : Description fonctionnelle



Reference number
ISO/IEC 9592-1 : 1989 (E)

Contents

Page

0 Introduction 1
1 Scope and field of application 3
2 References 4
3 Definitions 5
4 The Programmer's Hierarchical Interactive Graphics System 15
4.1 About this part of ISO/IEC 9592 15
4.1.1 Specification and conformance 15
4.1.2 Registration 15
4.2 Overview 16
4.3 Concepts 18
4.3.1 PHIGS concepts 18
4.3.2 Relationship to ISO 7942 (GKS) and ISO 8805 (GKS-3D) 20
4.3.3 Notational conventions 20
4.4 The centralized structure store 22
4.4.1 Structure elements and structures 22
4.4.2 Structure networks 24
4.4.3 Structure traversal and display 25
4.4.4 Structure editing 28
4.4.5 Manipulation of structures in CSS 29
4.4.6 CSS search and inquiry 30
4.4.7 Structure archival and retrieval 32
4.4.8 Generalized Structure Elements (GSE) 33
4.4.9 Application data 33
4.5 Graphical output 34
4.5.1 Structure elements and output primitives 34
4.5.2 Output primitive attributes 38
4.5.3 Polyline attributes 43
4.5.4 Polymarker attributes 43
4.5.5 Text attributes 44
4.5.6 Annotation text attributes 55
4.5.7 Text extent and concatenation 55
4.5.8 Fill area attributes 58
4.5.9 Fill area set attributes 62
4.5.10 Cell array attributes 63
4.5.11 Generalized drawing primitive attributes 63
4.5.12 Colour 63
4.5.13 View index 64
4.5.14 Hidden line / hidden surface removal (HLHSR) identifier 64

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4.5.15 Name set attribute 64
4.5.16 Minimal simulations 65
4.5.17 Degenerate primitives 65
4.6 Workstations 67
4.6.1 Workstation characteristics 67
4.6.2 Workstation selection 68
4.6.3 Controlling picture changes 68
4.6.4 Clearing the display surface 75
4.6.5 Sending messages to a workstation 75
4.6.6 Hidden line / hidden surface removal 76
4.7 Coordinate systems and transformations 77
4.7.1 Coordinate system handedness 77
4.7.2 Modelling transformations and clipping 77
4.7.3 Modelling utility functions 79
4.7.4 Viewing 80
4.7.5 Viewing utility functions 84
4.7.6 Workstation transformation 90
4.7.7 Transformation of locator input 92
4.7.8 Transformation of stroke input 93
4.8 Graphical input 95
4.8.1 Introduction to logical input devices 95
4.8.2 Logical input device model 96
4.8.3 Operating modes of logical input devices 97
4.8.4 Measures of each input class 100
4.8.5 Input queue and current event report 101
4.8.6 Initialization of input devices 102
4.8.7 Locator and stroke input using 2D input 104
4.9 PHIGS metafile interface 105
4.10 PHIGS states 107
4.11 Inquiry functions 108
4.12 Error handling 109
4.13 Special interfaces between PHIGS and application program 112
4.14 Minimum support criteria 113
5 PHIGS Functional Specification 116
5.1 Notational conventions 116
5.2 Control functions 117
5.3 Output primitive functions 122
5.4 Attribute specification functions 132
5.4.1 Bundled attribute selection 132
5.4.2 Individual attribute selection 133
5.4.3 Aspect source flag setting 150
5.4.4 Workstation attribute table definition 150
5.4.5 Workstation filter definition 158
5.4.6 Colour model control 159
5.4.7 HLHSR attributes 160
5.5 Transformation and clipping functions 161
5.5.1 Modelling transformations and clipping 161
5.5.2 View operations 165
5.5.3 Workstation transformation 167
5.5.4 Utility functions to support modelling 169
5.5.5 Utility functions to support viewing 176
5.6 Structure content functions 179
5.7 Structure manipulation functions 185
5.8 Structure display functions 188
5.9 Structure archiving functions 190
5.10 Input functions 197
5.10.1 Pick identifier and filter 197
5.10.2 Initialization of input devices 197

IECNORM.COM : Click to view the full PDF of ISO/IEC 9592-1:1989

5.10.3 Setting the mode of input devices 215
5.10.4 Request input functions 218
5.10.5 Sample input functions 221
5.10.6 Event input functions 225
5.11 Metafile functions 230
5.12 Inquiry functions 232
5.12.1 Introduction 232
5.12.2 Inquiry functions for operating state values 232
5.12.3 Inquiry functions for PHIGS description table 233
5.12.4 Inquiry functions for PHIGS state list 235
5.12.5 Inquiry functions for workstation state list 238
5.12.6 Inquiry functions for workstation description table 259
5.12.7 Inquiry function for structure state list 288
5.12.8 Inquiry functions for structure content 289
5.12.9 Inquiry functions for error state list 300
5.13 Error control functions 302
5.14 Special interface function 304
6 PHIGS data structures 305
6.1 Notation and data types 305
6.2 Operating states 308
6.3 PHIGS description table 309
6.4 PHIGS traversal state list 312
6.5 PHIGS state list 314
6.6 Workstation state list 316
6.7 Workstation description table 320
6.8 Structure state list 326
6.9 PHIGS error state list 327

Annexes

A Function Lists 328
A.1 Alphabetic 328
A.2 Order of appearance 334
B Error list 341
B.1 Implementation dependent 341
B.2 States 341
B.3 Workstations 341
B.4 Output attributes 341
B.5 Transformations and viewing 342
B.6 Structures 342
B.7 Input 343
B.8 Metafiles 343
B.9 Escape 343
B.10 Archive / retrieve 343
B.11 Miscellaneous 344
B.12 System 344
B.13 Reserved errors 344
C Interfaces 345
C.1 Introduction 345
C.2 Language Binding 345
C.3 Implementation 346
D Allowable differences in PHIGS implementations 348
D.1 Introduction 348
D.2 Global differences 348
D.3 Workstation dependent differences 349
E The PHIGS viewing model 352
F PHIGS/GKS differences 353

IECNORM.COM : Click to view the full PDF of ISO/IEC 9592-1:1989

G HLHSR considerations 355
H Relationship of CGM and PHIGS 356
H.1 Introduction 356
H.2 Scope 356
H.3 Overview of the differences between PHIGS and CGM 356
H.4 Mapping concepts 357
H.4.1 Principles 357
H.4.2 Workstations 357
H.4.3 Picture generation 358
H.4.4 Picture input 358
H.4.5 Coordinates and clipping 359
H.4.6 Workstation transformation 359
H.4.7 Colour table 360
H.4.8 Set representation 360
H.5 Metafile generation 360
H.5.1 Control functions 360
H.5.2 Structure traversal 362
H.5.3 Metafile description 363
H.5.4 User items 364
H.6 Interpretation of CGM by PHIGS 364
H.7 Mapping between item types and elements 366
I Colour models 367
I.1 Introduction 367
I.2 RGB colour model 368
I.3 CIELUV colour model 368
I.3.1 CIE XYZ colour space 368
I.3.2 CIE 1931 (Y,x,y) space 369
I.3.3 The CIE 1976 (L*u*v*) CIELUV uniform colour space 372
I.3.4 Colour differences 373
I.4 HSV colour model 374
I.5 HLS colour model 375
I.6 Conversion between colour models 375
I.6.1 CIE XYZ reference model 375
I.6.2 Conversion between CIELUV and CIE XYZ models 376
I.6.3 Conversion between RGB and CIE XYZ models 376
I.6.3.1 Derivation of conversion factors 376
I.6.3.2 Conversion from RGB to CIE XYZ 377
I.6.3.3 Conversion from CIE XYZ to RGB 377
I.6.3.4 Representation of black 377
I.6.3.5 Example conversion 377

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) together form a system for worldwide standardization as a whole. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for approval before their acceptance as International Standards. They are approved in accordance with procedures requiring at least 75 % approval by the national bodies voting.

International Standard ISO/IEC 9592-1 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

ISO/IEC 9592 consists of the following parts, under the general title *Information processing systems — Computer graphics — Programmer's Hierarchical Interactive Graphics System (PHIGS)*:

— *Part 1: Functional description*

— *Part 2: Archive file format*

— *Part 3: Clear-text encoding of archive file*

Annex D forms an integral part of this part of ISO/IEC 9592. Annexes A, B, C, E, F, G, H, I are for information only.

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Information processing systems — Computer graphics — Programmer's Hierarchical Interactive Graphics System (PHIGS) —

Part 1 :
Functional description

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0 Introduction

The Programmer's Hierarchical Interactive Graphics System (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 graphics data and the relationships between the graphical data.

This International Standard draws extensively on GKS (Graphical Kernel System ISO 7942) and GKS-3D (Graphical Kernel System for Three Dimensions ISO 8805) for its model and functionality. In addition this International Standard enables graphical (and application) data to be stored in a hierarchical data store. Information in the data store can be inserted, modified and deleted with the provided functions. The relationship of this part of ISO/IEC 9592 to GKS and GKS-3D is further described in 4.3.2.

The choice of which graphics standard to use will depend on a number of factors: application profile, overall system architecture, equipment available, existing application database interaction, system performance considerations, user interface requirements, management policy and other external factors. The aim of producing a compatible set of graphics standards in GKS, GKS-3D and PHIGS is to allow that choice to be made in the most flexible way.

The main reasons for introducing a standard in this area of computer graphics are

a) to allow application programs using dynamic hierarchical graphics to be easily portable between installations,

b) to aid the understanding and use of dynamic hierarchical graphics methods by application programmers;

c) to reduce program development costs and time; many of the functions currently performed by the application program will now be performed by PHIGS;

d) to serve manufacturers of graphics equipment as a guideline in providing useful combinations of graphics capabilities in a device.

To meet these objectives, a number of design principles were adopted:

e) Consistency: the mandatory requirements of PHIGS should not be mutually contradictive.

f) Compatibility: this Standard will be compatible with GKS and GKS-3D except when technical reasons justify differences.

g) Orthogonality: the functions should be independent of each other.

h) Completeness: all the functions necessary for application programs to use a dynamic hierarchical graphics system should be included.

i) Minimality: redundant functions are only supported where their availability enables application programs to improve performance or where some collection of capabilities is frequently used.

j) Programmer Experience: those using PHIGS should have a working knowledge of computer graphics.

k) Error Handling: error conditions should be minimized, and their impact well defined.

l) Device Independence: PHIGS should allow an application program to address facilities of different graphics input and output devices with minimal changes to the application program.

m) Device Dependence: PHIGS should allow an application program to address specific graphics input and output devices in a direct manner.

n) Implementability: it should be possible to support PHIGS functions using most languages on most operating systems.

o) Efficiency: PHIGS should be capable of being implemented and executed without consuming undue amounts of computer resources.

p) Interaction: Some application programs will require realtime or near-realtime response from PHIGS. PHIGS will not exclude such application programs though specific graphics devices and dedicated computer resources may be necessary.

Annexes A to C and E to I are given for information; they do not form part of this part of ISO/IEC 9592.

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1 Scope and field of application

This part of ISO/IEC 9592 specifies a set of functions for computer graphics programming, the Programmer's Hierarchical Interactive Graphics System (PHIGS). PHIGS is a graphics system for application programs that produce computer generated pictures on line graphics or raster graphics output devices. It supports operator input and interactions by supplying basic functions for graphical input and hierarchical picture definition. Picture definitions are retained in a *centralized structure store* where they may be edited by an application.

Pictures are displayed on *workstations* consisting of a single output device and a number of input devices. Several workstations can be used simultaneously. The application program is allowed to adapt its behaviour at a workstation to make best use of workstation capabilities.

Functions are specified for archiving picture definitions to file. In addition an interface to the Computer Graphics Metafile (ISO 8632) is described.

NOTE - For certain parameters of the functions, PHIGS defines value ranges as being reserved for registration (see 4.1.2). The meanings of these values will be defined using the established procedures.

This part of ISO/IEC 9592 defines a language independent nucleus of a graphics system for integration into a programming language. PHIGS is embedded in a language layer obeying the particular conventions of the language. Such language bindings are specified for ISO or ISO/IEC languages in ISO/IEC 9593.

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2 References

ISO 646, *Information processing - ISO 7-bit coded character set for information interchange.*

ISO 2022, *Information processing - ISO 7-bit and 8-bit coded character sets - Code extension techniques.*

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

ISO 6093, *Information processing - Representation of numeric values in character strings for information interchange.*

ISO 7942, *Information processing systems - Computer graphics - Graphical Kernel System (GKS) functional description.*

ISO 8632, *Information processing systems - Computer graphics - Metafile for the storage and transfer of picture description information*

- *Part 1 : Functional description*
- *Part 2 : Character encoding*
- *Part 3 : Binary encoding*
- *Part 4 : Clear text encoding*

ISO 8805, *Information processing systems - Computer graphics - Graphical Kernel System for Three Dimensions (GKS-3D) functional description.*

ISO/IEC 9593, *Information processing systems - Computer graphics - Programmer's Hierarchical Interactive Graphics System (PHIGS) language bindings.*

CIE Recommendations on colour space, supplement to CIE publication 15.

CIE 1976 Supplementary standard colour metric of server and coordinate systems.

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3 Definitions

For the purpose of this part of ISO/IEC 9592 the following definitions apply.

NOTE - As far as possible, graphics terminology which is commonly accepted and consistent with other graphics Standards is used.

3.1 acknowledgement: Output to the *operator* of a *logical input* device indicating that a *trigger* has fired.

3.2 addressable point: Any point of a device that can be addressed.

3.3 ancestor structure: A *parent structure* or the ancestor of a *parent structure*.

3.4 annotation: A class of *output primitives* that are defined in *normalized projection coordinates* but are placed with respect to a reference point which may be anywhere in *modelling coordinate space*. The plane on which the annotation appears is always parallel to the x-y plane of the *display space* and is unaffected by modelling and viewing transformations, but the reference point is transformed in the normal manner.

3.5 annotation style: An aspect of *annotation* indicating how relationships between an annotation primitive and a reference point are displayed.

3.6 annotation text relative: An *output primitive* consisting of a character string which is always drawn parallel to the x-y plane of the *display space*. Its position is determined by a reference point defined in *modelling coordinate space* and an offset in *normalized projection coordinates*.

3.7 application data: Data used by an application program, the nature of which is not specified in this standard. Application data is inserted into a *structure* as an "application data" *structure element*.

3.8 archive file: A mechanism for the storage and transportation of graphical data, represented by *PHIGS structures* and their contents.

3.9 aspects of output primitives: The appearance of *output primitives* is controlled by the values of a set of characteristics called "aspects" examples of which are the height of a character or the *linetype* of a *polyline*. Geometric aspects are *workstation* independent and are controlled by the corresponding *attributes*. For non-geometric aspects, the mapping between a particular aspect and its controlling *attribute* is defined by an associated *aspect source flag* (ASF). If the ASF is set to BUNDLED this aspect of the *output primitive* is controlled by the *bundle index attribute*. If the ASF is set to INDIVIDUAL then the aspect is controlled by the corresponding attribute.

3.10 aspect ratio: The ratio of lengths along the principal axes of an object.

3.11 aspect source flag (ASF): A flag indicating whether a particular *workstation* dependent *aspect of an output primitive* is selected from an *attribute* bundle, or as an individual *attribute* selection.

3.12 attribute: Attributes control the properties of *output primitives*. There are four types of attributes: geometric, non-geometric, viewing and identification. The geometric and non-geometric attributes control the values of *aspects of output primitives*.

3.13 back plane: A plane parallel to the *view plane* whose location is specified as an N coordinate value in the *view reference coordinate system*. *Output primitives* behind the back plane lie outside the *view volume*.

3.14 break action: An implementation dependent and *workstation* dependent mechanism enabling the *operator* to interrupt an input operation.

3.15 bundle index: An *attribute* of an *output primitive* which is an index into a *bundle table*; which defines the *workstation* dependent *aspects of the output primitive*.

3.16 bundle table: A *workstation* dependent table specifying aspects of one or more *output primitives*. *PHIGS* has *polyline*, *polymarker*, *text*, *interior*, and *edge* bundle tables.

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3.17 bundle table entry: A single entry in a *bundle table*. Each entry contains one value for each aspect which applies to the corresponding *output primitive*. This set is *workstation* dependent.

3.18 cell array: An *output primitive* consisting of a parallelogram of equal sized cells, each of which is a parallelogram and has a single colour.

3.19 centralized structure store (CSS): The conceptual *workstation* independent storage area for *structure networks*.

3.20 character base vector: An aspect of *text* which defines the direction of the baseline of a character. It is a two-dimensional vector in the *text plane* specified in the *''text'' structure element*.

3.21 character body: The rectangle defining the horizontal and vertical limits of an individual character.

3.22 character expansion factor: An aspect of *text* which specifies the deviation of *character width* from the defined *nominal value* of a given font on a given *workstation*.

3.23 character height: An aspect of *text* which specifies the *nominal value* for the height of an upper case character.

3.24 character set: A registered interpretation for entries in the character code table (see ISO 2022).

3.25 character spacing: An aspect of *text* which specifies the fraction of the font *nominal value* for *character height* to be added between adjacent *character bodies* in a *string*.

3.26 character up vector: An aspect of *text* which defines the principal up direction of the text string. It is a two-dimensional vector in the *text plane* specified in the *"text" structure element*.

3.27 character width: An aspect of *text* which specifies the *nominal value* of the width of a character. The actual width depends on the width to height ratio specified by the designer of the font to which the character belongs.

3.28 child structure: A *structure* specified in a *structure reference*.

3.29 choice device: A *logical input device* providing a non-negative integer defining one of a set of alternatives.

3.30 CIE: Abbreviation for the Commission Internationale de l'Eclairage. Used to refer to the CIE universal colour definition system used as a colour model.

3.31 CIELUV: Abbreviation for the *CIE* 1976 (L*u*v*) colour space.

3.32 clipping: Removing parts of *output primitives* which lie outside a specified volume. The exact effect of clipping some *output primitives* may be implementation or *workstation* dependent.

3.33 colour index: An index used to access an entry in a *colour table*.

3.34 colour model: Characterization of a *colour space* in terms of explicit parameters.

3.35 colour space: Geometric representation of colours in space, usually of three dimensions.

3.36 colour system: A colour coordinate system.

3.37 colour table: A *workstation* dependent table, in which the entries specify the values defining a particular colour.

3.38 composite modelling transformation: A transformation applied to *output primitives* produced during structure *traversal*. It is defined as the concatenation of the *local modelling transformation* and *global modelling transformations* such that the *local modelling transformation* is the first transformation to be applied.

3.39 conflict resolution flag: During the process of *structure archiving* from the *CSS* or *structure retrieval* from an archive, naming conflicts may occur between *structures* on the *archive file* and *structures* in the CSS. The conflict resolution flag indicates how these conflicts will be resolved.

3.40 connection identifier: An implementation specific means of defining the connection to one or more physical entities which constitutes a single *workstation*.

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Definitions

3.41 data record: A compound data type, the content of which is defined by the context within which it is used. For example, the content of the data records used in the input device initialization functions may vary depending upon the particular *prompt* and *echo type* specified in the invocation of the initialization function.

3.42 deferral mode: The deferral mode for a *workstation* is part of the *display update state* and specifies when changes to posted *structure networks* and the *workstation state list* shall be reflected in the displayed *image*.

3.43 descendant structure: A *child structure* or the descendant of a *child structure*.

3.44 device coordinates (DC): A device dependent coordinate system. In *PHIGS*, DC units are metres on a device capable of producing a precisely scaled *image*, and appropriate *workstation* dependent units otherwise.

3.45 device driver: The device dependent part of a *PHIGS* implementation that supports a physical graphics device. The device driver generates device dependent output and handles device dependent interaction.

3.46 device space: The space defined by the *addressable points* of a *display device*. *(Taken from ISO 7942 and ISO 8805)*

3.47 display device: A graphics device on which *images* can be represented. A display device is one possible component of a *workstation*.

3.48 display priority: The priority assigned to a *structure network* when it is posted. It is used to discriminate between *output primitives* when they are mapped to the same *display space* location.

3.49 display space:

(1) That portion of *device space* corresponding to the volume available for displaying *images*.

(2) The working space of an input device. *(Taken from ISO 7942 and ISO 8805)*

3.50 display surface: The physical area on a *display device* onto which *PHIGS images* may be placed.

3.51 display update state: Determines how and when the *display surface* is modified to reflect changes in the *centralized structure store* and the *workstation state list*. An application selects the display update state to take into account the capabilities of a *workstation* and the requirements of the application program. The display update state consists of the two *workstation* dependent aspects of *deferral mode* and *modification mode*.

3.52 echo: The immediate notification to the *operator* of the current *measure* of a *logical input device*.

3.53 echo area; echo volume: An area or volume, defined in *device coordinates*, which may be used for the display of a *prompt* or *echo*.

3.54 echo type: A parameter of device initialization which selects the *echo* technique for a particular *logical input device*.

3.55 edge: The set of boundaries of the polygons defined in the *fill area set output primitive*.

3.56 edge flag: An aspect of *fill area set* which enables or disables the display of *edges*.

3.57 edgetype: An aspect of *fill area set* which indicates the style of the *edges*.

3.58 edgewidth scale factor: An aspect of *fill area set* which indicates the relative width of the *image* of an *edge*. The edgewidth scale factor is applied to a *workstation* dependent *nominal value*.

3.59 edit mode: Determines whether a new *structure element* will replace the *structure element* at the *element pointer* or will be inserted into the open *structure* after the *element pointer*.

3.60 element pointer: A pointer used during *structure editing*, the value of which identifies the position in the open *structure* at which element deletion and creation will occur.

3.61 element position: A number associated with a *structure element* which indicates the element's position within a *structure*.

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3.62 element reference list: A list of references which define the hierarchy within one branch of a *structure network*. Each reference consists of a *structure identifier* and an *element position* within that *structure*. If the list contains N pairs, then the first N-1 pairs identify EXECUTE STRUCTURE elements. The jth such element references the structure named in the (j+1)st list element. The deepest element of the list may identify any type of structure element.

3.63 element type: The identifying classification of a *structure element*. For example, *fill area*, *label*, *application data*, *linewidth scale factor*.

3.64 empty interior style: One possible representation of the *interior* of a *fill area* or *fill area set output primitive*. If the *edges* are not displayed, the *image* of a *fill area set* with *interior style* empty is invisible. The *image* of a *fill area output primitive* with *interior style* empty is always invisible.

3.65 error state list: The data holding information about the most recent error condition.

3.66 escape: A function which provides access to implementation dependent or device dependent features not concerned with the generation of graphical output.

3.67 event mode: An operating mode for a *logical input device* in which asynchronous input is placed on the *event queue* as an *event report* when a *trigger* fires.

3.68 event queue: A time-ordered collection of *event reports*.

3.69 event report: An entry in the *event queue* which consists of a logical input value and identification of the logical input device responsible.

3.70 exclusion set: The portion of a *filter* which defines those *name set* members which are not eligible for a certain operation.

3.71 fill area: An *output primitive* consisting of a single polygon.

3.72 fill area set: An *output primitive* consisting of a set of *fill areas* with or without *edges*.

3.73 filter: The combination of the *inclusion set* and the *exclusion set* which identify *output primitives* eligible or ineligible for a certain operation. *PHIGS* supports filters for *picking*, *highlighting*, *invisibility*, and incremental spatial search.

3.74 font: A set of character representations all of which share certain visual characteristics.

3.75 front plane: A plane parallel to the *view plane* which is specified as an N coordinate value in the *view reference coordinate system*. *Output primitives* in front of the front plane lie outside the *view volume*. *(Taken from ISO 8805)*

3.76 generalized drawing primitive (GDP): An *output primitive* which accesses implementation dependent and *workstation* dependent geometric capabilities such as curve drawing.

3.77 generalized structure element (GSE): A *structure element* which is used to access implementation dependent, *workstation* dependent, or device dependent features during structure *traversal*. It is a *structure element* which accesses *attribute* or control functionality, but does not create an *output primitive*.

3.78 GKS: Graphical Kernel System (ISO 7942)

3.79 global modelling transformation: A component of the *composite modelling transformation*. When *traversal* of a *structure* begins, it is set to the current *composite modelling transformation* of the *parent structure* or if it is the posted *structure*, the default value in the *PHIGS description table*.

3.80 hatch interior style: One possible representation of the *interior* of a *fill area set* or *fill area output primitive*. The *interior* is filled with a pattern of parallel and/or crossing hatch lines, selected from the *workstation*'s *hatch table*.

3.81 hatch table: The table of the hatch values defined on a *workstation*.

3.82 hidden line/hidden surface removal (HLHSR): Removal of those parts of *output primitives* which are obscured by other *output primitives*.

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Definitions

3.83 highlighting: Emphasizing an *output primitive* by modifying its visual *attributes* in some *workstation* dependent manner.

3.84 highlighting filter: A *filter* consisting of two *name sets*, the highlighting *inclusion set* and the highlighting *exclusion set*, used to identify *output primitives* which are eligible for *highlighting*.

3.85 HLS: An abbreviation for the Hue, Lightness, Saturation *colour model*.

3.86 hollow interior style: One possible representation of the *interior* of a *fill area* or *fill area set output primitive*. The *image* is the boundary line only, including any boundaries created by *clipping*.

3.87 HSV: An abbreviation for the Hue, Saturation, Value *colour model*.

3.88 image: The appearance of objects after rendering.

3.89 implicit regeneration: The complete recreation of the contents of a *display surface* such that it is *visually correct*. This may occur when changes to the posted *structure networks* or the *workstation state list* invalidate the displayed *image*. Such a regeneration is not explicitly requested by the application program.

3.90 inclusion set: The portion of a *filter* which defines those *name set* members eligible for a certain operation.

3.91 inheritance: The mechanism by which *child structures* obtain initial *attribute* settings from their *ancestor structures*.

3.92 input class: The characterization of the functionality of a logical input device. There are six classes of logical input device: locator, stroke, valuator, choice, pick, and string.

3.93 input mode: One of the three possible methods of obtaining data from a logical input device: REQUEST, SAMPLE, or EVENT.

3.94 inquiry function: A mechanism for communicating to the application program data contained in a state list or description table.

3.95 interior: The set of points which lie inside a *fill area* or *fill area set*. *PHIGS* provides a rule for determining whether or not a given point is inside a *fill area* or *fill area set*.

3.96 interior style: An aspect which indicates the style used to fill the *interior* of a *fill area* or *fill area set*.

3.97 invisibility: The state of an *output primitive* being hidden from view even when lying within the *display surface* and not occluded by other *output primitives*.

3.98 invisibility filter: A *filter* consisting of two *name sets*, the *invisibility inclusion set* and the *invisibility exclusion set*, used to identify *output primitives* eligible for *invisibility*.

3.99 isotropic mapping: A transformation which preserves *aspect ratio*.

3.100 label: A *structure element*, consisting of an identifier, which can be used as a place-marker to facilitate *structure editing*.

3.101 language binding: The expression of a functional specification in the syntax of a particular programming language.

3.102 linetype: An aspect which indicates the style of the *image* of a *polyline*, such as solid, dashed or dotted.

3.103 linewidth scale factor: An aspect which indicates the relative width of the *image* of a *polyline*. The linewidth scale factor is applied to a *workstation* dependent *nominal value*.

3.104 local modelling transformation: A component of the *composite modelling transformation*. When *traversal* of a *structure* begins, it is set to the identity transformation.

3.105 locator device: A *logical input device* providing a position in *world coordinates* and an associated *view index*.

3.106 logical input device: An abstraction of one or more *physical input devices* which delivers logical input values to the application program.

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3.107 marker: A glyph with a specified appearance which is used to identify a location on a *display surface*. The shape of a marker is not subject to transformation.

3.108 marker size scale factor: An aspect which indicates the relative size of the *image* of a *marker*. The marker size scale factor is applied to a *workstation* dependent *nominal value*.

3.109 marker type: An aspect which selects the type of glyph used for *markers*.

3.110 measure: A value which is determined by the values of one or more *physical input devices* and a mapping from these values to a form required by one of the logical *input classes*. *(Taken from ISO 7942 and ISO 8805)*

3.111 measure process: A process which comes into existence when a *logical input device* is enabled for interaction. The current state of a measure process is the *measure*.

3.112 message: A *string* sent by the application program to a *workstation* principally for communication with the *operator*.

3.113 metafile: A mechanism for retaining and transporting graphical data and control information. A metafile contains a device independent description of one or more pictures. *(Taken from ISO 8632)*

3.114 minimal simulation: The minimal required action which is necessary when a *workstation* does not have the capability to render an *output primitive* as specified by the application.

3.115 modal: A type of change mechanism which extends its effect until another change specification supersedes it. *Attribute* settings and control functions are modal for a given *structure* and its *descendant structures*.

3.116 modelling coordinates: The device independent three-dimensional Cartesian coordinate system in in which graphical objects are defined by the application program using the *PHIGS output primitives*.

3.117 modelling transformation: See *local modelling transformation*, *global modelling transformation*, *composite modelling transformation*.

3.118 modification mode: Part of the *display update state*. The modification mode governs what category of visual effects shall be immediately achieved, and how they are achieved, on a *workstation*.

3.119 name set: An *output primitive attribute* consisting of a set of classifications defining the eligibility of *output primitives* for *highlighting*, *invisibility*, *picking* and incremental spatial search.

3.120 nominal value: The *workstation* dependent base value for *aspects of output primitives*.

3.121 normalized projection coordinates (NPC): The device independent three-dimensional Cartesian coordinate system in which the composition of images is specified to the graphics system. The view clipping limits and the *workstation window* are specified in NPC space.

3.122 operator: Person manipulating *physical input devices* so as to change the measures of *logical input devices* and cause their *triggers* to fire. *(Taken from ISO 7942 and ISO 8805)*

3.123 output primitive: A fundamental graphical display entity representing a geometric shape.

3.124 parallel transformation: The transformation of an object in which parallel lines in the object appear parallel in the resulting *image* without regard to relative distance or depth. *(Taken from ISO 8805)*

3.125 parent structure: A *structure* which contains one or more *structure references*.

3.126 pattern interior style: One possible representation of the *interior* of a *fill area* or *fill area set output primitive*. The *interior* is filled in with a two dimensional pixel pattern selected from the *workstation*'s *pattern table*.

3.127 pattern table: The table of the pattern values defined on a *workstation*.

3.128 perspective transformation: The transformation of an object in which parallel lines in the object which intersect the *view plane* appear to converge in the resulting *image* as a function of relative distance or depth. *(Taken from ISO 8805)*

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Definitions

3.129 PHIGS: The Programmer's Hierarchical Interactive Graphics System.

3.130 PHIGS description table: The data which represents the static *workstation* independent parameters of a *PHIGS* system.

3.131 PHIGS state list: The data which represents the dynamic *workstation* independent parameters of a *PHIGS* system.

3.132 PHIGS traversal state list: The data which represents the dynamic *workstation* independent parameters of a *PHIGS* system during *traversal* of a *structure network*. When *traversal* begins the *PHIGS* traversal state list values are set to the values defined in the *PHIGS description table*.

3.133 physical input device: Hardware capable of generating input. A physical input device is either part of a *display device* or a separate part of the *workstation*.

3.134 picking: An *operator* action of identifying an *output primitive* using a *pick device*.

3.135 pick device: A *logical input device* providing a *pick path*.

3.136 pick filter: A *filter* consisting of two *name sets*, the pick *inclusion set* and the pick *exclusion set* used to identify *output primitives* which are eligible for selection by a pick input operation.

3.137 pick identifier: A name associated with individual *output primitives*, and returned by a *pick device* as a component of the *pick path*.

3.138 pick path: The *element reference list* representing a path to a picked *output primitive* from its posted *structure*, consisting of the *structure identifier*, *pick identifier*, and *element position* for each level of hierarchy traversed.

3.139 polyline: An *output primitive* consisting of a connected sequence of straight lines between specified points.

3.140 polymarker: An *output primitive* consisting of a set of locations, each indicated by the same type of *marker*.

3.141 post: To identify a *structure network* for display on a particular *workstation*.

3.142 projection reference point (PRP): A point in *view reference coordinate space* which determines the direction of *projectors* when the *projection type* is PARALLEL, or from which all *projectors* emanate when the *projection type* is PERSPECTIVE. *(Taken from ISO 8805)*

3.143 projection type: The type of transformation to be used in view mapping, i.e., *parallel transformation* or *perspective transformation*.

3.144 projection viewport: A rectangular parallelepiped in *normalized projection coordinate* space. In the *PHIGS* viewing model, the view mapping transformation maps the contents of the *view volume* into the projection viewport.

3.145 projector: A conceptual line which passes through a point of an object and intersects the *view plane*.

3.146 prompt: Output to the *operator* indicating that a specific *logical input device* is available. *(Taken from ISO 7942 and ISO 8805)*

3.147 request mode: An operating mode for a *logical input device* in which *PHIGS* waits until the *operator* activates the appropriate *trigger* where upon the *measure* is returned.

3.148 RGB: An abbreviation for the Red, Green, Blue *colour model*.

3.149 sample mode: An operating mode for a *logical input device* in which the *measure* of a *logical input device* may be obtained immediately without waiting for a *trigger*.

3.150 solid interior style: One possible representation of the *interior* of a *fill area* or *fill area set output primitive*. The *interior* is filled with a uniform colour.

3.151 string: An ordered collection of character codes as described in ISO 2022.

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3.152 string device: A *logical input device* providing a *string*.

3.153 stroke device: A *logical input device* providing a sequence of points in *world coordinates*, and an associated *view index*.

3.154 structure: A linear sequence of *structure elements*.

3.155 structure archiving: The process of storing *structures* and *structure networks* in an *archive file* for subsequent *structure retrieval*.

3.156 structure editing: The modification of a *structure*, including its initial creation.

3.157 structure element: The fundamental unit of data in the *centralized structure store*, a sequence of which is collected to form a *structure*. Structure elements include elements causing the generation of *output primitives*, *attribute* selections, *labels*, *application data*, *NAME SET* specifications, transformation selections and *structure references*.

3.158 structure identifier: A unique application specified name used to reference a structure.

3.159 structure network: A collection of *structures* arranged with the topology of an acyclic directed graph, where *structures* are thought of as nodes and execute *structure elements* are thought of as connections from the *parent structure* to the *child structure*.

3.160 structure reference: The invocation of one *structure* from within another by an execute *structure element* or the invocation of a *structure* by posting.

3.161 structure retrieval: The process of copying *structures* from an *archive file* to the *centralized structure store*.

3.162 structure state list: The data which represents information about each *structure* in the *centralized structure store*.

3.163 text: An *output primitive* consisting of a character string drawn at a specified position on a specified *text plane*.

3.164 text alignment: An aspect of *text* which specifies the mode of justification. This aspect has horizontal and vertical components.

3.165 text direction vectors: Two vectors, specified as part of the "*text*" *structure element*, which, together with the *text position*, define the *text plane*.

3.166 text extent: A parallelogram defining the minimum area which completely encloses the *character bodies* in a *string*.

3.167 text font: An aspect of *text* which indicates certain visual properties of a character, such as typeface.

3.168 text local coordinate system: The local coordinate system for *text output primitives* within which all geometric *text attributes* are measured.

3.169 text path: An aspect of *text* which controls the relative positioning of successive characters in a *string*.

3.170 text plane: The plane in which a *text output primitive* appears.

3.171 text position: A point, specified as part of the "*text*" *structure element*, which, together with the *text direction vectors*, determine the *text plane*. It also determines, together with *text alignment*, the location of the *string*.

3.172 text precision: An aspect of *text* which selects the fidelity with which the drawing of a *text output primitive* matches the appearance selected by an application program.

3.173 transformation pipeline: The ordered sequence of transformations which convert *modelling coordinates* to *device coordinates*.

3.174 traversal: The process of stepping through a *structure network*, elaborating each *structure element* by generating an *output primitive* or changing the state lists.

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Definitions

3.175 traversal state list: See *PHIGS traversal state list*.

3.176 trigger: A *physical input device* or set of devices that an *operator* can use to indicate significant moments in time. *(Taken from ISO 7942 and ISO 8805)*

3.177 trigger process: A process which notifies an associated *logical input device* when a *trigger* is fired. The trigger process only exists when a device is in *EVENT mode*, or in *REQUEST mode* with a request pending.

3.178 unpost: To remove the identification of a *structure* for display on a particular *workstation*.

3.179 valuator device: A *logical input device* providing a real number.

3.180 view index: An *output primitive attribute* that selects the *view representation* applied to *output primitives* and geometric *attributes* during structure *traversal*.

3.181 view mapping matrix: A 4×4 matrix which specifies the transformation of points from *view reference coordinates* to *normalized projection coordinates*.

3.182 view orientation matrix: A 4×4 matrix which specifies the conversion of points from *world coordinates* to *view reference coordinates*.

3.183 view plane: A plane parallel to the U-V plane in *view reference coordinate space (VRC)*. It is specified as an N coordinate value in VRC.

3.184 view plane normal: A vector in *world coordinates*, relative to the *view reference point*, which defines the N coordinate axis of the *view reference coordinate system*.

3.185 view reference coordinate (VRC) system: A device independent three-dimensional Cartesian coordinate system in which the parameters for the view mapping transformation are specified. The axes of the view reference coordinate system are called the U, V and N axes. The position and orientation of this coordinate system, relative to *world coordinates*, are defined by the *view reference point*, the *view plane normal* and the *view up vector*. *(Taken from ISO 8805)*

3.186 view reference point: A point in *world coordinates* which defines the *view reference coordinate system* origin. *(Taken from ISO 8805)*

3.187 view representation: A single entry in the *view table*. It consists of the *view orientation matrix*, the *view mapping matrix*, the view clipping limits and a set of clipping indicators.

3.188 view table: The table of *view representations* defined on a *workstation*. Its entries are referenced by the *view index attribute*.

3.189 view transformation input priority: Determines the order in which *view table* entries are tested when selecting the inverse viewing transformation to be applied to locator and stroke input.

3.190 view up vector: A vector defined in *world coordinate* space. The *view reference coordinate system* V coordinate axis is defined as an orthogonal projection of the view up vector onto the plane through the *view reference point* and perpendicular to the *view plane normal*. Vectors which are parallel to the view up vector in *world coordinate* space will appear vertical in the final *image*. *(Taken from ISO 8805)*

3.191 view volume: The view volume is determined by the *view window* defined in the *view plane*, the *front plane*, the *back plane*, and *projectors* through the corners of the *view window*. If the *projection type* is PERSPECTIVE, the *projectors* all pass through the *projection reference point*, the view volume is therefore a frustum. If the *projection type* is PARALLEL, the projectors are parallel to the vector joining the *projection reference point* to the centre of the *view window*, the view volume in this case is a parallelepiped. In two dimensional application programs, the view volume reduces to the *view window*. *(Taken from ISO 8805)*

3.192 view window: A rectangle in the *view plane*. *Projectors* passing through the corners of the view window define the left, right, bottom and top surfaces of the *view volume*. *(Taken from ISO 8805)*

3.193 visually correct: The display on a *workstation* is visually correct when it corresponds exactly to the state of *centralized structure store* and the *workstation state list*.

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3.194 workstation: *PHIGS* is based on the concept of abstract graphical resources, which provide the logical interface through which the application program controls physical devices. A workstation consists of zero or one *display space* and zero or more *logical input devices*.

3.195 workstation category: A property of a *workstation* which indicates whether it can perform graphics input only, graphics output only, or both.

3.196 workstation description table: The data which represents capabilities for a particular *workstation type*.

3.197 workstation identifier: A unique application specified name used to identify a particular *workstation*.

3.198 workstation state list: The data which represents dynamic information for a particular *workstation*.

3.199 workstation transformation: A transformation which maps the contents of the *workstation window* into the *workstation viewport*, preserving *aspect ratio* in X and Y, but not necessarily in Z.

3.200 workstation type: A type or class of actual *workstation*, sharing common characteristics and a single *workstation description table*.

3.201 workstation viewport: A rectangular parallelepiped in *device coordinate* space. All graphics output appears within this volume. *(Taken from ISO 7942 and ISO 8805)*

3.202 workstation window: A rectangular parallelepiped in *normalized projection coordinate* space. Its contents are mapped by the *workstation transformation* into the *workstation viewport*. *(Taken from ISO 8805)*

3.203 world coordinates (WC): The device independent three-dimensional Cartesian coordinate system used by the application program to organize modelled objects for display. The effect of applying the *composite modelling transformation* to *modelling coordinates* is to produce world coordinates.

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4 The Programmer's Hierarchical Interactive Graphics System

4.1 About this part of ISO/IEC 9592

4.1.1 Specification and conformance

The set of functions known as PHIGS shall be as described in clauses 4, 5 and 6. A conforming implementation of PHIGS shall correctly implement all the functions described. Minimum support criteria are specified in table 1 (4.14). A conforming PHIGS implementation shall also provide the information described in annex D and the minimum support specified in 4.3. In a conforming implementation all graphical capabilities that can be addressed by PHIGS shall be used only via PHIGS.

4.1.2 Registration

For certain parameters of the functions, PHIGS defines value ranges as being reserved for registration. 1) The meanings of these values will be defined in the register. These procedures do not apply to values and value ranges defined as being workstation or implementation dependent; these values and ranges are not standardized.

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1) For the purpose of this International Standard and according to the rules for the designation and operation of registration authorities in the ISO/IEC JTC 1 procedures, the ISO and IEC Councils have designated the National Institute of Standards and Technology (National Computer Systems Laboratory), A-266 Technology Building, Gaithersburg, MD 20899, USA to act as registration authority.

4.2 Overview

The Programmer's Hierarchical Interactive Graphics System (PHIGS) provides a functional interface between an application program and a configuration of graphical input and output devices. The functional interface contains basic functions for dynamic interactive hierarchical graphics on a wide variety of graphics equipment.

The interface is at such a level of abstraction that hardware peculiarities are shielded from the application program. As a result, a simplified interface presenting uniform output primitives (POLYLINE, POLYMARKER, TEXT, ANNOTATION TEXT RELATIVE, FILL AREA, FILL AREA SET, CELL ARRAY, GENERALIZED DRAWING PRIMITIVE), and uniform input classes (LOCATOR, STROKE, VALUATOR, CHOICE, PICK, STRING) is obtained.

In 4.4 the concepts of structures and the centralized structure store are introduced.

In 4.5 and 4.8 the concepts of basic output, input and the organization of input and output sequences are outlined.

In 4.6 a central concept, the workstation, is introduced both for structuring PHIGS and for realizing device independence. The concept of multiple workstations allows simultaneous output to and input from various display systems.

Some PHIGS concepts are described as being *workstation dependent*. This means that an implementation is allowed to specify the characteristics of these concepts on a workstation by workstation basis.

All workstation dependent concepts are explicit in the standard. Other PHIGS concepts are described as being *implementation dependent*. This means that an implementation is allowed to determine the effect (rather than having the effect mandated by the standard). However, such effects shall be the same on all workstations in a single implementation.

Annex D describes allowable differences between PHIGS implementations.

PHIGS defines only a language independent nucleus of a graphics system. For integration into a language, PHIGS is embedded in a language dependent layer containing the language conventions, for example, parameter and name assignment.

The layer model represented in figure 1 illustrates the role of PHIGS in a graphics system. Each layer may call the functions of the adjoining lower layers. In general the application program uses the application oriented layer, the language dependent layer, other application dependent layers, and operating system resources.

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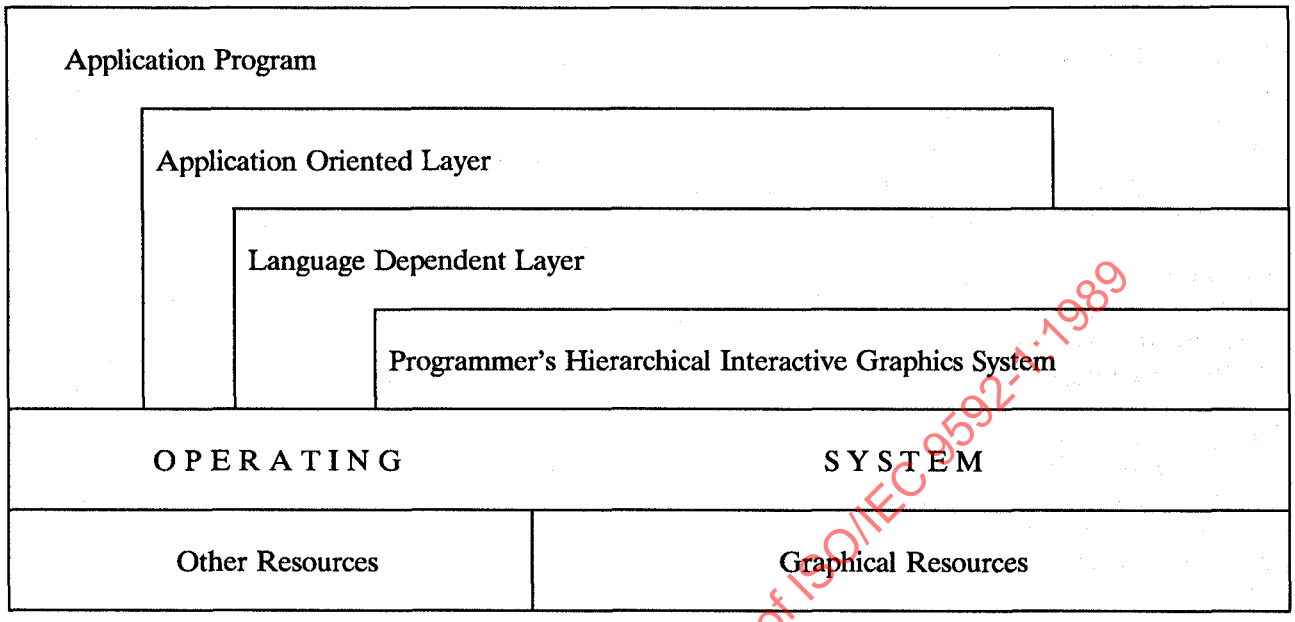


Figure 1 - Layer model of PHIGS

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4.3 Concepts

4.3.1 PHIGS concepts

PHIGS supports the storage and manipulation of data in a centralized hierarchical data structure, known as the *centralized structure store* (CSS). The fundamental entity of data is a *structure element* and these are grouped together into units called *structures*. Structures are organized as acyclic directed graphs called *structure networks*. The creation and manipulation of the data structure is independent of its display.

Structure elements can be either graphical data or application specific data. Graphical data consists of information for structure management and control as well as for output definition. Functions are provided to edit structures by the insertion and removal of structure elements. Functions are also provided to support searching and inquiry of the content and topology of structure networks and the CSS in general.

The graphical output that is generated by PHIGS is built up from two groups of basic elements called *output primitives* and *primitive attributes*. The output primitives are abstractions of basic actions a device can perform, such as drawing lines and displaying character strings. The attributes control the properties of the primitives on a device, such as their aspects; for example linetype, colour, and character height. Non-geometric aspects such as colour can be controlled for each workstation separately to make best use of its capabilities.

The graphical information that is input from a device as a result of operator actions is mapped by PHIGS onto six classes of input, each represented by a data type referred to as a logical input value. An instance of such a device representation is called a logical input device. The effect of input actions on the display surface, such as prompts and echoes, is controlled by PHIGS for each logical input device individually.

The two abstract concepts (abstract output and abstract input) are the building blocks of an abstract workstation. A PHIGS workstation represents a unit consisting of zero or one display surfaces and zero or more input devices, such as keyboard, tablet and lightpen. The workstation presents these devices to the application program as a configuration of abstract devices thereby shielding the hardware peculiarities.

Graphical output on a workstation is produced by traversing a structure identified for display on that workstation and interpreting the structure elements. Application specific data is generally ignored during structure traversal.

The geometric information (coordinates) stored within the graphical structure elements are processed through workstation independent and workstation dependent stages. The workstation independent stage of structure traversal performs a mapping from modelling coordinates to a world coordinate system during which graphical structure elements can produce output primitives.

The workstation dependent stage then performs a transformation on the geometric information contained in output primitives, attributes and logical input values (locator and stroke). These transformations perform mappings between four coordinate systems, namely:

a) World Coordinates (WC) used to defined a uniform coordinate system for all abstract workstations;

b) View Reference Coordinates (VRC), used to define a view;

c) Normalized Projection Coordinates (NPC) used to facilitate assemblies of different views;

d) Device Coordinates (DC), one coordinate system per workstation representing its display space.

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Output primitives and attributes are mapped from WC to VRC by the view orientation transformation, from VRC to NPC by the view mapping transformation and finally from NPC to DC by the workstation transformation. Locator and stroke input is mapped by the inverse of these transformations from DC to WC.

Regions may be identified in the world and normalized projection coordinate systems which, during the mappings described above, may result in the clipping of portions of graphical output which lie outside one or more of the regions. Modelling clip regions may be defined in modelling coordinates. These regions are then transformed to world coordinates and combined to form a composite modelling clip region which may then be applied to the graphical output. Another clip region is defined as part of a view definition to limit the generation of graphical output. A third clip region associated with the workstation transformation identifies a subset of the image for display on the workstation.

The attributes which control the appearance of parts of the picture (output primitives, prompt and echo types) on the display space are organized in a uniform manner. Two groups of attributes apply to the appearance of each output primitive: primitive attributes (that are workstation independent) and workstation attributes. Primitive attributes are specified modally and are bound to a primitive when it is created at structure traversal time. The primitive attributes include all geometric aspects of primitives, such as character height for text and pattern size for fill area and fill area set. In addition, the non-geometric aspects of primitives are controlled by the primitive attributes in one of two ways. Either an attribute is used to specify a group of the non-geometric aspects of the primitive by an index (or set of indices in the case of the fill area primitives) which points to a workstation dependent representation (set of values) or one attribute is used to specify each of the non-geometric aspects of the primitive in a workstation independent way. The former is referred to as bundled specification and the latter is referred to as individual specification. In addition, when a primitive is created by traversal an index is bound to it which selects the view orientation and view mapping transformations which are workstation dependent.

Each primitive has associated with it a NAME SET attribute defined at structure traversal time. This NAME SET attribute defines the eligibility of the primitive for highlighting, invisibility, picking and incremental spatial search. A filter mechanism is incorporated in PHIGS with an inclusion and exclusion set mask at each workstation to control specific rendering of the primitives.

The attribute selection is controlled by the nature of the structure network. The effect of an attribute is defined within the structure in which it occurs and in subsequent structures below it in the hierarchy. Output renderings of the same structure may therefore be different due to the inheritance of attributes.

Workstation attributes include representations for those non-geometric aspects which are workstation dependent, and are selected via bundle indices. For example, the representations (or bundles) for polyline each contain values of linetype, linewidth scale factor and colour index. Workstation attributes also specify the colour and pattern tables and control the updating of the display. Workstation attributes can be reset dynamically.

Hidden lines or hidden surfaces may be removed using a workstation dependent method (see 4.5.14 and 4.6.6).

The attributes which control the operation of logical input devices can be specified either upon initialization or as part of input device setting, depending upon the attributes. Through initialization, an initial value, a prompt and echo technique, and an area on the device for echoing can be specified. A data record may further provide device specific attributes. Through input device setting, the operating mode may be selected and the echo may be switched on or off. The operating modes of logical input devices specify who (operator or application program) has the initiative:

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e) SAMPLE input is acquired directly by the application program;

f) REQUEST input is produced by the operator in direct response to the application program;

g) EVENT input is generated asynchronously by the operator and is collected in a queue for the application program.

PHIGS provides an interface to enable the information contained in the centralized structure store to be archived or retrieved. These PHIGS *archive files* provide for the storage and interchange of graphics models expressed as PHIGS structure networks.

PHIGS also provides an interface to a system for filing graphical image information for the purpose of external long term storage and exchange of graphical image information. The interface consists of a metafile output workstation, which writes to a graphics metafile, and a metafile input workstation, which reads from the metafile. In addition to the normal functions for output to workstations, a metafile workstation may accept items containing non-graphical information. Input from a metafile is controlled by read and interpret functions.

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4.3.2 Relationship to ISO 7942 (GKS) and ISO 8805 (GKS-3D)

The primary emphasis of PHIGS is different from that of GKS/GKS-3D. Unlike GKS/GKS-3D, PHIGS is not restricted to graphics and provides data structure definition and editing facilities which are not necessarily related to graphical output. PHIGS defines data structures which can be rendered as graphical output, rather than being purely directed towards providing graphical output and interaction.

Whereas GKS provides for graphical output and interaction in a 2D space, GKS-3D and PHIGS provide graphical output and interaction in a 3D space. The relationship between GKS and GKS-3D is necessarily closer than that between GKS and PHIGS, and whereas GKS-3D is oriented towards the direct output of graphical primitives grouped into segments, PHIGS provides data structures which are traversed to produce graphical output. However, the output primitives and their attributes generated at structure traversal time are a superset of those of GKS-3D.

PHIGS provides the same underlying model of input as GKS-3D. The measure of the pick logical input device is extended to identify the structure element in the CSS which generates the primitive picked by the operator.

The original GKS concept of the workstation has been extended to support the increased dimensionality. Also, PHIGS supports posting to workstations rather than workstation activation for the purpose of directing graphics output to a workstation.

Annex F describes the technical differences between PHIGS and GKS/GKS-3D.

4.3.3 Notational conventions

This Standard uses the following typographical conventions.

a) The names of attributes of primitives appear in upper case (see 4.5.2).

b) Geometric aspects of primitives appear in upper case. Non-geometric aspects appear in lower case except when the corresponding individually specified attributes are being used, in which case they appear in upper case (see 4.5.2).

c) The names of entries in the PHIGS data structures (e.g. state lists and description tables) appear in lower case surrounded by single quotation marks.

d) The names of structure elements appear in lower case surrounded by double quotation marks.

e) The names of PHIGS functions appear in upper case.

f) The values of an enumeration data type appear in upper case (see 6.1).

g) The names of data types appear in upper case.

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4.4 The centralized structure store

4.4.1 Structure elements and structures

PHIGS supports the storage and manipulation of data in a *centralized structure store* (CSS). The CSS contains graphical and application data organized into units called *structures*, which may be related to each other hierarchically to form *structure networks*. Each structure is identified by a unique name which is specified by the application.

A structure consists of a sequence of *structure elements*, where a structure element is the fundamental entity of data. Structure elements are used to represent application specified graphics data for output primitives, attribute selections, view selections, modelling transformations and clipping, name sets, invocations of other structures, and to represent application data. In addition, generalized structure elements can be used to access additional, implementation dependent features. Label structure elements may be used to identify locations in structures to assist in editing. Structure elements cannot exist outside of structures.

The following structure elements are defined in PHIGS.

Output primitive structure elements

polyline 3	fill area 3
polyline	fill area
polymarker 3	fill area set 3
polymarker	fill area set
text 3	cell array 3
text	cell array
annotation text relative 3	generalized drawing primitive 3
annotation text relative	generalized drawing primitive

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Attribute specification structure elements

set polyline index	set annotation text character up vector
set polymarker index	set annotation text path
set text index	set annotation text alignment
set interior index	set annotation style
set edge index	set interior style
set linetype	set interior style index
set linewidth scale factor	set interior colour index
set polyline colour index	set edge flag
set marker type	set edgetype
set marker size scale factor	set edgewidth scale factor
set polymarker colour index	set edge colour index
set text font	set pattern size
set text precision	set pattern reference point and vectors
set character expansion factor	set pattern reference point
set character spacing	add names to set
set text colour index	remove names from set
set character height	set individual ASF
set character up vector	set hlhsr identifier
set text path	set view index
set text alignment	set pick identifier
set annotation text character height	

Transformation and clipping structure elements

set local transformation 3	set modelling clipping volume 3
set local transformation	set modelling clipping volume
set global transformation 3	set modelling clipping indicator
set global transformation	restore modelling clipping volume

Control structure element

execute structure

Editing structure element

label

Generalized structure element

generalized structure element

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Application data element

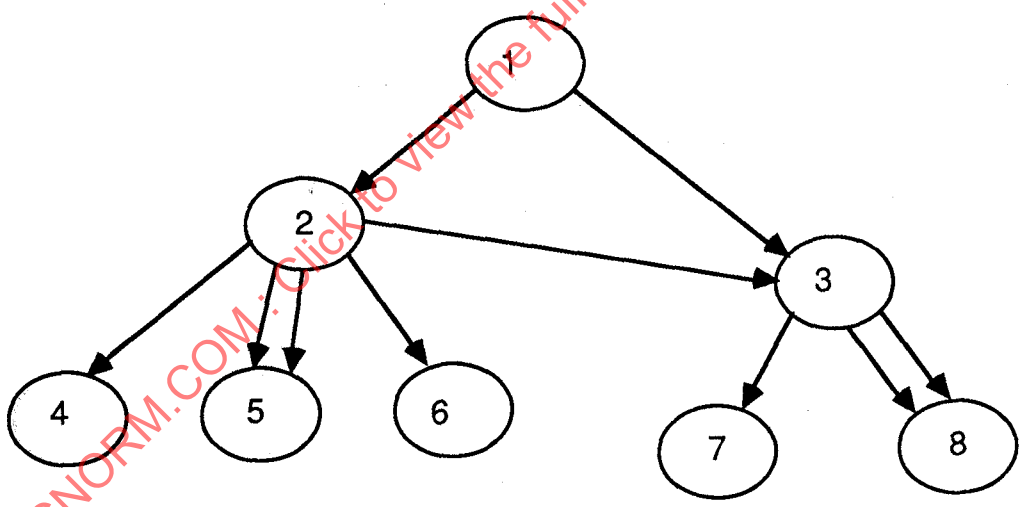
application data

Although the PHIGS CSS is conceptually a centralized data model, this does not preclude an implementation from decentralizing the physical organization of the data storage, provided that this implies no restrictions on the functionality.

4.4.2 Structure networks

Structure networks are organized as directed acyclic graphs. That is, a structure may contain invocations of other structures contained within the CSS. The invocation of a structure is achieved using the "*execute structure* " element. Such an invocation is known as a *structure reference*. Structure networks cannot be recursive: there should not exist a sequence of invocations from a structure which results in the invocation of that structure; however, it is not mandated that this condition be checked.

A PHIGS structure network can be represented diagrammatically as shown in figure 2. Here, the structures are represented by circles labelled with the structure identifiers, and structure references are shown by arrows, which point to the invoked structures.



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Figure 2 - A hierarchical structure network

When a structure S contains invocations of other structures, it is said to be a *parent* of those structures; correspondingly, each of the invoked structures is said to be a *child* of S. For example, structure 2 is the parent of structures 4,5, and 6; structures 2 and 3 are children of structure 1. Also, structures 1 and 2 are said to be *ancestors* of structures 4,5 and 6; while structures 7 and 8 are *descendants* of structures 1, 2 and 3.

Many types of operations available to the application are allowed on structure networks within the CSS. These are structure display, structure editing, structure manipulation, search and inquiry, and structure

archival and retrieval. Conceptually, all changes to the CSS, which result from any of the above operations are atomic and take effect immediately. However, the actual time at which visual changes take effect depends on the capabilities of the workstation and the current display update state (see 4.6.3).

For all of the structure operations, a structure exists if and only if the PHIGS CSS has knowledge of the structure's unique identifier. A structure can be created in one of the following ways:

a) when a reference to non-existent structure is inserted into a structure in the CSS;

b) when the structure is opened for the first time;

c) when the structure is posted for display on a workstation;

d) when the structure is referenced in any function changing the structure identifier;

e) when a structure not existing in the CSS is retrieved from an archive;

f) when a non-existent structure is emptied.

The following functions take no action if a specified structure is non-existent:

g) an unpost operation;

h) an operation to copy all elements from a non-existent structure into the currently open structure;

i) a delete structure operation.

4.4.3 Structure traversal and display

A structure network is identified for display on a workstation by the posting function, POST STRUCTURE. A structure may be displayed only if it is a member of a posted structure network (see figure 3).

When a non-existent structure is posted, a new empty structure is created and posted. The functions UNPOST STRUCTURE and UNPOST ALL STRUCTURES are used to disassociate structure networks from a workstation. The structure display functions affect the 'table of posted structures' in the workstation state lists. The actual display of the structures identified in the 'table of posted structures' is subject to display update state (see 4.6.3).

To display a network, the structure elements have to be extracted from the centralized structure store and processed. *Traversal* is an operation used to describe a method of structure element processing. Traversal of a network leads to the display of graphical output from the structure network at each workstation to which the network is posted. Conceptually, traversal is a process which is associated with each instance of a posted structure network. The process remains in existence until the structure network is unposted from the workstation through UNPOST or DELETE functions.

The traversal process interprets each structure element in the structure network sequentially, starting at the first element of the top of the network. Any change to the posted structure network triggers a retraversal of the structure network, so that any changes to a posted structure network are processed immediately. Whether the resulting changes are visible at the workstation depends on the display update state of the workstation (see 4.6.3). No knowledge of how traversal takes place is required. Its effect is as described above. How the traverser chooses to achieve the effect is implementation dependent.

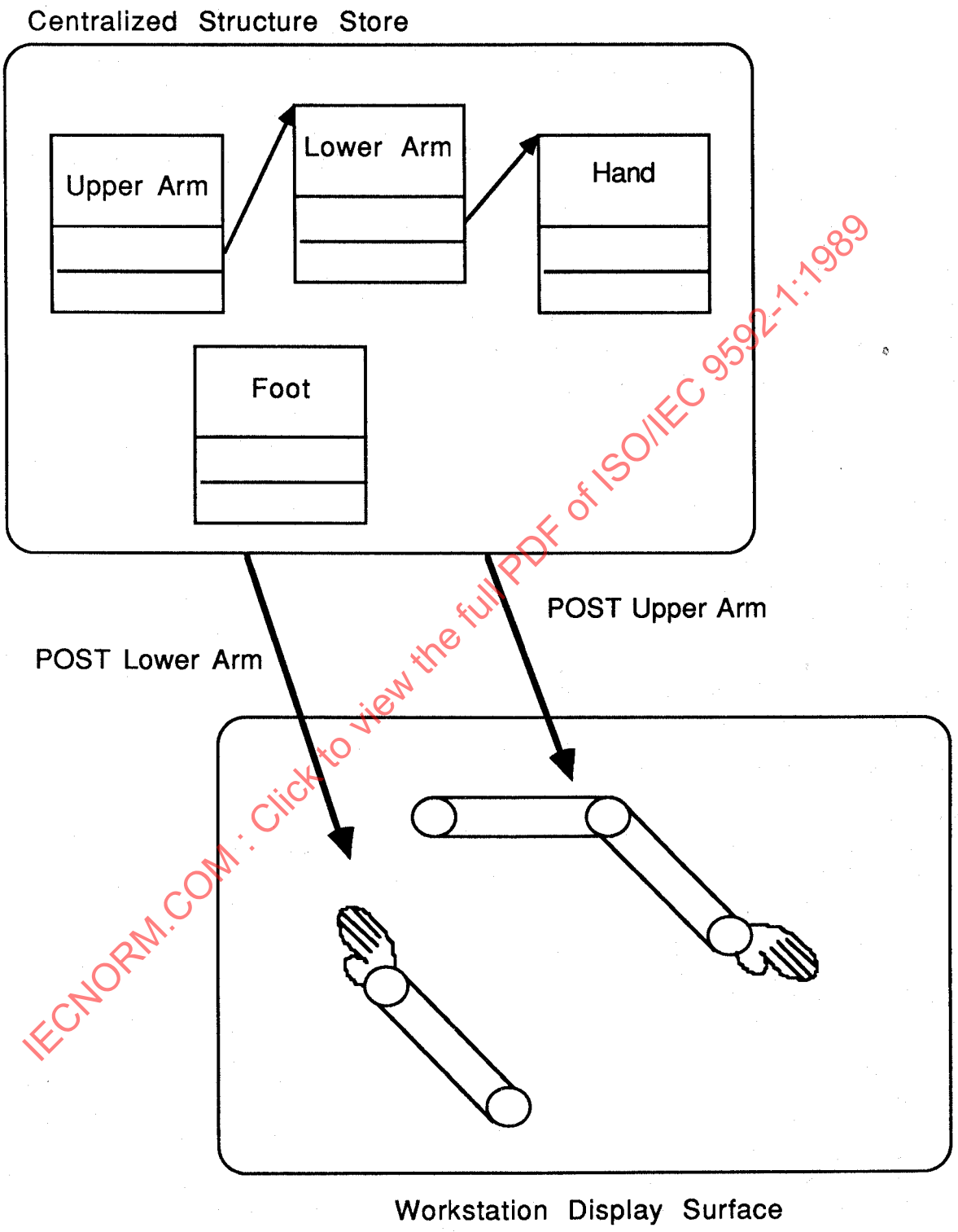
A *display priority* is assigned to a structure network when it is posted. The application indicates relative importance of posted structure networks through this display priority. If multiple structures are posted for display to the same display space location the implementation will ensure the display of the higher priority structure network. Where two structures have the same priority, an implicit priority based on the

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sequence of posting is used, whereby the last posted structure network has the higher priority.

A PHIGS *traversal state list* is associated with each traversal process. Values in this state list may be accessed or modified when structure elements are interpreted. Each time a traversal is initiated, the associated PHIGS traversal state list is initialized. The initial values are taken from the PHIGS description table.

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Figure 3 - A structure network with two posted structure networks

When a structure is traversed each structure element is interpreted. The initial values in the PHIGS traversal state list are taken from the PHIGS description table. The structure elements of the structure network are executed sequentially. The effect of interpreting a structure element depends on the type of the structure element. Output primitive elements result in the creation of output primitives; structure elements of other types either modify values in the PHIGS traversal state list, or are ignored. Traversal of generalized structure elements may affect all the state lists defined in PHIGS which includes the centralized structure store. When an "execute structure" element is encountered during the traversal, the following actions occur:

a) traversal of the current structure is suspended;

b) the current state of the PHIGS traversal state list is saved;

c) global and local modelling transformations are set (see 4.7.2);

d) the executed structure network is completely traversed;

e) the saved PHIGS traversal state list values are restored;

f) traversal of the current structure is resumed.

A set of default actions is defined so that errors do not occur at traversal time.

4.4.4 Structure editing

PHIGS provides the ability to individually access and modify each structure element within a structure. Editing functions are available to insert new structure elements, replace elements with new structure elements, delete structure elements, navigate within a structure and inquire structure element content.

A structure consists of a sequence of elements. Element positions are implicitly numbered 0..n, where element position 1 is the first element and element position 0 is before the first element. This implicit numbering is always maintained in a consecutive, ascending order with one number per structure element; this means that a structure element position is not fixed and may change as elements are inserted into or deleted from the structure.

A structure is identified for editing by the OPEN STRUCTURE function. If the structure does not exist in the CSS, a structure will be created. Only one structure may be open for editing at any one time. The INQUIRE OPEN STRUCTURE function is provided to determine the identifier of the current open structure. Editing of a structure ends when the CLOSE STRUCTURE function is invoked.

When a structure is opened for editing an *'element pointer'* is established which points at the last element in the structure. The element position may be in the range 0..n, where 0 refers to the beginning of the structure (i.e. before the first element) and n refers to the last element in the structure. An INQUIRE ELEMENT POINTER function is provided to determine the value of the 'element pointer'.

Several functions are provided for manipulating the 'element pointer'. The 'element pointer' may be set to an absolute position with the function SET ELEMENT POINTER, or relative to a position with the function OFFSET ELEMENT POINTER. The offset value may be negative or positive for element pointer movement backwards or forwards respectively. Attempted movement beyond the structure's bounds will always leave the 'element pointer' at the bound it would have exceeded. The 'element pointer' may also be positioned using the function SET ELEMENT POINTER AT LABEL, which positions the 'element pointer' at a "label" structure element. A "label" element is inserted into the structure using the LABEL function. Labels need not be unique within a structure.

When a structure is open the application program may insert additional elements into the structure or

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replace existing structure elements using the functions which define structure elements (e.g. TEXT, SET POLYLINE INDEX, EXECUTE STRUCTURE). The *'edit mode'*, as defined by the function SET EDIT MODE, defines whether a new element replaces the element pointed to by the 'element pointer' or is added after the element pointed to by the 'element pointer'. In either case the 'element pointer' is then updated to point to the new element.

The COPY ALL ELEMENTS FROM STRUCTURE function can be used to copy all the elements of a structure into the open structure. This copy operation always inserts the copied elements; 'edit mode' does not apply to the copy operation. The 'element pointer' is left pointing at the last element copied.

Three functions are provided to delete elements. The DELETE ELEMENT function will delete the element at which the 'element pointer' is pointing. Consecutive elements may be deleted as a group with the DELETE ELEMENT RANGE function. This function deletes all the elements between and including the lower element position and the higher element position. To delete a group of elements delimited by labels, the DELETE ELEMENTS BETWEEN LABELS function is used. This function will delete all elements between the specified labels. The label elements themselves are not deleted. Following all three delete functions, the 'element pointer' is positioned at the element immediately preceding the element, or group of elements, which was deleted.

All the elements of a structure may be deleted by invoking the EMPTY STRUCTURE function. This function only deletes the contents of the structure and has no effect on references to it. Upon completion of this function, an empty structure will always exist.

Inquiry functions are provided which allow interrogation of the element pointed to by the 'element pointer'. The function INQUIRE CURRENT ELEMENT TYPE AND SIZE returns the type of the element and its size. The parameters of the element may then be obtained by using the INQUIRE CURRENT ELEMENT CONTENT function.

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4.4.5 Manipulation of structures in CSS

The following operations apply to structures as whole units in the CSS.

A structure may be deleted by invoking the DELETE STRUCTURE function. This function deletes the structure and all references to it contained in other structures. After the DELETE STRUCTURE call, the structure no longer exists in the CSS. If the deleted structure is referenced by an element in the currently open structure, and if the 'element pointer' is positioned after the "execute structure" element to be deleted, the 'element pointer' is updated such that it still refers to the same element. If the 'element pointer' is positioned at the "execute structure "element to be deleted, the 'element pointer' will be positioned at the preceding element after the structure deletion operation. The DELETE ALL STRUCTURES function is provided to delete all structures from the CSS.

A function is provided to delete a structure network. The DELETE STRUCTURE NETWORK function will delete the indicated structure and structures in the structure network originating with the specified structure. The handling of structures referenced by other structures outside the specified structure network is controlled by a reference handling flag. When this flag is specified as KEEP, those structures referenced outside the specified structure network are not deleted. When this flag is specified as DELETE each structure of the specified structure network is deleted as if DELETE STRUCTURE were called to delete each structure individually. The specified structure is always deleted.

A structure which is to be deleted may currently be posted for display. In this case, the effect is as though the structure were first unposted and then deleted.

A structure's identifier can be changed to another value with the CHANGE STRUCTURE IDENTIFIER function. All the structure identifiers of a given value associated with "execute structure" elements can be modified with the CHANGE STRUCTURE REFERENCES function. Both of these actions can be performed simultaneously by calling the CHANGE STRUCTURE IDENTIFIER AND REFERENCES function. All of these functions can change the arrangement of an existing structure network. If any part of a posted structure network is modified by an invocation of any of the above functions visual changes will result subject to display update state. The functions will create new, empty structures if the specified structures are non-existent.

Inquiry functions are provided to retrieve information about structure identifiers. All existing structure identifiers are returned by the INQUIRE STRUCTURE IDENTIFIERS function.

4.4.6 CSS search and inquiry

PHIGS provides functionality for interrogating the CSS by means of searching and inquiry functions. These may be performed independently of whether a structure is open for editing.

INQUIRE ELEMENT TYPE AND SIZE and INQUIRE ELEMENT CONTENT allow full details of a specified structure element to be determined.

The relationship of a structure to other structures within the CSS may be determined by INQUIRE PATHS TO ANCESTORS and INQUIRE PATHS TO DESCENDANTS. The former returns paths which reference the specified structure while the latter returns paths which are referenced by a particular structure. Paths are returned as a list of element references. The path order and path depth can be specified to determine the portion of each path returned. Path depth determines the maximum number of element references returned in any one path or portion of path. In case of truncation the path order determines whether the head or tail portion of the path is returned. The truncation may result in two or more portions of paths having the same set of element references. Only one such portion will be returned such that all of the returned path portions are distinct.

The ELEMENT SEARCH function is provided to permit searching within a single structure for an element of a particular element type or one of a set of element types. The range of element types to be searched is restricted by the set of element types indicated by element inclusion and exclusion sets. The search is conducted within a single specified structure. The direction of the search from the specified structure element can be specified.

The INCREMENTAL SPATIAL SEARCH (ISS) function allows a structure network to be searched for the next occurrence of a graphical output structure element which satisfies the specified search criteria. The initial starting position for the search and the found position of the structure element that satisfies the search criteria are defined by search paths.

A search path is an *element reference list* which consists of a list of (structure identifier, element position) pairs. The first pair defines the topmost structure of the structure network and the position in that structure of the "execute structure" element that contains the name of the structure identifier that contains the second pair of the list and so on. The last pair in the list defines the structure and position within that structure of the search path position.

The search begins at the structure element following the element identified by the search path position. The search is conceptually a traversal with structure elements being examined sequentially and matched against the search criteria. Element position zero is permitted so that the search may start at the first element of a structure. Search filters are applied to the NAME SET attribute of each graphical output

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structure element (see 4.5.15). Graphical output structure elements which satisfy the incremental spatial search filters are checked for proximity to the search reference point. The search can either be conducted with modelling clipping applied or not.

For "text" elements the spatial extent is the enclosing rectangle calculated using the values of the geometric attributes (character height, character up vector, text path and text alignment) arising from traversal together with the following values for the workstation dependent attributes: text font, 1; text precision, STROKE; character expansion factor, 1; and character spacing, 0.

For "annotation text relative" elements, the only proximity relationship used is closeness to the annotation reference point.

The search terminates when a graphical output structure element which meets the above criteria is identified during the traversal. The complete search path is returned as the found path. The found path may be used as a search path to start a subsequent search from the position reached.

The search ceiling is an integer which defines a position in the list of the search path. The structure identifier at this position of the list defines a ceiling for the search. Searching will continue until either a graphical output structure element matches the search criteria or the end of the structure identified by the search ceiling is reached.

If a search is successful, the complete found path is returned. An unsuccessful search returns a null found path.

The function is *incremental* in that, having found a match, the search may be continued by invoking INCREMENTAL SPATIAL SEARCH again with the found path as the next starting path. The ceiling may be left unchanged. The search continues from the element position following the last matched position. This allows all elements matching the search criteria to be found for a given portion of a structure network.

Filters may be specified which control which output primitives structure elements in the structures searched are considered.

The filters operate upon the NAME SET associated with an output primitive structure element at traversal time; the NAME SET value that would be defined in the 'current name set' in the PHIGS traversal state list during traversal for display. Each filter consists of an inclusion set and an exclusion set. To be accepted by a filter, the NAME SET has to have at least one name in common with the inclusion set and no names in common with the exclusion set. This is exactly the same condition as is used by the workstation filters which control the highlighting and visibility of primitives.

The filters are organized into two lists, the normal filter list and the inverted filter list which operate in opposite senses. Their effect can be described in the following way.

A structure element is said to be *accepted* if it is declared eligible (see 4.5.15) when the NAME SET is applied to the filter. A structure element is said to be *rejected* if it is declared ineligible when the NAME SET is applied to the filter. For a structure element to be considered a candidate for the spatial search it has to have been accepted by each of the filters in the normal filter list and has to have been rejected by each of the filters in the inverted filter list.

As an example, suppose it is required that only the structure elements corresponding to the pickable (of some pick device) and visible primitives on some workstation take part in the search. Then the normal filter list would contain one entry, which is a copy of the 'pick filter' of the pick device, and the inverted

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filter list would contain one entry, which is a copy of the 'invisibility filter' of the same workstation. The structure elements whose associated NAME SETs are accepted by the normal filter list correspond to the pickable primitives on that workstation and the structure elements whose associated NAME SETs are rejected by the inverted filter list correspond to the visible primitives on that workstation. The result of the filtering process is that the structure elements corresponding to the pickable and visible primitives will be considered.

If the normal filter list is empty, then all structure elements are considered to have satisfied the acceptance criteria for normal filters. If the inverted filter list is empty, all structure elements are considered to have satisfied the rejection criteria for inverted filters.

4.4.7 Structure archival and retrieval

PHIGS provides functionality for accessing archive files. In ISO/IEC 9592-2 the specification and encoding of archive files and their corresponding generation and retrieval processes are explained. In this part of ISO/IEC 9592 the functionality to access these archive files is defined. An archive file is a medium for storing structure definitions. PHIGS functionality provides for archiving (storing) from the centralized structure store to an archive file, retrieving from an archive file to the centralized structure store, or deleting from an archive file. This set of functions may be applied to a list of structures, a list of structure networks, or to all structures defined either in centralized structure store or in an archive file.

OPEN ARCHIVE FILE initiates and CLOSE ARCHIVE FILE terminates access to archive files. Several archive files may be open simultaneously. The 'maximum number of simultaneously open archive files' is defined in the PHIGS description table and can be inquired with INQUIRE PHIGS FACILITIES. Structures are stored in an archive file with ARCHIVE STRUCTURES, ARCHIVE STRUCTURE NETWORKS, and ARCHIVE ALL STRUCTURES. Structures are recovered from an archive file with RETRIEVE STRUCTURES, RETRIEVE STRUCTURE NETWORKS, and RETRIEVE ALL STRUCTURES. Structures are deleted from an archive file with DELETE STRUCTURES FROM ARCHIVE, DELETE STRUCTURE NETWORKS FROM ARCHIVE, and DELETE ALL STRUCTURES FROM ARCHIVE.

In addition to the above functions there are functions to inquire information about the contents of an archive file. RETRIEVE STRUCTURE IDENTIFIERS returns the identifiers of structures in an archive file. INQUIRE ARCHIVE STATE VALUE returns the archive state of PHIGS. A value of AROP indicates that at least one archive file is open. INQUIRE ARCHIVE FILES returns the names of currently open archive files.

The relationship of a structure to other structures within an archive file may be determined by RETRIEVE PATHS TO ANCESTORS and RETRIEVE PATHS TO DESCENDANTS. The former returns paths which reference the specified structure while the latter returns paths which are referred by a particular structure. Paths are returned as a list of element references. The path order and path depth can be specified to determine the portion of each path returned. Path depth determines the maximum number of element references returned in any one path or portion of path. In case of truncation the path order determines whether the head or tail portion of the path is returned. The truncation may result in two or more portions of paths having the same set of element references. Only one such portion will be returned such that all of the returned path portions are distinct.

As a data protection measure the PHIGS state list contains conflict resolution flags for archival and retrieval. These flags may be set with SET CONFLICT RESOLUTION and inquired with INQUIRE CONFLICT RESOLUTION. The 'archival conflict resolution flag' is used to control what happens when an attempt is made to archive structures whose identifiers already exist in the archive file. The 'retrieval

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conflict resolution flag' is used to control what happens when an attempt is made to retrieve structures whose identifiers already exist in the CSS. The conflict resolution flags may have the values MAINTAIN, ABANDON or UPDATE. A value of MAINTAIN causes the archival or retrieval operation to only write structures into the archive or CSS if they do not already exist, thereby maintaining existing structures. A value of ABANDON causes the archival or retrieval operation to be abandoned in the event of such conflict, leaving the CSS or archive as it was before the operation started, and an error is generated. A value of UPDATE allows structures to be overwritten.

To permit detection of such conflicts or to determine which structures caused a naming conflict there are functions to inquire potential conflicts. INQUIRE ALL CONFLICTING STRUCTURES compares all structure identifiers in the CSS with those in the specified archive file and returns a list of those which occur in both. INQUIRE CONFLICTING STRUCTURES IN NETWORK compares only those structure identifiers in the specified network in the CSS or the specified archive file with all the structures in the other and returns a list of those which occur in both.

4.4.8 Generalized Structure Elements (GSE)

PHIGS provides the GENERALIZED STRUCTURE ELEMENT to enable access during traversal to special control and attribute related actions that are beyond the scope of the standardized PHIGS structure elements. GSEs are characterized by an identifier and a data record. Traversal of a GSE does not generate an output primitive; GENERALIZED DRAWING PRIMITIVE elements are provided for this purpose. Traversal of GSE's may affect all the state lists defined in PHIGS which includes the CSS. GSE's do not generate errors during traversal.

4.4.9 Application data

An application programmer may insert application specific data into the open structure with the APPLICATION DATA function. This information is for use solely by the application program, and is not interpreted or modified in any way by the PHIGS implementation. During traversal of the structure, the application data is ignored for OUT and OUTIN workstations, but may generate data for MO workstations.

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4.5 Graphical output

4.5.1 Structure elements and output primitives

The graphical information that is generated by PHIGS and routed to workstations is built up of basic pieces of information called output primitives. Output primitives are generated from structure elements by structure traversal:

a) POLYLINE: PHIGS generates a set of connected lines defined by a point sequence.

b) POLYMARKER: PHIGS generates symbols of one type centred at given positions.

c) TEXT: PHIGS generates a character string at a given position on an arbitrary plane in modelling coordinate space.

d) ANNOTATION TEXT RELATIVE: PHIGS generates a character string at a specified position in an x-y plane in NPC space according the annotation style. It is related to a specified reference point whose coordinates are given in modelling coordinates. The position of the annotation text, the annotation point, is given by an offset specified in NPC space from the transformed reference point.

e) FILL AREA: PHIGS generates a single polygonal area which may be hollow or filled with a uniform colour, a pattern, or a hatch style. No edge control is provided.

f) FILL AREA SET: PHIGS generates a set of polygonal areas which may be hollow or filled with a uniform colour, a pattern, or a hatch style, with or without edges. This allows for specifying areas with holes or disjoint regions that shall be treated as a single entity, particularly for hidden line / hidden surface removal computation.

g) CELL ARRAY: PHIGS generates a two dimensional array of cells with individual colours.

h) GENERALIZED DRAWING PRIMITIVE(GDP): PHIGS addresses special geometric output capabilities of a workstation such as the drawing of spline curves, circular arcs, and elliptic arcs. The objects are characterized by an identifier, a set of points and additional data. PHIGS applies all transformations to the points but leaves the interpretation to the workstation.

Text, fill area, fill area set, and cell array are planar primitives in arbitrary planes. Conceptually these planes have two sides and zero thickness. The viewing transformation determines which side of these primitives is seen. Annotation text relative is also a planar primitive, but is constrained to lie in an x-y plane in NPC space.

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The plane in which the text primitive lies is defined by a point and two vectors that are contained in the definition of the text primitive. The plane in which the annotation text relative primitive lies is the x-y plane of the normalized projection coordinate system to which the modelling coordinate point is transformed.

The character string used by the text and annotation text primitives contains a sequence of character codes. These may include character codes which result in switching character sets as described in ISO 2022. The default character set is defined in ISO 646 (or a character set including ISO 646). It is implementation dependent whether additional character sets are supported.

It is implementation dependent whether character control codes in the current character set are interpreted. Character codes undefined in the current character set are treated as null characters.

For fill area and fill area set primitives, the plane of the primitives is defined by the points of the respective primitives.

Ensuring that the points of fill areas and fill area sets are coplanar is the responsibility of the application program. While slightly non-coplanar points (e.g. owing to numerical roundoff errors) should be mapped to a plane, the effect of large divergences is implementation dependent.

The interior of a fill area and fill area set is defined in the following way (see figure 4). For a given point, create a straight line starting at that point and going to infinity. If the number of intersections between the straight line and the fill area boundary is odd, the point is within the fill area, otherwise it is outside. If the straight line passes through a fill area vertex tangentially, the intersection count is not affected.

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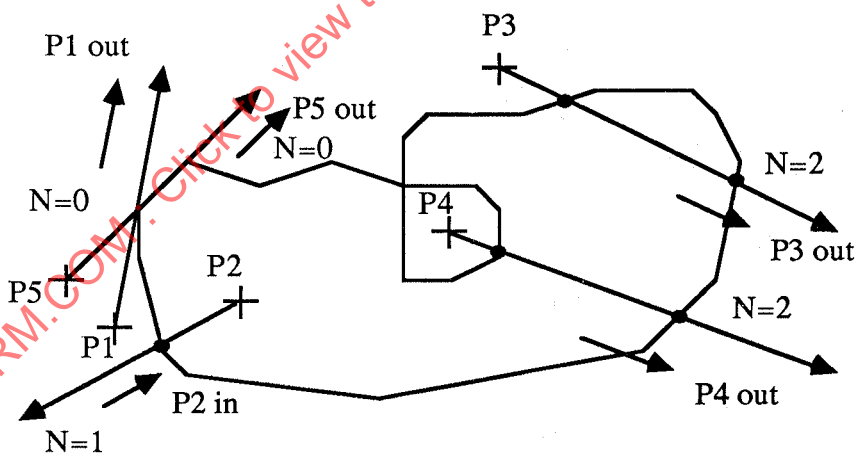


Figure 4 - Area inside of a polygon

If a fill area or fill area set is clipped, the new boundaries generated become part of the displayed interior. While it is recommended that these new boundaries be included in the HOLLOW representation, it is dependent on the hidden line / hidden surface removal method whether or not they are displayed. These boundaries are not displayed as edges for fill area set primitives. Multiple subareas may be generated (see figure 5).

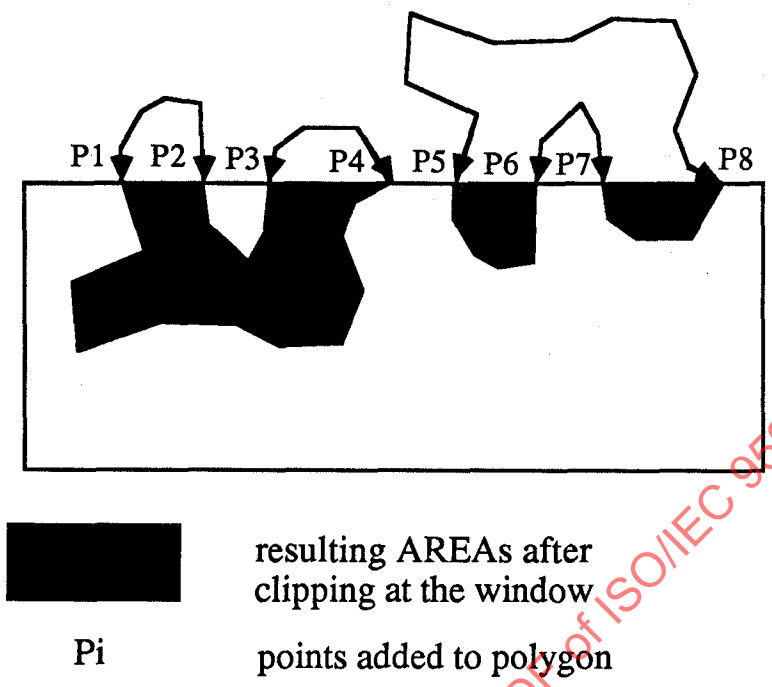


Figure 5 - Examples of FILL AREA and FILL AREA SET clipping

The plane in which the 3D form of the cell array primitive lies is defined by three points, P,Q, and R, contained in the definition of the cell array primitive.

A parallelogram is defined by the points P, Q, R, and (QX+RX-PX, QY+RY-PY, QZ+RZ-PZ). This parallelogram is conceptually divided into a grid of DX×DY cells, where DX and DY are the dimensions of the colour index array. If (PX,PY,PZ) are the coordinates of the cornerpoint P, (QX,QY,QZ) are the coordinates of the cornerpoint Q, and (RX,RY,RZ) are the coordinates of the cornerpoint R, the cell dimensions may be determined as follows:

Each cell has a width defined by:

$$\frac{\sqrt{(PX-QX)^2+(PY-QY)^2+(PZ-QZ)^2}}{DX}$$

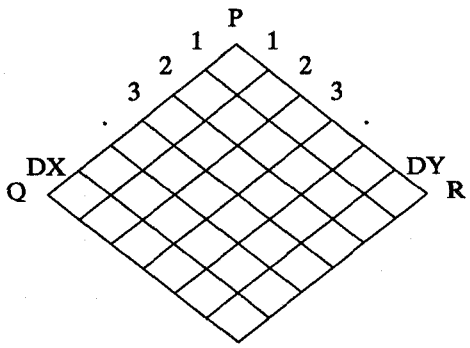
Each cell has a height defined by:

$$\frac{\sqrt{(PX-RX)^2+(PY-RY)^2+(PZ-RZ)^2}}{DY}$$

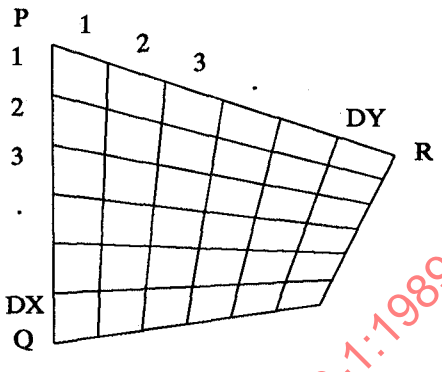
The colour of each cell is specified by the index of the corresponding element of the colour index array. The colour indices are mapped from the two dimensional cell array on a row-wise basis starting at corner P and proceeding to corner Q and so on. If an index is not present in the colour table on a workstation, index 1 is used on that workstation. Note that this rule also applies to index values less than 0.

The grid defined by P, Q, R, DX, and DY is subject to all transformations potentially transforming the cells into quadrilaterals. Portions of a transformed cell lying outside the window are clipped.

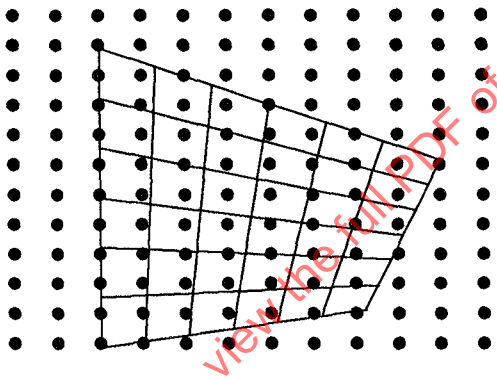
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CELL ARRAY
DX × DY CELLS



TRANSFORMED
CELL ARRAY



PIXEL LOCATIONS
ON DISPLAY SURFACE

Cells are mapped onto display surface.
If display location is within cell, then
cell colour is assigned to pixel

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Figure 6 - Mapping of CELL ARRAY 3

The 2D form of the cell array primitive is defined by two points P and Q, defining a rectangle, which is taken to be aligned with the modelling coordinate axes. This rectangle is conceptually divided into a grid of DX×DY cells. Each cell has a width of |PX-QX|/DX, and a height of |PY-QY|/DY, where (PX,PY) are the coordinates of the cornerpoint P, and (QX,QY) are the coordinates of the cornerpoint Q. The colour of each cell is specified by the index of the corresponding element of the colour index array. The colour indices are mapped into the two dimensional cell array on a row-wise basis starting at corner (PX,PY) and proceeding to corner Q and so on. If an index is not present in the colour table on a workstation, index 1 is used on that workstation. Note that this rule also applies to index values less than 0.

The rectangular grid defined by P, Q, DX, and DY is subject to all transformations, potentially

transforming the rectangular cells into quadrilaterals. Portions of a transformed cell lying outside the window are clipped. Mapping the transformed cells onto the pixels of a raster display is performed by the following rules:

i) If the centrepoint of a pixel lies within the quadrilateral defined by the transformed rectangle, its colour is set.

j) The pixel will be assigned the colour of the cell which contains the pixel's centrepoint. Thus, the pixel colour is selected by point sampling the transformed rectangle at the pixel centrepoint, not by area sampling or filtering. If the pixel centre lies on a cell boundary it is implementation dependent which of the adjacent cells is used to determine the colour of the pixel.

4.5.2 Output primitive attributes

Each output primitive potentially has four types of attributes (geometric, non-geometric, viewing and identification). The first two attribute types determine the exact appearance of the output primitive. The third attribute type selects the viewing and HLHSR parameters for the workstation dependent sections of the pipeline. The fourth attribute type determines visibility, pickability and highlighting of primitives, and is used to identify a primitive, or group of primitives, when a primitive is picked.

The PHIGS primitive attribute specification functions create structure elements in the centralized structure store. During traversal these attribute setting structure elements set corresponding elements of the PHIGS traversal state list. The PHIGS traversal state list is not accessible from the application program. A separate function is provided for each primitive attribute (except the ASFs: see later in this sub-clause) to allow the application program to specify the value of an attribute without unnecessarily specifying the values of other attributes. During creation of an output primitive, during structure traversal, these values are bound to the primitive and cannot be changed afterwards.

Attributes of the first type control the geometric aspects of primitives. These are aspects that affect the shape or size of the entire primitive (for example, CHARACTER HEIGHT for TEXT). Hence they are sometimes referred to as geometric attributes. Geometric attributes are workstation independent and, if they represent coordinate data (points or displacements), they are expressed in modelling coordinates. The geometric attributes of TEXT and ANNOTATION TEXT RELATIVE are an exception as they are specified in a text local coordinate system.

When the values of geometric attributes defined in the PHIGS traversal state list are bound to their respective primitives, the values are subject to the same transformations as the geometric data contained in the definition of the primitive. When the values of annotation text geometric attributes defined in the PHIGS traversal state list are bound to their respective primitives, the values are subject only to the transformations which occur after the transformation into NPC space. Hence changes in the modelling and viewing transformations will not affect the values of geometric attributes already stored in the PHIGS traversal state list.

Attributes of the second type control the non-geometric aspects of primitives. These are aspects that affect a primitive's appearance (for example, linetype for POLYLINE, or colour index for all primitives except CELL ARRAY) or the shape or size of the component parts of the primitive (for example, marker size scale factor for POLYMARKER). Non-geometric aspects do not represent coordinate data. The non-geometric aspects of a primitive may be specified either via a bundle or individually.

Bundled aspects are selected by a bundle index into a bundle table, each entry of which contains non-geometric aspects of a primitive. The non-geometric aspects are workstation dependent in that each

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workstation has its own set of bundle tables (stored in the workstation state list). The values in a particular bundle (or entry in the bundle table) may be different for different workstations.

For individual specification of aspects, there is a separate attribute for each non-geometric aspect. As with the attributes controlling the geometric aspects, these attributes are workstation independent and are stored during traversal in the PHIGS traversal state list.

For a given non-geometric aspect, the values that can be assigned to the appropriate bundle component are the same as the values that can be assigned to the corresponding attribute for individual specification. Because the bundles are set separately for each workstation, the values of their components are restricted to the valid values for that workstation. For individual attribute specification, such restrictions are not imposed. Default actions for the display of a primitive are defined to occur even if it is created with a value of an individually specified attribute that is invalid on a particular workstation. Thus traversal time errors do not occur.

As described above, GENERALIZED DRAWING PRIMITIVE (GDP) and CELL ARRAY do not have associated bundle tables nor corresponding individually specified attributes. The GDP may use the most appropriate bundle tables or sets of individually specified attributes for each GDP function. For example, if a GDP function is most similar to a FILL AREA, then the fill area bundle table or the set of individually specified fill area attributes would be used. CELL ARRAY contains colour index information as part of its definition but has no other non-geometric aspects.

The method of specification of the non-geometric aspects of a primitive may be chosen separately for each aspect. A further group of primitive attributes, called ASPECT SOURCE FLAGS (ASFs), take the values INDIVIDUAL and BUNDLED to specify the choice. As with the other primitive attributes, these attributes are workstation independent and are stored, during traversal, in the PHIGS traversal state list. There is one ASF for each non-geometric aspect. The initial values of all of the ASFs are the same; this may be either BUNDLED or INDIVIDUAL, the choice being implementation dependent. If the initial values are not altered the system will operate

a) as if individual specification of non-geometric aspects were not a system feature, if the initial values of all of the ASFs are BUNDLED;

b) as if specification of non-geometric aspects via a bundle were not a system feature, if the initial values of all of the ASFs are INDIVIDUAL.

The flags may be set during structure traversal by the structure element "set individual ASF", which is generated from the SET INDIVIDUAL ASF function.

When a primitive is displayed, the values of the non-geometric aspects with which it is displayed are determined as follows:

c) if the ASF for an aspect is INDIVIDUAL, the value used on all workstations is the value of the corresponding individually specified attribute of the primitive;

d) if the ASF for an aspect is BUNDLED, the value used on a workstation is the value of the corresponding component of the workstation dependent bundle, pointed to by the bundle index.

Colour is a non-geometric aspect of a primitive, which is specified as an index into a separate colour table. There is a colour table on each workstation into which all the colour indices point. Similarly, other entries in a bundle, or corresponding individually specified attributes, may be indices either into another workstation table (for example, style index when interior style PATTERN is used) or into a workstation dependent list (for example, linetypes for polyline).

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There are two attributes of the third type, the VIEW INDEX and HLHSR IDENTIFIER. The attribute VIEW INDEX identifies an entry in a workstation dependent view table. The attribute HLHSR IDENTIFIER supplies HLHSR information to the workstation. The interpretation of the identifier is implementation dependent (see 4.5.14). Implementation of the functions to control hidden line / hidden surface removal is obligatory, but the functions may have no effect on the appearance of primitives.

There are two attributes of the fourth type, which apply to each primitive, namely PICK IDENTIFIER and NAME SET. The attribute PICK IDENTIFIER is used for identifying a primitive, or a group of primitives, in a structure when that structure is picked. The attribute NAME SET is a set of classifications defining, in part, the eligibility of the primitive for highlighting, invisibility, pickability and incremental spatial search.

The explicitly specified attributes that apply to each output primitive (attributes controlling non-geometric aspects, geometric attributes, view attributes and pick identifier) are:

e) POLYLINE:
- POLYLINE INDEX
- LINETYPE
- LINEWIDTH SCALE FACTOR
- POLYLINE COLOUR INDEX
- LINETYPE ASF
- LINEWIDTH SCALE FACTOR ASF
- POLYLINE COLOUR INDEX ASF
- VIEW INDEX
- HLHSR IDENTIFIER
- PICK IDENTIFIER
- NAME SET

f) POLYMARKER:
- POLYMARKER INDEX
- MARKER TYPE
- MARKER SIZE SCALE FACTOR
- POLYMARKER COLOUR INDEX
- MARKER TYPE ASF
- MARKER SIZE FACTOR ASF
- POLYMARKER COLOUR INDEX ASF
- VIEW INDEX
- HLHSR IDENTIFIER
- PICK IDENTIFIER
- NAME SET

g) TEXT:
- TEXT INDEX
- TEXT FONT
- TEXT PRECISION
- CHARACTER EXPANSION FACTOR
- CHARACTER SPACING
- TEXT COLOUR INDEX
- TEXT FONT ASF
- TEXT PRECISION ASF
- CHARACTER EXPANSION FACTOR ASF
- CHARACTER SPACING ASF
- TEXT COLOUR INDEX ASF
- CHARACTER HEIGHT

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CHARACTER UP VECTOR
TEXT PATH
TEXT ALIGNMENT
VIEW INDEX
HLHSR IDENTIFIER
PICK IDENTIFIER
NAME SET

h) ANNOTATION TEXT RELATIVE:

TEXT INDEX
TEXT FONT
TEXT PRECISION
CHARACTER EXPANSION FACTOR
CHARACTER SPACING
TEXT COLOUR INDEX
TEXT FONT ASF
TEXT PRECISION ASF
CHARACTER EXPANSION FACTOR ASF
CHARACTER SPACING ASF
TEXT COLOUR INDEX ASF
ANNOTATION TEXT CHARACTER HEIGHT
ANNOTATION TEXT CHARACTER UP VECTOR
ANNOTATION TEXT PATH
ANNOTATION TEXT ALIGNMENT
ANNOTATION STYLE
VIEW INDEX
HLHSR IDENTIFIER
PICK IDENTIFIER
NAME SET

i) FILL AREA:

INTERIOR INDEX
INTERIOR STYLE
INTERIOR STYLE INDEX
INTERIOR COLOUR INDEX
INTERIOR STYLE ASF
INTERIOR STYLE INDEX ASF
INTERIOR COLOUR INDEX ASF
PATTERN SIZE
PATTERN REFERENCE POINT
PATTERN REFERENCE VECTORS
VIEW INDEX
HLHSR IDENTIFIER
PICK IDENTIFIER
NAME SET

j) FILL AREA SET:

INTERIOR INDEX
INTERIOR STYLE
INTERIOR STYLE INDEX
INTERIOR COLOUR INDEX
INTERIOR STYLE ASF
INTERIOR STYLE INDEX ASF
INTERIOR COLOUR INDEX ASF
EDGE INDEX

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		EDGE FLAG EDGETYPE EDGEWIDTH SCALE FACTOR EDGE COLOUR INDEX EDGE FLAG ASF EDGETYPE ASF EDGEWIDTH SCALE FACTOR ASF EDGE COLOUR INDEX ASF PATTERN SIZE PATTERN REFERENCE POINT PATTERN REFERENCE VECTORS VIEW INDEX HLHSR IDENTIFIER PICK IDENTIFIER NAME SET
k)	CELL ARRAY:	VIEW INDEX HLHSR IDENTIFIER PICK IDENTIFIER NAME SET
l)	GENERALIZED DRAWING PRIMITIVE:	Zero or more of the sets e) to k) except that VIEW INDEX, HLHSR IDENTIFIER, PICK IDENTIFIER, and NAME SET are always attributes.

The attributes for each primitive are described in 4.5.3 to 4.5.15. VIEW INDEX is described in more detail in 4.5.13. In the descriptions, attributes appear in upper case (for example, the attributes CHARACTER HEIGHT and PICK IDENTIFIER); aspects appear in both upper and lower case, according to their context. Geometric aspects are always controlled by geometric attributes and so appear in upper case (for example, the aspect CHARACTER HEIGHT). Non-geometric aspects may be controlled via a <bundle> INDEX or by individually specified attributes. Non-geometric aspects appear in lower case unless the corresponding individually specified attributes are being used. Individually specified attributes appear in upper case (for example, the aspect linetype but the individually specified LINETYPE).

The entries in the bundle, pattern and colour tables may be set separately for each workstation. Some predefined definitions for table entries are contained in the workstation description table and are used as initial values. The application program may select a standard definition or may define the values of a specific entry explicitly. Only the most commonly used (or anticipated) combinations of values need be predefined for each output type workstation. At least those predefined entries with indices up to the minimum number of predefined entries are distinguishable from each other. Other combinations of values can be specified by the SET <bundle | VIEW | PATTERN | COLOUR> REPRESENTATION function, possibly after inquiring the workstation capabilities. The tables, which are on every workstation of categories OUTPUT and OUTIN (i.e. they are workstation attributes), are:

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view table
polyline bundle table
polymarker bundle table
text bundle table
interior bundle table
edge bundle table
pattern table
colour table

The values in these tables may be changed dynamically. The only way of changing the aspects of a primitive that are stored in a bundle table is by changing the bundle table entry. However, note that a change in a bundle table entry can be reflected in a displayed primitive only if the values of the corresponding primitive's ASFs for the aspects in the bundle table are BUNDLED. The entry 'dynamic modification accepted' in the workstation description table indicates which changes lead to an implicit regeneration (may be deferred) (IRG), and which can be performed immediately (IMM). The display update states are explained in more detail in 4.6.3.

During traversal, and when initiating a measure process (see 4.8), if an index into a bundle table or individual attribute is out of range or undefined, a default value is used. This applies to the workstation state list tables and to linetype, marker type, text font and edge type. For marker type the default value is three (3). Otherwise, the default value is one (1).

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4.5.3 Polyline attributes

Polyline has no geometric attributes. The representation of polyline on the workstation is controlled by the POLYLINE INDEX, or the set of individually specified polyline attributes (LINETYPE, LINEWIDTH SCALE FACTOR and POLYLINE COLOUR INDEX) or some combination of the two, depending upon the values of the ASFs for linetype, linewidth scale factor and polyline colour index. The POLYLINE INDEX is a pointer into the polyline bundle table, each entry of which contains values for linetype, linewidth scale factor and polyline colour index.

Linetypes 1 to 4 are predefined as solid, dashed, dotted and dashed-dotted. Every workstation of category OUTPUT or OUTIN realizes linetypes 1 to 4 with recognizable styles. Linetypes greater than 4 are reserved for registration (see 4.1.2). Linetypes less than 1 may be available but their styles are implementation dependent. The linetype specifies a sequence of line segments and gaps which are repeated to draw a polyline. It is workstation dependent whether this sequence is restarted or continued at the start of the polyline, at the start of a clipped piece of polyline, and at each vertex of a polyline.

The linewidth is calculated as a nominal linewidth multiplied by the linewidth scale factor. This value is mapped by the workstation to the nearest available linewidth. For example, if the value is less than or equal to zero (0), the thinnest available linewidth is used.

4.5.4 Polymarker attributes

Polymarker has no geometric attributes. The representation of polymarker at the workstation is controlled by the POLYMARKER INDEX, or the set of individually specified polymarker attributes (MARKER TYPE, MARKER SIZE SCALE FACTOR and POLYMARKER COLOUR INDEX) or some combination of the two, depending upon the values of the ASFs for marker type, marker size scale factor, and polymarker colour index. The POLYMARKER INDEX is a pointer into the polymarker

bundle table, each entry of which contains values for marker type, marker size scale factor and polymarker colour index.

Marker types 1 to 5 are predefined as dot, plus sign, asterisk, circle, and diagonal cross each centred on the positions they are identifying. Every workstation of category OUTPUT or OUTIN realizes marker types 1 to 5 with recognizable shapes at the given positions. Marker types greater than 5 are reserved for registration (see 4.1.2). Marker types less than 1 may be available but their forms are implementation dependent.

The marker size is calculated as a nominal size multiplied by the marker size scale factor. This size is mapped by the workstation to the nearest available size. For example, if the size is less than or equal to zero (0), the smallest available marker size is used. Marker type 1 is always displayed as the smallest displayable dot.

The marker is visible (independent of whether it is obscured by another primitive) if, and only if, the marker position is within the clipping volume. The clipping of markers whose position is inside the clipping volume, but whose rendering would extend outside the clipping volume, is workstation dependent.

Since the polymarker has no geometric attributes, transformations affect only the marker position and not the appearance of the marker glyph.

4.5.5 Text attributes

Text is a planar primitive. The plane of the text primitive is defined by a point and two vectors contained in the definition of the text primitive. The point is called the text position. The two vectors are called the first and second text direction vectors. The point and these vectors define a text plane and a local coordinate system on that plane in which all geometric text attributes are measured; the coordinate system is known as the *text local coordinate* system. The text local coordinate system has unit size unscaled from modelling coordinates.

Let P be the text position and U and V be the first and second text direction vectors respectively. The text plane is the plane that contains P and is perpendicular to U×V. The origin of the text local coordinate system is at the point P. The positive X axis of the text local coordinate system is parallel to U. Let T be a vector perpendicular to U and in the text plane. If T·V is positive, then the positive Y axis is parallel to T; otherwise, the positive Y axis is opposite T. In the following all references to coordinates refer to this text local coordinate system unless explicitly stated otherwise.

Text has the geometric attributes CHARACTER HEIGHT, CHARACTER UP VECTOR, TEXT PATH, and TEXT ALIGNMENT which are specified and used as described in this sub-clause.

Text also has two implicitly specified geometric attributes CHARACTER WIDTH and CHARACTER BASE VECTOR. These are implicitly specified by the functions SET CHARACTER HEIGHT and SET CHARACTER UP VECTOR respectively. They otherwise behave like ordinary text geometric attributes (their values are bound to TEXT primitives when the primitives are created and cannot be changed afterwards and these values are subject to the same transformations as the geometric data contained in the definition of the primitive). The CHARACTER BASE VECTOR is set to a vector, of arbitrary length, at a right angle in the clockwise direction, to the CHARACTER UP VECTOR.

The representation of text at the workstation is controlled by the TEXT INDEX, or the set of individually specified text attributes (TEXT FONT, TEXT PRECISION, CHARACTER EXPANSION FACTOR, CHARACTER SPACING, and TEXT COLOUR INDEX) or some combination of the two,

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depending upon the values of the ASFs for text font, text precision, character expansion factor, character spacing and text colour index. The TEXT INDEX is a pointer into the text bundle table, each entry of which contains values for text font, text precision, character expansion factor, character spacing and text colour index.

Precise control of the appearance of TEXT on a workstation is provided by the following aspects: CHARACTER HEIGHT, CHARACTER WIDTH, character expansion factor, TEXT PATH, CHARACTER UP VECTOR, CHARACTER BASE VECTOR, character spacing and TEXT ALIGNMENT. However, the use of these values in displaying text is determined by the setting of the text font and text precision aspects. The CHARACTER HEIGHT specifies the nominal height of a capital letter character. The CHARACTER WIDTH specifies the nominal width of a character; the actual width depends upon the width to height ratio of the character indicated by the font designer and may vary from character to character. The character expansion factor specifies the deviation of the width to height ratio of the character from the ratio indicated by the font designer. The CHARACTER UP VECTOR gives the up direction of a character. The CHARACTER BASE VECTOR gives the direction of the baseline of a character. Only the directions, not the lengths, of these vectors are relevant. TEXT PATH has the possible values RIGHT, LEFT, UP and DOWN. It specifies the writing direction of the text string. For RIGHT, the text string is written along a baseline in the direction of the CHARACTER BASE VECTOR. For LEFT, the baseline direction is the opposite direction of the CHARACTER BASE VECTOR. For UP, the character path coincides with the direction of the CHARACTER UP VECTOR. For DOWN, it is the opposite direction of the CHARACTER UP VECTOR. For the UP and DOWN text path directions the characters are arranged so that the centres of the character bodies are on a straight line in the direction of the CHARACTER UP VECTOR.

The character spacing value specifies how much additional space is to be inserted between two adjacent character bodies. If the value of character spacing is zero, the character bodies are arranged one after the other along the TEXT PATH, without any additional space between. A positive value of character spacing will insert additional space between character bodies. A negative value of character spacing will cause adjacent character bodies to overlap. Character spacing is specified as a fraction of the font nominal character height.

The effect of the aspects CHARACTER HEIGHT, CHARACTER WIDTH, character expansion factor, TEXT PATH, character spacing and text font is to define an (imaginary) rectangle with its sides parallel to the X and Y axes of the text local coordinate system, enclosing the text. The bounds of this enclosing rectangle are as follows. For TEXT PATH = LEFT or RIGHT, the height of the rectangle is the height of the character body of the specified font; the left side of the rectangle is the left side of the character body of the leftmost character and the right side of the rectangle is the right side of the character body of the rightmost character. For TEXT PATH = UP or DOWN, the top of the rectangle is the top of the character body of the topmost character and similarly, the bottom of the rectangle is the bottom of the bottommost character; the width of the rectangle is the width of the widest character in the specified font.

The effect of the CHARACTER UP VECTOR and CHARACTER BASE VECTOR attributes is to transform the enclosing rectangle, thus defining an enclosing parallelogram, the text extent parallelogram (the rectangle has been rotated and sheared).

The TEXT ALIGNMENT attribute controls the positioning of this text extent parallelogram in relation to the text position. For simplicity the TEXT ALIGNMENT is described in terms of the default CHARACTER UP VECTOR and CHARACTER BASE VECTOR, when the text extent parallelogram is actually a rectangle. The horizontal component of TEXT ALIGNMENT has four values: LEFT, CENTRE, RIGHT and NORMAL. If the horizontal component is LEFT, the left side of the text extent parallelogram passes through the text position. Similarly, if the value is RIGHT, the right side of the text

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extent parallelogram passes through the text position. If the horizontal component is CENTRE, the text position lies midway between the left and right sides of the text extent parallelogram. Thus if TEXT PATH = UP or DOWN, the straight line passing through the centrelines of the characters also passes through the text position. The vertical component of TEXT ALIGNMENT has six values: TOP, CAP, HALF, BASE, BOTTOM and NORMAL. These each correspond to one of the font specific horizontal lines in the definition of a character (see figure 7). A value of TOP causes the top of the text extent parallelogram to pass through the text position. A value of CAP causes the text position to lie on the capline of the whole string (TEXT PATH = LEFT or RIGHT) or on the capline of the topmost character in the string (TEXT PATH = UP or DOWN). A value of HALF causes the text position to lie on the halfline of the whole string (TEXT PATH = LEFT or RIGHT) or on a line halfway between the halflines of the top and bottom characters (TEXT PATH = UP or DOWN). A value of BASE causes the text position to lie on the baseline of the whole string (TEXT PATH = LEFT or RIGHT) or on the baseline of the bottom character in the string (TEXT PATH = UP or DOWN). A value of BOTTOM causes the bottom of the text extent parallelogram to pass through the text position.

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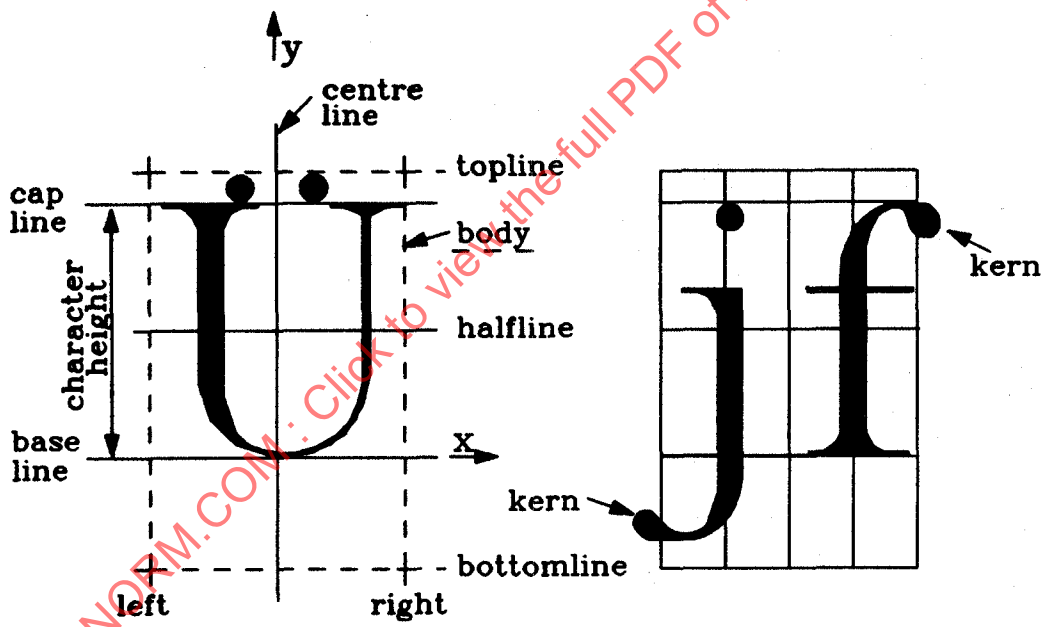


Figure 7 - Font description coordinate system

In the general case, the orientation referred to as horizontal is that of the CHARACTER BASE VECTOR with RIGHT representing direction of that vector and LEFT being opposite to it. Similarly the orientation referred to as vertical is that of the CHARACTER UP VECTOR with UP representing the direction of that vector and DOWN being opposite to it.

Either component of TEXT ALIGNMENT can take the value NORMAL. For each value of TEXT PATH, the effect of a particular component being NORMAL is equivalent to one of the other values of that component. In each case, the equivalent alignment value is chosen to achieve a natural alignment

for that TEXT PATH value. The complete list of equivalent values is:

TEXT PATH	NORMAL Horizontal and Vertical Alignments
RIGHT	(LEFT, BASE)
LEFT	(RIGHT, BASE)
UP	(CENTRE, BASE)
DOWN	(CENTRE, TOP)

The initial values of the geometric text attributes are:

CHARACTER HEIGHT	0.01
CHARACTER UP VECTOR	(0,1)
TEXT PATH	RIGHT
TEXT ALIGNMENT	(NORMAL, NORMAL)

and the initial values of the implicitly specified geometric text attributes are:

CHARACTER WIDTH	0.01 (i.e. the same value as the initial value of CHARACTER HEIGHT)
CHARACTER BASE VECTOR	(1,0)

The text font value is used to select a particular font on the workstation. Every workstation supports at least two fonts; namely font number 1 and font number 2. Each of these shall be able to generate graphical representations of the characters defined in ISO 646, (or a character set including ISO 646), the default character set. The two representations shall be visually distinguishable from each other. Font numbers greater than 2 are reserved for registration (see 4.1.2). Font numbers less than 1 may be supported but are implementation dependent. Each font supports the representation of all characters in all supported character sets. A request to represent a character not contained in the font will result in the generation of an implementation dependent representation which indicates that the requested representation is unavailable.

The text precision value is used to select the "closeness" of the text representation at the workstation in relation to that defined by the workstation independent text attributes and the transformation and clipping currently applicable. The text precision value has the following possible values:

a) STRING: The TEXT character string is generated in the requested text font and is positioned by aligning the TEXT output primitive at the given text position. CHARACTER HEIGHT, CHARACTER WIDTH and character expansion factor are evaluated as closely as reasonable, given the capabilities of the workstation. CHARACTER UP VECTOR, CHARACTER BASE VECTOR, TEXT PATH, TEXT ALIGNMENT and character spacing, need not be used. Clipping is done in an implementation and workstation dependent way.

b) CHAR: The TEXT character string is generated in the requested text font. For the representation of each individual character, the aspects CHARACTER HEIGHT, CHARACTER WIDTH, the up direction of the CHARACTER UP VECTOR, the baseline direction of the CHARACTER BASE VECTOR, and the character expansion factor are evaluated as closely as possible, in a workstation dependent way. The spacing used between character bodies is evaluated exactly; the character body, for this purpose, is an ideal character body, calculated precisely from the text aspects and the font dimensions. The position of the resulting text extent parallelogram is determined by the TEXT ALIGNMENT and the text position. Clipping is performed at least on a

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character by character basis.

c) STROKE: The text character string in the requested text font is displayed at the text position by applying all text aspects. The character string is clipped exactly at the clipping boundaries.

STROKE precision does not necessarily mean vector strokes; as long as the representation adheres to the rules governing STROKE precision, the font may be realized in any form, for example by raster fonts.

When the text is viewed in perspective, each character may have a different height. The effect of perspective need only be reflected in the leading edge of the first character for STRING precision and the leading edge of each character for CHAR precision.

The leading edge of a character depends on the TEXT PATH. For TEXT PATH LEFT and RIGHT, the leading edge is the left or right side of the character body, depending on which side is closest to the text position. If both sides are equidistant, the leading edge is the left side of the character body. For TEXT PATH UP and DOWN, the leading edge is the top or bottom of the character body, again depending on which side is closest to the text position. If both sides are equidistant, the leading edge is the top of the character body.

All text precisions are supported as follows. A workstation may use a higher precision than the one requested for this purpose, i.e. if STROKE precision is supported in a particular font, the implication is that both STRING and CHAR precision are available in that font. With the exception of font numbers 1 and 2, it is not necessary for a workstation to support all precisions for a given font (i.e. for a given font, STROKE can be missing or both STROKE and CHAR can be missing). Text font and text precision are workstation mandatory. That is, every workstation supports at least two STROKE precision text fonts. Font number 1 contains the character set defined by ISO 646 (or a character set including ISO 646). In addition, font number 1 shall be monospaced with a workstation independent aspect ratio. Font number 2 contains a representation of ISO 646 (or a character set including ISO 646) that is visually distinguishable from font 1. This implies that, for STROKE precision text, some sort of software character generator is required for those implementations that have inadequate hardware. Not all workstations need to support all fonts, but for those that do, the same font number is used to select that font on all workstations of a particular installation.

Fonts are defined only within the PHIGS implementation. The font designer specifies the shape of the symbol representing each character in a local 2D cartesian font coordinate system. Fonts are either monospaced or proportionally spaced. For a monospaced font, the font designer specifies the size of the character body (left, right, bottomline and topline) and the positions within the character body of the font baseline, halfline, capline and centreline (see figure 7). For proportionally spaced fonts, the font designer can define left and right differently for each character in the font. For monospaced fonts, the character bodies of all characters have the same size. For proportionally spaced fonts, the width of the bodies may differ from character to character. The character body edges are parallel to the axes of the font coordinate system. The font baseline, the font halfline and the capline are parallel to the x-axis of the font coordinate system, and within the vertical extent of the body. The position of the font halfline is defined by the font designer for use in aligning text strings. The centreline is parallel to the y-axis and bisects the body. Their exact positions are specified by the font designer.

The height of a character in the font coordinate system is given by the height from the font baseline to the capline. The width of a character is given by the width of the character body. The width of a character may include space on either side of the character and this space is generally evenly split between the left and right sides of the character. It is assumed that the characters lie within their body, except that kerned characters may exceed the side limits of the character body.

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In general, the top limits of the bodies for a font are identical with, or very close to, the typographical capline or ascender line, and the bottom limit to the descender line. The space, if any, between the top-line and the capline may be used for an additional mark over the character, for example an accent. However, these and other details are purely for the use of the font designer. The intention is only that characters placed with their bodies touching in the horizontal direction should give an appearance of good normal spacing, and characters touching in the vertical direction will avoid clashes between ascenders and descenders (typographically "set solid").

Since the values of CHARACTER HEIGHT, CHARACTER WIDTH, CHARACTER UP VECTOR and CHARACTER BASE VECTOR are given in the text local coordinate system, but the characters are generated on the workstation in device coordinates, using the workstation dependent font and precision, the geometric attributes need to be transformed in such a way that the workstation can generate the characters in the way intended.

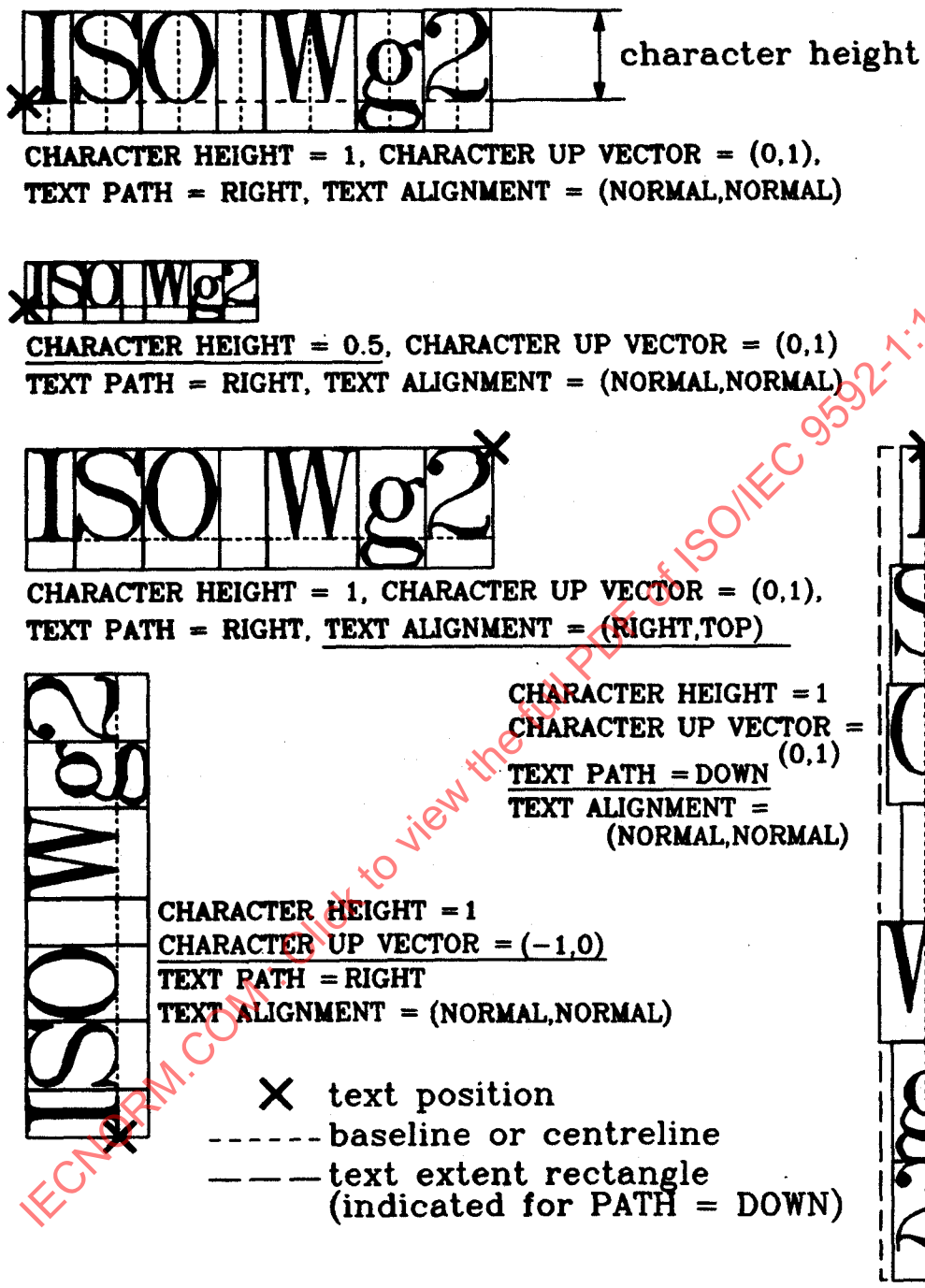
The following is an outline of how this can be achieved, solely for the purpose of clarification. A series of rectangles, aligned and positioned on the text plane by applying the text attributes defined by the PHIGS traversal state list to the nominal character body extent rectangle, is passed through the transformation pipeline. The rectangle height is CHARACTER HEIGHT and is parallel to the CHARACTER UP VECTOR. The rectangle width is CHARACTER WIDTH and is parallel to the CHARACTER BASE VECTOR. The modelling coordinates of the four corners of this rectangle are transformed by the modelling, viewing and workstation transformations. The resulting quadrilateral can be used by the workstation character generator. Thus the shape of individual characters can be transformed.

On the workstation, the height of a character is given by the length of the transformed height vector; the character up direction is given by the direction of the transformed height vector; the width of a character is given by the length of the transformed width vector multiplied by the font width to height ratio for the character and by the character expansion factor; the character base direction is given by the direction of the transformed width vector. The characters are arranged together in a text extent quadrilateral, depending on the values of TEXT PATH and character spacing. The text extent quadrilateral is then positioned according to the value of TEXT ALIGNMENT and the text position, contained in the definition of the TEXT primitive.

The resulting characters need conform to the shape of the character extent quadrilateral exactly for STROKE precision. For STRING precision text, the character height and width vectors need be evaluated only at the leading edge of the first character. For CHAR precision, the character height and width vectors need be evaluated only at the leading edge of each character.

Figures 8 to 11 give examples of the effects of different values of text aspects.

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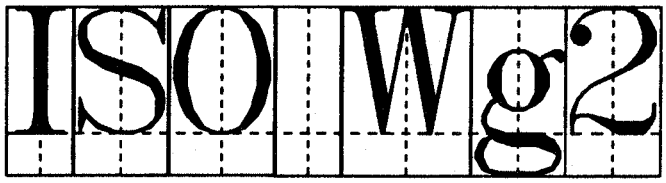
NOTES

1 Examples are illustrated with STROKE precision, a character expansion factor of 1 and a zero character spacing.

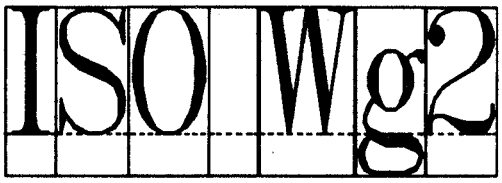
2 Capline = topline in these examples.

3 Changed attributes are underlined.

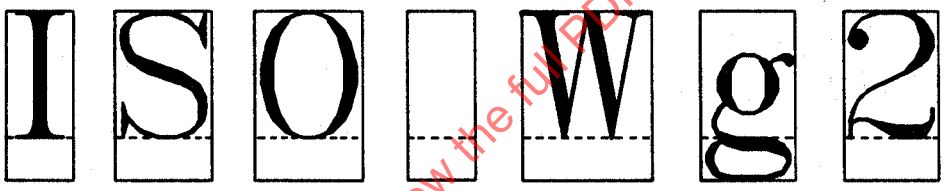
Figure 8 - Effects of changes in geometric text attributes



CHARACTER EXPANSION FACTOR = 1, CHARACTER SPACING = 0



CHARACTER EXPANSION FACTOR = 0.75, CHARACTER SPACING = 0



CHARACTER EXPANSION FACTOR = 1, CHARACTER SPACING = 0.3

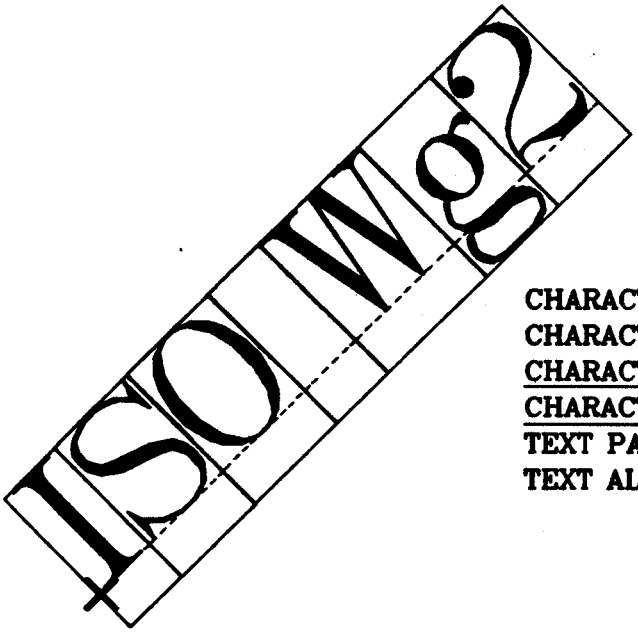
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NOTES

1 Examples are illustrated with default values of the geometric text attributes and with STROKE precision.

2 Changed attributes are underlined.

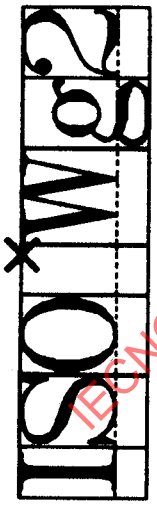
Figure 9 - Effects of changes in CHARACTER SPACING and character expansion factor



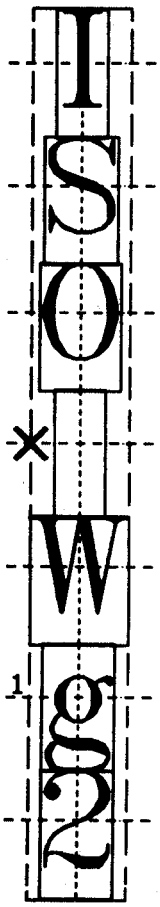
CHARACTER EXPANSION FACTOR = 1
CHARACTER SPACING = 0
CHARACTER HEIGHT = 1.414
CHARACTER UP VECTOR = (−1,1)
TEXT PATH = RIGHT
TEXT ALIGNMENT = (NORMAL,NORMAL)



CHARACTER EXPANSION FACTOR = 1
CHARACTER SPACING = −0.3
CHARACTER HEIGHT = 1
CHARACTER UP VECTOR = (0,1)
TEXT PATH = LEFT
TEXT ALIGNMENT = (NORMAL,NORMAL)



CHARACTER EXPANSION FACTOR = 1
CHARACTER SPACING = 0
CHARACTER HEIGHT = 1
CHARACTER UP VECTOR = (−1,0)
TEXT PATH = RIGHT
TEXT ALIGNMENT = (CENTRE,TOP)



CHARACTER EXPANSION FACTOR = 1
CHARACTER SPACING = 0
CHARACTER HEIGHT = 1
CHARACTER UP VECTOR = (0,1)
TEXT PATH = DOWN
TEXT ALIGNMENT = (LEFT,HALF)

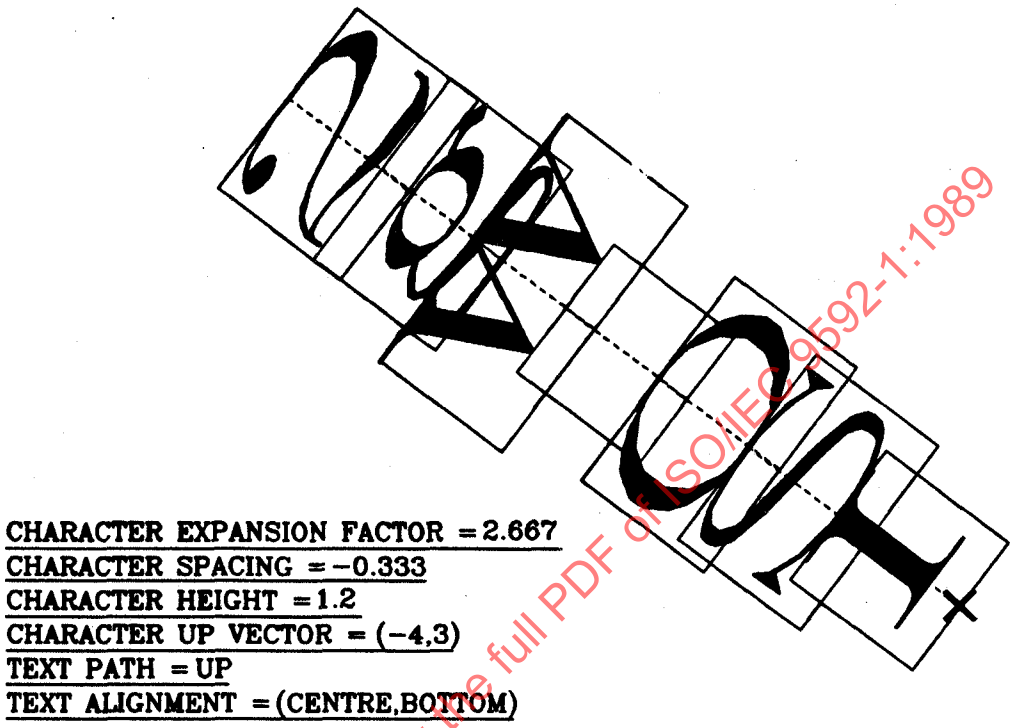
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NOTES

1 Changes from the top example of figures 8 and 9 are underlined.

2 In the last example, halflines of all characters are shown.

Figure 10 - Effects of combined changes in text attributes



NOTE - Changes from the top example of figures 8 and 9 are underlined.

Figure 11 - Effects of combined changes in text attributes

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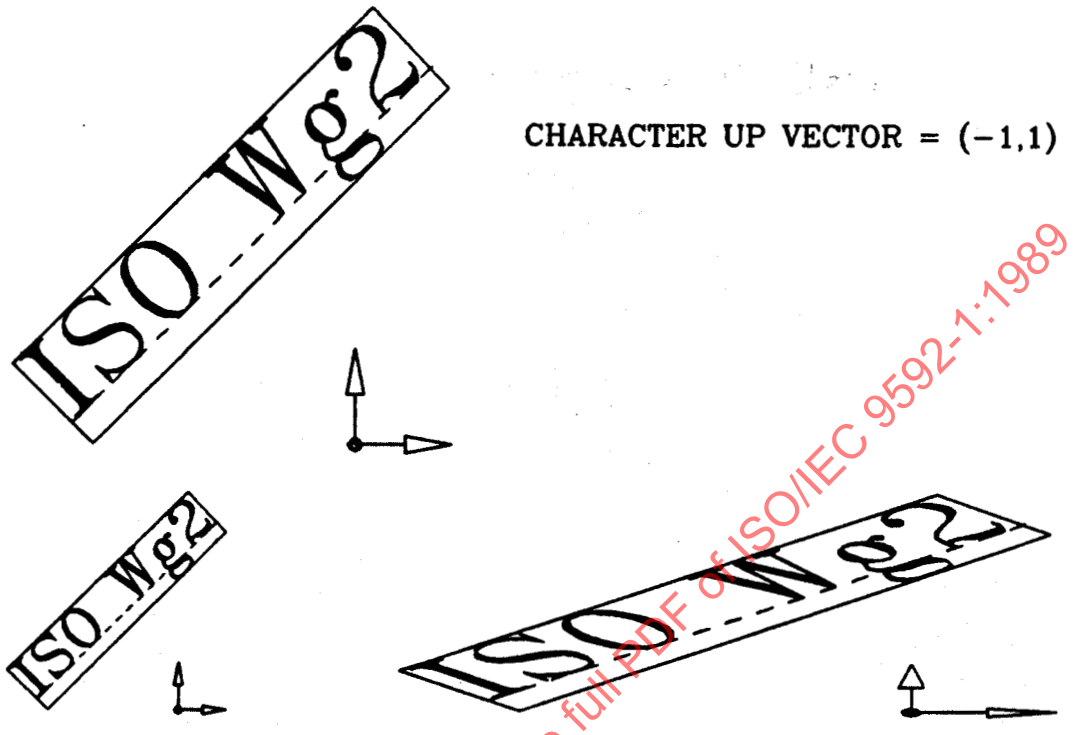


Figure 12 - Effects of different transformations on text in STROKE precision

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4.5.6 Annotation text attributes

Annotation text primitives differ from text primitives in that while the reference point may be positioned anywhere in modelling coordinate space, the plane upon which the characters are generated will always be parallel to the display surface. Annotation text primitives are planar primitives. The plane of an annotation text primitive is defined to be the x-y plane in normalized projection coordinates (NPC) identified by the Z-coordinate of the annotation point in NPC. The annotation point is derived from information in the structure element. A local coordinate system on this plane is defined with origin at the annotation point and X and Y axes parallel to and with the same direction as the X and Y axes of the NPC system. All annotation text geometric attributes are specified with respect to this text local coordinate system. Thus all transformations affect the reference point, but only the workstation transformation affects the annotation text primitive.

Annotation text has the geometric attributes ANNOTATION TEXT CHARACTER HEIGHT, ANNOTATION TEXT CHARACTER UP VECTOR, ANNOTATION TEXT PATH, ANNOTATION TEXT ALIGNMENT and ANNOTATION STYLE. Annotation text also has two implicitly specified geometric attributes ANNOTATION TEXT CHARACTER WIDTH and ANNOTATION TEXT CHARACTER BASE VECTOR. These are implicitly specified by the functions SET ANNOTATION TEXT CHARACTER HEIGHT and SET ANNOTATION TEXT CHARACTER UP VECTOR respectively. They otherwise behave like the explicitly defined geometric attributes.

The representation of annotation text at the workstation is controlled by the same non-geometric text attributes as those used by the text primitive; TEXT INDEX, or the set of individually specified attributes (TEXT FONT, TEXT PRECISION, CHARACTER EXPANSION FACTOR, CHARACTER SPACING, and TEXT COLOUR INDEX).

Once the text local coordinate system for the annotation text has been determined, all operations involved in processing the annotation text primitive are identical to those used for processing text primitives. The effect of TEXT geometric attributes is described in 4.5.5. This same description can be applied to annotation text by replacing the TEXT geometric attributes of 4.5.5 with annotation text geometric attributes.

ANNOTATION STYLE affects the visual representation of annotation text primitives. Two styles are defined in the standard. ANNOTATION STYLE 1 indicates that the reference point is not visually connected to the annotation point. ANNOTATION STYLE 2 indicates that the reference point and annotation point are visually connected by a line whose non-geometric representation is obtained from the settings of the polyline attributes. ANNOTATION STYLE values greater than 2 are reserved for registration. ANNOTATION STYLE values less than 1 are implementation dependent.

Annotation text is visible (independent of whether it is obscured by another primitive) if, and only if, the reference point is within the clipping volume. The clipping of annotation text, including any style components, whose reference point is inside the clipping volume, but whose rendering would extend outside the clipping volume, is workstation dependent.

4.5.7 Text extent and concatenation

The text extent rectangle is the minimum rectangle which completely encloses the character bodies of the text string (see figure 13). This may be determined by INQUIRE TEXT EXTENT which calculates the value of the text extent rectangle in the text local coordinate system of the text primitive, independent of the character up vector and of all clipping and transformations. The text position is assumed to be at (0,0). The text attributes are specified as input to the function, with a workstation type to qualify the text font. For font 1 the results are workstation independent. For other fonts the results may be workstation

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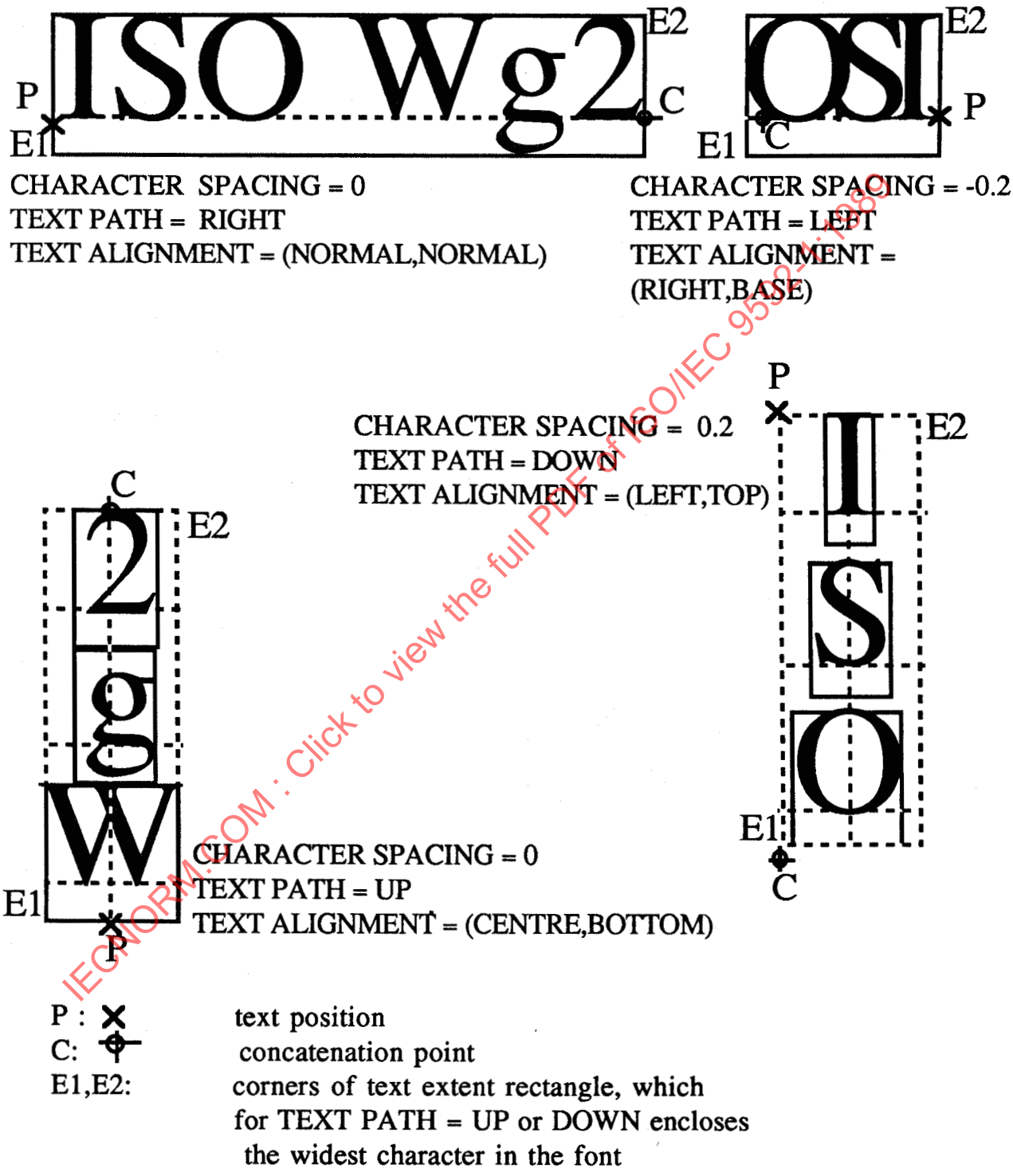
dependent. STROKE precision is assumed so that the information retrieved is exact.

The text extent rectangle is returned as two sets of X & Y bound specifications. For UP and DOWN text paths, the widest character body in the font determines the width of the text extent rectangle.

INQUIRE TEXT EXTENT also calculates the concatenation point and returns its offset from the text position. This includes the inter-character spacing, as determined by character spacing, following the last character in the text string. Hence the concatenation point will lie on the text extent rectangle only if the value of character spacing is zero. An appropriate modelling transformation, to account for CHARACTER UP VECTOR rotation, should be applied to the offset.

In order to concatenate a subsequent text string, the same text attributes should be used, except for TEXT ALIGNMENT or ANNOTATION TEXT ALIGNMENT. TEXT ALIGNMENT or ANNOTATION TEXT ALIGNMENT should be modified according to the following rules. If the text path is RIGHT or LEFT, the horizontal component of TEXT ALIGNMENT or ANNOTATION TEXT ALIGNMENT should be NORMAL. If the TEXT PATH is UP or DOWN, the vertical component of TEXT ALIGNMENT or ANNOTATION TEXT ALIGNMENT should be NORMAL.

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Figure 13 - Examples of replies to INQUIRE TEXT EXTENT with different text attributes

4.5.8 Fill area attributes

Fill area has geometric attributes PATTERN REFERENCE POINT, PATTERN REFERENCE VECTORS, and PATTERN SIZE. It also has two implicitly specified geometric attributes PATTERN WIDTH VECTOR and PATTERN HEIGHT VECTOR. These are implicitly specified by the other geometric attributes. Like ordinary geometric attributes, their values are bound to the fill area primitives when the primitives are created and cannot be changed afterwards. These values are subject to the same transformations as the geometric data contained in the definition of the primitive. The usage of the fill area geometric attributes is described later in this sub-clause.

The representation of fill area at the workstation is controlled by the INTERIOR INDEX, or the set of individually specified fill area attributes (INTERIOR STYLE, INTERIOR STYLE INDEX, and INTERIOR COLOUR INDEX) or some combination of the two depending upon the values of the ASFs for INTERIOR STYLE, INTERIOR STYLE INDEX, and INTERIOR COLOUR INDEX. The INTERIOR INDEX is a pointer into the interior bundle table, each entry of which contains values for the INTERIOR STYLE, INTERIOR STYLE INDEX and INTERIOR COLOUR INDEX.

The interior style is used to determine in what style the area should be filled. It has the following values:

a) HOLLOW: No filling, but draw the bounding polyline, using the INTERIOR COLOUR INDEX currently selected (either via the interior bundle or individually, depending upon the corresponding ASF). The linetype and linewidth of this bounding polyline are implementation dependent.

b) SOLID: Fill the interior of the fill area or fill area set using the INTERIOR COLOUR INDEX currently selected (either via the interior bundle or individually, depending upon the corresponding ASF).

c) PATTERN: Fill the interior of the fill area or fill area set using the INTERIOR STYLE INDEX currently selected (either via the interior bundle or individually, depending upon the corresponding ASF) as an index into the pattern table. In this context, the INTERIOR STYLE INDEX is sometimes referred to as the pattern index.

d) HATCH: Fill the interior of the fill area or fill area set using the INTERIOR COLOUR INDEX and the INTERIOR STYLE INDEX currently selected (either via the interior bundle or individually, depending upon the corresponding ASFs). The INTERIOR STYLE INDEX is used as a pointer into the list of hatch styles, in which case it is sometimes referred to as the hatch index.

e) EMPTY: No filling.

For interior style HOLLOW, the bounding polyline is drawn along boundaries created by clipping (see 4.5.1). For interior styles HOLLOW, EMPTY and HATCH, the treatment of fill area primitives is HLHSR method dependent. Depending on the HLHSR method in use it may be possible for fill areas rendered using these styles to occlude parts of a picture that are behind the fill areas.

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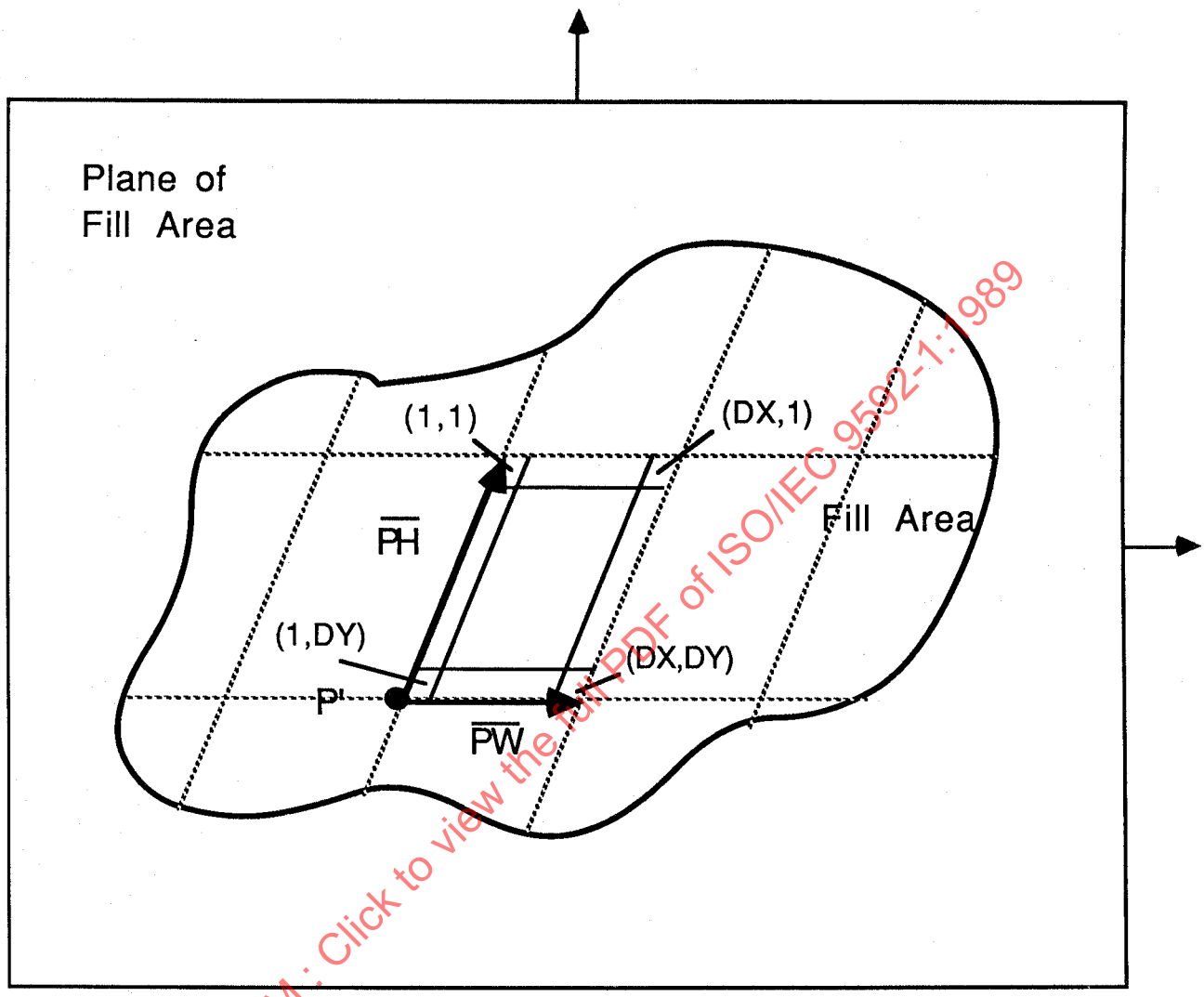


Figure 14 - Replication of the pattern box with fill areas

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For interior style PATTERN, the pattern is defined by the pattern representation, which specifies an array (DX × DY) of colour indices which are pointers into the colour table. The size and starting position of the pattern are determined by a pattern box in a local coordinate system on the fill area plane. The pattern box is defined as follows:

f) The PATTERN REFERENCE POINT and PATTERN REFERENCE VECTORS are projected along a normal vector onto the fill area plane.

g) The origin of the box (the box may actually be a parallelogram) is the projection of the PATTERN REFERENCE POINT.

h) The PATTERN WIDTH VECTOR is one side of the pattern box. Its direction is parallel to the projection of the first PATTERN REFERENCE VECTOR. Its length is equal to that of the SX component of the current PATTERN SIZE.

i) The PATTERN HEIGHT VECTOR is the adjacent side of the pattern box. Its direction is parallel to the projection of the second PATTERN REFERENCE VECTOR. Its length is equal to that of the SY component of the current PATTERN SIZE.

The pattern box is conceptually divided into a grid of DX × DY cells. The colour index array is associated with the cells as follows. The element (1,DY) is associated with the cell having the projected PATTERN REFERENCE POINT at one corner. Elements with increasing first dimension are associated with successive cells in the direction of the PATTERN WIDTH VECTOR. Elements with decreasing second dimension are associated with successive cells in the direction of the PATTERN HEIGHT VECTOR. The pattern is mapped onto the fill area by replicating the pattern box in directions parallel to its sides until the entire fill area is covered. The pattern is subjected to the same transformations as the fill area primitive.

If the projected pattern box is degenerate, an implementation dependent technique determines the location and shape of the pattern box.

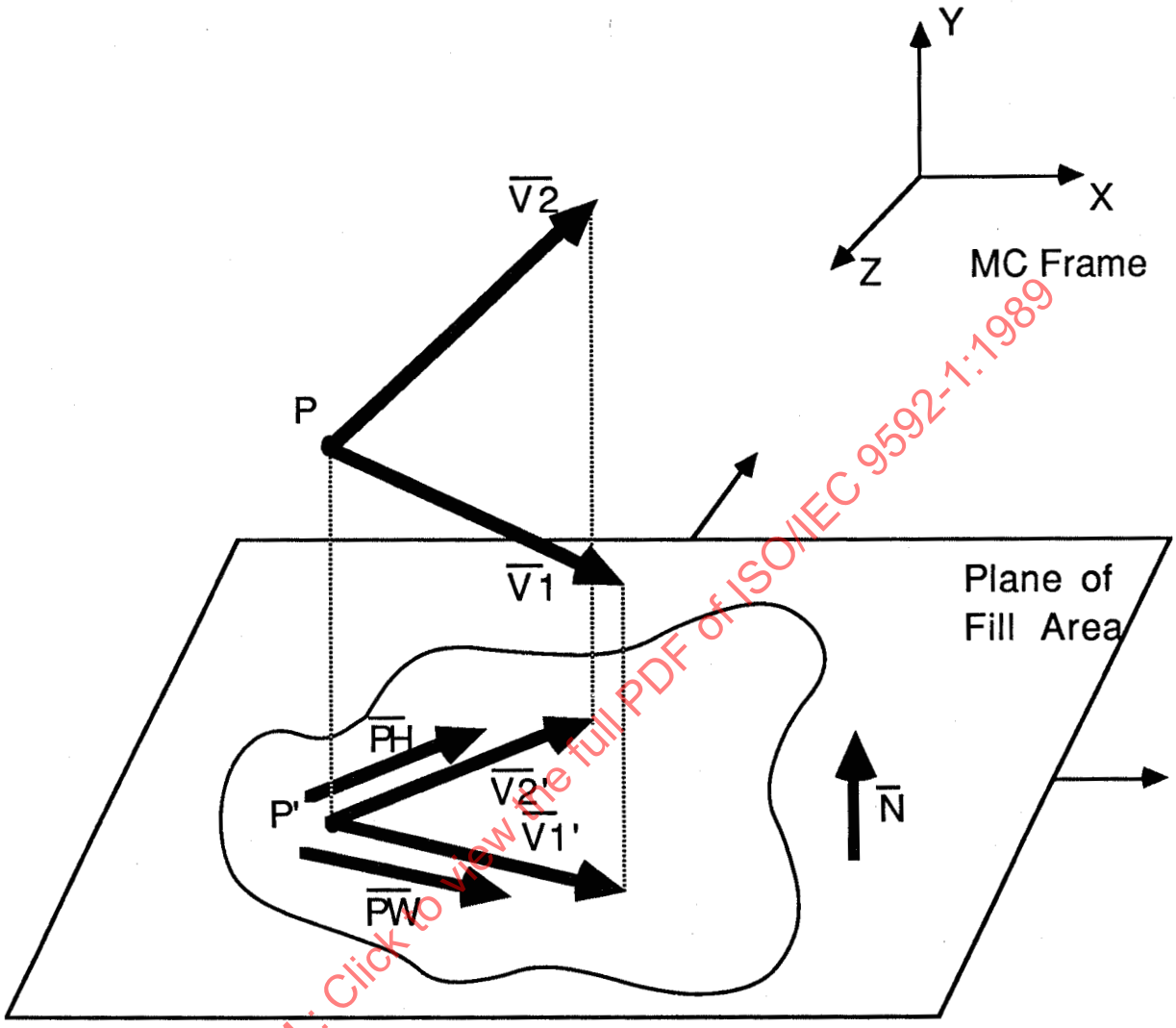
Mapping the transformed pattern cells to the pixels of a raster display is performed by the following rules:

j) if the centre of a pixel lies inside the quadrilateral defined by the transformed cell, its colour is set;

k) if the pixel centre lies on a cell boundary it is implementation dependent which of the adjacent cells is used to determine the colour of the pixel;

l) the pixel is assigned the colour of the cell corresponding to the pixel's centre.

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P = Pattern Reference Point
V1, V2 = Pattern Reference Vectors
P' = Projection of Pattern Reference Point
V1', V2' = Projection of Pattern Reference Vectors
PW, PH = Pattern Width, Pattern Height Vectors
N = Normal Vector to Plane of Fill Area

Figure 15 - Projection of the PATTERN REFERENCE POINT AND VECTORS onto the plane of the fill area

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For a workstation which can implement patterns but not transformable patterns, a suitable action is to generate non-transformed patterns to fill a polygon.

For interior style HATCH, the hatch index selects among hatch styles: hatch styles greater than 0 are

reserved for registration (see 4.1.2); hatch styles less than 1 are implementation dependent. Whether hatching is affected by transformations is workstation dependent.

Interior styles HOLLOW and EMPTY are available on every workstation of category OUTPUT or OUTIN. It is workstation dependent which of the interior styles SOLID, PATTERN and HATCH are available.

4.5.9 Fill area set attributes

Fill area set uses the same interior style attributes as fill area (see 4.5.8).

Another set of aspects for fill area set permits independent control of the edges of fill area sets. The aspects, which can be either individual or bundled, are:

edge flag
edgetype
edgewidth scale factor
edge colour index

The edge flag can have values ON or OFF. When the value is OFF, the edge is not drawn. When the value is ON, the edge is rendered according to the other EDGE attributes. Every fill area set primitive has an EDGE INDEX attribute, which selects the bundle from the workstation edge bundle table. For each edge aspect an aspect source flag exists that controls whether the individual aspect is bound to the fill area set or whether the value is taken from the bundle designated by the EDGE INDEX, as follows:

EDGE FLAG ASF
EDGETYPE ASF
EDGEWIDTH SCALE FACTOR ASF
EDGE COLOUR INDEX ASF

The edges drawn according to the above aspects are drawn on top of the interior. Conceptually edges and interior are disjoint; in practice, they may overlap. Parts of edges that are clipped are not visible.

Edgetypes are drawn from the identical set of values with the same meanings as linetypes. Every workstation of category OUTPUT or OUTIN shall support edgetype 1, solid.

The edgewidth is calculated as a nominal edgewidth multiplied by the edgewidth scale factor. This value is mapped by the workstation to the nearest available edgewidth. For example, if the value is less than or equal to zero (0), the thinnest available edgewidth is used.

For FILL AREA SET primitives with interior style HOLLOW, the rendering of the bounding polyline may be overlaid by the rendering of the edge since the boundary is considered part of the interior. This may lead to the bounding polyline being visible between gaps of non-solid EDGETYPEs, or around the rendering of the edge.

New boundaries created by clipping are not displayed as edges (see 4.5.1).

Fill area set primitives displayed with interior style EMPTY are visible only if edge flag is ON.

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4.5.10 Cell array attributes

Cell array has no attributes other than PICK IDENTIFIER, VIEW INDEX and NAME SET. However, an array of colour indices, which are pointers into the colour table, is part of the definition of a cell array.

The rules to determine the colours of pixels of a raster display in rendering a cell array are the same as for a FILL AREA interior style PATTERN (see 4.5.8).

4.5.11 Generalized drawing primitive attributes

Generalized Drawing Primitive (GDP) has no explicit geometric attributes. Such information may be specified in the GDP data record. The representation of the GDP at the workstation is controlled by zero or more of the sets of polyline, polymarker, text, annotation text, fill area and fill area set attributes (see 4.5.2). Whether bundle indices or associated individually specified attributes are used depends upon the values of the appropriate ASFs. The sets of attributes most appropriate for the specified GDP function are selected for the GDP as part of the definition of the GDP and are recorded in the workstation description table. Similarly, if a GDP is essentially a cell array, then an array of colour indices would be specified in the GDP data record.

4.5.12 Colour

In PHIGS colour is specified in a number of different situations. It may be an aspect of a primitive, in which case it is specified either in the bundle for that primitive or by the individual colour attribute for that primitive. It may be part of a pattern for FILL AREA or FILL AREA SET, in which case an array of colours is specified, or it may be part of a primitive itself, namely CELL ARRAY, when an array of colours is also specified. In each case, the colour is specified as an index into a colour table on the workstation. On each workstation, there is a colour table into which all the colour indices point.

The size of the colour table is workstation dependent but entries 0 and 1 always exist. Entry 0 corresponds to the background colour. The background colour is the colour of the display surface after it has been cleared. Entry 1 is the default foreground colour and entries higher than 1 correspond to alternative foreground colours.

Colours are described by a colour model together with a specification of colour coordinates in the colour space of that model. There is a colour model in effect at each workstation, specified by the 'current colour model' entry in the workstation state list.

Colours are associated with a colour index by the function SET COLOUR REPRESENTATION. The function INQUIRE COLOUR REPRESENTATION can be used to determine the colour associated with a colour index. The parameters of these functions describe the colour as a specification of colour coordinates in the colour space of the current colour model. The number of coordinates necessary to specify colour, and their interpretation, depends on the current colour model.

NOTE - The default colour model is workstation dependent.

The current colour model at a workstation is set by the control function SET COLOUR MODEL. This function selects the colour model used for interpretation of the parameters of SET COLOUR REPRESENTATION and INQUIRE COLOUR REPRESENTATION. It does not affect the colours associated with the indices. The current colour model at a workstation can be inquired by the function INQUIRE COLOUR MODEL.

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Colour models 1 to 4 are predefined as RGB, CIELUV, HSV, and HLS. Only RGB and CIELUV are required to be available. Colour models greater than 4 are reserved for registration. Colour models less than 1 are implementation dependent. These colour models and the appropriate conversion algorithms are described in annex I. The colour models available on a workstation can be inquired by the function INQUIRE COLOUR MODEL FACILITIES.

When colours are associated with a colour index they are mapped to the nearest colour available on the workstation. On some workstations it may not be possible to change the background colour, and in this case the mapping of a specific colour to the nearest available for the background colour may be different from the mapping of the same colour for the foreground colours.

Some workstations are not capable of displaying colours (for example, workstations only capable of displaying colours with equal red, green, and blue intensities or workstations only capable of displaying colours which are different intensities of the same colour); these are referred to as monochrome workstations. Whether a workstation is capable of colour is recorded in the "colour available" entry in the workstation description table which can be inquired by the function INQUIRE COLOUR FACILITIES. On monochrome workstations, the intensity is computed from the colour values in a workstation dependent way (a recommended algorithm can be found in clause D.3 of annex D).

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4.5.13 View index

An attribute of each primitive is the VIEW INDEX. The index selects viewing parameters from a view table at each workstation. The VIEW INDEX is treated in the same fashion as the other bundle indices. The VIEW REPRESENTATION is workstation dependent.

4.5.14 Hidden line / hidden surface removal (HLHSR) identifier

An attribute for each primitive is the HLHSR IDENTIFIER. The HLHSR IDENTIFIER is interpreted at the workstation in an implementation dependent manner (see 4.6.6).

4.5.15 Name set attribute

A NAME SET is an attribute for each primitive.

Two structure elements control the value of the NAME SET attribute during structure traversal, "add names to set" and "remove names from set". When an "add names to set" structure element is encountered during traversal, the 'current name set' entry in the PHIGS traversal state list is set to the union of the NAME SET defined by this structure element and the current value of the entry. When a "remove names from set" structure element is encountered, all elements of the NAME SET defined by this structure element are removed from the 'current name set' entry in the PHIGS traversal state list.

Each workstation has two sets for each of highlighting and invisibility and each input device of class PICK has two sets for pick, which act as filters during traversal. They are the *xxx* inclusion set and the *xxx* exclusion set (where "*xxx*" can be "invisibility", "highlighting", or "pick"). These two sets are defined with a SET *xxx* FILTER function. In order for a primitive to be eligible for highlighting, invisibility, or pick, the primitive's NAME SET, shall have at least one member in the *xxx* inclusion set (i.e. the intersection of the NAME SET with the *xxx* inclusion set shall not be the empty set) and shall not have any member in the *xxx* exclusion set (i.e. the intersection of the NAME SET with the *xxx* exclusion set shall be the empty set). If both the inclusion and the exclusion sets are empty the default for all primitives is that they

are not highlighted, not invisible (visible), and are not pickable.

To restate this more formally:

Let
N be the 'current name set' in the PHIGS traversal state list, and
S be the specified NAME SET,
I be the *xxx* INCLUSION SET,
E be the *xxx* EXCLUSION SET, and
$\varnothing$ be the empty set.

Then the operation ADD NAMES TO SET is

$$N \leftarrow N \bigcup S$$

and the operation REMOVE NAMES FROM SET is

$$N \leftarrow N - S$$

and eligibility for one of the *xxx* operations is defined by

$$(N \bigcap I \neq \varnothing) \; AND \; (N \bigcap E = \varnothing)$$

If N or I = $\varnothing$, nothing will ever be included, while if E = $\varnothing$ nothing that is included will be excluded.

The number of available names for NAME SETs is defined in the PHIGS description table and can be inquired with INQUIRE PHIGS FACILITIES. The range of accessible names shall be at least 0-63 and during traversal, any NAME SET shall be able to contain all 64 names in the range 0-63. In addition, workstation filters shall be able to contain all 64 names in the range 0-63.

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4.5.16 Minimal simulations

The polyline, polymarker, and text primitives shall always be fully supported. In particular, note that all PHIGS implementations are required to support all three values of text precision for at least text font numbers one and two. PHIGS specifies required minimal simulations for fill area, fill area set, and cell array. An implementation may choose to support only the minimal simulation for efficiency considerations, hardware limitations, etc. The minimal simulation required for a cell array primitive is a line drawn around the extent of the cell array primitive. The colour of this line is implementation dependent. There is no minimal simulation required for a Generalized Drawing Primitive (GDP); i.e. an implementation or workstation may ignore it.

4.5.17 Degenerate primitives

For each primitive, mathematically or visually degenerate cases may occur. For example, fill area vertices may be collinear when displayed, either as defined by the application or as a result of the viewing (or other) transformation. The appearance of a degenerate primitive on the display surface is workstation

dependent.

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4.6 Workstations

4.6.1 Workstation characteristics

PHIGS is based on the concept of abstract graphical workstations. These provide the logical interface through which the application program controls physical devices. This abstract workstation can be implemented by any combination of hardware and software. The abstract workstation is capable of accepting input, output or both. Data in the centralized structure store may be displayed under application control on any open workstation. Each workstation includes a number of tables to contain workstation description data, workstation state, and workstation dependent attribute information.

For every type of workstation present in a PHIGS implementation there exists a generic workstation description table which describes the standard capabilities and characteristics of the workstation. When the workstation is opened, a new specific workstation description table is created for that workstation containing information which is derived from the generic workstation description table, obtained from the device itself, and possibly from other implementation dependent sources. The content of the specific workstation description table may change at any time while the workstation is open. The application program can inquire which generic capabilities are available before the workstation is open. The specific capabilities may be inquired while the workstation is open by first inquiring the workstation type of an open workstation to obtain the workstation type of the specific workstation description table and then using this workstation type as a parameter to the inquiry functions which query the workstation description table. This information may be used by the application program to adapt its behaviour accordingly. If capabilities are requested that a particular workstation does not provide or, in the case of the generic workstation description table, is not yet available a standard error reaction is defined. Certain minimal capabilities of a workstation are detailed in 4.14.

An abstract graphical workstation with maximum capabilities

a) has one addressable display space of fixed resolution;

b) allows only rectangular display spaces (the display space cannot consist of a number of separate parts);

c) permits the specification and use of smaller display spaces than the maximum while guaranteeing that no display image is generated outside the specified display space;

d) supports several linetypes, text fonts, character sizes, etc to allow output primitives to be drawn with different attributes;

e) has one or more logical input devices for each input class;

f) permits REQUEST, SAMPLE and EVENT type input;

g) allows logical input devices to be in REQUEST, SAMPLE or EVENT mode independently of each other;

h) has access to the centralized structure store and can traverse and display structure network(s) when directed to do so;

i) permits definition of several transformations which support 3D viewing operations.

In practice, the workstation is not necessarily equipped with all of these capabilities.

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Each workstation has a type. Each workstation type falls into one of five categories:

OUTPUT	Output
INPUT	Input
OUTIN	Output and input
MO	Metafile output
MI	Metafile input

An output workstation has only output capabilities. It can display all output primitives, with the possible exception of the GENERALIZED DRAWING PRIMITIVE which is optional. Minimal requirements for displaying primitives are listed in 4.14.

A workstation of category INPUT has at least one logical input device, but no output capability.

A workstation of category OUTIN has the characteristics of both an OUTPUT and INPUT workstation. In addition, the existence of a workstation in this category in a PHIGS implementation gives rise to additional requirements regarding logical input devices (see 4.8.1).

The categories MO and MI are special facilities for filing graphical information for external storage and exchange. They are treated as workstations for the purposes of control, but otherwise have quite different characteristics (see 4.9).

Actual workstations may provide more capabilities than those listed in the workstation description table. These cannot be used by PHIGS. However, if the workstation itself provides sufficient intelligence, the additional capabilities may be accessed via the GENERALIZED DRAWING PRIMITIVE, GENERALIZED STRUCTURE ELEMENT or ESCAPE functions, or used locally by the workstation operator. As an example, if a workstation has two display surfaces, the operator may switch locally from one to the other without notifying PHIGS or the application program. More than one display surface can be controlled by PHIGS only by defining a separate workstation for each display surface.

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4.6.2 Workstation selection

The application program references a workstation by means of a workstation identifier. Connection to a particular workstation is established by the function OPEN WORKSTATION, which associates the workstation identifier with a generic workstation type and a connection identifier. The current state of each open workstation is kept in a workstation state list for that workstation. When the workstation is opened a specific workstation description table is created as described in 4.6.1 and a new workstation type for this workstation description table replaces the generic workstation type in the workstation state list. When the workstation is closed the specific workstation type created when the workstation was opened becomes unavailable for further use. Either a generic workstation type or the specific workstation type of any open workstation may be specified as the workstation type parameter in any function which inquires data from a workstation description table. Structure manipulation and input can be performed on all appropriate workstations which are open.

4.6.3 Controlling picture changes

The picture displayed on the display surface is primarily controlled by the state of the CSS and workstation state list values. Changes to the CSS or to workstation state, therefore, cause picture changes.

PHIGS distinguishes 17 categories of picture changes:

view representation modification
polyline bundle representation modification
polymarker bundle representation modification
text bundle representation modification
interior bundle representation modification
edge bundle representation modification
pattern representation modification
colour representation modification
workstation transformation modification
highlighting filter modification
invisibility filter modification
HLHSR mode modification
structure content modification
post structure
unpost structure
delete structure
reference modification (structure identifier changes)

PHIGS permits wide variation in the ways in which a workstation supports picture changes. It may be difficult for some PHIGS functions that change the picture on a display surface to achieve the effect immediately on some workstations. For example, a change to a bundle table entry might require the whole display to be regenerated. To permit an application to tailor its behaviour to workstation picture change capabilities there are two functions INQUIRE DYNAMICS OF WORKSTATION ATTRIBUTES and INQUIRE DYNAMICS OF STRUCTURES for inquiring whether a workstation supports "dynamic" picture changes for each of the 17 categories of picture changes.

For each category there is a "dynamic modification accepted for xxx" entry in the workstation description table. These entries can have any of three values:

a) IMM: All picture changes of the category in question can be performed *IMMediately*.

b) IRG: Some picture changes of the category in question can be performed only via a picture regeneration. It is possible that in some cases, some changes can be executed correctly immediately. For example, when no structures are posted, most changes can usually be executed without a picture regeneration. In certain modes an *Implicit ReGeneration* may be performed to accomplish picture changes, hence the name, IRG.

c) CBS: Some picture changes of the category in question can be performed correctly only via a picture regeneration. For these changes, a quick update method is provided so that the picture change *Can Be Simulated* to achieve an indication of the effect without regeneration. A completely correct effect will still require regeneration. Simulating a picture change should provide immediate visual output but should also provide a relatively clear indication of the picture change being simulated. As with IRG, it is possible that some changes can be executed correctly immediately if the state of the picture allows it.

In order to take into account the capabilities of a workstation and the requirements of the application program, the application program can choose among a variety of strategies for controlling picture changes. The application can control the degree to which and the timing when the picture reflects the actual state of the CSS and the workstation tables. The application can control the timing of display modification to gain certain visual effects and to use the capabilities of a workstation more efficiently. Display changes can be delayed or simulated by quick update methods. Simulations are workstation dependent.

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The 'deferral mode' and 'modification mode' entries in the workstation state list, set by SET DISPLAY UPDATE STATE, indicate respectively the current timing when the picture is made correct with respect to the CSS and the workstation state and the method to be used for picture changes between times that the picture is made correct.

The 'state of visual representation' (SVR) entry in the workstation state list describes the relation between the current state of the display surface and the correct picture determined by the CSS and the workstation state. This entry is set according to the flow of control shown in Figures 16 and 17. The possible values are as follows:

d) CORRECT: the display surface shows the correct picture;

e) DEFERRED: one or more picture changes necessary to present the correct picture on the display surface have been deferred (not initiated) at this time;

f) SIMULATED: one or more picture changes necessary to present the correct picture on the display surface have been simulated (using a quick update method) at this time, and no changes have been deferred.

This value can be inquired with the INQUIRE DISPLAY UPDATE STATE function.

The possible values of deferral mode are ASAP, BNIG, BNIL, ASTI, and WAIT.

When ASAP mode is in effect, the picture on the workstation becomes visually correct *As Soon As Possible*. PHIGS ensures that the actions necessary to achieve this visual effect are initiated before control is returned to the application program, but owing to possible delays not under the influence of PHIGS, the actions are not necessarily completed before control is returned. The value of the 'modification mode' entry in the workstation state list is ignored. The 'state of visual representation' entry in the workstation state list is always CORRECT.

When ASTI (*At Some TIme*) mode is in effect, the implementation can choose at any time to make the picture visually correct. Whenever it chooses to make it correct, the 'state of visual representation' entry is set to CORRECT.

The two modes BNIG and BNIL are provided to ensure that the picture is correct while an interaction is in progress. BNIG (*Before Next Interaction Globally*) ensures that the picture is correct as soon as possible while an interaction with any logical input device is in progress on any workstation. BNIL (*Before Next Interaction Locally*) is similar to BNIG, but only considers logical input devices on the workstation on which BNIL is in effect. An interaction is said to be "underway" when a REQUEST is pending or while an applicable input device is in EVENT or SAMPLE mode. If no interaction is taking place, BNIG and BNIL operate like ASTI.

ASTI, BNIG, and BNIL can validly be implemented like ASAP.

When WAIT mode is in effect, the picture is made correct *When the Application requests IT* via UPDATE WORKSTATION and REDRAW ALL STRUCTURES. Between the times these functions are called, exactly those picture changes occur that can be done using the method determined by the modification mode.

Whenever the implementation makes the picture correct it may use knowledge of how the current picture relates to CSS and workstation state, the current value of the state of visual representation, and a history of deferred and simulated picture changes in order to optimize its behaviour.

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Between times that the picture is made correct on a workstation because of deferral mode, the modification mode determines the method to be used for making picture changes. The methods associated with the values of modification mode are as follows:

g) NIVE: *No Immediate Visual Effects* mandated. There is no method for making picture changes between times the picture is made correct when the modification mode is NIVE. No changes occur.

h) UWOR: *Update WithOut Regeneration*. All picture changes that can be realized correctly immediately, without using regeneration or simulation, are performed when the modification mode is UWOR. This includes, but is not restricted to, picture changes whose 'dynamic modification accepted' entries in the workstation description table are IMM. For example, a fill area on a workstation that would normally require a regeneration to make it visible could produce the effect immediately if the display surface was empty or the current picture was independent of this fill area. No other picture changes are performed.

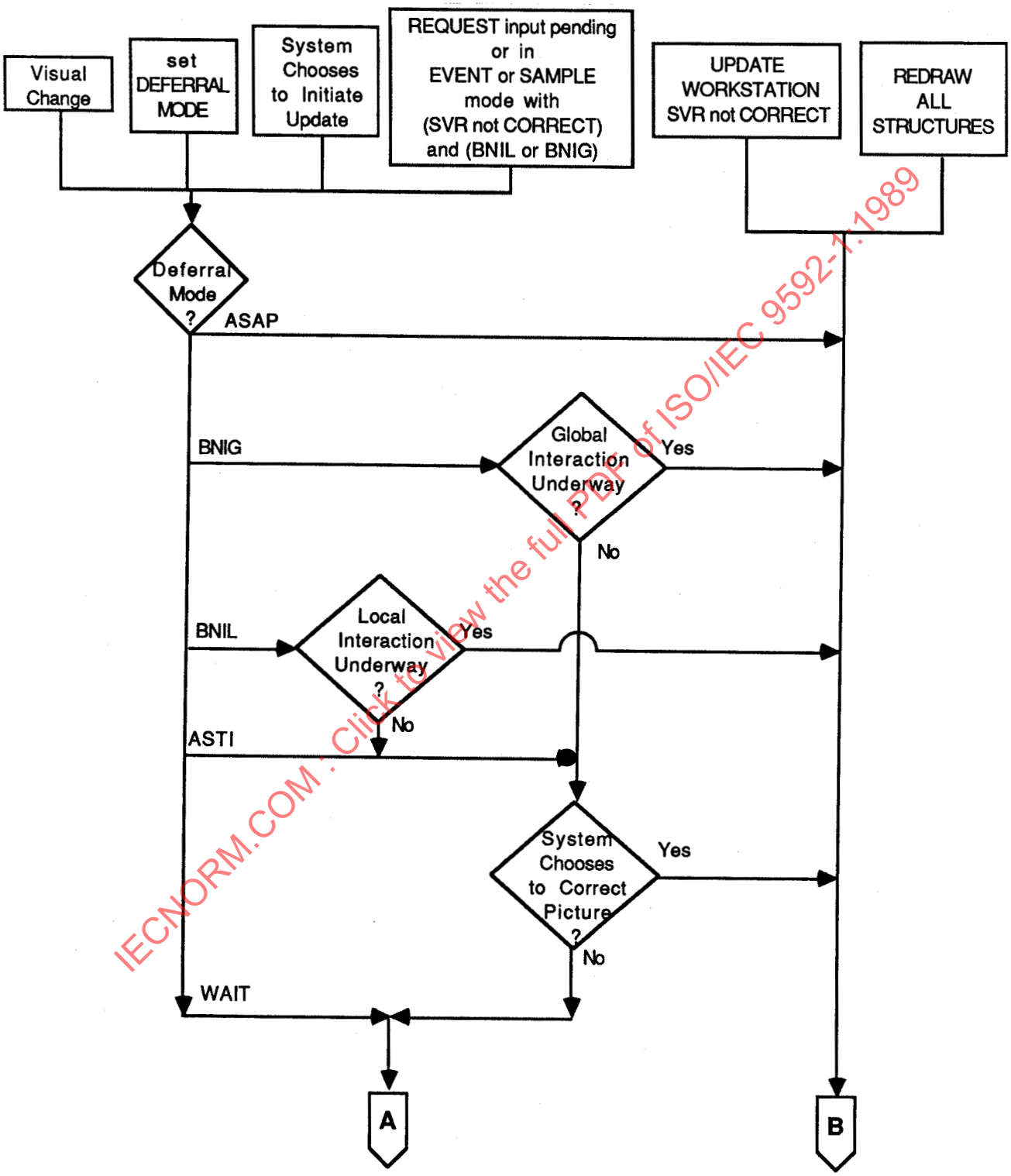
i) UQUM: *Use Quick Update Method*. All picture changes that can be realized correctly immediately, without using regeneration, together with those that can be simulated are performed when the modification mode is UQUM. This includes, but is not restricted to, picture changes whose 'dynamic modifications accepted' entries in the workstation description table are set to IMM and CBS. No other picture changes are performed.

Note that changes to the modification mode are not retroactive to visual effects which are pending as a result of the state of the previous modification mode. For example, if the modification mode is currently NIVE, and the deferral mode is ASTI, then the visual effects of some PHIGS functions may be delayed, depending upon the implementation's interpretation of ASTI. If modification mode is subsequently changed to UQUM, those visual effects which are pending as a result of the previous NIVE state are not affected by the change in modification mode; the change to UQUM mode affects only subsequently generated visual effects.

Figures 16 and 17 illustrate the concepts of display update state. They show the flow of control for events that are significant in the context of controlling picture changes (like setting the deferral mode).

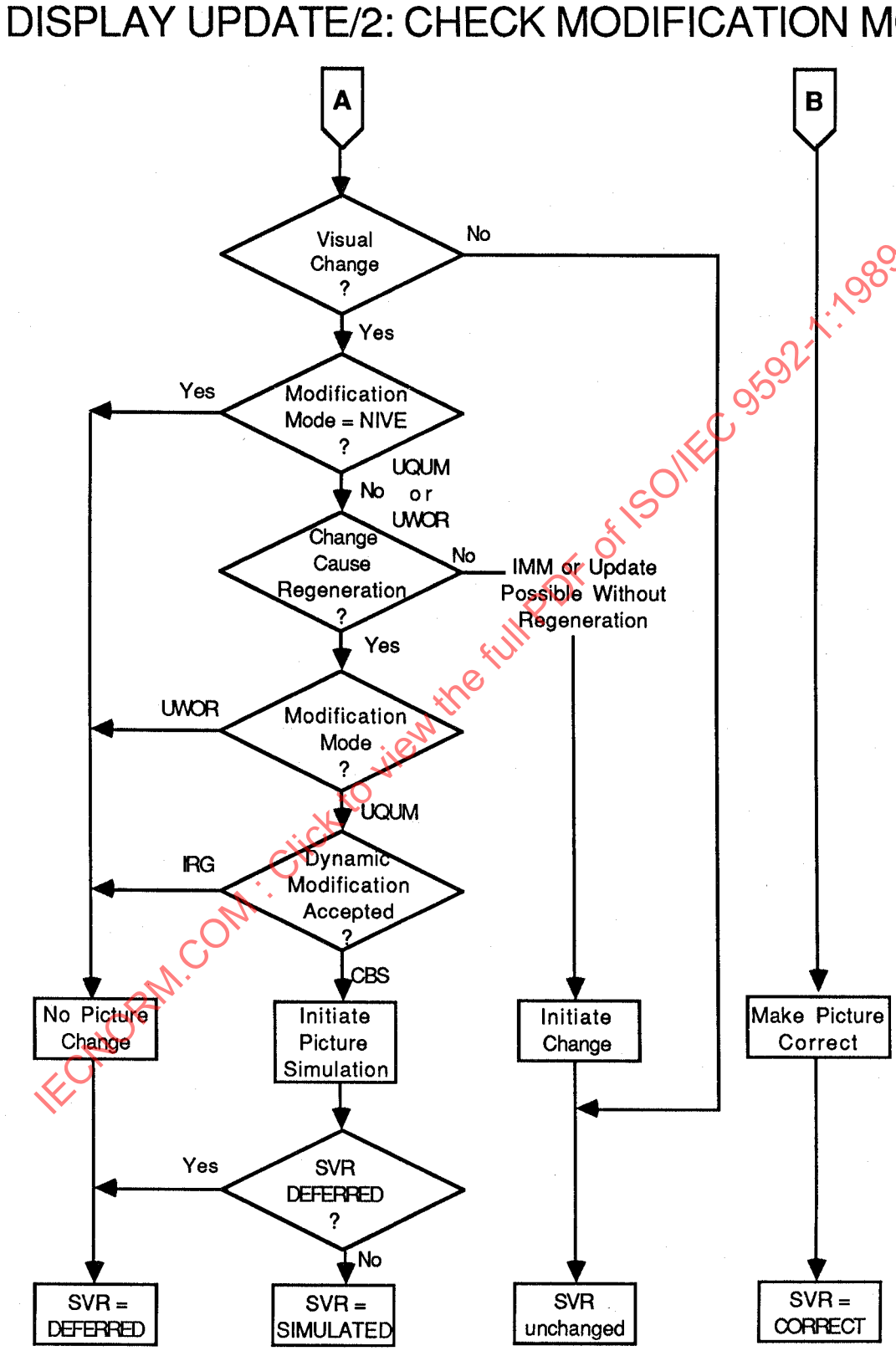
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DISPLAY UPDATE/1: IS CORRECT PICTURE REQUIRED



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Figure 16 - Display update flow diagram #1



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Figure 17 - Display update flow diagram #2

An implicit regeneration is made necessary if the functions listed below have a visible effect on the display image of the respective workstation:

j) if the 'dynamic modification accepted' entry in the workstation description table is IRG (implicit regeneration necessary) for the specified representation:

SET VIEW REPRESENTATION
SET POLYLINE REPRESENTATION
SET POLYMARKER REPRESENTATION
SET TEXT REPRESENTATION
SET PATTERN REPRESENTATION
SET INTERIOR REPRESENTATION
SET EDGE REPRESENTATION
SET COLOUR REPRESENTATION

k) if the 'dynamic modification accepted' entry in the workstation description table is IRG for the workstation transformation:

SET WORKSTATION WINDOW 3
SET WORKSTATION WINDOW
SET WORKSTATION VIEWPORT 3
SET WORKSTATION VIEWPORT

l) if the 'dynamic modification accepted' entry in the workstation description table is IRG for the visibility and highlighting filters respectively:

SET INVISIBILITY FILTER
SET HIGHLIGHTING FILTER

m) if the 'dynamic modification accepted' entry in the workstation description table is IRG for structure content modification, all functions which modify the content of the CSS with the exception of the LABEL and APPLICATION DATA functions;

n) if the 'dynamic modification accepted' entry in the workstation description table is IRG for post structure:

POST STRUCTURE

where the posted structure is not empty and has a priority less than that of an overlapping posted structure;

o) if the 'dynamic modification accepted' entry in the workstation description table is IRG for unpost structure:

UNPOST STRUCTURE
UNPOST ALL STRUCTURES

p) if the 'dynamic modification accepted' entry in the workstation description table is IRG for delete structure:

DELETE STRUCTURE
DELETE STRUCTURE NETWORK
DELETE ALL STRUCTURES
EMPTY STRUCTURE

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q) if the 'dynamic modification accepted' entry in the workstation description table is IRG for reference modification:

CHANGE STRUCTURE IDENTIFIER
CHANGE STRUCTURE REFERENCES
CHANGE STRUCTURE IDENTIFIER AND REFERENCES

r) if the 'dynamic modification accepted' entry in the workstation description table is IRG for the HLHSR mode:

SET HLHSR MODE

s) if any of the situations in j) through r) with the 'dynamic modification accepted' entry in the workstation description table CBS (c.f. IRG) and either the 'modification mode' is not UQUM or the 'deferral mode' demands the picture be correct;

t) if HLHSR MODE is such that the workstation will perform HLHSR and any additions or modifications to the display are made.

It is workstation dependent whether the following causes an implicit regeneration if it has a visible effect:

u) if HLHSR is being performed:

SET HLHSR IDENTIFIER

Deferred actions can be made visible at any time by the use of the UPDATE WORKSTATION function or by an appropriate change of the deferral state. Note that only when deferral mode is WAIT and modification mode is NIVE is it guaranteed that all changes to the display are deferred.

4.6.4 Clearing the display surface

Two capabilities are provided for clearing the display surface:

a) retraversal and redrawing of structures in the centralized structure store which are identified for display on a specific workstation;

b) clearing of the display surface.

Depending on the setting of the control flag, the application program can force the image on the display surface of a workstation to be regenerated by invoking the REDRAW ALL STRUCTURES function. When the control flag is set to the value CONDITIONALLY, the REDRAW ALL STRUCTURES function does not unnecessarily clear the display surface and redraw all structures. If the control flag is set to ALWAYS, a clearing of the workstation and redrawing of all structures always occurs. The display surface can be explicitly cleared by invoking the UNPOST ALL STRUCTURES function.

4.6.5 Sending messages to a workstation

The MESSAGE function allows a character string to be sent to a workstation. The application program has no control over the position and appearance of the character string and an implementation is allowed to place the string on a device distinct from, but associated with, the workstation. The character string may include any character codes supported by the implementation (see 4.5.1). The rules to be followed

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by an implementation are stated in 5.2.

4.6.6 Hidden line / hidden surface removal

Hidden line / hidden surface removal (HLHSR) is the process of determining which parts of primitives are invisible as a result of being obscured by other primitives when observed from the PRP or along the projection direction (see 4.7.4). In PHIGS, the method by which these parts are calculated is implementation dependent. Moreover, implementation of any HLHSR capabilities is optional.

HLHSR is controlled on a workstation dependent basis by the workstation attribute HLHSR MODE and, on a workstation independent basis, by the HLHSR IDENTIFIER. Both attributes are specified as integers, the meanings of which are determined in a workstation and implementation dependent manner. The attributes may not be used for other purposes than HLHSR. The default value for both attributes is 0. Where appropriate 0 should be the most convenient action for that workstation. See annex G for a discussion of possible implementation usage or interpretation of these attributes.

Adding a primitive may cause an implicit regeneration if HLHSR is being performed. Elements of a structure that are "invisible", due to appropriate settings of the workstation's invisibility filters and the state of the NAME SET during traversal, cannot obscure other primitives. Primitives that are not visible as a result of HLHSR may not be pickable (see 4.8.4). HLHSR takes precedence over display priority.

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4.7 Coordinate systems and transformations

4.7.1 Coordinate system handedness

All PHIGS coordinate systems are 3D, right-handed coordinate systems.

4.7.2 Modelling transformations and clipping

In PHIGS, the application programmer can compose a graphical picture from separate parts each of which can be defined within its own modelling coordinate system (MC). The relative positioning of the separate parts is achieved by having a single World Coordinate Space (WC) onto which all the defined modelling coordinate systems are mapped by a composite modelling transformation. These mappings are determined by a composite of modelling transformations. The world coordinate space can be regarded as a workstation independent abstract viewing space. PHIGS provides a modelling clip which may optionally be applied to primitives before viewing transformations are applied. Modelling clip limits may be specified to define a complex volume within the world coordinate system.

A modelling transformation is specified by defining a 4×4 or 3×3 homogeneous transformation matrix and a composition type as a structure element. On traversal graphical output structure elements become output primitives as the composite modelling transformation is applied. The composite modelling transformation is formed from the hierarchy of component modelling transformations in the current structure path. This maps coordinates in a modelling coordinate system to the world coordinate system as follows:

$$\begin{vmatrix} WCx \\ WCy \\ WCz \\ WCw \end{vmatrix} = \begin{vmatrix} C11 & C12 & C13 & C14 \\ C21 & C22 & C23 & C24 \\ C31 & C32 & C33 & C34 \\ C41 & C42 & C43 & C44 \end{vmatrix} \times \begin{vmatrix} MCx \\ MCy \\ MCz \\ 1 \end{vmatrix}$$

The composite modelling transformation is formed from the local modelling transformation L (defined within the current structure), and the global modelling transformation G (the composite modelling transformation initially inherited from the parent structure). The topmost structure of a posted structure network has the identity matrix as its initial global modelling transformation. The local modelling transformation for a structure is initially the identity matrix, but this will be modified when a "set local modelling transformation" or "set local modelling transformation 3" element is traversed.

The composite modelling transformation is computed as follows:

$$C \leftarrow G \times L$$

During traversal, when an "execute structure" element is encountered, the current local and global transformations are saved. After the referenced structure network has been traversed, the transformations are restored.

Modelling transformations are inserted into a structure with the SET LOCAL TRANSFORMATION functions. The transformation matrix, T, is incorporated as follows, depending on the composition type:

a) Composition Type = Replace

$$L' \leftarrow T$$
$$C' \leftarrow G \times L'$$

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b) Composition Type = Pre-concatenate

$L' \leftarrow L \times T$
$C' \leftarrow G \times L'$

c) Composition Type = Post-concatenate

$L' \leftarrow T \times L$
$C' \leftarrow G \times L'$

The SET GLOBAL TRANSFORMATION and SET GLOBAL TRANSFORMATION 3 functions can be used to replace the global modelling transformation. During structure traversal modifications to the global transformation only have effect within the structure in which they are encountered; descendant structures do not affect parent structures.

Modelling clipping is provided to allow clipping prior to viewing. The modelling clip uses the clipping volume as defined at structure traversal by applying operators to half-spaces defining acceptance regions. Portions of primitives outside the acceptance regions are clipped.

The SET MODELLING CLIPPING VOLUME 3 and SET MODELLING CLIPPING VOLUME functions are used to insert a structure element containing an operator, as denoted by an integer, and a sequence of half-spaces. Each half-space is defined by a point in modelling coordinates and a vector defining the normal to the plane defining the bound of the half space. This normal points in the direction of the half space. The half-spaces defined in the compounding structure element are intersected to define a clipping volume. During traversal a new 'current modelling clipping volume' is formed by combining the 'current modelling clipping volume' in the PHIGS traversal state list with the volume specified in "set modelling clipping volume" structure element. The combination operator is defined in the structure element.

When one of these structure elements is encountered during structure traversal, each half-space specified is transformed by the current composite modelling transformation. The resulting clipping volume is not affected by subsequent modelling transformation elements encountered during structure traversal.

Let S be the volume created by the intersection of the half-spaces, S_i, specified in the structure element, so:

$$S = S_1 \cap S_2 \cap \cdots \cap S_n$$

Let T and T' be the current and new values of the 'current modelling clipping volume' entry in the PHIGS traversal state list respectively, and Θ be the operator in the structure element. The new value of the 'current modelling clipping volume' is then given by:

$$T' \leftarrow T \; \Theta \; S$$

Operators 1 and 2 are defined as *replace* and *intersect* respectively. The new value of the 'current modelling clipping volume' for each of these operators is given by:

replace: $T' \leftarrow S$
intersect: $T' \leftarrow T$ AND S

The effect of operator 1 (replace) is to replace the 'current modelling clipping volume' with the volume specified by the structure element. The effect of operator 2 (intersect) is to create a volume which is the intersection of the 'current modelling clipping volume' with the volume specified by the structure element.

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All implementations shall support operators 1 and 2. Operators greater than 2 are reserved for registration. Operators less than 1 may be available, but their results are implementation dependent.

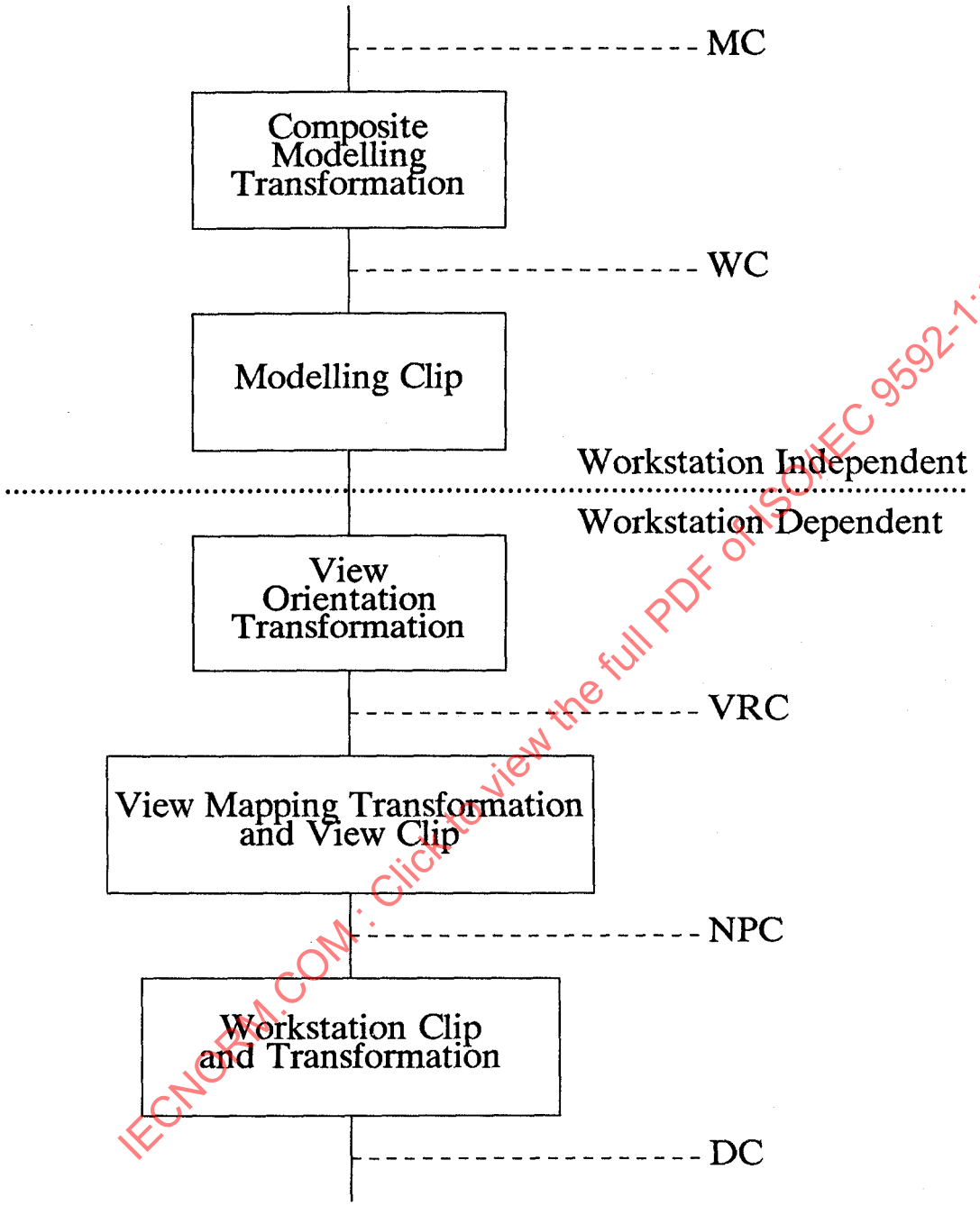
The RESTORE MODELLING CLIPPING VOLUME function creates a structure element which, during traversal, resets the 'current modelling clipping volume' to the value inherited by the structure being traversed.

The SET MODELLING CLIPPING INDICATOR function creates a structure element which, during traversal, enables or disables modelling clipping.

4.7.3 Modelling utility functions

PHIGS provides a comprehensive set of utility functions to compute transformations for use in SET LOCAL TRANSFORMATION, SET LOCAL TRANSFORMATION 3, SET GLOBAL TRANSFORMATION, and SET GLOBAL TRANSFORMATION 3. Included are utilities to produce matrices for reorientation of the current modelling coordinate system, to independently scale, translate or rotate the axes and to perform composite transformations (rotate, scale and translate).

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Figure 18 - The transformation pipeline

4.7.4 Viewing

Viewing is the mechanism whereby coordinates in the World Coordinate system are transformed to Normalized Projection Coordinates. Figure 18 shows the position of viewing in the graphics output pipeline. The view index attribute of a primitive is used to select an entry in a view table at each workstation.

Figure 19 illustrates the effect on primitives of having a view index attribute of 2 displayed on multiple workstations.

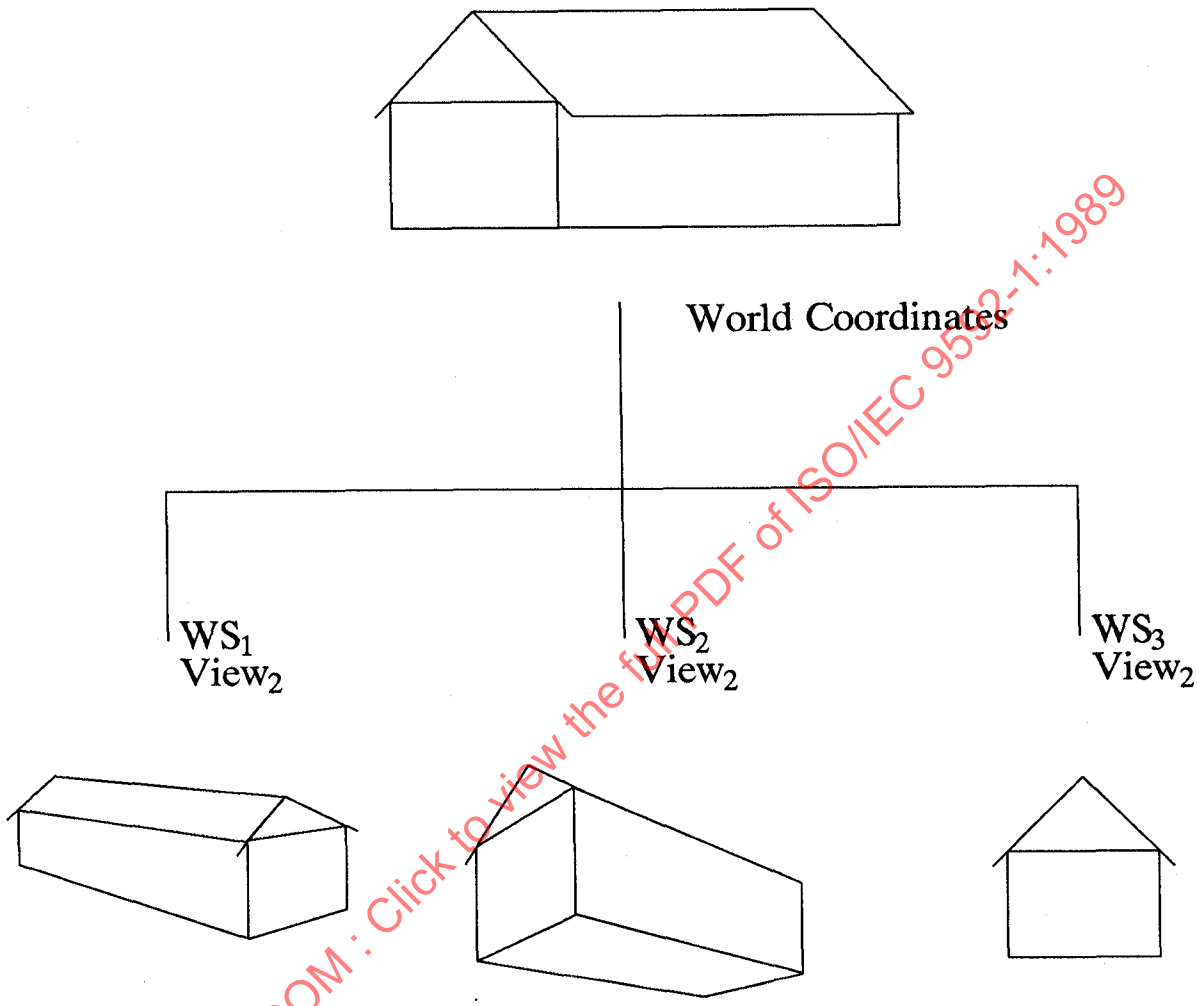


Figure 19 - Interpretation of the view index on workstations

The view table entry specifies a view orientation matrix, a view mapping matrix, view clipping limits in NPC, and three clipping indicators.

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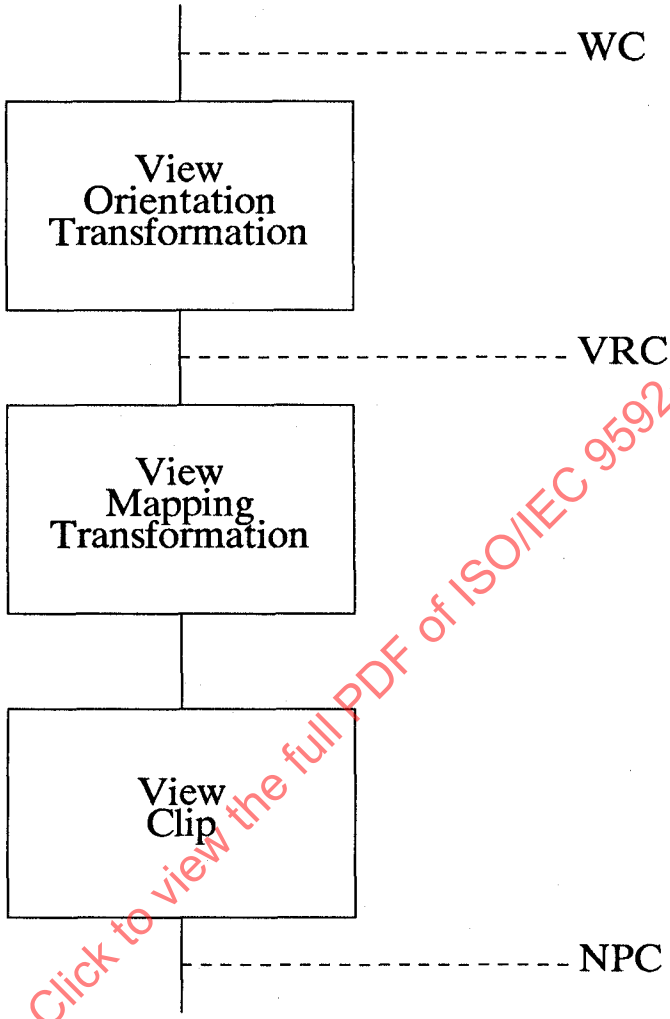


Figure 20 - Viewing model for view representation

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Figure 20 shows the three stages of viewing controlled by a view table entry. The two matrices are 4×4 homogeneous coordinate transformation matrices. The view clipping limits are 6 values, XMIN, XMAX, YMIN, YMAX, ZMIN, ZMAX, defining a rectangular parallelepiped oriented with edges parallel to the NPC axes. The three clipping indicators are of a two-valued enumerated data type and comprise the front clipping indicator which controls clipping against the z=ZMAX plane, the back clipping indicator which controls clipping against the z=ZMIN plane, and the x-y clipping indicator which controls clipping against x=XMIN, x=XMAX, y=YMIN and y=YMAX planes.

The purpose of the view orientation matrix is to transform homogeneous coordinate positions in WC into coordinates relative to the View Reference Coordinate system (VRC). The axes of the VRC system are called U, V and N.

The purpose of the view mapping matrix is to transform points in VRC to points in the Normalized Projection Coordinate system (NPC). This transformation is typically a parallel or perspective transformation.

The purpose of the view clipping limits is to specify the region of NPC space in which visible data may appear, provided clipping is turned on (the workstation clip may subsequently further restrict this region).

The purpose of the clipping indicators is to control whether the planes of the clipping limits are active or inactive, so that the potentially viewable portion of NPC may extend beyond the view clipping limits. If the x-y clipping indicator is NOCLIP the region of NPC space in which visible data may appear is unlimited in X and in Y. If the front clipping indicator is NOCLIP the region of NPC space in which visible data may appear is unlimited in the positive Z direction. If the back clipping indicator is NOCLIP the region of NPC space in which visible data may appear is unlimited in the negative Z direction.

All or part of the viewing operations may be accomplished by other technological means at the workstation in a manner not under application control. For example, workstations with holographic capabilities may use human perception to accomplish perspective. In this case it is workstation dependent whether all, part or none of the viewing mechanism is used in a workstation.

A workstation defined number of views can be stored in each workstation. They are numbered consecutively starting with zero. If the defined number of views on a workstation is N, they are numbered 0, 1, ..., N-1; the view table is densely populated.

In each view table there is a special entry, having index 0, that cannot be modified. It is predefined and contains the following information:

view orientation matrix:	identity, i.e. 1 0 0 0 0 1 0 0 0 0 1 0 0 0 0 1
view mapping matrix:	identity, i.e., 1 0 0 0 0 1 0 0 0 0 1 0 0 0 0 1
view clipping limits:	0, 1, 0, 1, 0, 1
x-y clipping indicator:	CLIP
front clipping indicator:	CLIP
back clipping indicator:	CLIP

The effect of view table entry 0 is to map the cube $[0,1] \times [0,1] \times [0,1]$ in WC to the cube in NPC: $[0,1] \times [0,1] \times [0,1]$.

In PHIGS, the predefined view table entries are initialized to values in the workstation description table, the others are initialized to the same values as view table entry 0. View table entries with index higher than 0 can be modified by the functions SET VIEW REPRESENTATION and SET VIEW REPRESENTATION 3. These functions take a workstation identifier and a view index in addition to the values to be stored in the view table entry.

SET VIEW REPRESENTATION is a 2D short-hand version of SET VIEW REPRESENTATION 3. Its matrices are expanded to 4×4, ZMIN and ZMAX are set to 0 and 1, and front clipping indicator and back clipping indicator are set to CLIP. The method for expanding a 3×3 matrix to a 4×4 matrix is:

$$\begin{vmatrix} a & b & c \\ d & e & f \\ g & h & j \end{vmatrix} \rightarrow \begin{vmatrix} a & b & 0 & c \\ d & e & 0 & f \\ 0 & 0 & 1 & 0 \\ g & h & 0 & j \end{vmatrix}$$

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Since the visual effect of setting a view representation can be deferred, each view representation has "current" entries, "requested" entries, and a 'view transformation update state' entry. The "current" entries are those in effect for output (on workstations of category OUTPUT, OUTIN and MO) and for input (on workstations of category OUTIN and INPUT). The "requested" entries contain the most recently set values (or defaults when the workstation has just been opened). The 'view transformation update state' entry can have the values PENDING and NOTPENDING.

For workstations of category OUTPUT, OUTIN and MO, the 'view transformation update state' entry is PENDING if the most recently set values are not in use in the current visual representation, that is the visual effect is deferred. The 'state of visual representation' in the workstation state list will have the value DEFERRED in this case.

For workstations of category INPUT, the 'view transformation update state' entry always has the value NOTPENDING.

When the visual effect of setting a view representation has been deferred, it ceases being deferred when the 'state of visual representation' in the workstation state list next becomes CORRECT (e.g. during UPDATE WORKSTATION or upon an implicit regeneration). Among the actions that occur while the picture is being made correct are assigning the values of the "requested" entries to the "current" entries and setting the 'view transformation update state' to NOTPENDING.

View table entries are ordered in a list defined by the view transformation input priority. Initially view table entries are in numeric order with view table entry zero having the highest view transformation input priority.

In PHIGS, the function SET VIEW INDEX creates a "set view index" structure element in the currently open structure with the view index specified. At traversal time such structure elements determine the view index attribute that is bound to subsequent output primitives.

4.7.5 Viewing utility functions

Utility functions are provided that compute 4×4 and 3×3 matrices suitable for use as view orientation matrices and view mapping matrices. The parameters for these utility functions are based on 3D and 2D models of orientation and projection. These models explain how certain parameters are used to determine 4×4 matrices. While PHIGS supports certain models, other models are possible and can be utilized by an application which may create its own matrices in accordance with its desired model.

All four of the utility functions described below have two output parameters, a matrix and an error indicator. The matrix is 4×4 or 3×3 depending on whether the modelling utility function is 3D or 2D. If the input parameters are incorrectly or inconsistently specified, the error indicator is set to indicate what the problem is and the ERROR HANDLING function is not invoked.

The model for view orientation provides for positioning and orienting the VRC system with respect to the WC system. The 3D model is supported by the function EVALUATE VIEW ORIENTATION MATRIX 3. The input parameters of this function are as follows.

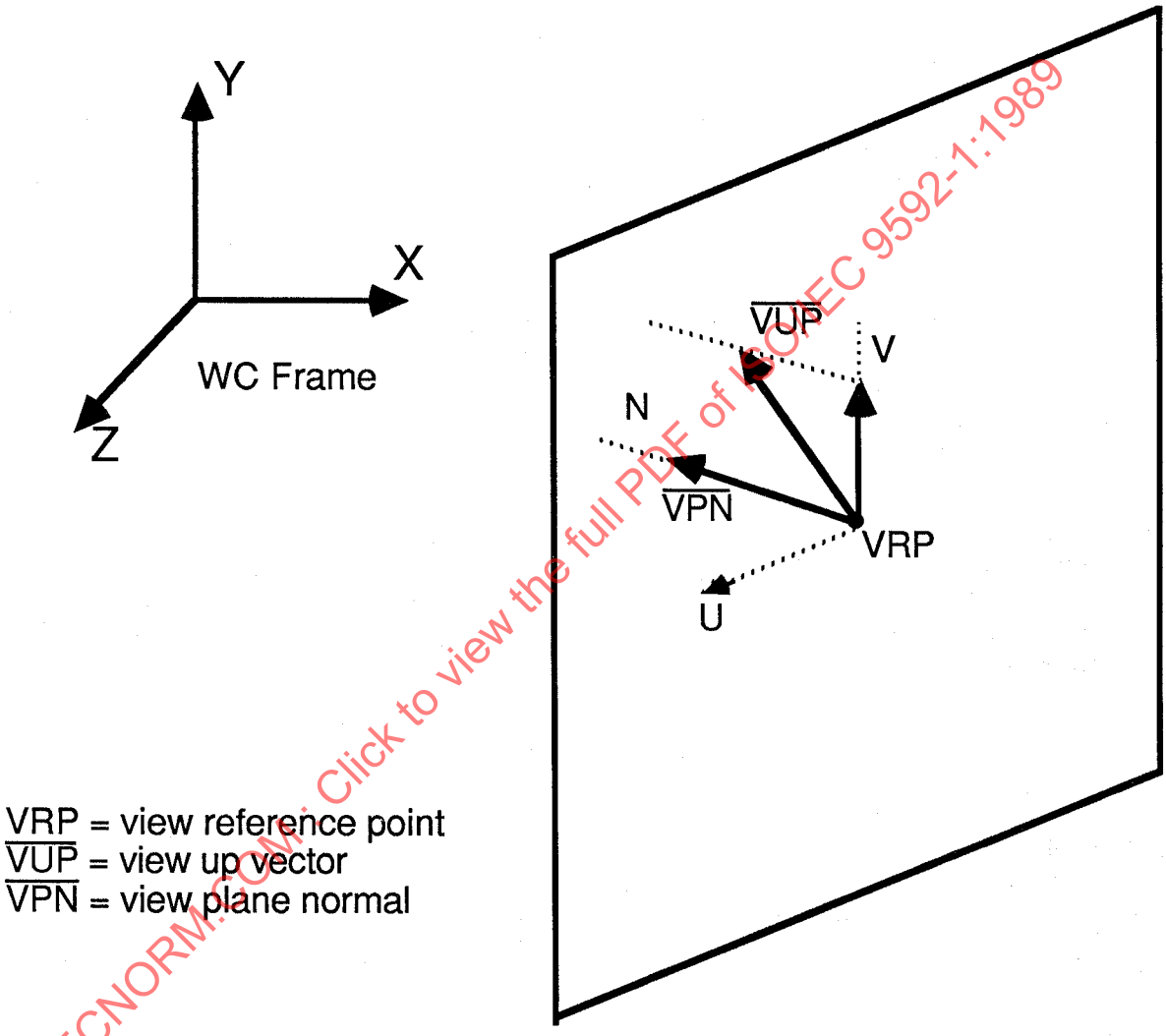
The "view reference point" in WC defines the origin of the VRC. The view reference point is typically a point on or near the object to be viewed.

The "view plane normal" is a vector relative to the view reference point and defines the N axis of the VRC system. The N axis is the third axis of the VRC system. The plane in WC that contains the view

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reference point and that is perpendicular to the view plane normal is called the "view reference plane".

The "view up vector" is a vector relative to the view reference point. The vector is projected onto the view reference plane via a projection parallel to the view plane normal. The projection of the view up vector onto the view reference plane determines the V axis of the VRC system. The U axis is determined such that the UVN axes form a right-handed coordinate system. Figure 21 shows the geometry of the up vector and the UVN axes.



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Figure 21 - Formation of V axis in VRC system

The 2D model for view orientation provides for positioning and orienting the VRC system in the x-y plane of the WC system. This model is supported by the function EVALUATE VIEW ORIENTATION MATRIX. The input parameters of this function are as follows.

The "view reference point" is a 2D point that defines a point in the WC Z=0 plane. This point becomes the origin of the VRC.

The "view up" vector is a 2D vector relative to the view reference point that indicates a direction in the

WC Z=0 plane. This direction becomes the V axis of the VRC. The N axis of the VRC system is parallel to the Z axis of the WC system. The U axis of the VRC system is determined such that the UVN axes form a right-handed coordinate system.

EVALUATE VIEW ORIENTATION MATRIX can also be viewed as a short-hand way of calling EVALUATE VIEW ORIENTATION MATRIX 3, with the following parameters held constant:

Z coordinate of view reference point is 0,
View plane normal is [0, 0, 1],
Z coordinate of view up vector is 0,

and followed by suppressing the third row and third column of the resulting 4×4 matrix as follows:

$$\begin{vmatrix} a & b & 0 & c \\ d & e & 0 & f \\ 0 & 0 & 1 & 0 \\ g & h & 0 & i \end{vmatrix} \rightarrow \begin{vmatrix} a & b & c \\ d & e & f \\ g & h & i \end{vmatrix}$$

The 3D model for view mapping provides for parallel and perspective transformation of the VRC system to the NPC system. This model is supported by the function EVALUATE VIEW MAPPING MATRIX 3. In this model a volume in VRC called the *view volume*, is mapped to a volume in NPC bounded by *projection viewport limits*. The 4×4 matrix returned by EVALUATE VIEW MAPPING MATRIX 3 performs this mapping. Figures 22 and 23 show typical view volumes associated with parallel and perspective views, respectively. The input parameters of this function are as follows.

The projection viewport is a rectangular parallelepiped in NPC space with edges parallel to the NPC axes. Although NPC conceptually extends beyond [0,1] × [0,1] × [0,1], the part of NPC in which the view clipping limits shall be located is the closed unit cube [0,1] × [0,1] × [0,1]. The six NPC values defining the projection viewport are referred to as XMIN, XMAX, YMIN, YMAX, ZMIN, and ZMAX. Typically the projection viewport limits and the view clipping limits will be set to the same values, but this is not mandatory.

The front plane, back plane, and view plane are planes parallel to the UV plane of the VRC system. They are specified as N coordinate values by the parameters "front plane distance", "back plane distance", and "view plane distance", respectively. The front plane and the back plane contain the front and back of the view volume. Conceptually, the View Reference Coordinate system is "oriented" (since VRC coordinates result from the "view orientation transformation"). Since the front plane should not be behind the back plane, the front plane distance shall not be less than the back plane distance.

The view window is a rectangular region on the view plane with sides parallel to the U and V axes. The view window is specified as U and V coordinate values by the "window limits" parameter. The window limits parameter consists of four values usually referred to as UMIN, UMAX, VMIN, and VMAX.

By definition the UMIN edge is the left edge of the view window, the UMAX edge is its right edge, the VMIN edge is its bottom edge, and the VMAX edge is its top edge.

The left, right, bottom and top edges of the view window, together with the projectors through those edges, define the left, right, bottom, and top surfaces of the view volume (respectively). In this model for view mapping, the term "projector" refers to an infinite line in VRC that is mapped (via the view mapping) to an infinite line in NPC of the form (X=constant, Y=constant, Z arbitrary). It should be noted that this meaning is slightly different from the meaning of "projector" common in mathematics.

The "projection type" parameter is an enumerated type with the values PARALLEL and

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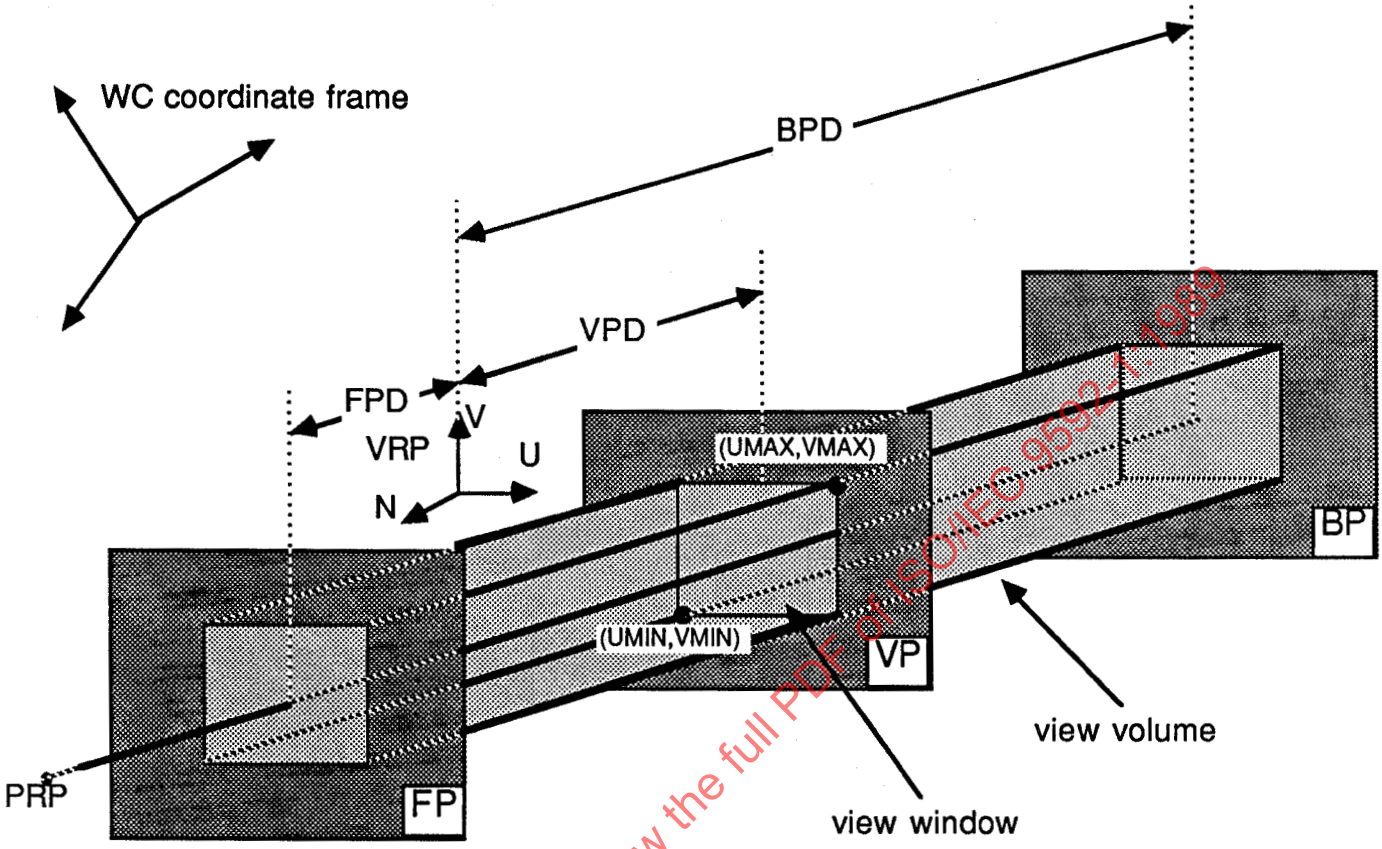
PERSPECTIVE.

The "projection reference point" (PRP) is a position in VRC space and serves to orient the projectors defining the surfaces of the view volume. If projection type is PARALLEL, the projectors are all parallel to the vector joining the PRP and the centre of the view window. The view volume is thus a parallelepiped. If projection type is PERSPECTIVE the projectors all pass through the PRP. In this case the projectors passing through the view window lie on the surface of a pair of infinite rectangular cones having their common vertex at the PRP. The view volume is thus a portion of this double cone.

There are the following restrictions on the parameters:

XMIN < XMAX
YMIN < YMAX
ZMIN ≤ ZMAX
XMIN, XMAX, YMIN, YMAX, ZMIN, ZMAX shall be in range [0,1], inclusive
UMIN < UMAX
VMIN < VMAX
Back plane distance shall be less than front plane distance unless ZMIN equals ZMAX in which case they may be equal.
The N coordinate of the PRP shall not equal the view plane distance.
For a projection type of PERSPECTIVE, the N coordinate of the PRP shall not lie between the front plane distance and the back plane distance.

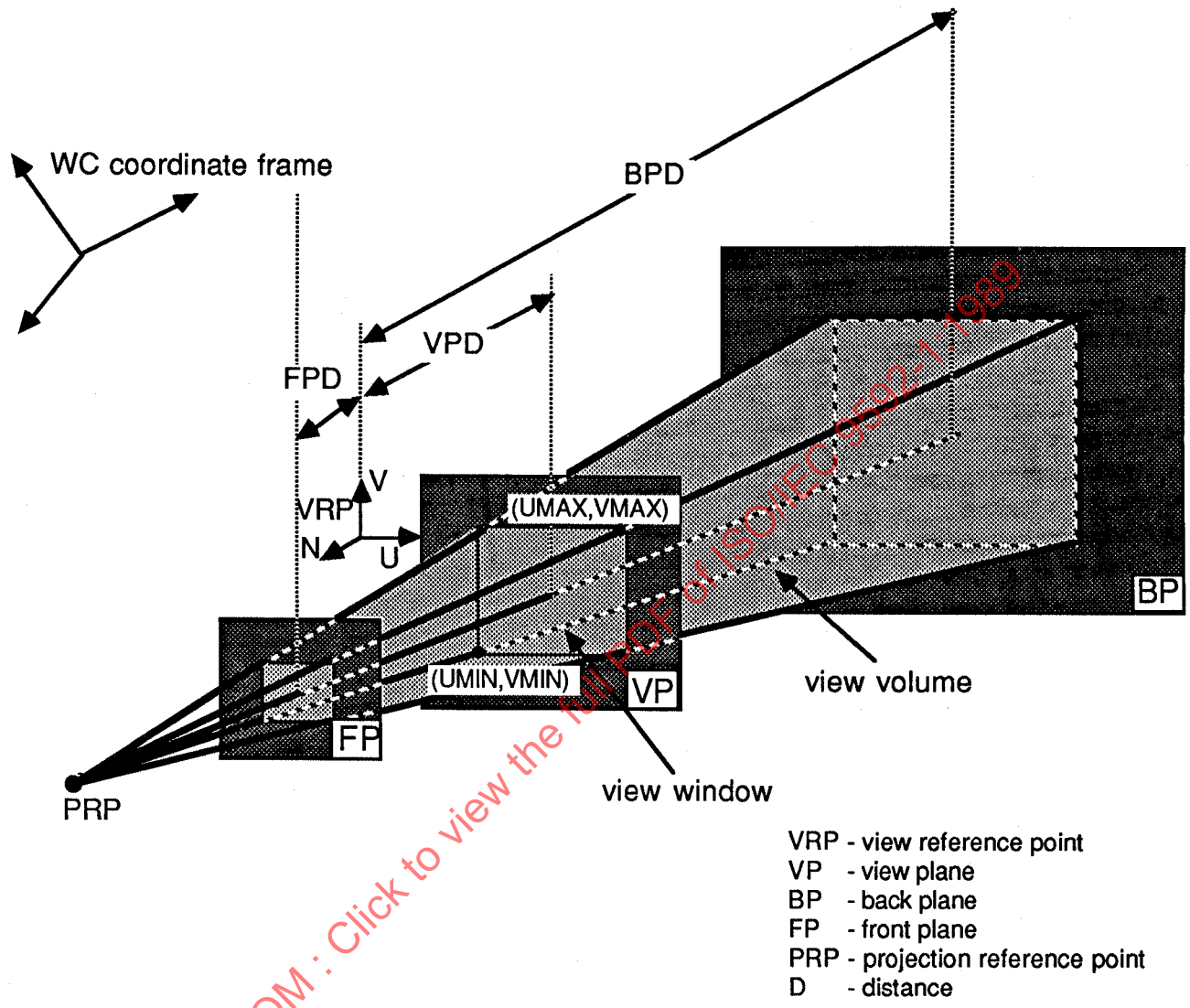
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VRP - view reference point
VP - view plane
BP - back plane
FP - front plane
PRP - projection reference point
D - distance

Figure 22 - Parallel projection view volume

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Figure 23 - Perspective projection view volume

The 2D model for view mapping provides for parallel transformation of the VRC system to the NPC system. This model is supported by the function EVALUATE VIEW MAPPING MATRIX. In general, the model permits one to specify a rectangle on the N=0 plane in VRC, and permits one to specify a rectangle on the Z=0 plane in NPC. The 4×4 matrix returned by EVALUATE VIEW MAPPING MATRIX then is such that the VRC rectangle is mapped to the NPC rectangle. The input parameters of this function are described below.

The rectangle in NPC is upright (sides parallel to the X and Y axes) and located on the Z = 0 plane. Although NPC conceptually extends beyond [0,1] in the X and Y axis, the NPC rectangle shall be located in the closed unit square [0,1] × [0,1]. The four NPC values defining the NPC rectangle are called XMIN, XMAX, YMIN, and YMAX.

The rectangle in VRC is upright (sides parallel to the U and V axes) and located on the N = 0 plane. The view window is specified as U and V coordinate values by the "window limits" parameter. The four

VRC values defining the window limits are called UMIN, UMAX, VMIN, and VMAX.

There are the following restrictions on the parameters:

XMIN < XMAX
YMIN < YMAX
UMIN < UMAX
VMIN < VMAX

The full definition of EVALUATE VIEW MAPPING MATRIX is that it is essentially a short-hand way of calling EVALUATE VIEW MAPPING MATRIX 3, with the following parameters held constant:

Front plane distance = 1
Back plane distance = 0
View plane distance = 0
View clipping limit ZMIN = 0
View clipping limit ZMAX = 1
Projection type = PARALLEL
Projection reference point = [(UMIN+UMAX)/2, (VMIN+VMAX)/2, 1.0]

and followed by suppressing the third row and third column of the resulting 4×4 matrix as follows:

$$\begin{vmatrix} a & b & 0 & c \\ d & e & 0 & f \\ 0 & 0 & 1 & 0 \\ g & h & 0 & i \end{vmatrix} \rightarrow \begin{vmatrix} a & b & c \\ d & e & f \\ g & h & i \end{vmatrix}$$

4.7.6 Workstation transformation

The NPC space can be regarded as a workstation dependent abstract image composition space. Each open workstation can select some part of its NPC space to be displayed somewhere on the workstation's physical display space. A particular workstation transformation is a mapping from NPC space into the device coordinate (DC) space for that workstation.

The units of device coordinates are metres on a device capable of producing a precisely scaled image (for example, on most plotters) and appropriate workstation dependent units otherwise (for example, on a display unit with unknown monitor size). In either case the device coordinate system maps onto the display space in the following way:

a) the DC origin is at the bottom left corner furthest from the observer of the display space;

b) the device coordinate units are related to the display space in such a way that a cube in device coordinates appears as a cube in the display space (this is trivially true if device coordinate units are metres);

c) x, y and z increase to the right, upwards and towards the observer respectively.

On some devices, device coordinate units do not coincide with addressable units, for example if the addressable units do not satisfy the above conditions.

The current size of the display space in device coordinates is recorded in the specific workstation description table (see 4.6.1).

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The workstation transformation allows different aspects of the composed picture to be viewed on different workstations. For example, a drawing could be output to a plotter at the correct scale and simultaneously some part of the drawing could be displayed on the full display space of an interactive terminal.

A workstation transformation is specified by defining the limits of a volume within NPC space within the range [0,1] × [0,1] × [0,1] (the workstation window), which is to be mapped onto a specified volume in DC space (the workstation viewport). Workstation window and workstation viewport limits specify rectangular parallelepipeds with edges parallel to the coordinate axes in NPC and DC. The volumes include their boundaries. To ensure that no output outside the workstation window is displayed, output is clipped at the workstation window boundaries, and this clipping cannot be disabled.

Workstation transformations can be changed by SET WORKSTATION WINDOW, SET WORKSTATION WINDOW 3, SET WORKSTATION VIEWPORT, and SET WORKSTATION VIEWPORT 3.

Since the visual effect of a change to the workstation transformation can be deferred, the workstation state list has "current" entries and "requested" entries for the workstation window and workstation viewport, and there is a 'workstation transformation update state' entry. The "current" entries are those in effect for output (on workstations of category OUTPUT, OUTIN and MO) and for input (on workstations of category OUTIN and INPUT). The "requested" entries contain the most recently set values (or defaults when the workstation has just been opened). The 'workstation transformation update state' entry can have the values PENDING and NOTPENDING.

For workstations of category OUTPUT, OUTIN and MO, the 'workstation transformation update state' entry is PENDING if the most recently set values are not in use in the current visual representation, that is the visual effect is deferred. The 'state of visual representation' entry in the workstation state list will have the value DEFERRED in this case.

For workstations of category INPUT, the 'workstation transformation update state' entry always has the value NOTPENDING.

When the visual effect of setting a workstation window or workstation viewport has been deferred, it ceases being deferred when the 'state of visual representation' in the workstation state list next becomes CORRECT (e.g. during UPDATE WORKSTATION or upon an implicit regeneration). Among the actions that occur while the picture is being made correct are assigning the values of the "requested" entries to the "current" entries and setting the 'workstation transformation update state' to NOTPENDING.

The workstation transformation can be specified at any time while the workstation is open. However, changing the workstation transformation may cause an implicit regeneration of the picture.

As the workstation window is defined within the NPC range [0,1] × [0,1] × [0,1], this ensures that the only part of NPC space that can be viewed on any workstation lies in the range [0,1] × [0,1] × [0,1]. If the workstation window and workstation viewport have different aspect ratios for x, y and z, the scaling specified would be different on each axis if the workstation window was mapped onto the workstation viewport in its entirety. The workstation transformation maps the workstation window onto the largest parallelepiped that can fit within the workstation viewport such that:

d) aspect ratio in x and y is preserved;

e) the lower left hand corner of the workstation window closest to 0 in z is mapped to the lower left hand corner of the workstation viewport furthest from the observer;

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f) the z extent of the workstation window is mapped to the entire z extent of the workstation viewport.

This results in a uniform mapping from NPC onto DC for x and y and hence performs translation and *equal* scaling with a positive scale factor for these two axes.

Thus, space is left unused at the top right side of the workstation viewport if the aspect ratios of the workstation window and workstation viewport are different.

All workstation transformations are set by default to map the range of NPC space ([0,1] × [0,1] × [0,1]) onto the whole of the workstation display space. If the display space is not a cube, the same rules as above apply to determine the scaling on each axis.

4.7.7 Transformation of locator input

The application programmer requires locator input to define a position in world coordinates. Conceptually, the input model is 3D, providing DC coordinates at the operator interface. However, two locator functions are provided, LOCATOR and LOCATOR 3, the former providing a shorthand form analogous to that defined for output primitives.

For the LOCATOR 3 function, the input position is returned to the application program as an (X,Y,Z) world coordinate point along with the view index used. For the LOCATOR function, the input position is returned only as an (X,Y) world coordinate point along with view index used. The Z world coordinate value is not passed to the application. There is only one pipeline for both the LOCATOR 3 and LOCATOR functions.

To return to the application program a position in world coordinates, it is necessary to transform the input data from DC to WC by applying the inverse viewing pipeline.

This is achieved by first transforming the input data from DC to NPC by the inverse workstation transformation which is in effect when LOCATOR input is generated. LOCATOR input can only be obtained from positions within the part of the current workstation viewport into which the current workstation window is mapped (note that this is a subset of the current workstation viewport whenever the aspect ratio of the current workstation viewport and current workstation window differ). Thus, LOCATOR input always defines a position in the NPC range [0,1] × [0,1] × [0,1].

The position in NPC space needs to be transformed from NPC to WC by the inverse of one of the viewing transformations. Each viewing transformation has associated with it a view transformation input priority which is only relevant to LOCATOR and STROKE input. View transformations are ordered in a list defined by the viewing transformation input priority. When a workstation is opened, a workstation dependent number of view transformations are initialized, and their view input priorities are set relative to view 0; view 0 is given the highest priority, view 1 the next highest priority and so on. Changing the view input priority of any view transformation is allowed at any time.

The LOCATOR input position in NPC is compared against the current view clipping limits of the view transformations to find the highest priority view transformation whose current view clipping limits contains the LOCATOR position. The point is then transformed by the inverse of the current view mapping matrix and the inverse of the current view orientation matrix of this view transformation and this inversely transformed LOCATOR position and the view index number of the view transformation used is returned to the application.

View number 0 is the identity transformation encompassing all of the NPC space cube and cannot be

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changed. Locator input is always within at least one set of current view clipping limits. The data flow for locator input is given in figure 24.

Setting the view transformation input priority of any view to a priority lower than that of view 0 effectively disables input from that view. (This is because all valid locator values are within view 0 which takes precedence.)

In EVENT mode, the generation and later translation of locator input cannot be considered an atomic action. Therefore it is advisable that the application program not invoke any function that affects the inverse transformation while a locator EVENT is outstanding.

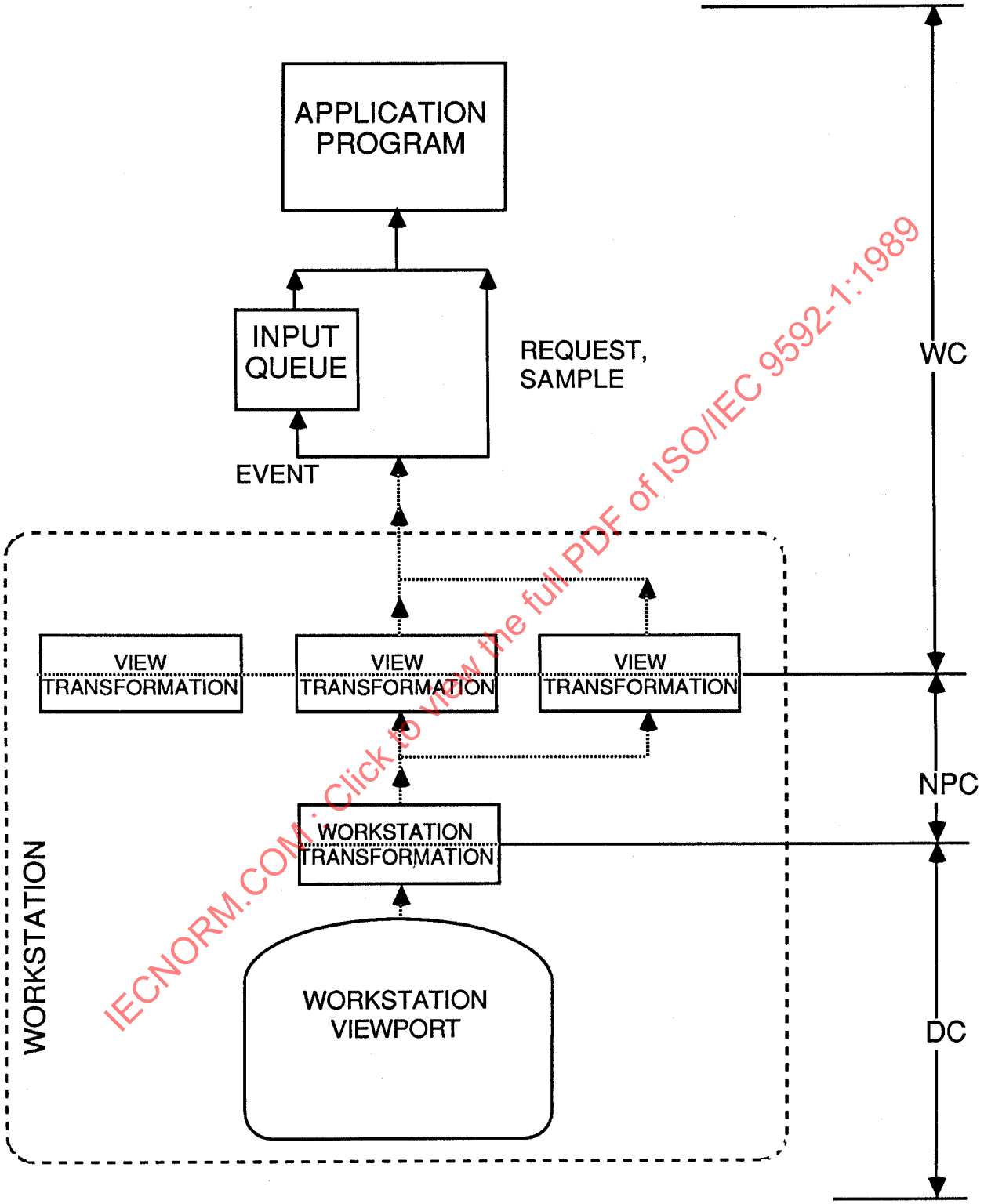
4.7.8 Transformation of stroke input

Similar considerations apply to the transformation of stroke input as apply to locator input, with the complication that more than one point is involved. As for locator input, two functions are provided, STROKE and STROKE 3, with the treatment of information passed back to the application program equivalent to that for LOCATOR and LOCATOR 3.

If SAMPLE mode stroke input is used, successive STROKE or STROKE 3 function calls may provide different world coordinate point sets caused by using different transformations in the procedure above.

In EVENT mode, stroke input has the same potential race condition as locator input, and the application program should be aware of the possible conflicts.

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Figure 24 - Data flow chart for locator input

4.8 Graphical input

4.8.1 Introduction to logical input devices

An application program obtains graphical input from an operator by controlling the activity of one or more logical input devices, which deliver logical input values to the program.

A logical input device is identified by a workstation identifier, an input class and a device number.

The workstation identifier identifies an open workstation, belonging to category INPUT or OUTIN, of which the logical input device is a part. The logical input device is implemented in terms of a physical input device or devices present on the workstation.

The input class determines the type of logical input value that the logical input device delivers. The six input classes and the logical input values they provide are:

a) LOCATOR: a position in world coordinates and a view index;

b) STROKE: a sequence of points in world coordinates and a view index;

c) VALUATOR: a real number;

d) CHOICE: a CHOICE status and a positive integer that represents a selection from a number of choices;

e) PICK: a PICK status, a pick path depth, and a pick path;

f) STRING: a character string.

The device number distinguishes different logical input devices of the same class on the same workstation.

A workstation of category INPUT or OUTIN contains at least one logical input device. A PHIGS implementation providing at least one OUTIN workstation always provides an operator with at least one input device of each class on the family of PHIGS OUTIN and INPUT workstations to which the operator has access.

Each logical input device can be operated in three modes, called operating modes. At any time a logical input device is in one, and only one, of the modes set by the invocation of a function in the group SET <input class> MODE. The three operating modes are REQUEST, SAMPLE and EVENT. Input from devices is obtained in different ways depending on the mode as follows:

g) REQUEST: A specific invocation of REQUEST <input class> causes an attempt to read a logical input value from a specified logical input device. This can only occur when the logical input device is in REQUEST mode. PHIGS waits until the input is entered by the operator or a break action is performed by the operator. The break action is dependent on the logical input device and on the implementation. If a break occurs, the logical input value is not valid.

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h) SAMPLE: A specific invocation of SAMPLE <input class> causes PHIGS, without waiting for an operator action, to return the current logical input value of a specified logical input device. This can only occur when the logical input device is in SAMPLE mode.

i) EVENT: PHIGS maintains one input queue containing temporally ordered event reports. An event report contains the identification of a logical input device and a logical input value from that device. Event reports are generated asynchronously, by operator action only, from input devices in EVENT mode.

The application program can remove the oldest event report from the queue, and examine its contents. The application can also flush from the queue all event reports from a specified logical input device.

A specific logical input device is said to be taking part in an interaction during the whole time that it is in SAMPLE or EVENT mode, but, when it is in REQUEST mode, only during the execution of a REQUEST <input class> function for that device. Alternatively, an interaction with the device may be said to be underway during that time. Many devices on many workstations may be taking part in interactions simultaneously.

4.8.2 Logical input device model

To describe the precise actions of the logical input devices, it is first necessary to describe their relationship with physical input devices, using the concept of measures and triggers.

A logical input device contains a measure, a trigger, an initial value, a prompt and echo type, an echo area / volume and a data record containing details about the prompt and echo type. A logical input device's measure and trigger are parts of the implementation of the workstation containing the logical input device. Initial value, prompt and echo type, echo area / volume, and data record can be supplied by the application program.

The measure of a logical input device is a value determined by one or more physical input devices together with a "measure mapping". More than one measure can simultaneously be determined by a single physical device; a separate measure mapping applies for each measure. A measure can be seen as the state of an independent, active process (a measure process). Each state corresponds exactly with a logical input value.

The current state of the measure process (i.e. the device's measure) is available to PHIGS as a logical input value. Whenever the device is taking part in an interaction, the measure process is in existence. Under other conditions, this process does not exist.

When a measure process comes into existence, the data in the workstation state list entry for the logical input device are examined. The initial value is checked for legality according to input class dependent rules explained in 4.8.4. If the check succeeds, the initial value is used as the current state of the process; otherwise a value dependent on the logical input device is used. Next, a prompt is output to indicate that the device is ready for use. (The prompt technique used by a device is determined by its prompt and echo type, which may be selected by calling the appropriate INITIALIZE function.) Creation of the measure process is then complete.

While the measure process is in existence, if echoing is required, output indicating the current state of the measure process is provided to the operator.

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The trigger of a logical input device is a physical input device or a set of them together with a "trigger mapping". The operator can use a trigger to indicate significant moments in time. At these moments, the trigger is said to "fire". A single operator action (for example, pressing a button or a light pen tip switch) causes the firing of not more than one trigger. Several logical input devices can refer to the same trigger.

A trigger can be seen as an independent, active process (a trigger process) that sends a message to one or more recipients when it fires. A logical input device is a recipient of its trigger if there is a pending REQUEST for it or if it is in EVENT mode. Both of these conditions can be true simultaneously for different logical input devices. If there is at least one recipient for a trigger, the trigger process is in existence. Under other conditions this process does not exist.

If a REQUEST for a logical input device is pending when the device's trigger fires, the measure of that device is used to satisfy the REQUEST. If one or more devices containing a given trigger are in EVENT mode when the trigger fires, the identifications of those devices and their measure values are passed to the input queue mechanism as separate event reports. The input queue mechanism is described in detail in 4.8.5.

When a trigger firing succeeds in satisfying a REQUEST, or adding event records to the input queue, PHIGS provides to the operator an acknowledgement the form of which depends on the implementation of the logical input device. The acknowledgement is not controllable by a PHIGS function.

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4.8.3 Operating modes of logical input devices

The mode of a logical input device may be changed by invoking the appropriate SET <input class> MODE function.

After an invocation of SET <input class> MODE with the parameter REQUEST, no measure process exists for the specified device and the device's identifier is not on its trigger's list of recipients. After an invocation with the parameter EVENT, a newly initiated measure process is in existence for the specified device and the device's identifier is on its trigger's list of recipients. After an invocation with the parameter SAMPLE, a newly initiated measure process is in existence for the specified device, but the device's identifier is not on its trigger's list of recipients.

Initially a logical input device is in REQUEST mode.

While a device is in REQUEST mode, a logical input value may be obtained by invoking the appropriate REQUEST <input class> function. The effects of doing so are as follows.

a) To create a measure process for the specified device and to set its value to the initial value from the workstation state list as described in 4.8.4. Echoing is performed by the measure process if echoing is on for the specified device.

b) To add the device's identifier to its trigger's list of recipients. If the list was previously empty, the trigger process is started.

c) To suspend PHIGS until the trigger of the specified device fires, or the operator invokes the break facility.

d) If the trigger fired, to set the logical input value to the current state of the measure process.

e) To destroy the measure process.

f) To remove the device's identifier from its trigger's list of recipients. If this list becomes empty, the trigger process is destroyed.

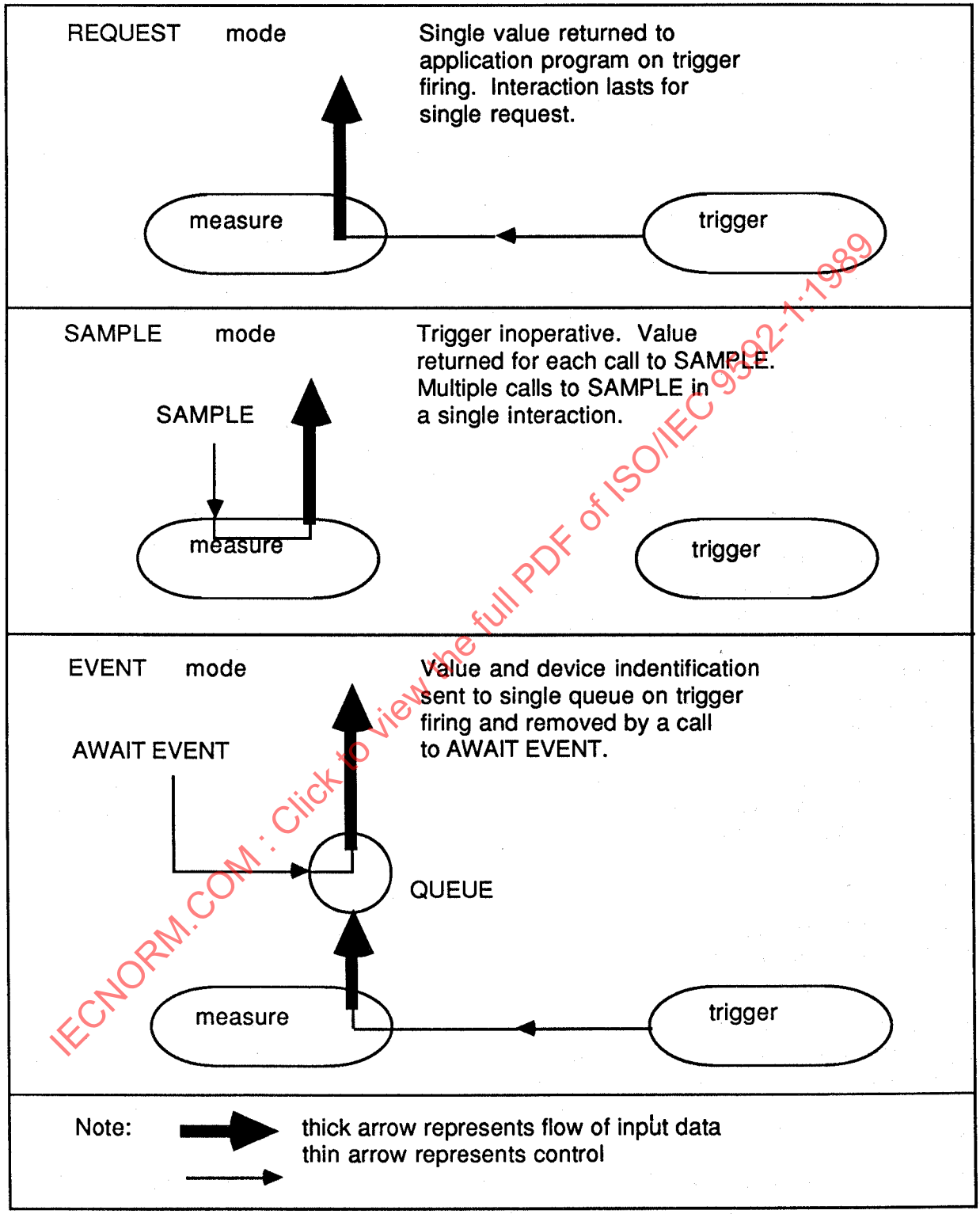
g) If the trigger fired, to return the logical input value and the status OK, otherwise to return the status NONE.

While a logical input device is in SAMPLE mode, a logical input value may be obtained by invoking the appropriate SAMPLE <input class> function. The effect of doing so is to set the logical input value to the current state of the measure process without waiting for a trigger firing. There is no implicit clearing of the measure value as a result of sampling a logical input device.

While a logical input device is in EVENT mode, logical input values are added as event reports to the input queue, and may be obtained in sequence by invoking AWAIT EVENT, and then invoking the appropriate GET <input class> function. (More details of the input queue are given in 4.8.5.)

Figure 25 shows the effect of every operating mode on the measure and trigger of a logical input device.

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Figure 25 - The relationship between the measure and trigger for different operating modes, illustrated for a single logical input device.

4.8.4 Measures of each input class

A LOCATOR measure consists of a position in world coordinates and a view index. Let P and I denote these values. This measure value is generated from a point $P^{(DC)}$ in the workstation viewport that originates from the physical input device coordinates in the following way:

a) Apply the inverse workstation transformation to transform $P^{(DC)}$ into $P^{(NPC)}$. If the workstation transformation has no inverse, the z-component of $P^{(NPC)}$ is set to the minimum z value of the workstation window.

b) Select all view representations on the workstation whose current view clipping limits contain the point $P^{(NPC)}$. Reject any view representations that contain viewing transformations with no inverse. Of the remaining view representations select the one with the highest view transformation input priority. The index that points to this view representation is called I.

c) Apply the inverse of this viewing transformation of view representation I to transform $P^{(NPC)}$ into $P^{(WC)}$.

A STROKE measure consists of a sequence of positions in world coordinates and a view index. Let $P_1 \ldots P_m$ and I denote these values. This measure value is generated from the points $P_i^{(DC)}$ $(1 \leq i \leq m)$ in the workstation viewport that originate from the physical input device coordinates in the following way:

d) Apply the inverse workstation transformation to transform $P_i^{(DC)}$ $(1 \leq i \leq m)$ into $P_i^{(NPC)}$ $(1 \leq i \leq m)$. If the workstation transformation has no inverse, the z-component of all of the $P_i^{(NPC)}$ are set to the minimum z value of the workstation window.

e) Select all view representations on the workstation whose current view clipping limits contain all of the points $P_i^{(NPC)}$ $(1 \leq i \leq m)$. Reject any view representations that contain viewing transformations with no inverse. Of the remaining view representations select the one with the highest view transformation input priority. The index that points to this view representation is called I.

f) Apply the inverse of this viewing transformation of view representation I to transform $P_i^{(NPC)}$ $(1 \leq i \leq m)$ into $P_i^{(WC)}$ $(1 \leq i \leq m)$.

These rules imply that no view having priority less than that of view 0 can appear in the state of a LOCATOR or STROKE measure process (note that with the default settings of the viewport input priorities, view 0 has the highest priority).

The LOCATOR and STROKE measure processes are 3D processes.

A VALUATOR measure provides logical input values that are real numbers. Each value lies between (possibly including) minimum and maximum values, which are in the data record in the workstation state list.

A CHOICE measure provides logical input values whose components are OK or NOCHOICE and an integer in the range 1 to a device dependent maximum specified in the workstation description table. If the first component is OK, then the integer is valid. Choice input typically occurs when an operator presses a button (the numeric identifier of the button determines the measure) or combination of buttons (the measure is derived from the combination of buttons pressed).

A PICK measure provides logical input values whose components are pick status (OK, NOPICK), and the identification of the picked primitive. To uniquely identify the picked primitive in the hierarchical structure of PHIGS requires the complete traversal path to be returned. The pick path contains the structure name, pick identifier and element sequence number of the structure element at each level. The PICK DEPTH is the number of levels returned in the PICK PATH.

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Picking occurs in the abstract 3D image created in NPC space. The abstract image contains definitions of all primitives (or portions of primitives) which have not been rejected by modelling and view clip operations and do not satisfy the invisibility filter. These definitions also contain suitable information for determining the pick path of each primitive. Some HLHSR methods may affect the generation of the abstract image. The effect on picking of such methods is method dependent.

Only primitives that are part of the abstract image and which satisfy the pick filter are eligible for picking. Primitives which satisfy the invisibility filter are not considered to be part of the abstract image. Picking shall act as if performed on the geometric definition of the primitives comprising the abstract image. Rendering effects, such as linewidth, which increase the area of the primitive may be considered. If more than one primitive is eligible according to the comments above, the implementation shall use a consistent procedure for determining the primitive that is picked.

The pick initial values are tested according to the above criteria whenever the pick measure process is initiated. If these criteria are not satisfied, the process state list is set to NOPICK. The pick measure is generated from information describing the relationship between the picked output primitive and its posted structure network. Pick devices exist only on workstations of category OUTIN.

A STRING measure provides logical input values that are character strings up to a device dependent maximum length specified by the 'available input buffer size' value in the data record in the workstation description table. The application can initialize a STRING device to establish an 'input buffer size' shorter than the 'available input buffer size'. The character set of the input string starts with the character set described in ISO 646 (or an implementation dependent character set which contains ISO 646). Switching of the character set can occur from character set shifting characters contained in the initial string or entered by the operator.

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4.8.5 Input queue and current event report

The input queue contains zero or more event reports. Event reports contain pairs of values (device identifier, logical input value) resulting from trigger firings. Event reports can be added to the input queue when logical input devices in EVENT mode are triggered by the operator. Events can be removed from the input queue by invocations of AWAIT EVENT, FLUSH DEVICE EVENTS and CLOSE WORKSTATION.

When a trigger that is part of one or more logical input devices in EVENT mode fires, the resulting event reports are entered into the queue and marked as a group of simultaneous event reports. An event report for each device is added to the input queue, if and only if there is room for the whole group of simultaneous event reports.

The order of reports within a group of simultaneous event reports is undefined.

If there is not room in the queue for all event reports when a trigger fires, input queue overflow has occurred. Input queue overflow is not reported to the application program immediately. It is reported via the error mechanism during the next invocation of any PHIGS function that can remove event reports from the input queue (AWAIT EVENT, FLUSH DEVICE EVENTS, and CLOSE WORKSTATION). The input queue has to be emptied before further event reports will be added. Between the detection of input queue overflow and the next time AWAIT EVENT is invoked with the input queue empty, no events are generated by trigger firings and thus no acknowledgements are provided. (This permits the application program to determine how many events were in the queue when overflow occurred by calling AWAIT EVENT with zero timeout.)

When the *input queue overflow* error is reported, the trigger causing the overflow is indicated by placing into the error state list the identification of any one of the logical input devices using that trigger which was in EVENT mode at the time the overflow was detected.

AWAIT EVENT, if the queue is not empty, removes the first event report after copying the logical input value into the current event report in the PHIGS state list. The workstation identifier, input class and device number are returned to the application program directly by AWAIT EVENT. If the queue is empty, AWAIT EVENT suspends execution until an event report is queued or until the specified timeout period has elapsed.

The application program may obtain the contents of the current event report by calling the appropriate GET <input class> functions or GET LOCATOR 3 or GET STROKE 3 functions, (the GET LOCATOR and GET STROKE functions being the respective shorthands for 2D information). Calls to GET LOCATOR and GET LOCATOR 3 will retrieve the same event report, with the Z coordinate information being discarded and not returned to the application program if the former function is used. The same relationship applies between GET STROKE and GET STROKE 3.

If, after removing the event report there remain in the queue other reports in the same group of simultaneous events as the removed report, the 'more simultaneous events' entry in the PHIGS state list is set to MORE. Otherwise it is set to NOMORE.

FLUSH DEVICE EVENTS removes all event reports for a specific device from the input queue. CLOSE WORKSTATION removes from the input queue all event reports for all logical input devices on that workstation.

If the 'more simultaneous events' entry has the value MORE, when either FLUSH DEVICE EVENTS or CLOSE WORKSTATION is invoked, and they remove all the remaining reports in the group of simultaneous event reports at the head of the queue, then the entry is set to NOMORE.

4.8.6 Initialization of input devices

When an input device is in REQUEST mode, it is possible to set certain parameters associated with each logical input device of each input class. This initialization function is invoked by calling the INITIALIZE <input class> or INITIALIZE <input class> 3 functions, the former providing a shorthand form, for those parameters affected by the three dimensional nature of the input model, e.g. the prompt and echo type and echo area / volume (which are retained in the 3D input model for all input classes).

To set the full complement of the input model device parameters in the workstation state list, the INITIALIZE <input class> 3 functions should be called, and provide the following information:

a) An initial value appropriate to the class. If the initial value violates the rules, an error occurs and the workstation state list is unchanged. For locator and stroke devices, if the initial view index is undefined when the device is initialized, no error occurs. When the measure process comes into existence, if the view index is still undefined, the default view index (0) is used to transform the initial point(s).

b) A prompt and echo type that selects the prompting technique and, if echoing is on, the echoing technique for a logical input device. An implementation dependent prompt and echo type (type 1) is required for all logical input devices. Further prompt and echo types appropriate to each class are defined but not required. These further types are listed with the appropriate initialize function. Prompt and echo types above those are reserved for registration. Prompt and echo types less than 0 are device dependent.

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c) An echo area / volume (XMIN,XMAX,YMIN,YMAX,ZMIN,ZMAX) in device coordinates. Input device implementations may use the echo area /volume for certain prompt and echo types to display prompts or echoes.

d) A data record. Some input classes have positions in the data record reserved for specific control values. These reserved positions are of two types. The first type shall be interpreted if provided by the application. The second type may be interpreted if provided by the application. A third type of entry in the data record is used for specific prompt and echo types. These entries may be interpreted if provided by the application. An implementation can claim support for a prompt and echo type even if it does not use all of the items in the data record for this type. There is a fourth type of entry which provides additional information that is implementation dependent and can be specific to a device or prompt and echo type.

The data record items of the first type (shall be interpreted if provided by the application) are

1) stroke - input buffer size;
2) valuator - low and high values;
3) string - input buffer size.

The data record items of the second type (may be interpreted if provided by the application) are

4) stroke - initial editing position, spatial interval between points, and time interval between points;
5) string - initial editing position.

The data record items of the third type (prompt and echo type specific - may be interpreted if provided by the application) are described in the relevant INITIALIZE <input class> functions.

An application need only supply those values in the data record up to the last one that it requires. Succeeding data record entries for data record items of the first two types will be derived from the current values in the workstation state list. All data record items specific to a prompt and echo type shall be provided by the application if that prompt and echo type is specified.

If no initialize functions are called, then the default rules apply. If INITIALIZE <input class> functions are called, then any parameters associated with the extra dimensionality (i.e., any z value of the input model) are not altered. However, if the z value of the initial point of the locator or the first point of the initial stroke is invalid, then the z value is set to the value corresponding to z = zmax of the workstation window.

When a logical input device is REQUESTed, or when it is set to EVENT or SAMPLE mode, its measure is set to the initial value from the workstation list, unless this is not a valid measure for the device. If it is not a valid measure for the device, the measure is set to a device dependent value, except for pick devices, for which the measure is set to NOPICK.

Prompt and echo types describe both the prompt, which informs the operator that the device is available, and the echo, which informs the operator of the state of the measure. The functions provided to control input device mode, SET <input class> MODE, also control whether echo is on or off. In addition, an implementation dependent acknowledgement of successful trigger firings is provided.

The parameters which may be initialized by the application are an initial measure value, prompt and echo type, echo area / volume, and a data record. These parameters play a similar role for all input classes. In the case of PICK, pick path order may be initialized by the application also. A description of the types of items in the data record is given above. Items of the first type (shall be interpreted if provided by the

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application) appear at the beginning of the data record followed by items of the second type (may be interpreted if provided by the application). The third type of items (prompt and echo type specific - may be interpreted if provided by the application) follows the items of the first and second types. Only one set of data items of the third type can exist in the data record at any one time. Items of the fourth type follow the items specified above.

4.8.7 Locator and stroke input using 2D input

The input model in PHIGS is conceptually 3D with locator and stroke input data processed from DC to WC coordinates. This implies that the model shall support 2D input devices by appending a third value obtained internally (from the workstation state tables), or externally (by some extra operation, e.g. request the operator to type in a value). Whether REQUEST LOCATOR, REQUEST STROKE, SAMPLE LOCATOR, SAMPLE STROKE, GET LOCATOR or GET STROKE obtain a Z coordinate from the operator of a 2D input device is implementation dependent.

For example, under certain circumstances the implementation may determine that for a REQUEST LOCATOR or REQUEST STROKE command the physical input of the Z coordinate is not required since the Z coordinate will be discarded at the end of the input pipeline. Similar comments apply to SAMPLE LOCATOR and SAMPLE STROKE.

For EVENT input a valid Z coordinate may be required, since no knowledge is available at the time the information is being input about whether it will be retrieved by a GET <input class> or GET <input class> 3 function.

The implementation should specify how 3D input has been realized.

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4.9 PHIGS metafile interface

For the purpose of long-term filing of graphical information, PHIGS provides an interface to files called graphical metafiles. They can be used for

a) transporting graphical information between systems;

b) transporting graphical information from one place to another (for example, by means of magnetic tapes);

c) transporting graphical information from one graphical application to another (for example, between PHIGS application programs and application programs using other graphical standards);

d) storing accompanying non-graphical information.

These purposes cover different aims including picture capture and session capture, the latter also being called audit trail. For the capture of structure definitions, PHIGS provides an archive file format which enables the contents of the centralized structure store to be captured. Pictures in PHIGS are created by traversal of the centralized structure store. PHIGS provides the MO workstation category to capture pictures generated by the traversal process. The precise way in which this is realized is implementation dependent. Annex H of this part of ISO/IEC 9592 describes a mechanism which enables pictures to be captured in a sensible manner as a CGM metafile. In this case the MO workstation uses display update mode WAIT-NIVE, and a picture description is recorded in the metafile when the UPDATE WORKSTATION or REDRAW ALL STRUCTURES functions are invoked by the application program.

Metafiles are input to PHIGS using workstations of category MI. Several different workstations of categories MO and MI can be used concurrently.

It is implementation dependent whether some workstation control and inquiry functions are applicable to or meaningful for MO and MI workstations. The workstation description table for a workstation type of category MO has the same entries as one for category OUTPUT, but for any specific MO workstation type values for some of the entries may not be available. Different workstation types of category MO can have different entries unavailable. In the case that values of workstation description table entries are not available for a certain workstation type of category MO, inquiring those values returns an error indicator. Opening a workstation of that type causes the workstation state list entries that are defined to be initialized from unavailable values to be in an implementation dependent state until the application invokes PHIGS functions that set those entries. For example, inquiry of those entries can return an implementation dependent error value and attempted output using those entries can generate errors.

The application program may write data into a metafile using WRITE ITEM TO METAFILE.

Three functions GET ITEM TYPE FROM METAFILE, READ ITEM FROM METAFILE and INTERPRET ITEM are provided to read and interpret metafiles. These functions assume that a metafile consists of a sequence of items. Each item is composed of an item type, an item data record length and an item data record. The item type indicates the meaning of the content of the metafile item. PHIGS is able to interpret some types of items and is not able to interpret others. In the second category are items that contain information that was written by an application program (e.g., using WRITE ITEM TO METAFILE). When an MI workstation is opened, the first item in the metafile becomes the 'current item'.

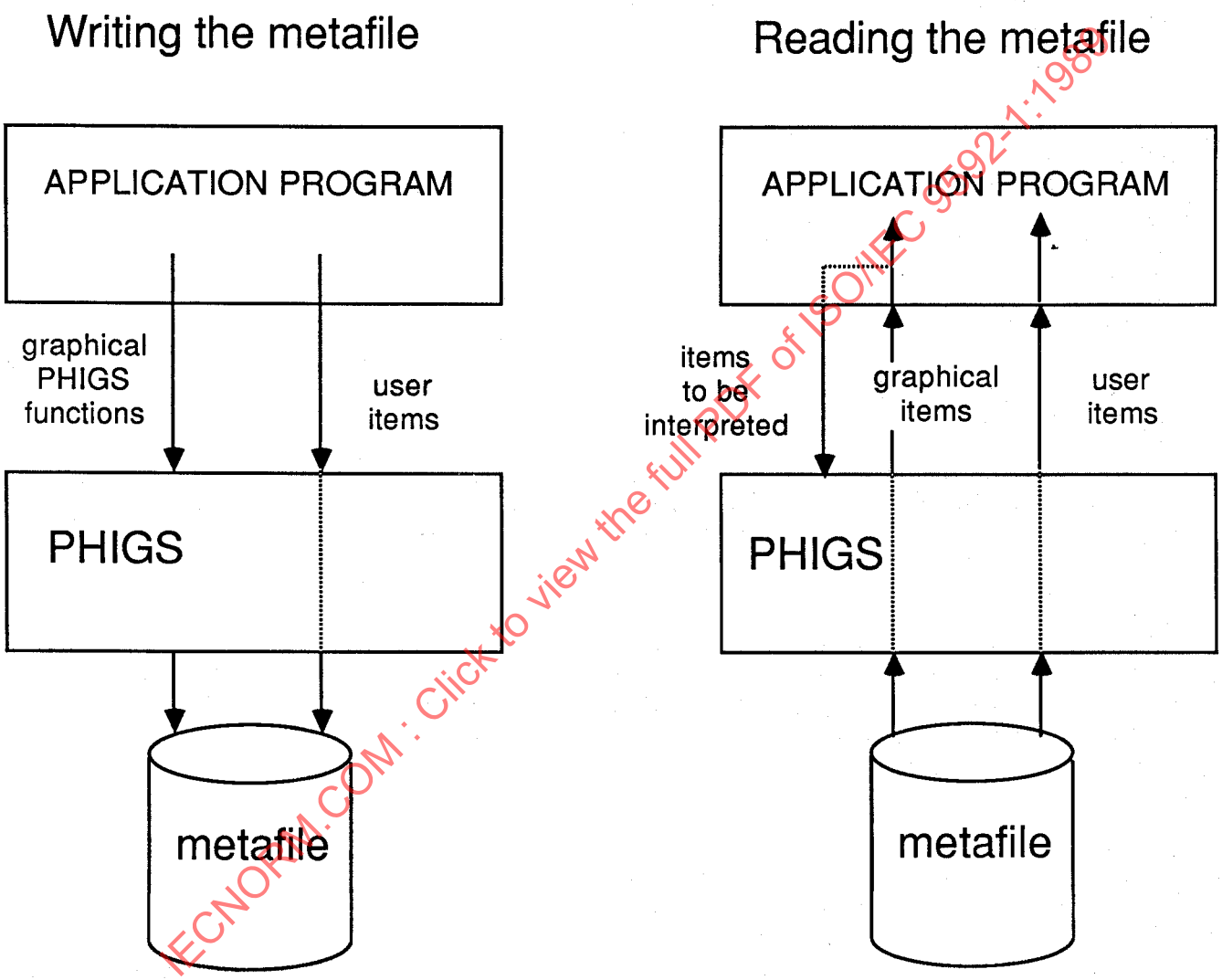
GET ITEM FROM METAFILE delivers the item type and item data record length of the current item.

READ ITEM FROM METAFILE copies the contents of the item data record of the current item into a data area supplied by the application program and then makes the next item in the metafile the current item.

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INTERPRET ITEM acts on the contents of a metafile item data record supplied by the application program (as delivered by READ ITEM FROM METAFILE). The metafile type is determined by INTERPRET ITEM from the item type and item data record parameters. The specification of the format and content of a metafile is not part of this standard. For CGM metafiles (ISO 8632), Annex H describes the suggested effects of INTERPRET ITEM.

Figure 26 shows one possible relationship between the application program, PHIGS, and a metafile.



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Figure 26 - Possible usage of metafile

4.10 PHIGS states

PHIGS is defined by four operating state variables, each of which has at least two possible values. The four state variables and their values are:

1) System State.

PHOP = PHIGS open.
PHCL = PHIGS closed.

2) Workstation State.

WSOP = Workstation open. At least one workstation is open.
WSCL = Workstation closed. No workstations are open.

3) Structure State.

STOP = Structure open.
STCL = Structure closed.

4) Archive State.

AROP = Archive open. At least one archive file is open.
ARCL = Archive closed. No archive files are open.

The state values are contained in global variables which are initialized before the first invocation of PHIGS. The initial values are PHCL, WSCL, STCL, and ARCL. The operating states differ in so far as individual PHIGS functions are allowed only in certain operating states, as indicated in the functional descriptions in clause 5.

The overall state of PHIGS is defined by a set of state variables having specific values. These state variables are characterized by the fact that they allow a complete description of the effects of the functions. The total set of PHIGS state variables contains the following subsets:

a) operating states;
b) PHIGS state list;
c) PHIGS traversal state list;
d) structure state list for every existing structure;
e) input queue;
f) workstation state list for every open workstation;
g) PHIGS error state list.

Certain functions cause these state subsets to be allocated, made available and cancelled. When these state subsets are allocated, they are initialized with default values. When initializing a workstation state list, some of the default values will be taken from a workstation description table which contains an entry for each workstation type supported by the PHIGS implementation. The values of the states are modified by the PHIGS functions and can be inquired by the application program.

When an error condition is detected during execution of a PHIGS function, PHIGS calls an error handling function. During execution of the ERROR HANDLING function, PHIGS is in an error substate which corresponds to the operating state when the function was called. In this error substate, PHIGS allows only inquiry functions, the EMERGENCY CLOSE PHIGS function, and the ERROR LOGGING function to be executed and no modifications to any of the state lists except the error state list.

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4.11 Inquiry functions

Inquiry functions return values directly from or derived from the various state lists and workstation description tables. The data types of the values and the default values of the entries are summarized in 6.1. The inquiry functions of PHIGS are designed in such a way that they do not cause any errors to be generated. Inquiry functions for values that may be logically unavailable have an output parameter, 'error indicator', that determines whether or not the other returned values are valid. The error indicator parameter is of type integer and, in the event of the other values not being available, returns an error number, which identifies the appropriate PHIGS error condition. The same error numbers are used as for non-inquiry functions and thus the standard list of error messages should be consulted. If the values are available, zero is returned in the 'error indicator' parameter. For all 'error indicator' values except zero the returned output values are implementation dependent. The description of each inquiry function lists the error indicator values that the function can return. Some inquiry functions that retrieve values from the workstation state lists have an input parameter of type 'Enumeration' that can take the following values:

a) SET: the values are returned exactly as provided by the application program;

b) REALIZED: the values returned are those used by the workstation when the actual values are mapped to the available values in the workstation.

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4.12 Error handling

For each PHIGS function, a finite number of error situations is specified, any of which will cause the ERROR HANDLING function to be called. Every PHIGS implementation supports this error checking. The ERROR HANDLING function provides an interface between PHIGS and the application program. The ERROR HANDLING function, if provided by the application program, may interpret the information about the error and may store data in a data area for subsequent interpretation by the application program after return from the PHIGS function that caused the error.

The PHIGS error handling strategy is derived from the following classification of errors:

I errors resulting in a precisely defined reaction;

II errors resulting in an attempt to save the results of previous operations;

III errors which cause unpredictable results including the loss of information.

PHIGS recognizes three situations in which errors are detected:

A error detected in PHIGS functions;

B error detected in functions called from PHIGS (driver functions, operating system functions);

C error detected in other areas of the application program.

If errors are detected outside PHIGS (situation C), either the application program may regain control over the execution or program execution will be terminated abnormally. In the latter case, results are unpredictable (class III), and in the worst situation, all graphical information produced so far in this job may be lost. If, however, the application program obtains control, it may attempt to close PHIGS properly or at least attempt an emergency closure by calling the EMERGENCY CLOSE PHIGS function. Similarly, if the error occurs in functions called by PHIGS and control is not returned properly to PHIGS, the effects are unpredictable.

The EMERGENCY CLOSE PHIGS function is an implementation dependent facility. Its purpose is to save as much of the graphical information produced as possible. The effects of this function on the workstations are left undefined in this standard. The EMERGENCY CLOSE PHIGS function may be called directly from the application program. It is also called from PHIGS itself as a standard error reaction to class II errors.

Finally, all errors that are listed explicitly as part of the definition of PHIGS functions belong to class I. Either they are detected within PHIGS itself (situation A) or a function called from PHIGS has returned control, to the corresponding PHIGS function, with the appropriate error information (situation B). In all these class I cases, PHIGS calls the ERROR HANDLING function. If a PHIGS function is invoked with more than one error condition applicable, at least one error is reported.

The application program may either provide its own ERROR HANDLING function or may use that provided as part of PHIGS. Any ERROR HANDLING function accepts the following information from PHIGS:

a) the identification of the error condition;

b) the identification of the PHIGS function that called the ERROR HANDLING function;

c) the error file.

The ERROR HANDLING function provided by PHIGS just calls the ERROR LOGGING function, using the same set of parameters. The latter performs the following actions:

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d) writes an error message and PHIGS function identification on the error file;

e) returns to the calling function.

This two-stage calling of the error functions allows the application program to supply its own ERROR HANDLING function, while still having access to services provided by the ERROR LOGGING function, as shown in the following example of an application program supplied ERROR HANDLING function.

Example

```
ERROR HANDLING (error number, identification of PHIGS function, error file);
  Interpret PHIGS function and error identification
  in order to select the following cases:
CASE 'special treatment':
  Interpret error parameters as passed from PHIGS;
  Store information for application program in application supplied data area;
  Return to calling PHIGS function;
CASE 'standard treatment':
  Call ERROR LOGGING function with all the above parameters;
  Return to calling PHIGS function;
END.
```

A PHIGS application may suppress transfer of control to the ERROR HANDLING function by setting the 'error reporting mode' in the PHIGS error state list to OFF using the SET ERROR HANDLING MODE function. The default value for 'error reporting mode' is ON.

All PHIGS functions perform the following actions after detecting an error condition:

f) set error state to ON;

g) call ERROR HANDLING function with appropriate parameters;

h) set error state to OFF;

i) Perform built-in error reaction (normally, a function causing an error has no effect; to accomplish this in some cases requires clean-up operations).

All PHIGS functions check on entry (in the following order):

j) that PHIGS is in the correct state;

k) that the values of input parameters are valid.

At least the first error detected is reported except that, in the case of inquiry functions, the first error detected is returned via the error indicator.

The application program supplied ERROR HANDLING function has access to the set of PHIGS state variables. However, no modification of PHIGS state is possible during error handling, i.e. only PHIGS inquiry functions, the ERROR LOGGING function and the EMERGENCY CLOSE PHIGS function may be called by the application program supplied ERROR HANDLING function. This is achieved by setting the error state to ON prior to calling the ERROR HANDLING function from PHIGS and setting the error state to OFF afterwards. An inquiry function cannot generate an error.

Error numbers for errors originating in PHIGS functions can be found in clause 5 under each PHIGS function.

The following error numbers are reserved:

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l) Unused error numbers less than 2 000 are reserved for future standardization.

m) Error numbers 2 000 to 3 999 are reserved for language bindings.

n) Error numbers greater than or equal to 4 000 are reserved for registration.

NOTE - Error numbers are registered in the the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When an error has been approved by ISO, the error number will be assigned by the Registration Authority.

When multiple errors are possible for a PHIGS function, the order in which they are listed in clause 5 is the order in which an implementation should test for and report any error conditions.

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4.13 Special interfaces between PHIGS and application program

A uniform escape mechanism for allowing access to installation and hardware specific features (a "standard way of being non-standard") is provided by means of the ESCAPE function. Although the use of this mechanism reduces the portability of the application program, it does so in an easily identifiable manner.

The ESCAPE function does not generate geometric output; by contrast, the GENERALIZED DRAWING PRIMITIVE can generate geometric output not otherwise generated by PHIGS.

The ESCAPE function cannot affect the CSS; by contrast, the GENERALIZED DRAWING PRIMITIVE and GENERALIZED STRUCTURE ELEMENT functions do generate structure elements.

Examples of specific escape functions anticipated are:

a) support of raster devices allowing the display of more than one frame buffer;

b) use of raster-op hardware to manipulate already defined cell arrays.

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4.14 Minimum support criteria

In PHIGS, capabilities are expressed by functions and by ranges of parameters of those functions. It is recognized that not all implementations will be able to support all possible capabilities, so minimum support criteria are defined.

There are three different types of capability:

a) An explicitly defined and required capability. Every PHIGS implementation supports the capability.

b) An explicitly defined and non-required capability. A PHIGS implementation may support the capability and, if it does, it is implemented according to explicit function definitions.

c) A conceptually defined and non-required capability. A PHIGS implementation may provide the capability. Its implementation follows general rules given by the PHIGS concepts and functional definitions.

The set of explicitly defined and required capabilities includes

d) 5 predefined polyline, polymarker, interior and edge bundles, and 6 predefined text bundles;

e) linetypes 1 to 4;

f) marker types 1 to 5;

g) all text precisions;

h) interior styles HOLLOW and EMPTY;

i) one input device for each input class;

j) prompt and echo type 1;

k) edgetype 1;

l) colour models RGB and CIELUV;

m) modelling clipping operators 1 and 2;

n) ability to clip against a modelling clipping volume bounded by 6 distinct planes;

o) text fonts 1 and 2;

p) text font 1 is monospaced;

q) annotation styles 1 and 2;

r) maximum length of normal and inverted filter lists supported;

s) range of accessible names for NAME SETs: 0-63 (see 4.5.15).

The set of explicitly defined and non-required capabilities includes

t) interior styles SOLID, PATTERN, HATCH;

u) transformable patterns;

v) prompt and echo types beyond type 1 that are defined;

w) edgetypes other than SOLID;

x) colour models HSV and HLS.

The set of conceptually defined and non-required capabilities includes

y) linetypes beyond 4;

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z) marker types beyond 5;
aa) colour models beyond the defined set;
ab) specific generalized drawing primitives;
ac) prompt and echo types beyond the defined set;
ad) specific escape functions;
ae) quick update methods;
af) HLHSR;
ag) modelling clipping operators beyond 2;
ah) annotation styles beyond 2;
ai) specific generalized structure elements.

Table 1 - Minimum required support

Colour models (see note 7)	2	Edgewidths	1
Foreground Colours	1	Predefined patterns (see note 2)	1
Linetypes	4	Settable patterns (see notes 2 and 6)	10
Linewidths	1	Hatch styles (see note 3)	3
Predefined polyline bundles	5	Predefined view table entries (see note 4)	6
Settable polyline bundles	20	Settable view table entries	5
Marker types	5	Display priorities	2
Marker sizes	1	Input classes	6
Predefined polymarker bundles	5	Prompt and echo types per device	1
Settable polymarker bundles	20	Length of input queue (see note 5)	20
Character heights (see note 1)	1	Available string buffer size (characters)	72
Character expansion factors (see note 1)	1	Available stroke buffer size (points)	64
Character sets	1	Workstations of category OUTIN	1
String precision fonts	1	MO workstations	0
Character precision fonts	1	MI workstations	0
Stroke precision fonts	2	Archive Files	1
Predefined text bundles	6	HLHSR identifiers	1
Settable text bundles	20	Modelling clipping operators	2
Predefined interior bundles	5	Distinct planes in modelling clipping volume	6
Settable interior bundles	20	Annotation styles	2
Predefined edge bundles	5	ISS filter list length	1
Settable edge bundles	20	Number of available names in nameset	64
Edgetypes	1		

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NOTES

1 Relevant only for character and string precision text.

2 Relevant only for workstations supporting PATTERN interior style.

3 Relevant only for workstations supporting HATCH interior style.

4 View table entry 0 is always defined, cannot be changed, and is set to the default values.

5 In the case of variable size event reports (i.e. stroke and string), the minimum support requirement assumes event reports whose size is the respective available buffer size in the table above.

6 The minimum support for settable patterns refers to patterns with a grid size of 2 × 2 cells.

7 The colour models RGB and CIELUV are mandatory.

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5 PHIGS Functional Specification

5.1 Notational conventions

The heading of each function specifies

a) the function's name, and

b) the PHIGS operating states in which the function may be used. A quadruple representing each of the four PHIGS operating states is listed in the following form:

(<system state>,<workstation state>,<structure state>,<archive state>)

Each entry of the quadruple can have the two possible values described in 4.10, and in addition the value "*" indicating that that particular PHIGS operating state has no effect on the function (e.g. if "(PHOP,*,*,*)", the function only requires that PHIGS be open; it does not matter whether a workstation is open, a structure is open, or an archive file is open).

The parameter lists indicate for each entry

c) whether the entry is an input (In) or output (Out) parameter;

d) the name of the parameter;

e) for coordinate data, the coordinate system (TLC, MC, WC, NPC, DC) used in the function call (coordinate systems are explained in 4.7, while the text local coordinate system is described in 4.5.5, 4.5.6 and 4.5.7);

f) either, for enumeration type data, the permitted values, or, for real and integer data, any restriction on their value range (for example, ">0"); the notation is explained in 6.1;

g) the data type itself; the notation for the types is explained in 6.1

All error states for a given function are identified.

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5.2 Control functions

OPEN PHIGS (PHCL,WSCL,STCL,ARCL)

Parameters:

In	error file	F
In	amount of memory units for buffer area	I

Effect: The 'system state' is set to PHOP. The PHIGS state list is allocated and initialized as indicated in 6.5. The PHIGS description table and the workstation description tables are made available.

The entry 'error file' in the PHIGS error state list is set to the value specified by the first parameter, error file. The permitted buffer areas which can be used by PHIGS for internal purposes is limited.

NOTE - Certain environments may not permit dynamic memory management. In this case the buffer area may be limited in a static way to be described in the installation documentation.

References: 4.10 4.12

Errors:

001 *Ignoring function, function requires state (PHCL,WSCL,STCL,ARCL)*
450 *Ignoring function, the specified error file is invalid*

CLOSE PHIGS (PHOP,WSCL,STCL,ARCL)

Parameters:

none

Effect: The 'system state' is set to PHCL. The PHIGS description table, the PHIGS state list and the workstation description tables become unavailable. All PHIGS buffers are released and all PHIGS files are closed.

NOTE - PHIGS can be reopened by invoking the function OPEN PHIGS.

References: 4.10 4.12

Errors:

004 *Ignoring function, function requires state (PHOP,WSCL,STCL,ARCL)*

OPEN WORKSTATION (PHOP,*,*,*)

Parameters:

In	workstation identifier	WI
In	connection identifier	C
In	workstation type	W

Effect: The 'workstation state' is set to the state WSOP. PHIGS requests the operating system to establish the specified connection for a workstation characterized in the workstation description table by the 'workstation type'. The workstation state list is allocated and initialized. The workstation identifier is added to the 'set of open workstations' in the PHIGS state list.

When a workstation is opened, a specific workstation description table is created. This workstation description table is derived from:

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a) the generic workstation description table specified by the workstation type parameter;

b) information obtained from the device;

c) other implementation dependent sources.

A 'workstation type', which identifies the specific workstation description table is placed in the workstation state list. The 'workstation type' can be inquired from the workstation state list and used in subsequent inquiries to obtain information from the workstation description table.

OPEN WORKSTATION ensures that the display surface is clear, but does not clear the surface needlessly.

References: 4.6.2 4.10

Errors:

002 *Ignoring function, function requires state (PHOP,*,*,*)*
053 *Ignoring function, workstation identifier already is in use*
050 *Ignoring function, connection identifier not recognized by the implementation*
052 *Ignoring function, workstation type not recognized by the implementation*
055 *Ignoring function, workstation cannot be opened for an implementation dependent reason*
063 *Ignoring function, opening this workstation would exceed the maximum number of simultaneously open workstations*

CLOSE WORKSTATION **(PHOP,WSOP,*,*)**

Parameters:

In workstation identifier WI

Effect: An implicit UPDATE WORKSTATION (with the parameter regeneration flag set to PERFORM) is performed for the specified workstation. The workstation state list is deallocated. The workstation identifier is removed from the 'set of open workstations' in the PHIGS state list and from the 'list of workstations to which posted' in the structure state list for every structure posted to this workstation. The input queue is flushed of all events from all devices on the workstation being closed. If the 'identification of one of the logical input devices that caused an input queue overflow' entry in the PHIGS error state list refers to this workstation identifier, then all the contents of that entry become undefined.

The specific workstation description table, created when the workstation was opened, becomes unavailable and the workstation type value associated with this specific workstation description table becomes undefined.

The connection to the workstation is released. The workstation state is set to WSCL if no workstations remain open. The display surface need not be cleared when CLOSE WORKSTATION is invoked, but it may be cleared.

References: 4.6.2 4.8.5 4.10

Errors:

003 *Ignoring function, function requires state (PHOP,WSOP,*,*)*
054 *Ignoring function, the specified workstation is not open*
256 *Warning, the input queue has overflowed*

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REDRAW ALL STRUCTURES **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	control flag	(CONDITIONALLY, ALWAYS)	E

Effect: All of the following actions are executed in the given sequence:

a) All deferred actions for the specified workstation are executed (without intermediate clearing of the display surface).

b) If the control flag is set to CONDITIONALLY, the display surface is cleared only if the 'display surface empty' entry in the workstation state list is NOTEMPTY. If the control flag is set to ALWAYS, the display surface is cleared regardless of the setting of the 'display surface empty' entry. The entry is set to EMPTY.

c) For every entry in the view table in the workstation state list, if the 'view transformation update state' entry is PENDING, the 'current view orientation matrix', 'current view mapping matrix', 'current view clipping limits', 'current x-y clipping indicator', 'current back clipping indicator', 'current front clipping indicator' entries are assigned the values of the respective requested entries; and the 'view transformation update state' entry is set to NOTPENDING.

d) If the 'workstation transformation update state' entry in the workstation state list is PENDING, the 'current workstation window' and 'current workstation viewport' entries are assigned the values of the 'requested workstation window' and 'requested workstation viewport' entries; and the 'workstation transformation update state' entry is set to NOTPENDING.

e) If the 'HLHSR update state' entry in the workstation state list is PENDING, the 'current HLHSR mode' entry in the workstation state list is assigned the value of the 'requested HLHSR mode' entry; and the 'HLHSR update state' entry is set to NOTPENDING.

f) All structures posted for this workstation (i.e., contained in the 'list of posted structures' in the workstation state list) are redisplayed. This action typically causes the 'display surface empty' entry in the workstation state list to be set to NOTEMPTY if the set of structures posted to the workstation is also not empty.

g) The 'state of visual representation' entry in the workstation state list is set to CORRECT.

References: 4.6.3 4.6.4

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)

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UPDATE WORKSTATION **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	regeneration flag	(PERFORM,POSTPONE)	E

Effect: All deferred actions for the specified workstation are executed (without intermediate clearing of the display surface). If the regeneration flag is set to PERFORM and the 'state of visual representation' entry in the workstation state list is DEFERRED or SIMULATED, then the following additional actions are executed in the given sequence:

a) The display surface is cleared only if the 'display surface empty' entry in the workstation state list is NOTEMPTY. The entry is set to EMPTY.

b) For every entry in the view table in the workstation state list, if the 'view transformation update state' entry is PENDING, the 'current view orientation matrix', 'current view mapping matrix', 'current view clipping limits', 'current x-y clipping indicator', 'current back clipping indicator', 'current front clipping indicator' entries are assigned the values of the respective requested entries; and the 'view transformation update state' entry is set to NOTPENDING.

c) If the 'workstation transformation update state' entry in the workstation state list is PENDING, the 'current workstation window' and 'current workstation viewport' entries are assigned the values of the 'requested workstation window' and 'requested workstation viewport' entries; and the 'workstation transformation update state' entry is set to NOTPENDING.

d) If the 'HLHSR update state' entry in the workstation state list is PENDING, the 'current HLHSR mode' entry in the workstation state list is assigned the value of the 'requested HLHSR mode' entry; and the 'HLHSR update state' entry is set to NOTPENDING.

e) All structures posted for this workstation (i.e., contained in the 'list of posted structures' in the workstation state list) are redisplayed. This action typically causes the 'display surface empty' entry in the workstation state list to be NOTEMPTY if the set of structures posted to the workstation is also not empty.

f) The 'state of visual representation' entry in the workstation state list is set to CORRECT.

NOTE - If regeneration flag is PERFORM, UPDATE WORKSTATION suspends the effect of SET DISPLAY UPDATE STATE. In that case, it is equivalent to the following sequence of functions:

```
INQUIRE WORKSTATION STATE;
save deferral state;
SET DISPLAY UPDATE STATE (ASAP, ... );
set deferral state to saved value;
```

If the value of 'state of visual representation' is CORRECT or the regeneration flag is set to POSTPONE, UPDATE WORKSTATION initiates the transmission of blocked data. If the value of 'state of visual representation' is DEFERRED or SIMULATED and the regeneration flag is PERFORM, UPDATE WORKSTATION behaves as REDRAW ALL STRUCTURES ON WORKSTATION.

References: 4.6.3 4.6.4

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)

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SET DISPLAY UPDATE STATE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	deferral mode	(ASAP, BNIG, BNIL, ASTI, WAIT)	E
In	modification mode	(NIVE, UWOR, UQUM)	E

Effect: The entries 'deferral mode' and 'modification mode' for the specified workstation are set in the workstation state list. Depending on the new value of 'deferral mode', the transmission of deferred output may be initiated.

References: 4.6.3

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)

MESSAGE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier	WI
In	message	S

Effect: The message function:

a) may display a message at an implementation dependent location on the workstation viewport or on some separate device associated with the workstation.

b) does not alter the PHIGS state list.

c) may affect the workstation in a purely local way (for example, requesting the operator to change paper). Possible effects on the execution of the application program or on subsequent commands sent to the workstation by PHIGS shall be stated explicitly in the implementation dependencies manual.

References: 4.6.5

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open

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5.3 Output primitive functions

POLYLINE 3 **(PHOP,*,STOP,*)**

Parameters:

In	point list	MC	L(P3)

Effect: This function fully specifies the three dimensional form of the polyline primitive. Depending upon the 'edit mode', a "polyline 3" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "polyline 3" structure element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted a connected sequence of straight lines is generated starting from the element's first point and ending at the element's last point. The current values of the polyline attributes, as defined in the PHIGS traversal state list (see 6.4), are bound to the primitive. The polyline attributes are described in 4.5.3.

A "polyline 3" element with less than two points will be placed in the open structure. When a "polyline 3" element with less than two points is interpreted it will have no visual effect.

References: 4.5.1 4.5.2 4.5.3 4.5.12 4.5.13 4.5.14 4.5.15 4.5.16 4.5.17 4.6.3

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

POLYLINE **(PHOP,*,STOP,*)**

Parameters:

In	point list	MC	L(P2)

Effect: This function specifies the two dimensional (X and Y), shorthand form of the polyline primitive. The "polyline" form is assumed to have the z-coordinate equal to 0. Depending upon the 'edit mode', a "polyline" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "polyline" structure element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted a connected sequence of straight lines is generated starting from the element's first point and ending at the element's last point. The current values of the polyline attributes, as defined in the PHIGS traversal state list (see 6.4), are bound to the primitive. The polyline attributes are described in 4.5.3.

A "polyline" element with less than two points will be placed in the open structure. When a "polyline" element with less than two points is interpreted it will have no visual effect.

References: 4.5.1 4.5.2 4.5.3 4.5.12 4.5.13 4.5.14 4.5.15 4.5.16 4.5.17 4.6.3

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

POLYMARKER 3 **(PHOP,*,STOP,*)**

Parameters:

In	point list	MC	L(P3)

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Effect: This function fully specifies the three dimensional form of the polymarker primitive. Depending upon the 'edit mode', a "polymarker 3" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "polymarker 3" structure element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted a sequence of markers is generated to identify all of the element's positions. The current values of the polymarker attributes, as defined in the PHIGS traversal state list (see 6.4), are bound to the primitive. The polymarker attributes are described in 4.5.4.

References: 4.5.1 4.5.2 4.5.4 4.5.12 4.5.13 4.5.14 4.5.15 4.5.16 4.5.17 4.6.3

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

POLYMARKER **(PHOP,*,STOP,*)**

Parameters:

In	point list	MC	L(P2)

Effect: This function specifies the two dimensional (X and Y), shorthand form of the polymarker primitive. The "polymarker" form is assumed to have z-coordinate equal to 0. Depending upon the 'edit mode', a "polymarker" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "polymarker" structure element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted a sequence of markers is generated to identify all of the element's positions. The current values of the polymarker attributes, as defined in the PHIGS traversal state list (see 6.4), are bound to the primitive. The polymarker attributes are described in 4.5.4.

References: 4.5.1 4.5.2 4.5.4 4.5.12 4.5.13 4.5.14 4.5.15 4.5.16 4.5.17 4.6.3

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

TEXT 3 **(PHOP,*,STOP,*)**

Parameters:

In	text position	MC	P3
In	text direction vectors	MC	2×V3
In	character string		S

Effect: This function fully specifies the three dimensional form of the text primitive. Depending upon the 'edit mode', a "text 3" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "text 3" structure element. The values specified by the parameters are associated with the element.

When an element of this type is interpreted a character string is generated. The current values of the text attributes, as defined in the PHIGS traversal state list (see 6.4), are bound to the primitive. The text attributes are described in 4.5.5.

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The 3D text primitive is located on the plane defined by the element's text position and the element's text direction vectors.

The first text direction vector defines the positive X-axis of the text local coordinate system. The first and second text direction vectors are used to define the positive Y-axis of the text local coordinate system. The directions specified by character up vector and text path will be relative to this text local coordinate system (as described in 4.5.5).

When an element of this type is interpreted, if the element's text direction vectors fail to define the text local coordinate system (i.e. one of the vectors is zero length or the vectors are parallel), the values (1,0,0) and (0,1,0) will be used.

NOTE - Text is clipped in a way that depends on text precision as defined by the text attributes in the PHIGS traversal state list.

References: 4.5.1 4.5.2 4.5.5 4.5.12 4.5.13 4.5.14 4.5.15 4.5.16 4.5.17 4.6.3

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

TEXT **(PHOP,*,STOP,*)**

Parameters:

In	text position	MC	P2
In	character string		S

Effect: This function specifies the two dimensional (X and Y), shorthand form of the text primitive. The "text" form is assumed to have z-coordinate equal to 0. The text local coordinate system is the x-y plane as defined in the modelling coordinate system. Depending upon the 'edit mode', a "text" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "text" structure element. The values specified by the parameters are associated with the element.

When an element of this type is interpreted a character string is generated. The current values of the text attributes, as defined in the PHIGS traversal state list (see 6.4), are bound to the primitive. The text attributes are described in 4.5.5.

NOTE - Text is clipped in a way that depends on the text precision as defined by the text attributes in the PHIGS traversal state list.

References: 4.5.1 4.5.2 4.5.5 4.5.12 4.5.13 4.5.14 4.5.15 4.5.16 4.5.17 4.6.3

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

ANNOTATION TEXT RELATIVE 3 **(PHOP,*,STOP,*)**

Parameters:

In	reference point	MC	P3
In	annotation offset	NPC	V3
In	character string		S

Effect: This function fully specifies the three dimensional form of the annotation text relative primitive. Depending upon the 'edit mode', an "annotation text relative 3" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "annotation text relative 3" element. The values specified by the parameters are associated with the element.

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When an element of this type is interpreted a character string is generated according to the 'current annotation style' entry in the PHIGS traversal state list. The 3D annotation point is computed by adding the element's annotation offset to the element's transformed reference point. The 3D annotation point specifies a position in NPC space that forms the origin of the text local coordinate system. The z-component of the annotation point specifies the x-y plane in NPC space on which the annotation will be placed. The current values of the annotation text attributes, as defined in the PHIGS traversal state list (see 6.4), are bound to the primitive. The annotation text attributes are described in 4.5.6.

If the 'current annotation style' entry in the PHIGS traversal state list indicates that a lead line is to be generated, the lead line connects the transformed reference point with the annotation point. The appearance of the lead line is derived from the polyline attributes defined in the PHIGS traversal state list.

References: 4.5.1 4.5.2 4.5.6 4.5.12 4.5.13 4.5.14 4.5.15 4.5.16 4.5.17 4.6.3

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

ANNOTATION TEXT RELATIVE **(PHOP,*,STOP,*)**

Parameters:

In	reference point	MC	P2
In	annotation offset	NPC	V2
In	character string		S

Effect: This function specifies the two dimensional (X and Y), shorthand form of the annotation text relative primitive. The "annotation text relative" element assumes both the reference point and annotation offset z-coordinates equal zero (0). Depending upon the 'edit mode', an "annotation text relative" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "annotation text relative" element. The values specified by the parameters are associated with the element.

When an element of this type is interpreted a character string is generated according to the 'current annotation style' entry in the PHIGS traversal state list. The annotation point is computed by adding the element's annotation offset to the element's transformed reference point. The annotation point specifies a position in NPC space that forms the origin of the text local coordinate system. The z-coordinate of the annotation point specifies the x-y plane in NPC space on which the annotation will be placed. The current values of the annotation text attributes, as defined in the PHIGS traversal state list (see 6.4), are bound to the primitive. The annotation text attributes are described in 4.5.6.

If 'current annotation style' in the PHIGS traversal state list indicates that a lead line is to be generated, the lead line connects the transformed reference point with the annotation point. The appearance of the lead line is derived from the polyline attributes defined in the PHIGS traversal state list.

References: 4.5.1 4.5.2 4.5.6 4.5.12 4.5.13 4.5.14 4.5.15 4.5.16 4.5.17 4.6.3

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

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FILL AREA 3 **(PHOP,*,STOP,*)**

Parameters:

In	point list	MC	L(P3)

Effect: This function fully specifies the three dimensional form of the fill area primitive. Depending upon the 'edit mode', a "fill area 3" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "fill area 3" structure element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted an implicitly closed polygonal area is generated. The current values of the fill area (interior) attributes, as defined in the PHIGS traversal state list (see 6.4), are bound to the primitive. The fill area attributes are described in 4.5.8.

A "fill area 3" element with less than three vertices will be placed in the open structure. When a "fill area 3" element with less than three vertices is interpreted it will have no visual effect.

NOTE - The planarity of a FILL AREA 3 primitive is not verified by PHIGS; the results when a non-planar fill area is displayed are implementation dependent.

There is an important distinction between the FILL AREA and FILL AREA SET primitives. FILL AREA SET primitives have edge attributes, but FILL AREA primitives do not.

References: 4.5.1 4.5.2 4.5.8 4.5.12 4.5.13 4.5.14 4.5.15 4.5.16 4.5.17 4.6.3

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

FILL AREA **(PHOP,*,STOP,*)**

Parameters:

In	point list	MC	L(P2)

Effect: This function specifies the two dimensional (X and Y), shorthand form of the fill area primitive. The fill area primitive is assumed to have z-coordinates equal to 0. Depending upon the 'edit mode', a "fill area" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "fill area" structure element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted an implicitly closed polygonal area is generated. The current values of the fill area (interior) attributes, as defined in the PHIGS traversal state list (see 6.4), are bound to the primitive. The fill area attributes are described in 4.5.8.

A "fill area" element with less than three vertices will be placed in the open structure. When a "fill area" element with less than three vertices is interpreted it will have no visual effect.

NOTE - There is an important distinction between the FILL AREA and FILL AREA SET primitives. FILL AREA SET primitives have edge attributes, but FILL AREA primitives do not.

References: 4.5.1 4.5.2 4.5.8 4.5.12 4.5.13 4.5.14 4.5.15 4.5.16 4.5.17 4.6.3

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

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FILL AREA SET 3 **(PHOP,*,STOP,*)**

Parameters:

In	list of point lists	MC	L(L(P3))

Effect: This function fully specifies the three dimensional form of the fill area set primitive. Depending upon the 'edit mode', a "fill area set 3" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "fill area set 3" structure element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted a set of polygonal areas made up of the collection of subareas is generated. A subarea is defined by a single list of points. Each subarea is implicitly closed. The current values of the fill area set (interior and edge) attributes, as defined in the PHIGS traversal state list (see 6.4), are bound to the primitive. The fill area set attributes are described in 4.5.9.

A "fill area set 3" element with a subarea (defined by a single list of points) with less than three vertices or an empty list of point lists will be placed in the open structure. When a "fill area set 3" element with a subarea with less than three vertices or an empty list of point lists is interpreted it will have no visual effect.

The edges of the fill area set are not necessarily displayed. The existence and appearance of edges are under attribute control.

NOTE - The planarity of FILL AREA SET 3 primitives is not verified by PHIGS; the results when a non-planar fill area is displayed are implementation dependent.

There is an important distinction between the FILL AREA and FILL AREA SET primitives. FILL AREA SET primitives have edge attributes, but FILL AREA primitives do not.

References: 4.5.1 4.5.2 4.5.8 4.5.9 4.5.12 4.5.13 4.5.14 4.5.15 4.5.16 4.5.17 4.6.3

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

FILL AREA SET **(PHOP,*,STOP,*)**

Parameters:

In	list of point lists	MC	L(L(P2))

Effect: This function specifies the two dimensional (X and Y), shorthand form of the fill area set primitive. The fill area set primitive is assumed to have z-coordinates equal to 0. Depending upon the 'edit mode', a "fill area set" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "fill area set" structure element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted a set of polygonal areas made up of the collection of subareas is generated. A subarea is defined by a single list of points. Each subarea is implicitly closed. The current values of the fill area set (interior and edge) attributes, as defined in the PHIGS traversal state list (see 6.4), are bound to the primitive. The fill area set attributes are described in 4.5.9.

A "fill area set" element with a subarea (defined by a single list of points) with less than three vertices or an empty list of point lists will be placed in the open structure. When a "fill area set" element with a subarea with less than three vertices or an empty list of point lists is interpreted it will have no visual effect.

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The edges of the fill area set are not necessarily displayed. The existence and appearance of edges are under attribute control.

NOTE - There is an important distinction between the FILL AREA and FILL AREA SET primitives. FILL AREA SET primitives have edge attributes, but FILL AREA primitives do not.

References: 4.5.1 4.5.2 4.5.8 4.5.9 4.5.12 4.5.13 4.5.14 4.5.15 4.5.16 4.5.17 4.6.3

Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*

CELL ARRAY 3 **(PHOP,*,STOP,*)**

Parameters:

In	cell parallelogram (P,Q,R)	MC	3×P3
In	colour index array	(0..n)	A(I)

Effect: This function fully specifies the three dimensional form of the cell array primitive. Depending upon the 'edit mode', a "cell array 3" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "cell array 3" structure element. The values specified by the parameters are associated with the element.

When an element of this type is interpreted a cell array is drawn using the element's cell parallelogram and the element's colour index array.

The minimal simulation required is to draw the transformed boundaries of the element's cell parallelogram, using implementation dependent colour, linewidth and linetype.

References: 4.5.1 4.5.2 4.5.10 4.5.12 4.5.13 4.5.14 4.5.15 4.5.16 4.5.17 4.6.3

Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*
117 Ignoring function, one of the dimensions of the colour index array is less than zero
113 Ignoring function, the colour index value is less than zero

CELL ARRAY **(PHOP,*,STOP,*)**

Parameters:

In	cell rectangle (P,Q)	MC	2×P2
In	colour index array	(0..n)	A(I)

Effect: This function specifies the two dimensional (X and Y) form of the cell array primitive. The "cell array" form is assumed to have z-coordinates equal to 0. Depending upon the 'edit mode', a "cell array" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "cell array" structure element. The values specified by the parameters are associated with the element.

When an element of this type is interpreted a cell array is drawn using the element's cell rectangle and the element's colour index array.

The minimal simulation required is to draw the transformed boundaries of the element's cell rectangle, using implementation dependent colour, linewidth and linetype.

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References: 4.5.1 4.5.2 4.5.10 4.5.12 4.5.13 4.5.14 4.5.15 4.5.16 4.5.17 4.6.3

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*
117 Ignoring function, one of the dimensions of the colour index array is less than zero
113 Ignoring function, the colour index value is less than zero

GENERALIZED DRAWING PRIMITIVE 3 (PHOP,*,STOP,*)

Parameters:

In	point list	MC	L(P3)
In	GDP 3 identifier		G3
In	GDP 3 data record		D

Effect: This function fully specifies the three dimensional form of the generalized drawing primitive. Depending upon the 'edit mode', a "generalized drawing primitive 3" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "generalized drawing primitive 3" structure element. The values specified by the parameters are associated with the element.

When an element of this type is interpreted a GENERALIZED DRAWING PRIMITIVE 3 (GDP 3), of the type indicated by the element's GDP 3 identifier, is drawn using the element's point list and the element's GDP 3 data record. The values of the entries in the PHIGS traversal state list, for the sets of polyline, polymarker, text, interior, or edge attributes, are bound to the primitive. When the GDP 3 generates output at the workstation, zero or more of the sets of attributes are used. In particular, the ones most appropriate for the specified GDP 3 primitive are selected for the GDP 3 as part of the definition of the GDP 3 (they are defined in the workstation description table). The GDP 3 behaves like other output primitives with respect to the transformation pipeline.

NOTE - The parameters are transmitted to the workstation and interpreted in a workstation dependent way. In this way special capabilities of the workstation can be addressed. No error occurs when an element of this type is interpreted if a particular workstation cannot display the GDP 3 primitive. The GDP 3 primitive is displayed on all workstations capable of doing so. For example, some of the primitives anticipated at present are:

a) sphere: points given are centre, peripheral point;

b) circular arc: points given are centre, start point, end point to be connected anticlockwise in modelling coordinates;

c) ellipsoid: points given are 2 focal points, peripheral point;

d) elliptic arc: points given are 2 focal points, start point, end point to be connected anticlockwise in modelling coordinates;

e) interpolating curve (for example, spline): points given are interpolated.

The recommended set of attributes to use for examples b, d and e above would be the polyline attributes. The recommended set of attributes to use for examples a and c above would be the fill area or fill area set attributes.

It should be emphasized that the points of the element's point list are transformed by PHIGS after the interpretation of the points (as defining, say, a spline curve or circle) is performed by the workstations. The intention is that the geometric form of the primitive will be transformed in a similar way to other primitives. For example, a GDP 3, which defines a circle, would appear as an ellipse when the transformation has differential scaling for coordinate axes. Each specific GDP 3 definition defines how the transformation is applied to the points and the shape of the GDP 3 in order that this effect is achieved. Though the points cannot be clipped, the resulting output of the GDP 3 is clipped against any enabled clipping boundaries. If a specific GDP 3 is available on a workstation but is unable to be generated because the current transformations or clipping are such that the preceding conditions would be violated, no error is generated, but the GDP 3 is not

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generated.

The element's GDP 3 data record attribute list may contain additional data for each point (for example, vertex order for splines) which remain untransformed. These have to be defined for a specific GDP 3. In defining a new GDP 3, the PHIGS design concepts (see clause 0) are not violated. The set of generalized drawing primitives implemented on a workstation may be empty.

Where the function's GDP 3 identifier parameter is bound to an integer in a programming language, GDP 3 identifiers greater than 0 are reserved for registration and GDP 3 identifiers less than 0 are implementation dependent.

GDP 3 identifiers are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority (see 4.1.2). When a GDP 3 has been approved by ISO, the GDP 3 identifier will be assigned by the Registration Authority.

"Generalized drawing primitive 3" elements are placed into the open structure even if the specified generalized drawing primitive 3 is not supported by the implementation. When an element of this type is interpreted, if a "generalized drawing primitive 3" element is encountered that the workstation does not recognize, it will be ignored.

References: 4.5.1 4.5.2 4.5.11 4.5.12 4.5.13 4.5.14 4.5.15 4.5.16 4.6.3 4.13

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

GENERALIZED DRAWING PRIMITIVE **(PHOP,*,STOP,*)**

Parameters:

In	point list	MC	L(P2)
In	GDP identifier		G2
In	GDP data record		D

Effect: This function specifies the two dimensional (X and Y), shorthand form of the generalized drawing primitive. The "generalized drawing primitive" form is assumed to have z-coordinates equal to 0. Depending upon the 'edit mode', a "generalized drawing primitive" element is inserted into the structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "generalized drawing primitive" structure element. The values specified by the parameters are associated with the element.

When an element of this type is interpreted a generalized drawing primitive (GDP), of the type indicated by the element's GDP identifier, is drawn using the element's point list and the element's GDP data record. The values of the entries in the PHIGS traversal state list, for the sets of polyline, polymarker, text, interior, or edge attributes, are bound to the primitive. When the GDP generates output at the workstation, zero or more of the sets of attributes are used. In particular, the ones most appropriate for the specified GDP function are selected for the GDP as part of the definition of the GDP (they are defined in the workstation description table). The GDP behaves like other output primitives with respect to the transformation pipeline.

NOTE - The parameters are transmitted to the workstation and interpreted in a workstation dependent way. In this way special capabilities of the workstation can be addressed. No error occurs when an element of this type is interpreted if a particular workstation cannot display the GDP primitive. The GDP primitive is displayed on all workstations capable of doing so. For example, some of the primitives anticipated at present are:

a) circle: points given are centre, peripheral point;

b) circular arc: points given are centre, start point, end point to be connected anticlockwise in modelling coordinates;

c) ellipse: points given are 2 focal points, peripheral point;

d) elliptic arc: points given are 2 focal points, start point, end point to be connected anticlockwise in modelling coordinates;

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e) interpolating curve (for example, spline): points given are interpolated.

The recommended set of attributes to use for the above GDP examples would be the polyline attributes.

It should be emphasized that the points of the element's point list are transformed by PHIGS after the interpretation of the points (as defining, say, a spline curve or circle) is performed by the workstations. The intention is that the geometric form of the primitive will be transformed in a similar way to other primitives. For example, a GDP, which defines a circle, would appear as an ellipse when the transformation has differential scaling for coordinate axes. Each specific GDP definition defines how the transformation is applied to the points and the shape of the GDP in order that this effect is achieved. Though the points cannot be clipped, the resulting output of the GDP is clipped against any enabled clipping boundaries. If a specific GDP is available on a workstation but is unable to be generated because the current transformations or clipping are such that the preceding conditions would be violated, no error is generated, but the GDP is not generated.

The element's GDP data record attribute list may contain additional data for each point (for example, vertex order for splines) which remain untransformed. These have to be defined for a specific GDP. In defining a new GDP, the PHIGS design concepts (see clause 0) are not violated. The set of generalized drawing primitives implemented on a workstation may be empty.

Where the function's GDP identifier parameter is bound to an integer in a programming language, GDP identifiers greater than 0 are reserved for registration and GDP identifiers less than 0 are implementation dependent.

GDP identifiers are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority (see 4.1.2). When a GDP has been approved by ISO, the GDP identifier will be assigned by the Registration Authority.

"Generalized drawing primitive" elements are placed into the open structure even if the specified generalized drawing primitive is not supported by the implementation. When an element of this type is interpreted, if a "generalized drawing primitive" element is encountered that the workstation does not recognize, it will be ignored.

References: 4.5.1 4.5.2 4.5.11 4.5.12 4.5.13 4.5.14 4.5.15 4.5.16 4.6.3 4.13

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

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5.4 Attribute specification functions

5.4.1 Bundled attribute selection

SET POLYLINE INDEX **(PHOP,*,STOP,*)**

Parameters:

In	polyline index	(1..n)	I

Effect: Depending upon the 'edit mode', a "set polyline index" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set polyline index" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current polyline index' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent POLYLINE output primitives.

References: 4.4 4.5.2 4.5.3

Errors:

005 *Ignoring function, function requires state (PHOP,*,STOP,*)*
100 *Ignoring function, the bundle index value is less than one*

SET POLYMARKER INDEX **(PHOP,*,STOP,*)**

Parameters:

In	polymarker index	(1..n)	I

Effect: Depending upon the 'edit mode', a "set polymarker index" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set polymarker index" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current polymarker index' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent POLYMARKER output primitives.

References: 4.4 4.5.2 4.5.4

Errors:

005 *Ignoring function, function requires state (PHOP,*,STOP,*)*
100 *Ignoring function, the bundle index value is less than one*

SET TEXT INDEX **(PHOP,*,STOP,*)**

Parameters:

In	text index	(1..n)	I

Effect: Depending upon the 'edit mode', a "set text index" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set text index" element. The value specified by the parameter is associated with the element.

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When an element of this type is interpreted the 'current text index' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent TEXT and annotation text output primitives.

References: 4.4 4.5.2 4.5.5 4.5.6

Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*
100 Ignoring function, the bundle index value is less than one

SET INTERIOR INDEX **(PHOP,*,STOP,*)**

Parameters:

In	interior index	(1..n)	I

Effect: Depending upon the 'edit mode', a "set interior index" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set interior index" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current interior index' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent FILL AREA and FILL AREA SET output primitives.

References: 4.4 4.5.2 4.5.8 4.5.9

Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*
100 Ignoring function, the bundle index value is less than one

SET EDGE INDEX **(PHOP,*,STOP,*)**

Parameters:

In	edge index	(1..n)	I

Effect: Depending upon the 'edit mode', a "set edge index" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set edge index" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current edge index' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent FILL AREA SET output primitives.

References: 4.4 4.5.2 4.5.9

Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*
100 Ignoring function, the bundle index value is less than one

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5.4.2 Individual attribute selection

SET LINETYPE **(PHOP,*,STOP,*)**

Parameters:

In linetype I

Effect: Depending upon the 'edit mode', a "set linetype" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set linetype" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current linetype' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent POLYLINE output primitives displayed when the 'current linetype ASF' entry in the PHIGS traversal state list is INDIVIDUAL. This value does not affect the display of subsequent POLYLINE output primitives displayed when the 'current linetype ASF' entry in the PHIGS traversal state list is BUNDLED.

Linetypes are as follows:

≤0	implementation dependent
1	solid line
2	dashed line
3	dotted line
4	dashed-dotted line
≥5	reserved for registration

When an element of this type is interpreted, if the element's linetype is not available on a workstation, linetype 1 is used on that workstation.

NOTE - Linetype values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority (see 4.1.2). When a linetype has been approved by ISO, the linetype will be assigned by the Registration Authority.

References: 4.4 4.5.2 4.5.3

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET LINEWIDTH SCALE FACTOR **(PHOP,*,STOP,*)**

Parameters:

In linewidth scale factor R

Effect: Depending upon the 'edit mode', a "set linewidth scale factor" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set linewidth scale factor" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current linewidth scale factor' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent POLYLINE output primitives displayed when the 'current linewidth scale factor ASF' entry in the PHIGS traversal state list is INDIVIDUAL. This value does not affect the display of subsequent POLYLINE output primitives displayed when the 'current linewidth scale factor ASF' entry in the PHIGS traversal state list is BUNDLED.

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When an element of this type is interpreted the element's linewidth scale factor value is multiplied by the nominal linewidth on a workstation; the result is mapped by the workstation to the nearest available linewidth.

References: 4.4 4.5.2 4.5.3

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET POLYLINE COLOUR INDEX **(PHOP,*,STOP,*)**

Parameters:

In	polyline colour index	(0..n)	I

Effect: Depending upon the 'edit mode', a "set polyline colour index" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set polyline colour index" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current polyline colour index' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent POLYLINE output primitives displayed when the 'current polyline colour index ASF' entry in the PHIGS traversal state list is INDIVIDUAL. This value does not affect the display of subsequent POLYLINE output primitives displayed when the 'current polyline colour index ASF' entry in the PHIGS traversal state list is BUNDLED.

When an element of this type is interpreted, if the element's polyline colour index is not available on a workstation, colour index 1 is used on that workstation.

References: 4.4 4.5.2 4.5.3

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*
113 Ignoring function, the colour index value is less than zero

SET MARKER TYPE **(PHOP,*,STOP,*)**

Parameters:

In	marker type	I

Effect: Depending upon the 'edit mode', a "set marker type" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set marker type" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current marker type' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent POLYMARKER output primitives displayed when the 'current marker type ASF' entry in the PHIGS traversal state list is INDIVIDUAL. This value does not affect the display of subsequent POLYMARKER output primitives displayed when the 'current marker type ASF' entry in the PHIGS traversal state list is BUNDLED.

Marker types are centred symbols as follows:

≤0	implementation dependent

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1	. dot
2	+ plus sign
3	* asterisk
4	o circle
5	× diagonal cross
≥6	reserved for registration

Marker type 1 is always displayed as the smallest displayable dot, since a "dot" has no size, therefore scaling a sizeless entity has no effect.

When an element of this type is interpreted, if the element's marker type is not available on a workstation, marker type 3 (*) is used on that workstation.

NOTE - Marker type values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority (see 4.1.2). When a marker type has been approved by ISO, the marker type will be assigned by the Registration Authority.

References: 4.4 4.5.2 4.5.4

Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET MARKER SIZE SCALE FACTOR **(PHOP,*,STOP,*)**

Parameters:

In	marker size scale factor		R

Effect: Depending upon the 'edit mode', a "set marker size scale factor" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set marker size scale factor" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current marker size scale factor' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent POLYMARKER output primitives displayed when the 'current marker size scale factor ASF' entry in the PHIGS traversal state list is INDIVIDUAL. This value does not affect the display of subsequent POLYMARKER output primitives displayed when the 'current marker size scale factor ASF' entry in the PHIGS traversal state list is BUNDLED.

When an element of this type is interpreted the element's marker size scale factor value is multiplied by the nominal marker size on a workstation; the result is mapped by the workstation to the nearest available marker size.

References: 4.4 4.5.2 4.5.4

Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET POLYMARKER COLOUR INDEX **(PHOP,*,STOP,*)**

Parameters:

In	polymarker colour index	(0..n)	I

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Effect: Depending upon the 'edit mode', a "set polymarker colour index" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set polymarker colour index" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current polymarker colour index' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent POLYMARKER output primitives displayed when the 'current polymarker colour index ASF' entry in the PHIGS traversal state list is INDIVIDUAL. This value does not affect the display of subsequent POLYMARKER output primitives displayed when the 'current polymarker colour index ASF' entry in the PHIGS traversal state list is BUNDLED.

When an element of this type is interpreted, if the element's polymarker colour index is not available on a workstation, colour index 1 is used on that workstation.

References: 4.4 4.5.2 4.5.4

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*
113 Ignoring function, the colour index value is less than zero

SET TEXT FONT **(PHOP,*,STOP,*)**

Parameters:

In	text font	I

Effect: Depending upon the 'edit mode', a "set text font" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set text font" structure element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current text font' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent TEXT and annotation text output primitives displayed when the 'current text font ASF' entry in the PHIGS traversal state list is INDIVIDUAL. This value does not affect the display of subsequent TEXT and annotation text output primitives displayed when the 'current text font ASF' entry in the PHIGS traversal state list is BUNDLED.

Text font 1 contains a graphical representation of the characters defined in ISO 646 (or a character set including ISO 646) (see 4.5.5 and 4.5.6). Text font 2 contains a graphical representation of the same characters which are visually distinguishable from the same characters in text font 1. Text fonts greater than 2 are reserved for registration. Text fonts less than 1 are implementation dependent.

When an element of this type is interpreted, if the element's text font is not available in the current precision on a workstation, text font 1 and text precision STRING are used on that workstation.

NOTE - Text font numbers are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority (see 4.1.2). When a text font has been approved by ISO, the text font number will be assigned by the Registration Authority.

References: 4.4 4.5.2 4.5.5 4.5.6

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

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SET TEXT PRECISION **(PHOP,*,STOP,*)**

Parameters:

In	text precision	(STRING,CHAR,STROKE)	E

Effect: Depending upon the 'edit mode', a "set text precision element" is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set text precision" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current text precision' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent TEXT and annotation text output primitives displayed when the 'current text precision ASF' entry in the PHIGS traversal state list is INDIVIDUAL. This value does not affect the display of subsequent TEXT and annotation text output primitives displayed when the 'current text precision ASF' entry in the PHIGS traversal state list is BUNDLED.

When an element of this type is interpreted, if the element's text precision is not available in the current font on a workstation, text precision STRING and text font 1 are used on that workstation.

References: 4.4 4.5.2 4.5.5 4.5.6

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET CHARACTER EXPANSION FACTOR **(PHOP,*,STOP,*)**

Parameters:

In	character expansion factor	R

Effect: Depending upon the 'edit mode', a "set character expansion factor" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set character expansion factor" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current character expansion factor' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent TEXT and annotation text output primitives displayed when the 'current character expansion factor ASF' entry in the PHIGS traversal state list is INDIVIDUAL. This value does not affect the display of subsequent TEXT and annotation text output primitives displayed when the 'current character expansion factor ASF' entry in the PHIGS traversal state list is BUNDLED.

When an element of this type is interpreted only the magnitude of the character expansion factor is considered. If the result of taking the absolute value of the character expansion factor value is less than the smallest supported character expansion factor on a workstation, the smallest supported character expansion factor on that workstation is used. If the result is greater than the largest supported character expansion factor on a workstation, the largest supported character expansion factor on that workstation is used.

References: 4.4 4.5.2 4.5.5 4.5.6

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

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SET CHARACTER SPACING **(PHOP,*,STOP,*)**

Parameters:

In	character spacing	R

Effect: Depending upon the 'edit mode', a "set character spacing" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set character spacing" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current character spacing' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent TEXT and annotation text output primitives displayed when the 'current character spacing ASF' entry in the PHIGS traversal state list is INDIVIDUAL. This value does not affect the display of subsequent TEXT and annotation text output primitives displayed when the 'current character spacing ASF' entry in the PHIGS traversal state list is BUNDLED.

References: 4.4 4.5.2 4.5.5 4.5.6

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET TEXT COLOUR INDEX **(PHOP,*,STOP,*)**

Parameters:

In	text colour index	(0..n)	I

Effect: Depending upon the 'edit mode', a "set text colour index" element index is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set text colour index" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current text colour index' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent TEXT and annotation text output primitives displayed when the 'current text colour index ASF' entry in the PHIGS traversal state list is INDIVIDUAL. This value does not affect the display of subsequent TEXT and annotation text output primitives displayed when the 'current text colour index ASF' entry in the PHIGS traversal state list is BUNDLED.

When an element of this type is interpreted, if the element's text colour index is not available on a workstation, colour index 1 is used on that workstation.

References: 4.4 4.5.2 4.5.5 4.5.6

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*
113 Ignoring function, the colour index value is less than zero

SET CHARACTER HEIGHT **(PHOP,*,STOP,*)**

Parameters:

In	character height	TLC	R

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Effect: Depending upon the 'edit mode', a "set character height" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set character height" element. The value specified by the parameter is associated with the element.

The character height parameter is specified in the text local coordinate system and is measured along the character up vector. For TEXT output primitives the text local coordinate system has unit size unscaled from modelling coordinates.

When an element of this type is interpreted the 'current character height' entry in the PHIGS traversal state list is set to the magnitude of the value associated with the element. Then the 'current character width' entry in the PHIGS traversal state list is set to a value derived from the 'current character height' (see 4.5.5). These values are used when displaying subsequent TEXT output primitives.

When an element of this type is interpreted, if the element's character height or character width is not available on a workstation, the nearest supported character height or character width available on that workstation is used.

References: 4.4 4.5.2 4.5.5

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET CHARACTER UP VECTOR **(PHOP,*,STOP,*)**

Parameters:

In	character up vector	TLC	V2

Effect: Depending upon the 'edit mode', a "set character up vector" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set character up vector" element. The value specified by the parameter is associated with the element.

The character up vector parameter is specified in the text local coordinate system. For TEXT output primitives the text local coordinate system has unit size unscaled from modelling coordinates.

When an element of this type is interpreted the 'current character up vector' entry in the PHIGS traversal state list is set to the value associated with the element. The 'current character base vector' entry in the PHIGS traversal state list is set to a vector, of arbitrary length, at right angles in the clockwise direction to the value associated with the element. These values are used when displaying subsequent TEXT output primitives.

When an element of this type is interpreted, if the character up vector is determined to be degenerate (i.e. the vector is zero (0) length), the value (0,1) is used for the character up vector and the value (1,0) is used for the character base vector.

References: 4.4 4.5.2 4.5.5

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

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SET TEXT PATH **(PHOP,*,STOP,*)**

Parameters:

In	text path	(RIGHT,LEFT,UP,DOWN)	E

Effect: Depending upon the 'edit mode', a "set text path" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set text path" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current text path' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent TEXT output primitives.

NOTE - A change in the value of the 'current text path' entry may make the value of the 'current text alignment' entry inappropriate.

References: 4.4 4.5.2 4.5.5

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET TEXT ALIGNMENT **(PHOP,*,STOP,*)**

Parameters:

In	text alignment horizontal	(NORMAL,LEFT,CENTRE,RIGHT)	E
In	text alignment vertical	(NORMAL,TOP,CAP,HALF,BASE,BOTTOM)	E

Effect: Depending upon the 'edit mode', a "set text alignment" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set text alignment" element. The values specified by the parameters are associated with the element.

When an element of this type is interpreted the 'current text alignment' entry in the PHIGS traversal state list is set to the values associated with the element. These values are used when displaying subsequent TEXT output primitives. Text alignment has two components: horizontal and vertical.

References: 4.4 4.5.2 4.5.5

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET ANNOTATION TEXT CHARACTER HEIGHT **(PHOP,*,STOP,*)**

Parameters:

In	annotation text character height	TLC	R

Effect: Depending upon the 'edit mode', a "set annotation text character height" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set annotation text character height" element. The value specified by the parameter is associated with the element.

The annotation text character height parameter is specified in the text local coordinate system and is measured along the annotation text character up vector. For annotation text output primitives the text local coordinate system has unit size unscaled from NPC.

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When an element of this type is interpreted the 'current annotation text character height' entry in the PHIGS traversal state list is set to the magnitude of the value associated with the element. Then the 'current annotation text character width' entry in the PHIGS traversal state list is set to a value derived from the 'current annotation text character height' (see 4.5.5). These values are used when displaying subsequent annotation text output primitives.

When an element of this type is interpreted, if the element's annotation text character height or annotation text character width is not available on a workstation, the nearest supported character height or character width available on that workstation is used.

References: 4.4 4.5.2 4.5.6

Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET ANNOTATION TEXT CHARACTER UP VECTOR (PHOP,*,STOP,*)

Parameters:

In	annotation text character up vector	TLC	V2

Effect: Depending upon the 'edit mode', a "set annotation text character up vector" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set annotation text character up vector" element. The value specified by the parameter is associated with the element.

The annotation text character up vector parameter is specified in the text local coordinate system. For annotation text output primitives the text local coordinate system has unit size unscaled from NPC.

When an element of this type is interpreted the 'current annotation text character up vector' entry in the PHIGS traversal state list is set to the value associated with the element. The 'current annotation text character base vector' entry in the PHIGS traversal state list is set to a vector, of arbitrary length, at right angles in the clockwise direction to the value associated with the element. These values are used when displaying subsequent annotation text output primitives.

When an element of this type is interpreted, if the annotation text character up vector is determined to be degenerate (i.e. the vector is zero (0) length), the value (0,1) is used for the annotation text character up vector and the value (1,0) is used for the annotation text character base vector.

References: 4.4 4.5.2 4.5.6

Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET ANNOTATION TEXT PATH (PHOP,*,STOP,*)

Parameters:

In	annotation text path	(RIGHT,LEFT,UP,DOWN)	E

Effect: Depending upon the 'edit mode', a "set annotation text path" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set annotation text path" element. The value specified by the parameter is associated with the element.

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When an element of this type is interpreted the 'current annotation text path' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent annotation text output primitives.

NOTE - A change in the value of the 'current annotation text path' entry may make the value of the 'current annotation text alignment' entry inappropriate.

References: 4.4 4.5.2 4.5.6

Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET ANNOTATION TEXT ALIGNMENT **(PHOP,*,STOP,*)**

Parameters:

In	annotation text alignment horizontal	(NORMAL,LEFT,CENTRE,RIGHT)	E
In	annotation text alignment vertical	(NORMAL,TOP,CAP,HALF,BASE,BOTTOM)	E

Effect: Depending upon the 'edit mode', a "set annotation text alignment" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set annotation text alignment" element. The values specified by the parameters are associated with the element.

When an element of this type is interpreted the 'current annotation text alignment' entry in the PHIGS traversal state list is set to the values associated with the element. These values are used when displaying subsequent annotation text output primitives. Annotation text alignment has two components: horizontal and vertical.

References: 4.4 4.5.2 4.5.6

Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET ANNOTATION STYLE **(PHOP,*,STOP,*)**

Parameters:

In	annotation style	I

Effect: Depending upon the 'edit mode', a "set annotation style" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set annotation style" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current annotation style' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent annotation text output primitives.

Annotation style are as follows:

≤0	implementation dependent
1	unconnected
2	lead line using current polyline attributes
≥3	reserved for registration

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When an element of this type is interpreted, if the element's annotation style is not available on a workstation, annotation style 1 is used on that workstation.

NOTE - Annotation style values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority (see 4.1.2). When an annotation style has been approved by ISO, the annotation style will be assigned by the Registration Authority.

References: 4.4 4.5.2 4.5.6

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET INTERIOR STYLE **(PHOP,*,STOP,*)**

Parameters:

In	interior style	(HOLLOW,SOLID,PATTERN,HATCH,EMPTY)	E

Effect: Depending upon the 'edit mode', a "set interior style" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set interior style" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current interior style' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent FILL AREA and FILL AREA SET output primitives displayed when the 'current interior style ASF' entry in the PHIGS traversal state list is INDIVIDUAL. This value does not affect the display of subsequent FILL AREA and FILL AREA SET output primitives displayed when the 'current interior style ASF' entry in the PHIGS traversal state list is BUNDLED.

The interior style is used to determine in what style an area is filled (see 4.5.8 and 4.5.9).

When an element of this type is interpreted, if the element's interior style is not available on a workstation, interior style HOLLOW is used on that workstation.

References: 4.4 4.5.2 4.5.8 4.5.9

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET INTERIOR STYLE INDEX **(PHOP,*,STOP,*)**

Parameters:

In	interior style index	I

Effect: Depending upon the 'edit mode', a "set interior style index" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set interior style index" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current interior style index' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent FILL AREA and FILL AREA SET output primitives displayed when the 'current interior style index ASF' entry in the PHIGS traversal state list is INDIVIDUAL. This value does not affect the display of subsequent FILL AREA and FILL AREA SET output primitives displayed when the 'current interior style index ASF' entry in the PHIGS traversal state list is BUNDLED.

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For interior styles HOLLOW, SOLID and EMPTY, the interior style index is unused. For interior style PATTERN, the interior style index value is greater than 0 and is a pointer into the pattern tables of the workstations. For interior style HATCH, the interior style index value determines which of a number of hatch styles is used: hatch styles greater than 0 are reserved for registration; hatch styles less than 1 are workstation dependent.

When an element of this type is interpreted, if the element's interior style index is not available on a workstation, interior style index 1 is used on that workstation. If interior style index 1 is not present on that workstation, the result is workstation dependent.

NOTE - Hatch style values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority (see 4.1.2). When a hatch style has been approved by ISO, the hatch style value will be assigned by the Registration Authority.

References: 4.4 4.5.2 4.5.8 4.5.9

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET INTERIOR COLOUR INDEX **(PHOP,*,STOP,*)**

Parameters:

In	interior colour index	(0..n)	I

Effect: Depending upon the 'edit mode', a "set interior colour index" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set interior colour index" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current interior colour index' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent FILL AREA and FILL AREA SET output primitives displayed when the 'current interior colour index ASF' entry in the PHIGS traversal state list is INDIVIDUAL. This value does not affect the display of subsequent FILL AREA and FILL AREA SET output primitives displayed when the 'current interior colour index ASF' entry in the PHIGS traversal state list is BUNDLED. For interior style EMPTY, the interior colour index is unused.

When an element of this type is interpreted, if the element's interior colour index is not available on a workstation, colour index 1 is used on that workstation.

References: 4.4 4.5.2 4.5.8 4.5.9

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*
113 Ignoring function, the colour index value is less than zero

SET EDGE FLAG **(PHOP,*,STOP,*)**

Parameters:

In	edge flag	(OFF,ON)	E

Effect: Depending upon the 'edit mode', a "set edge flag" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set edge flag" element. The value specified by the parameter is associated with the element.

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When an element of this type is interpreted the 'current edge flag' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent FILL AREA SET output primitives displayed when the 'current edge flag ASF' entry in the PHIGS traversal state list is INDIVIDUAL. This value does not affect the display of subsequent FILL AREA SET output primitives displayed when the 'current edge flag ASF' entry in the PHIGS traversal state list is BUNDLED.

References: 4.4 4.5.2 4.5.9

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET EDGETYPE **(PHOP,*,STOP,*)**

Parameters:

In	edgetype	I

Effect: Depending upon the 'edit mode', a "set edgetype" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set edgetype" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current edgetype' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent FILL AREA SET output primitives displayed when the 'current edgetype ASF' entry in the PHIGS traversal state list is INDIVIDUAL. This value does not affect the display of subsequent FILL AREA SET output primitives displayed when the 'current edgetype ASF' entry in the PHIGS traversal state list is BUNDLED.

Edgetypes are as follows:

≤0	implementation dependent
1	solid line
2	dashed line
3	dotted line
4	dashed-dotted line
≥5	reserved for registration

Edgetypes 2 through 4 are explicitly defined and non-required.

When an element of this type is interpreted, if the specified edgetype is not available on a workstation, edgetype 1 is used on that workstation.

NOTE - Registered edgetypes and registered linetypes are drawn from the same set of values.

References: 4.4 4.5.2 4.5.9

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET EDGEWIDTH SCALE FACTOR **(PHOP,*,STOP,*)**

Parameters:

In	edgewidth scale factor	R

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Effect: Depending upon the 'edit mode', a "set edgewidth scale factor" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set edgewidth scale factor" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current edgewidth scale factor' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent FILL AREA SET output primitives displayed when the 'current edgewidth scale factor ASF' entry in the PHIGS traversal state list is INDIVIDUAL. This value does not affect the display of subsequent FILL AREA SET output primitives displayed when the 'current edgewidth scale factor ASF' entry in the PHIGS traversal state list is BUNDLED.

When an element of this type is interpreted the edgewidth scale factor is multiplied by the nominal edgewidth on a workstation; the result is mapped by the workstation to the nearest available edgewidth.

References: 4.4 4.5.2 4.5.9

Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET EDGE COLOUR INDEX **(PHOP,*,STOP,*)**

Parameters:

In	edge colour index	(0..n)	I

Effect: Depending upon the 'edit mode', a "set edge colour index" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set edge colour index" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current edge colour index' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent FILL AREA SET output primitives displayed when the 'current edge colour index ASF' entry in the PHIGS traversal state list is INDIVIDUAL. This value does not affect the display of subsequent FILL AREA SET output primitives displayed when the 'current edge colour index ASF' entry in the PHIGS traversal state list is BUNDLED.

When an element of this type is interpreted, if the element's edge colour index is not available on a workstation, colour index 1 is used on that workstation.

References: 4.4 4.5.2 4.5.9

Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*
113 Ignoring function, the colour index value is less than zero

SET PATTERN SIZE **(PHOP,*,STOP,*)**

Parameters:

In	pattern size	MC SX,SY>0	2×R

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Effect: Depending upon the 'edit mode', a "set pattern size" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set pattern size" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current pattern size' entry in the PHIGS traversal state list is set to the value associated with the element. When the currently selected (either via the interior bundle or individually, depending on the corresponding ASF) interior style is PATTERN, this value is used, where possible, in conjunction with the 'current pattern reference point' and 'current pattern reference vectors' entries in the PHIGS traversal state list for displaying FILL AREA, FILL AREA 3, FILL AREA SET, and FILL AREA SET 3 output primitives.

When an element of this type is interpreted only the magnitudes of the pattern size components are considered. If either of the pattern size components is degenerate (i.e. the absolute value of the component is zero (0)) the element will be ignored.

References: 4.4 4.5.2 4.5.8 4.5.9

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET PATTERN REFERENCE POINT AND VECTORS **(PHOP,*,STOP,*)**

Parameters:

In	pattern reference point	MC	P3
In	pattern reference vectors	MC	2×V3

Effect: Depending upon the 'edit mode', a "set pattern reference point and vectors" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set pattern reference point and vectors" element. The values specified by the parameters are associated with the element.

When an element of this type is interpreted the 'current pattern reference point' and 'current pattern reference vectors' entries in the PHIGS traversal state list are set to the values associated with the element (see 4.5.8). When the currently selected (either via the interior bundle or individually, depending on the corresponding ASF) interior style is PATTERN, these values are used, where possible, in conjunction with the 'current pattern size' entry in the PHIGS traversal state list for displaying FILL AREA, FILL AREA 3, FILL AREA SET, and FILL AREA SET 3 output primitives.

When an element of this type is interpreted, if the pattern reference vectors define a degenerate case (i.e. one of the vectors is zero (0) length or the vectors are parallel), the structure element will be ignored.

References: 4.4 4.5.2 4.5.8 4.5.9

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET PATTERN REFERENCE POINT **(PHOP,*,STOP,*)**

Parameters:

In	reference point	MC	P2

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Effect: This form of the set pattern reference point attribute specifies the attribute using a 2-dimensional shorthand for 3D. The set pattern reference point form is assumed to have a z-coordinate equal to zero (0).

Depending upon the 'edit mode', a "set pattern reference point" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set pattern reference point" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current pattern reference point' entry in the PHIGS traversal state list is set to the value associated with the element (with a z-coordinate value equal to zero (0)) and the 'current pattern reference vectors' entry in the PHIGS traversal state list is set to (1,0,0) and (0,1,0). When the currently selected (either via the interior bundle or individually, depending on the corresponding ASF) interior style is PATTERN, these values are used, where possible, in conjunction with the 'current pattern size' entry in the PHIGS traversal state list for displaying FILL AREA, FILL AREA 3, FILL AREA SET, and FILL AREA SET 3 output primitives.

References: 4.4 4.5.2 4.5.8 4.5.9

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

ADD NAMES TO SET **(PHOP,*,STOP,*)**

Parameters:

In class names SET(NM)

Effect: Depending upon the 'edit mode', an "add names to set" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "add names to set" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the members of the name set associated with the element are added to the 'current name set' entry in the PHIGS traversal state list. The 'current name set' entry in the PHIGS traversal state list is associated with subsequent primitives.

References: 4.4 4.5.2 4.5.15

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

REMOVE NAMES FROM SET **(PHOP,*,STOP,*)**

Parameters:

In class names SET(NM)

Effect: Depending upon the 'edit mode', a "remove names from set" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "remove names from set" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the members of the name set associated with the element are removed from the 'current name set' entry in the PHIGS traversal state list. The 'current name set' entry in the PHIGS traversal state list is associated with subsequent primitives.

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References: 4.4 4.5.2 4.5.15

Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*

5.4.3 Aspect source flag setting

SET INDIVIDUAL ASF **(PHOP,*,STOP,*)**

Parameters:

In	aspect identifier	(see enumeration below)	E
In	aspect source	(BUNDLED, INDIVIDUAL)	E

Effect: Depending upon the 'edit mode', a "set individual ASF" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set individual ASF" element. The values specified by the parameters are associated with the element.

The following are the elements of the enumeration type aspect identifier:

LINETYPE,
LINEWIDTH_SCALE_FACTOR,
POLYLINE_COLOUR_INDEX,
MARKER_TYPE,
MARKER_SIZE_SCALE_FACTOR,
POLYMARKER_COLOUR_INDEX,
TEXT_FONT,
TEXT_PRECISION,
CHARACTER_EXPANSION_FACTOR,
CHARACTER_SPACING,
TEXT_COLOUR_INDEX,
INTERIOR_STYLE,
INTERIOR_STYLE_INDEX,
INTERIOR_COLOUR_INDEX,
EDGE_FLAG,
EDGETYPE,
EDGEWIDTH_SCALE_FACTOR,
EDGE_COLOUR_INDEX

When an element of this type is interpreted the Aspect Source Flag (ASF) in the PHIGS traversal state list, identified by the element's aspect identifier, is set to the value specified by the element's aspect source. These values are used by subsequent output primitives.

References: 4.4 4.5.2

Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*

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5.4.4 Workstation attribute table definition

SET POLYLINE REPRESENTATION **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	polyline index	(1..n)	I
In	linetype		I
In	linewidth scale factor		R
In	polyline colour index	(0..n)	I

Effect: In the polyline bundle table in the workstation state list of the specified workstation, the given polyline index is associated with the specified parameters.

Linetype:
linetypes are as follows:

≤0	implementation dependent
1	solid line
2	dashed line
3	dotted line
4	dashed-dotted line
≥5	reserved for registration

Linewidth scale factor:
a scale factor applied to the nominal linewidth. When an element of this type is interpreted the linewidth scale factor is multiplied by the nominal linewidth on a workstation; the result is mapped by the workstation to the nearest available linewidth.

Polyline colour index:
pointer into the colour table of the workstation. When an element of this type is interpreted, if the specified polyline colour index is not available on the workstation, colour index 1 is used.

The polyline bundle table in the workstation state list has predefined entries taken from the workstation description table; a number (see 4.14) are predefined for every workstation of category OUTPUT and OUTIN. Any table entry (including the predefined entries) may be redefined with this function.

When polylines are displayed during structure traversal, the 'current polyline index' in the PHIGS traversal state list refers to an entry in the polyline bundle table. If the 'current polyline index' is not present in the polyline bundle table, polyline index 1 is used. Which of the aspects in the entry are used depends upon the setting of the corresponding ASFs (see 4.5.2).

NOTE - Linetype values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority (see 4.1.2). When a linetype has been approved by ISO, the linetype will be assigned by the Registration Authority.

References: 4.5.2 4.5.3 4.6.3

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Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
100 Ignoring function, the bundle index value is less than one
103 Ignoring function, setting this bundle table entry would exceed the maximum number of entries allowed in the workstation bundle table
104 Ignoring function, the specified linetype is not available on the specified workstation
113 Ignoring function, the colour index value is less than zero

SET POLYMARKER REPRESENTATION (PHOP,WSOP,*,*)

Parameters:

In	workstation identifier		WI
In	polymarker index	(1..n)	I
In	marker type		I
In	marker size scale factor		R
In	polymarker colour index	(0..n)	I

Effect: In the polymarker bundle table in the workstation state list of the specified workstation, the given polymarker index is associated with the specified parameters.

Marker type:
marker types are centred symbols as follows:

≤0	implementation dependent
1	· dot
2	+ plus sign
3	* asterisk
4	o circle
5	× diagonal cross
≥6	reserved for registration

Marker type 1 is always displayed as the smallest displayable dot, since a "dot" has no size, therefore scaling a sizeless entity has no effect.

Marker size scale factor:
a scale factor applied to the nominal marker size. During structure traversal the marker size scale factor is multiplied by the nominal marker size on a workstation; the result is mapped by the workstation to the nearest available marker size.

Polymarker colour index:
pointer into the colour table of the workstation. During structure traversal, if the specified polymarker colour index is not available on the workstation, colour index 1 is used.

The polymarker bundle table in the workstation state list has predefined entries taken from the workstation description table; a number (see 4.14) are predefined for every workstation of category OUTPUT and OUTIN. Any table entry (including the predefined entries) may be redefined with this function.

When polymarkers are displayed during structure traversal, the 'current polymarker index' in the PHIGS traversal state list refers to an entry in the polymarker bundle table. If the 'current polymarker index' is not present in the polymarker bundle table, polymarker index 1 is used. Which of the aspects in the entry are used depends upon the setting of the corresponding ASFs (see

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4.5.2).

NOTE - Marker type values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority (see 4.1.2). When a marker type has been approved by ISO, the marker type value will be assigned by the Registration Authority.

References: 4.5.2 4.5.4 4.6.3

Errors:

003 *Ignoring function, function requires state (PHOP,WSOP,*,*)*
054 *Ignoring function, the specified workstation is not open*
059 *Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)*
100 *Ignoring function, the bundle index value is less than one*
103 *Ignoring function, setting this bundle table entry would exceed the maximum number of entries allowed in the workstation bundle table*
105 *Ignoring function, the specified marker type is not available on the specified workstation*
113 *Ignoring function, the colour index value is less than zero*

SET TEXT REPRESENTATION **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	text index	(1..n)	I
In	text font		I
In	text precision	(STRING,CHAR,STROKE)	E
In	character expansion factor		R
In	character spacing		R
In	text colour index	(0..n)	I

Effect: In the text bundle table in the workstation state list of the specified workstation, the given text index is associated with the specified parameters.

Text font:

a single text aspect; a particular text font can be available at some, but not necessarily all, precisions. The text font value is used to select a particular font on this workstation. Text font 1 contains a graphical representation of the characters defined in ISO 646 (or a character set including ISO 646) (see 4.5.5 and 4.5.6). Text font 2 contains a graphical representation of the same characters which are visually distinguishable from the same characters in text font 1. Text fonts greater than 2 are reserved for registration. Text fonts less than 1 are implementation dependent. During structure traversal, if the text font is not available in the specified text precision on a workstation, text font 1 and text precision STRING are used on that workstation.

Text precision:

The text precision value determines the fidelity with which the other text aspects are used. The values of text precision, in order of increasing fidelity, are STRING, CHAR and STROKE (see 4.5.5 and 4.5.6). During structure traversal, if the specified text precision is not available in the specified text font on a workstation, text precision STRING and text font 1 are used on that workstation.

Character expansion factor:

specifies the deviation of the width to height ratio of the characters from the ratio indicated by the font designer. During structure traversal only the magnitude of the character expansion factor is considered. If the result of taking the absolute value of the character expansion factor value is less than the smallest supported character expansion factor on a workstation, the

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smallest supported character expansion factor on that workstation is used. If the result is greater than the largest supported character expansion factor on a workstation, the largest supported character expansion factor on that workstation is used.

Character spacing:
specifies how much additional space is to be inserted between two adjacent character bodies. Character spacing is specified as a fraction of the font-nominal character height.

Text colour index:
a pointer into the colour table of the workstation. During structure traversal, if the specified text colour index is not available on the workstation, colour index 1 is used.

The text bundle table in the workstation state list has predefined entries taken from the workstation description table; a number (see 4.14) are predefined for every workstation of category OUTPUT and OUTIN. Any table entry (including the predefined entries) may be redefined with this function.

When text or annotation text is displayed during structure traversal, the 'current text index' in the PHIGS traversal state list refers to an entry in the text bundle table. If the 'current text index' is not present in the text bundle table, text index 1 is used. Which of the aspects in the entry are used depends upon the setting of the corresponding ASFs (see 4.5.2).

NOTE - Text font numbers are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority (see 4.1.2). When a text font has been approved by ISO, the text font number will be assigned by the Registration Authority.

References: 4.5.2 4.5.5 4.5.6 4.6.3

Errors:
003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
100 Ignoring function, the bundle index value is less than one
103 Ignoring function, setting this bundle table entry would exceed the maximum number of entries allowed in the workstation bundle table
106 Ignoring function, the specified font is not available for the requested text precision on the specified workstation
113 Ignoring function, the colour index value is less than zero

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SET INTERIOR REPRESENTATION (PHOP,WSOP,*,*)

Parameters:

In	workstation identifier		WI
In	interior index	(1..n)	I
In	interior style	(HOLLOW,SOLID,PATTERN,HATCH,EMPTY)	E
In	interior style index		I
In	interior colour index	(0..n)	I

Effect: In the interior bundle table in the workstation state list of the specified workstation, the given interior index is associated with the specified parameters.

Interior style:
is used to determine in what style the interior of the fill area or fill area set should be filled. The possible values are: HOLLOW, SOLID, PATTERN, HATCH, and EMPTY (see 4.5.8 and 4.5.9). During structure traversal, if the requested interior style is not available on the

workstation, HOLLOW will be used on that workstation.

Interior style index:
For interior styles HOLLOW, SOLID and EMPTY, the interior style index value is unused. For interior style PATTERN, this value is greater than 0 and is a pointer into the pattern table of the workstation. For interior style HATCH, this value determines which of a number of hatch styles is used: hatch styles greater than 0 are reserved for registration; hatch styles less than 1 are workstation dependent. During structure traversal, if the requested interior style index is not available on the workstation, interior style index 1 will be used on that workstation.

Interior colour index:
a pointer into the colour table of the workstation. During structure traversal, if the specified interior colour index is not available on the workstation, colour index 1 is used.

The interior bundle table in the workstation state list has predefined entries taken from the workstation description table; a number (see 4.14) are predefined for every workstation of category OUTPUT and OUTIN. Any table entry (including the predefined entries) may be redefined with this function.

When fill areas or fill area sets are displayed during structure traversal, the 'current interior index' in the PHIGS traversal state list refers to an entry in the interior bundle table. If the 'current interior index' is not present in the interior bundle table, interior index 1 is used. Which of the aspects in the entry are used depends upon the setting of the corresponding ASFs (see 4.5.2).

NOTE - Hatch style values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority (see 4.1.2). When a hatch style has been approved by ISO, the hatch style value will be assigned by the Registration Authority.

References: 4.5.2 4.5.8 4.5.9 4.6.3

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
100 Ignoring function, the bundle index value is less than one
103 Ignoring function, setting this bundle table entry would exceed the maximum number of entries allowed in the workstation bundle table
108 Ignoring function, the specified interior style is not available on the workstation
112 Ignoring function, the pattern index value is less than one
113 Ignoring function, the colour index value is less than zero

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SET EDGE REPRESENTATION (PHOP,WSOP,*,*)

Parameters:

In	workstation identifier		WI
In	edge index	(1..n)	I
In	edge flag	(OFF,ON)	E
In	edgetype		I
In	edgewidth scale factor		R
In	edge colour index	(0..n)	I

Effect: In the edge bundle table in the workstation state list of the specified workstation, the given edge index is associated with the specified parameters.

Edge flag:
enables or disables the drawing of an edge when displaying a fill area set. For value OFF, the edge aspects associated with the given index are not used and the fill area set is drawn using only the relevant interior style. For value ON, the fill area set edge is displayed using the values defined in the edge representation. The edge has higher precedence than the interior of the fill area set. The boundary drawn for interior style HOLLOW is considered part of the interior. Consequently, the HOLLOW boundary may not be visible when an edge is drawn.

Edgetype:
edgetypes are as follows:

≤0	implementation dependent
1	solid line
2	dashed line
3	dotted line
4	dashed-dotted line
≥5	reserved for registration

Edgetypes 2 through 4 are explicitly defined and non-required.

Edgewidth scale factor:
a scale factor applied to the nominal edgewidth. During structure traversal the edgewidth scale factor is multiplied by the nominal edgewidth on a workstation; the result is mapped by the workstation to the nearest available edgewidth.

Edge colour index:
a pointer into the colour table of the workstation. During structure traversal, if the specified edge colour index is not available on the workstation, colour index 1 is used.

The edge bundle table in the workstation state list has predefined entries taken from the workstation description table; a number (see 4.14) are predefined for every workstation of category OUTPUT and OUTIN. Any table entry (including the predefined entries) may be redefined with this function.

When fill area sets are displayed during structure traversal, the 'current edge index' in the PHIGS traversal state list refers to an entry in the edge bundle table. If the 'current edge index' is not present in the edge bundle table, edge index 1 is used. Which of the aspects in the entry are used depends upon the setting of the corresponding ASFs (see 4.5.2).

NOTE - Edgetype values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority (see 4.1.2). When a edgetype has been approved by ISO, the edgetype will be assigned by the Registration Authority.

References: 4.5.2 4.5.9 4.6.3

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
100 Ignoring function, the bundle index value is less than one
103 Ignoring function, setting this bundle table entry would exceed the maximum number of entries allowed in the workstation bundle table
113 Ignoring function, the colour index value is less than zero
107 Ignoring function, the specified edgetype is not available on the specified workstation

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SET PATTERN REPRESENTATION **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	pattern index	(1..n)	I
In	pattern colour index array	(0..n)	A(I)

Effect: In the pattern table in the workstation state list of the specified workstation, the given pattern index is associated with the specified parameters.

The pattern colour index array parameter defines an array (DX × DY) of colour index values which point into the colour table of the specified workstation. The arrangement of cells associated with the pattern colour index array is described in 4.5.8.

If the workstation supports interior style PATTERN, the pattern table in the workstation state list has predefined entries taken from the workstation description table; a number (see 4.14) are predefined for every workstation of category OUTPUT and OUTIN supporting interior style PATTERN. Any table entry (including the predefined entries) may be redefined with this function.

When fill areas or fill area sets are displayed during structure traversal, if the currently selected (either via the interior bundle or individually, depending upon the corresponding ASF) interior style is PATTERN, the 'current interior style index' in the PHIGS traversal state list refers to an entry in the pattern table. If the 'current interior style index' is not present in the pattern table, interior style index 1 is used. If interior style index 1 is not present (i.e. interior style PATTERN is not supported for this workstation), the result is workstation dependent.

During structure traversal, if a pattern colour index specified in the pattern colour index array is not available on the workstation, colour index 1 is used.

References: 4.5.2 4.5.8 4.5.9 4.6.3

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
112 Ignoring function, the pattern index value is less than one
103 Ignoring function, setting this bundle table entry would exceed the maximum number of entries allowed in the workstation bundle table
116 Ignoring function, one of the dimensions of pattern colour index array is less than one
113 Ignoring function, the colour index value is less than zero

SET COLOUR REPRESENTATION **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	colour index	(0..n)	I
In	colour specification		CLR

Effect: In the colour table in the workstation state list of the specified workstation, the given colour index is associated with the specified parameters. The colour is mapped by the workstation to the nearest available.

The colour specification parameters are the coordinates of the colour in the current colour model at the workstation (as defined by the 'current colour model' in the workstation state list).

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The colour table in the workstation state list has predefined entries taken from the workstation description table; at least indices 0 and 1 are predefined for every workstation of category OUTPUT and OUTIN. Any table entry (including the predefined entries) may be redefined with this function.

When output primitives are displayed during structure traversal, the applicable current colour index in the PHIGS traversal state list refers to an entry in the colour table. If the colour index is not present in the colour table, colour index 1 is used. The background colour is defined by colour index 0.

NOTE - On monochrome workstations, the intensity is computed from the colour parameters in a workstation dependent way.

References: 4.5.2 4.5.12 4.6.3

Errors:

003 *Ignoring function, function requires state (PHOP,WSOP,*,*)*
054 *Ignoring function, the specified workstation is not open*
059 *Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)*
113 *Ignoring function, the colour index value is less than zero*
103 *Ignoring function, setting this bundle table entry would exceed the maximum number of entries allowed in the workstation bundle table*
118 *Ignoring function, one of the components of the colour specification is out of range. The valid range is dependent upon the current colour model*

5.4.5 Workstation filter definition

SET HIGHLIGHTING FILTER **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier	WI
In	highlighting filter	FR

Effect: The 'highlighting filter' entry in the workstation state list of the specified workstation is set to the value specified by the parameter.

During structure traversal, the workstation processes the filter against the 'current name set' in the PHIGS traversal state list to determine whether subsequent primitives are highlighted. Primitives will be highlighted on a workstation when both the inclusion set of the 'highlighting filter', in the workstation state list, intersected with the 'current name set' is non-empty and the exclusion set of the 'highlighting filter', in the workstation state list, intersected with the 'current name set' is empty.

References: 4.4 4.5.2 4.5.15

Errors:

003 *Ignoring function, function requires state (PHOP,WSOP,*,*)*
054 *Ignoring function, the specified workstation is not open*
059 *Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)*

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SET INVISIBILITY FILTER **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier	WI
In	invisibility filter	FR

Effect: The 'invisibility filter' entry in the workstation state list of the specified workstation is set to the value specified by the parameter.

During structure traversal, the workstation processes the filter against the 'current name set' in the PHIGS traversal state list to determine whether subsequent primitives are invisible. Primitives will be invisible on a workstation when both the inclusion set of the 'invisibility filter', in the workstation state list, intersected with the 'current name set' is non-empty and the exclusion set of the 'invisibility filter', in the workstation state list, intersected with the 'current name set' is empty.

References: 4.4 4.5.2 4.5.15

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)

5.4.6 Colour model control

SET COLOUR MODEL **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier	WI
In	colour model	I

Effect: The 'current colour model' in the workstation state list of the specified workstation is set to the value specified by the parameter.

The 'current colour model' defines the interpretation of the colour parameters for colour definition and inquiry of the contents of the colour table.

Colour models are as follows:

≤0	implementation dependent
1	RGB
2	CIELUV
3	HSV
4	HLS
≥5	reserved for registration

NOTE - Colour model values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority (see 4.1.2). When a colour model has been approved by ISO, the colour model value will be assigned by the Registration Authority.

References: 4.5.2 4.5.12 4.6.3

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
110 Ignoring function, the specified colour model is not available on the workstation

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5.4.7 HLHSR attributes

SET HLHSR IDENTIFIER **(PHOP,*,STOP,*)**

Parameters:

In	HLHSR identifier	I

Effect: Depending upon the 'edit mode', a "set HLHSR identifier" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set hlhsr identifier" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current HLHSR identifier' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent output primitives and supplies HLHSR information to the workstation.

When an element of this type is interpreted, if the element's HLHSR identifier cannot be interpreted at the workstation, the workstation will use another HLHSR identifier.

References: 4.4 4.5.14 4.6.6

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET HLHSR MODE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier	WI
In	HLHSR mode	I

Effect: The 'requested HLHSR mode' entry in the workstation state list of the specified workstation is set to the value specified by the parameter.

If the 'dynamic modification accepted for HLHSR mode' entry in the workstation description table is set to IMM, or if the 'display surface empty' entry in the workstation state list is set to EMPTY, then the 'current HLHSR mode' entry in the workstation state list is set to the value specified by the parameter and the 'HLHSR update state' entry is set to NOTPENDING. Otherwise, the 'HLHSR update state' entry in the workstation state list is set to PENDING and the 'current HLHSR mode' entry is not changed.

References: 4.5.14 4.6.6

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
111 Ignoring function, the specified HLHSR mode is not available on the specified workstation

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5.5 Transformation and clipping functions

5.5.1 Modelling transformations and clipping

SET LOCAL TRANSFORMATION 3 **(PHOP,*,STOP,*)**

Parameters:

In	transformation matrix	4×4×R
In	composition type (PRECONCATENATE,POSTCONCATENATE,REPLACE)	E

Effect: Depending upon the 'edit mode', a "set local transformation 3" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set local transformation 3" element. The values specified by the parameters are associated with the element.

When an element of this type is interpreted the 'current local modelling transformation' entry in the PHIGS traversal state list is combined with the element's transformation matrix. The composition method is specified by the element's composition type. The 'current local modelling transformation' entry in the PHIGS traversal state list is set to the result of this matrix composition. This value is used when displaying subsequent output primitives during structure traversal.

References: 4.4 4.7.2

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET LOCAL TRANSFORMATION **(PHOP,*,STOP,*)**

Parameters:

In	transformation matrix	3×3×R
In	composition type (PRECONCATENATE,POSTCONCATENATE,REPLACE)	E

Effect: Depending upon the 'edit mode', a "set local transformation" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set local transformation" element. The values specified by the parameters are associated with the element.

When an element of this type is interpreted the 'current local modelling transformation' entry in the PHIGS traversal state list is combined with the element's transformation matrix after expanding the 3×3 matrix into a 4×4 matrix in the following way:

$$\begin{vmatrix} a & b & c \\ d & e & f \\ g & h & j \end{vmatrix} \rightarrow \begin{vmatrix} a & b & 0 & c \\ d & e & 0 & f \\ 0 & 0 & 1 & 0 \\ g & h & 0 & j \end{vmatrix}$$

The composition method is specified by the element's composition type. The 'current local modelling transformation' entry in the PHIGS traversal state list is set to the result of this matrix composition. This value is used when displaying subsequent output primitives during structure traversal.

References: 4.4 4.7.2

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

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SET GLOBAL TRANSFORMATION 3 **(PHOP,*,STOP,*)**

Parameters:

In	transformation matrix	4×4×R

Effect: Depending upon the 'edit mode', a "set global transformation 3" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set global transformation 3" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current global modelling transformation' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent output primitives during structure traversal.

References: 4.4 4.7.2

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET GLOBAL TRANSFORMATION **(PHOP,*,STOP,*)**

Parameters:

In	transformation matrix	3×3×R

Effect: Depending upon the 'edit mode', a "set global transformation" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set global transformation" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current global modelling transformation' entry in the PHIGS traversal state list is set to the value associated with the element after expanding the 3×3 matrix into a 4×4 matrix in the following way:

$$\begin{vmatrix} a & b & c \\ d & e & f \\ g & h & j \end{vmatrix} \rightarrow \begin{vmatrix} a & b & 0 & c \\ d & e & 0 & f \\ 0 & 0 & 1 & 0 \\ g & h & 0 & j \end{vmatrix}$$

This value is used when displaying subsequent output primitives during structure traversal.

References: 4.4 4.7.2

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

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SET MODELLING CLIPPING VOLUME 3 **(PHOP,*,STOP,*)**

Parameters:

In	operator		I
In	half-spaces	MC	L(HS3)

Effect: Depending upon the 'edit mode', a "set modelling clipping volume 3" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set modelling clipping volume 3" element. The values specified by the parameters are associated with the element.

When an element of this type is interpreted the 'current modelling clipping volume' entry in the PHIGS traversal state list is set to a value computed as follows.

The element's half-spaces are transformed by the composite modelling transformation and then intersected to form a clipping volume S. If no half-spaces are provided the clipping volume S is defined to be all of modelling coordinate space. S is combined, as specified by the element's operator, with the 'current modelling clipping volume' to form the new value of the 'current modelling clipping volume'. This volume is used to clip subsequent output primitives during structure traversal.

Operator values produce effects as indicated:

≤0	implementation dependent
1	replace
2	intersect
≥3	reserved for registration

When an element of this type is interpreted, if the element's operator is not supported by the implementation, the element is ignored.

When an element of this type is interpreted, if any half-space is found to be degenerate, the structure element is ignored.

NOTE - Modelling clipping operators are registered in the ISO International Register of Graphics Items, which is maintained by the Registration Authority (see 4.1.2). When a modelling clipping operator has been approved by ISO, the modelling clipping operator will be assigned by the Registration Authority.

References: 4.4 4.7.2

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET MODELLING CLIPPING VOLUME **(PHOP,*,STOP,*)**

Parameters:

In	operator		I
In	half-spaces	MC	L(HS2)

Effect: Depending upon the 'edit mode', a "set modelling clipping volume" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set modelling clipping volume" element. The values specified by the parameters are associated with the element.

When an element of this type is interpreted the 'current modelling clipping volume' entry in the PHIGS traversal state list is set to a value computed as follows.

Each element's two dimensional half-space is expanded to a three dimensional half-space by setting the z coordinate of the point and normal vector equal to 0. These half-spaces are then transformed by the composite modelling transformation and the half-spaces are intersected to form a clipping volume S. If no half-spaces are provided the clipping volume S is defined to be all of modelling coordinate space. S is combined, as specified by the element's operator, with the 'current modelling clipping volume' to form the new value of the 'current modelling clipping volume'. This volume is used to clip subsequent output primitives during structure traversal.

Operator values produce effects as indicated:

≤0	implementation dependent
1	replace

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2 intersect
≥3 reserved for registration

When an element of this type is interpreted, if the element's operator is not supported by the implementation, the element is ignored.

When an element of this type is interpreted, if any half-space is found to be degenerate, the structure element is ignored.

NOTE - Modelling clipping operators are registered in the ISO International Register of Graphics Items, which is maintained by the Registration Authority (see 4.1.2). When a modelling clipping operator has been approved by ISO, the modelling clipping operator will be assigned by the Registration Authority.

References: 4.4 4.7.2

Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET MODELLING CLIPPING INDICATOR **(PHOP,*,STOP,*)**

Parameters:

In modelling clipping indicator (CLIP,NOCLIP) E

Effect: Depending upon the 'edit mode', a "set modelling clipping indicator" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set modelling clipping indicator" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current modelling clipping indicator' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used to determine whether subsequent output primitives will be clipped against the modelling clipping volume during structure traversal.

References: 4.4 4.7.2

Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*

RESTORE MODELLING CLIPPING VOLUME **(PHOP,*,STOP,*)**

Parameters:

none

Effect: Depending upon the 'edit mode', a "restore modelling clipping volume" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "restore modelling clipping volume" element.

When an element of this type is interpreted the 'current modelling clipping volume' entry in the PHIGS traversal state list is restored to the value inherited by that structure. This value is used when displaying subsequent output primitives during structure traversal.

References: 4.4 4.7.2

Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*

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5.5.2 View operations

SET VIEW INDEX **(PHOP,*,STOP,*)**

Parameters:

In	view index	(0..n)	I

Effect: Depending upon the 'edit mode', a "set view index" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to the "set view index" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the 'current view index' entry in the PHIGS traversal state list is set to the value associated with the element. This value is used when displaying subsequent output primitives during structure traversal.

References: 4.4 4.7.4

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*
114 Ignoring function, the view index value is less than zero

SET VIEW REPRESENTATION 3 **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier			WI
In	view index		(1..n)	I
In	view orientation matrix			4×4×R
In	view mapping matrix			4×4×R
In	view clipping limits	XMIN<XMAX,YMIN<YMAX,ZMIN≤ZMAX	NPC	3×B
In	x-y clipping indicator		(CLIP,NOCLIP)	E
In	back clipping indicator		(CLIP,NOCLIP)	E
In	front clipping indicator		(CLIP,NOCLIP)	E

Effect: The 'requested view orientation matrix', 'requested view mapping matrix', 'requested view clipping limits', 'requested x-y clipping indicator', 'requested back clipping indicator', and 'requested front clipping indicator' values for the specified view in the workstation state list are set to the specified values.

For workstations of category OUTPUT, OUTIN, OUTIN and MO, the 'view transformation update state' entry for the specified view in the workstation state list is set to PENDING if the visual effect of this function's invocation is deferred; otherwise it is set to NOTPENDING. For workstations of category INPUT this entry is always NOTPENDING.

If the 'view transformation update state' entry is NOTPENDING the corresponding "current" values for the specified view in the workstation state list are set to the "requested" values; otherwise the "current" values are not changed.

References: 4.7.4

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Errors:
- *003 Ignoring function, function requires state (PHOP,WSOP,*,*)*
- *054 Ignoring function, the specified workstation is not open*
- *057 Ignoring function, specified workstation is of category MI*
- *115 Ignoring function, the view index value is less than one*
- *150 Ignoring function, setting this view table entry would exceed the maximum number of entries allowed in the workstations view table*
- *153 Ignoring function, invalid view clipping limits; XMIN≥XMAX, YMIN≥YMAX or ZMIN>ZMAX*
- *154 Ignoring function, the view clipping limits are not within NPC range*

SET VIEW REPRESENTATION **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier			WI
In	view index		(1..n)	I
In	view orientation matrix			3×3×R
In	view mapping matrix			3×3×R
In	view clipping limits	XMIN<XMAX,YMIN<YMAX	NPC	2×B
In	x-y clipping indicator		(CLIP,NOCLIP)	E

Effect: The view orientation matrix and the view mapping matrix are first expanded to 4x4 matrices. Then, the 'requested view orientation matrix' and 'requested view mapping matrix' values for the specified view in the workstation state list are set to the expanded values and the 'requested x-y clipping indicator' value is set to the specified value. The X and Y portions of the 'requested view clipping limits' for the specified view are set to the specified values and the Z portion are set to the default values.

For workstations of category OUTPUT, OUTIN, OUTIN and MO, the 'view transformation update state' entry for the specified view in the workstation state list is set to PENDING if the visual effect of this function's invocation is deferred; otherwise it is set to NOTPENDING. For workstations of category INPUT this entry is always NOTPENDING.

If the 'view transformation update state' entry is NOTPENDING the corresponding "current" values for the specified view in the workstation state list are set to the "requested" values; otherwise the "current" values are not changed.

References: 4.7.4

Errors:
- *003 Ignoring function, function requires state (PHOP,WSOP,*,*)*
- *054 Ignoring function, the specified workstation is not open*
- *057 Ignoring function, specified workstation is of category MI*
- *115 Ignoring function, the view index value is less than one*
- *150 Ignoring function, setting this view table entry would exceed the maximum number of entries allowed in the workstations view table*
- *153 Ignoring function, invalid view clipping limits; XMIN≥XMAX, YMIN≥YMAX or ZMIN>ZMAX*
- *154 Ignoring function, the view clipping limits are not within NPC range*

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SET VIEW TRANSFORMATION INPUT PRIORITY **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	view index	(0..n)	I
In	reference view index	(0..n)	I
In	relative priority	(HIGHER,LOWER)	E

Effect: On the specified workstation, the view transformation input priority of the view representation with the specified view index is set to the next higher or lower priority relative to the reference view representation, according to the specified relative priority. If the specified view index is the same as the reference view index, the function has no effect.

References: 4.7.4 4.7.7 4.7.8 4.8.7

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
057 Ignoring function, specified workstation is of category MI
114 Ignoring function, the view index value is less than zero
101 Ignoring function, the specified representation has not been defined

5.5.3 Workstation transformation

SET WORKSTATION WINDOW 3 **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	workstation window limits	XMIN<XMAX,YMIN<YMAX,ZMIN≤ZMAX NPC	3×B

Effect: The 'requested workstation window' in the workstation state list is set to the value specified by the parameter.

For workstations of category OUTPUT, OUTIN and MO, the 'workstation transformation update state' entry in the workstation state list is set to PENDING if the visual effect of this function's invocation is deferred; otherwise it is set to NOTPENDING. For workstations of category INPUT this entry is always NOTPENDING.

If the 'workstation transformation update state' entry is NOTPENDING the 'current workstation window' entry is assigned the value of the 'requested workstation window' entry; otherwise the "current" values are not changed.

NOTE - The workstation transformation is an isotropic transformation. If the workstation window and workstation viewport do not have the same aspect ratio, not all of the workstation viewport will be used.

References: 4.7.6

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
057 Ignoring function, specified workstation is of category MI
151 Ignoring function, invalid window; XMIN≥XMAX, YMIN≥YMAX, ZMIN>ZMAX, UMIN≥UMAX or VMIN≥VMAX
156 Ignoring function, the workstation window limits are not within NPC range

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SET WORKSTATION WINDOW **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier			WI
In	workstation window limits	XMIN<XMAX,YMIN<YMAX	NPC	2×B

Effect: The x and y components of the 'requested workstation window' in the workstation state list are set to the x and y coordinates of the parameter. The z coordinates of the 'requested workstation window' and 'current workstation window' are not changed.

For workstations of category OUTPUT, OUTIN and MO, the 'workstation transformation update state' entry in the workstation state list is set to PENDING if the visual effect of this function's invocation is deferred; otherwise it is set to NOTPENDING. For workstations of category INPUT this entry is always NOTPENDING.

If the 'workstation transformation update state' entry is NOTPENDING the 'current workstation window' entry is assigned the x and y coordinates of the 'requested workstation window' entry; otherwise the "current" values are not changed.

NOTE - The workstation transformation is an isotropic transformation. If the workstation window and workstation viewport do not have the same aspect ratio, not all of the workstation viewport will be used.

References: 4.7.6

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
057 Ignoring function, specified workstation is of category MI
151 Ignoring function, invalid window; XMIN≥XMAX, YMIN≥YMAX, ZMIN>ZMAX, UMIN≥UMAX or VMIN≥VMAX
156 Ignoring function, the workstation window limits are not within NPC range

SET WORKSTATION VIEWPORT 3 **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier			WI
In	workstation viewport limits	XMIN<XMAX,YMIN<YMAX,ZMIN≤ZMAX	DC	3×B

Effect: The 'requested workstation viewport' in the workstation state list is set to the value specified by the parameter.

For workstations of category OUTPUT, OUTIN and MO, the 'workstation transformation update state' entry in the workstation state list is set to PENDING if the visual effect of this function's invocation is deferred; otherwise it is set to NOTPENDING. For workstations of category INPUT this entry is always NOTPENDING.

If the 'workstation transformation update state' entry is NOTPENDING the 'current workstation viewport' entry is assigned the value of the 'requested workstation viewport' entry; otherwise the "current" values are not changed.

NOTE - The workstation transformation is an isotropic transformation. If the workstation window and workstation viewport do not have the same aspect ratio, not all of the workstation viewport will be used.

References: 4.7.6

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Errors:
003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
057 Ignoring function, specified workstation is of category MI
152 Ignoring function, invalid viewport; XMIN≥XMAX, YMIN≥YMAX or ZMIN>ZMAX
157 Ignoring function, the workstation viewport is not within display space

SET WORKSTATION VIEWPORT **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	workstation viewport limits	XMIN<XMAX,YMIN<YMAX DC	2×B

Effect: The x and y components of the 'requested workstation viewport' in the workstation state list are set to the x and y coordinates of the parameter. The z coordinates of the 'requested workstation viewport' and 'current workstation viewport' are not changed.

For workstations of category OUTPUT, OUTIN and MO, the 'workstation transformation update state' entry in the workstation state list is set to PENDING if the visual effect of this function's invocation is deferred; otherwise it is set to NOTPENDING. For workstations of category INPUT this entry is always NOTPENDING.

If the 'workstation transformation update state' entry is NOTPENDING the 'current workstation viewport' entry is assigned the x and y coordinates of the 'requested workstation viewport' entry; otherwise the "current" values are not changed.

NOTE - The workstation transformation is an isotropic transformation. If the workstation window and workstation viewport do not have the same aspect ratio, not all of the workstation viewport will be used.

References: 4.7.6

Errors:
003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
057 Ignoring function, specified workstation is of category MI
152 Ignoring function, invalid viewport; XMIN≥XMAX, YMIN≥YMAX or ZMIN>ZMAX
157 Ignoring function, the workstation viewport is not within display space

5.5.4 Utility functions to support modelling

TRANSLATE 3 **(PHOP,*,*,*)**

Parameters:

In	translation vector	DX,DY,DZ	V3
Out	error indicator		I
Out	transformation matrix		4×4×R

Effect: A 3D homogeneous transformation matrix to perform the specified 3D axis translation is returned in transformation matrix.

The error indicator is returned as 0 if PHIGS is in state PHOP. Otherwise, the error indicator is set to the following value:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.7.3

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Errors:
none

TRANSLATE **(PHOP,*,*,*)**

Parameters:

In	translation vector	DX,DY	V2
Out	error indicator		I
Out	transformation matrix		3×3×R

Effect: A 2D homogeneous transformation matrix to perform the specified 2D axis translation is returned in transformation matrix.

The error indicator is returned as 0 if PHIGS is in state PHOP. Otherwise, the error indicator is set to the following value:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.7.3

Errors:
none

SCALE 3 **(PHOP,*,*,*)**

Parameters:

In	scale factors	SX,SY,SZ	3×R
Out	error indicator		I
Out	transformation matrix		4×4×R

Effect: A 3D homogeneous transformation matrix to perform the specified 3D axis scaling is returned in transformation matrix.

The error indicator is returned as 0 if PHIGS is in state PHOP. Otherwise, the error indicator is set to the following value:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.7.3

Errors:
none

SCALE **(PHOP,*,*,*)**

Parameters:

In	scale factors	SX,SY	2×R
Out	error indicator		I
Out	transformation matrix		3×3×R

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Effect: A 2D homogeneous transformation matrix to perform the specified 2D axis scaling is returned in transformation matrix.

The error indicator is returned as 0 if PHIGS is in state PHOP. Otherwise, the error indicator is set to the following value:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.7.3

Errors:

none

ROTATE X **(PHOP,*,*,*)**

Parameters:

In	rotation angle in radians (positive if anticlockwise)	R
Out	error indicator	I
Out	transformation matrix	4×4×R

Effect: A 3D homogeneous transformation matrix to rotate the axes about the X axis is returned in transformation matrix.

The error indicator is returned as 0 if PHIGS is in state PHOP. Otherwise, the error indicator is set to the following value:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.7.3

Errors:

none

ROTATE Y **(PHOP,*,*,*)**

Parameters:

In	rotation angle in radians (positive if anticlockwise)	R
Out	error indicator	I
Out	transformation matrix	4×4×R

Effect: A 3D homogeneous transformation matrix to rotate the axes about the Y axis is returned in transformation matrix.

The error indicator is returned as 0 if PHIGS is in state PHOP. Otherwise, the error indicator is set to the following value:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.7.3

Errors:

none

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ROTATE Z **(PHOP,*,*,*)**

Parameters:

In	rotation angle in radians (positive if anticlockwise)	R
Out	error indicator	I
Out	transformation matrix	4×4×R

Effect: A 3D homogeneous transformation matrix to rotate the axes about the Z axis is returned in transformation matrix.

The error indicator is returned as 0 if PHIGS is in state PHOP. Otherwise, the error indicator is set to the following value:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.7.3

Errors:

none

ROTATE **(PHOP,*,*,*)**

Parameters:

In	rotation angle in radians (positive if anticlockwise)	R
Out	error indicator	I
Out	transformation matrix	3×3×R

Effect: A 2D homogeneous transformation matrix to perform the specified 2D axis rotation is returned in transformation matrix.

The error indicator is returned as 0 if PHIGS is in state PHOP. Otherwise, the error indicator is set to the following value:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.7.3

Errors:

none

COMPOSE MATRIX 3 **(PHOP,*,*,*)**

Parameters:

In	transformation matrix A	4×4×R
In	transformation matrix B	4×4×R
Out	error indicator	I
Out	composed transformation matrix	4×4×R

Effect: The 3D homogeneous transformation matrix to perform the transformation defined as:

[transformation matrix A] × [transformation matrix B]

is returned in composed transformation matrix.

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The error indicator is returned as 0 if PHIGS is in state PHOP. Otherwise, the error indicator is set to the following value:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.7.3

Errors:

none

COMPOSE MATRIX **(PHOP,*,*,*)**

Parameters:

In	transformation matrix A	3×3×R
In	transformation matrix B	3×3×R
Out	error indicator	I
Out	composed transformation matrix	3×3×R

Effect: The 2D homogeneous transformation matrix to perform the transformation defined by:

[transformation matrix A] × [transformation matrix B]

is returned in composed transformation matrix.

The error indicator is returned as 0 if PHIGS is in state PHOP. Otherwise, the error indicator is set to the following value:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.7.3

Errors:

none

TRANSFORM POINT 3 **(PHOP,*,*,*)**

Parameters:

In	point	P3
In	transformation matrix	4×4×R
Out	error indicator	I
Out	transformed point	P3

Effect: The result of applying transformation matrix to point is returned as transformed point.

The error indicator is returned as 0 if PHIGS is in state PHOP. Otherwise, the error indicator is set to the following value:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.7.3

Errors:

none

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TRANSFORM POINT **(PHOP,*,*,*)**

Parameters:

In	point		P2
In	transformation matrix		3×3×R
Out	error indicator		I
Out	transformed point		P2

Effect: The result of applying transformation matrix to point is returned as transformed point.

The error indicator is returned as 0 if PHIGS is in state PHOP. Otherwise, the error indicator is set to the following value:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.7.3

Errors:

none

BUILD TRANSFORMATION MATRIX 3 **(PHOP,*,*,*)**

Parameters:

In	fixed point		P3
In	shift vector	DX,DY,DZ	V3
In	rotation angle X in radians (positive if anticlockwise)		R
In	rotation angle Y in radians (positive if anticlockwise)		R
In	rotation angle Z in radians (positive if anticlockwise)		R
In	scale factors	SX,SY,SZ	3×R
Out	error indicator		I
Out	transformation matrix		4×4×R

Effect: A 3D homogeneous transformation matrix to perform the specified transformation is returned in transformation matrix. The order of transformation (all relative to the specified fixed point) is: scale, rotate x, rotate y, rotate z, and shift.

The error indicator is returned as 0 if PHIGS is in state PHOP. Otherwise, the error indicator is set to the following value:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.7.3

Errors:

none

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BUILD TRANSFORMATION MATRIX **(PHOP,*,*,*)**

Parameters:

In	fixed point		P2
In	shift vector	DX,DY	V2
In	rotation angle in radians (positive if anticlockwise)		R
In	scale factors	SX,SY	2×R
Out	error indicator		I
Out	transformation matrix		3×3×R

Effect: A 2D homogeneous transformation matrix to perform the specified transformation is returned in transformation matrix. The order of transformation is: scale, rotate (both relative to the specified fixed point), and shift.

The error indicator is returned as 0 if PHIGS is in state PHOP. Otherwise, the error indicator is set to the following value:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.7.3

Errors:

none

COMPOSE TRANSFORMATION MATRIX 3 **(PHOP,*,*,*)**

Parameters:

In	transformation matrix		4×4×R
In	fixed point		P3
In	shift vector	DX,DY,DZ	V3
In	rotation angle X in radians (positive if anticlockwise)		R
In	rotation angle Y in radians (positive if anticlockwise)		R
In	rotation angle Z in radians (positive if anticlockwise)		R
In	scale factors	SX,SY,SZ	3×R
Out	error indicator		I
Out	composed transformation matrix		4×4×R

Effect: A 3D homogeneous transformation matrix is returned in composed transformation matrix which is the composition of the specified matrix with the matrix defined by the fixed point, shift, rotate, and scale parameters. The order of transformation (all relative to the specified fixed point) is: scale, rotate x, rotate y, rotate z, and shift.

The error indicator is returned as 0 if PHIGS is in state PHOP. Otherwise, the error indicator is set to the following value:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.7.3

Errors:

none

COMPOSE TRANSFORMATION MATRIX **(PHOP,*,*,*)**

Parameters:

In	transformation matrix		3×3×R
In	fixed point		P2
In	shift vector	DX,DY	V2
In	rotation angle in radians (positive if anticlockwise)		R
In	scale factors	SX,SY	2×R
Out	error indicator		I
Out	composed transformation matrix		3×3×R

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Effect: A 2D homogeneous transformation matrix is returned in composed transformation matrix which is the composition of the specified matrix with the matrix defined by the fixed point, shift, rotate, and scale parameters. The order of transformation is: scale, rotate (both relative to the specified fixed point), and shift.

The error indicator is returned as 0 if PHIGS is in state PHOP. Otherwise, the error indicator is set to the following value:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.7.3

Errors:

none

5.5.5 Utility functions to support viewing

EVALUATE VIEW ORIENTATION MATRIX 3 **(PHOP,*,*,*)**

Parameters:

In	view reference point		WC	P3
In	view plane normal	DX,DY,DZ	WC	V3
In	view up vector	DX,DY,DZ	WC	V3
Out	error indicator			I
Out	view orientation matrix			4×4×R

Effect: If the view orientation parameters are consistent and well-defined, the error indicator is returned as 0 and a view orientation matrix to perform the specified orientation is returned. If the parameters are not well-defined or are inconsistent, an indication of the cause of the error is returned in the error indicator with one of the following values:

002 Ignoring function, function requires state (PHOP,,*,*)*
159 Ignoring function, the view plane normal vector has length zero
160 Ignoring function, the view up vector has length zero
161 Ignoring function, the view up and view plane normal vectors are parallel thus the viewing coordinate system cannot be established

References: 4.7.5

Errors:

none

EVALUATE VIEW ORIENTATION MATRIX **(PHOP,*,*,*)**

Parameters:

In	view reference point		WC	P2
In	view up vector	DX,DY	WC	V2
Out	error indicator			I
Out	view orientation matrix			3×3×R

Effect: If the view orientation parameters are consistent and well-defined, the error indicator is returned as 0 and a view orientation matrix to perform the specified orientation is returned. If the parameters are not well-defined or are inconsistent, an indication of the cause of the error is returned in the error indicator with one of the following values:

002 Ignoring function, function requires state (PHOP,,*,*)*
160 Ignoring function, the view up vector has length zero

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References: 4.7.5

Errors:

none

EVALUATE VIEW MAPPING MATRIX 3 **(PHOP,*,*,*)**

Parameters:

In	window limits	UMIN<UMAX,VMIN<VMAX	VRC	2×B
In	projection viewport limits	XMIN<XMAX,YMIN<YMAX,ZMIN≤ZMAX	NPC	3×B
In	projection type	(PARALLEL,PERSPECTIVE)		E
In	projection reference point		VRC	P3
In	view plane distance		VRC	R
In	back plane distance		VRC	R
In	front plane distance		VRC	R
Out	error indicator			I
Out	view mapping matrix			4×4×R

Effect: If the view mapping parameters are consistent and well-defined, the error indicator is returned as 0 and a view mapping matrix to perform the specified view mapping is returned. If the parameters are not well-defined or are inconsistent, an indication of the cause of the error is returned in the error indicator with one of the following values:

002 Ignoring function, function requires state (PHOP,,*,*)*

151 Ignoring function, invalid window; XMIN≥XMAX, YMIN≥YMAX, ZMIN>ZMAX, UMIN≥UMAX or VMIN≥VMAX

152 Ignoring function, invalid viewport; XMIN≥XMAX, YMIN≥YMAX or ZMIN>ZMAX

158 Ignoring function, front plane and back plane distances are equal when z-extent of the projection viewport is non-zero

162 Ignoring function, the projection reference point is between the front and back planes

163 Ignoring function, the projection reference point cannot be positioned on the view plane

164 Ignoring function, the back plane is in front of the front plane

155 Ignoring function, the projection viewport limits are not within NPC range

References: 4.7.5

Errors:

none

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EVALUATE VIEW MAPPING MATRIX **(PHOP,*,*,*)**

Parameters:

In	window limits	UMIN<UMAX,VMIN<VMAX	VRC	2×B
In	projection viewport limits	XMIN<XMAX,YMIN<YMAX	NPC	2×B
Out	error indicator			I
Out	view mapping matrix			3×3×R

Effect: If the view mapping parameters are consistent and well-defined, the error indicator is returned as 0 and a view mapping matrix to perform the specified view mapping is returned. If the parameters are not well-defined or are inconsistent, an indication of the cause of the error is returned in the error indicator with one of the following values:

002 Ignoring function, function requires state (PHOP,,*,*)*
151 Ignoring function, invalid window; XMIN≥XMAX, YMIN≥YMAX, ZMIN>ZMAX, UMIN≥UMAX or VMIN≥VMAX
152 Ignoring function, invalid viewport; XMIN≥XMAX, YMIN≥YMAX or ZMIN>ZMAX
155 Ignoring function, the projection viewport limits are not within NPC range

References: 4.7.5

Errors:

none

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5.6 Structure content functions

OPEN STRUCTURE **(PHOP,*,STCL,*)**

Parameters:

In structure identifier I

Effect: The specified structure is opened. If the specified structure does not exist, a new empty structure is created and opened. The 'element pointer' is positioned at the last element in the structure (or set to 0 for an empty structure) and the structure state becomes STOP.

References: 4.4.4

Errors:

006 Ignoring function, function requires state (PHOP,,STCL,*)*

CLOSE STRUCTURE **(PHOP,*,STOP,*)**

Parameters:

none

Effect: The open structure is closed and the structure state becomes STCL.

References: 4.4.4

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

EXECUTE STRUCTURE **(PHOP,*,STOP,*)**

Parameters:

In structure identifier I

Effect: Depending upon the 'edit mode', an "execute structure" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "execute structure" element. The value specified by the parameter is associated with the element. If the specified structure is non-existent, a new empty structure is created.

When an element of this type is interpreted the following actions occur:

a) traversal of the current structure is suspended;

b) the current state of the PHIGS traversal state list is saved;

c) the global modelling transformation is set to the current composite modelling transformation and the local modelling transformation is set to the identity matrix;

d) the structure network identified by the value associated with the element is completely traversed;

e) the saved PHIGS traversal state list values are restored;

f) traversal of the current structure is resumed.

References: 4.4.4

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Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*

LABEL **(PHOP,*,STOP,*)**

Parameters:

In label identifier I

Effect: Depending upon the 'edit mode', a "label" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "label" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted it is ignored.

References: 4.4.4

Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*

APPLICATION DATA **(PHOP,*,STOP,*)**

Parameters:

In application data D

Effect: Depending upon the 'edit mode', an "application data" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "application data" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted it is ignored.

References: 4.4.9

Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*

GENERALIZED STRUCTURE ELEMENT **(PHOP,*,STOP,*)**

Parameters:

In GSE identifier GS
In GSE data record D

Effect: Depending upon the 'edit mode', a "generalized structure element" element is inserted after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "generalized structure element" element. The values specified by the parameters are associated with the element.

When an element of this type is interpreted, an action of the type indicated by the element's GSE identifier is performed using the element's GSE data record. The action shall not create a primitive. It is appropriate for a GSE to be used for attribute and control functionality during traversal.

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NOTE - For some GSEs the parameters are transmitted to the workstation and interpreted in a workstation dependent way. In this way special capabilities of the workstation can be addressed. In other cases the GSE will have an effect on the CSS. No error occurs at structure traversal time if a particular workstation cannot realize the GSE.

The GSE data record may contain additional data. These have to be defined for a specific GSE. In defining a new GSE, the PHIGS design concepts (see clause 0) are not violated. The set of generalized structure elements implemented on a workstation may be empty.

Where the GSE identifier is bound to an integer in a programming language, GSE identifiers greater than 0 are reserved for registration and GSE identifiers less than 0 are implementation dependent.

GSE identifiers are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority (see 4.1.2). When a GSE has been approved by ISO, the GSE identifier will be assigned by the Registration Authority.

Generalized structure elements are placed into the open structure even if the specified generalized structure element is not supported by the implementation. When an element of this type is interpreted, if a generalized structure element is encountered that the workstation does not recognize, it will be ignored.

References: 4.4.1 4.4.8 4.13

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET EDIT MODE **(PHOP,*,*,*)**

Parameters:

In	edit mode	(INSERT,REPLACE)	E

Effect: The 'edit mode' in the PHIGS state list is set to the value specified. When 'edit mode' is INSERT new elements are inserted after the element pointed to by the 'element pointer'. When 'edit mode' is REPLACE new elements replace the element pointed to by the 'element pointer'. If the 'element pointer' is 0, then the new element is inserted immediately before element 1. The 'element pointer' pointer becomes 1 and points at the new element, and the remaining elements in the structure are implicitly renumbered.

References: 4.4.4

Errors:

002 Ignoring function, function requires state (PHOP,,*,*)*

COPY ALL ELEMENTS FROM STRUCTURE **(PHOP,*,STOP,*)**

Parameters:

In	structure identifier	I

Effect: The elements of the specified structure are copied into the open structure after the 'element pointer'. If the specified structure is the open structure, its contents are copied into itself after the 'element pointer'. The 'element pointer' is then updated to point to the last element that was copied. REPLACE 'edit mode' is ignored. If the specified structure is empty or non-existent, no action takes place.

References: 4.4.4

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Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET ELEMENT POINTER **(PHOP,*,STOP,*)**

Parameters:

In element position I

Effect: The 'element pointer' is set to element position. If element position is less than 0, the 'element pointer' is set to 0; if the element position is greater than the number of elements in the open structure, the 'element pointer' is set to point to the last element in the open structure.

References: 4.4.4

Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*

OFFSET ELEMENT POINTER **(PHOP,*,STOP,*)**

Parameters:

In element position offset I

Effect: The element position offset is added to the 'element pointer'. If the resultant value of 'element pointer' is less than 0, 'element pointer' is set to 0. If the resultant value of the 'element pointer' is greater than the number of elements in the open structure, the 'element pointer' is set to point to the last element in the open structure.

References: 4.4.4

Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET ELEMENT POINTER AT LABEL **(PHOP,*,STOP,*)**

Parameters:

In label identifier I

Effect: The 'element pointer' is set to point to the next occurrence of the specified label element within the open structure. If the 'element pointer' is already positioned at an occurrence of the specified label, the search for the next occurrence begins with the next structure element, otherwise it begins at the 'element pointer'. If no occurrence of the specified label exists between the 'element pointer' and the end of the open structure, an error is generated and the 'element pointer' is left unchanged.

References: 4.4.4

Errors:
005 Ignoring function, function requires state (PHOP,,STOP,*)*
205 Ignoring function, the label does not exist in the open structure between the element pointer and the end of the structure

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DELETE ELEMENT **(PHOP,*,STOP,*)**

Parameters:

none

Effect: The element pointed to by the 'element pointer' is deleted. The 'element pointer' is decremented by one, so that it points to the element which immediately preceded the deleted element. If the element position is zero (the 'element pointer' points before the first element), nothing is deleted and the 'element pointer' is not adjusted.

References: 4.4.4

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

DELETE ELEMENT RANGE **(PHOP,*,STOP,*)**

Parameters:

In	element position 1	I
In	element position 2	I

Effect: All structure elements **between and including** the lower element position and the higher element position are deleted. The 'element pointer' is updated to point to the element immediately preceding the deleted elements. If an element position is less than 1, a value of 0 is used; if an element position is greater than the number of elements in the open structure, a value pointing to the last element in the structure is used.

The effect is as though a SET ELEMENT POINTER followed by an INQUIRE ELEMENT POINTER were invoked for each element position parameter and then SET ELEMENT POINTER followed by DELETE ELEMENT were invoked for each element in the range resulting from the inquiries, in descending numeric order.

References: 4.4.4

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

DELETE ELEMENTS BETWEEN LABELS **(PHOP,*,STOP,*)**

Parameters:

In	label identifier 1	I
In	label identifier 2	I

Effect: All elements **between but not including** the occurrences of the two specified labels are deleted.

The labels between which the deletion will occur are found in the same way as they are in SET ELEMENT POINTER AT LABEL. A search for label identifier 1 is first performed starting at the element pointed to by the 'element pointer'. A search for label identifier 2 is then performed starting with the element following label identifier 1. If either of the specified labels do not exist between the 'element pointer' and the end of the open structure, an error is generated and the deletion operation is not performed.

The element pointer is set to point to the element which immediately preceded the group of elements deleted.

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References: 4.4.4

Errors:

005 *Ignoring function, function requires state (PHOP,*,STOP,*)*

206 *Ignoring function, one or both of the labels does not exist in the open structure between the element pointer and the end of the structure*

EMPTY STRUCTURE **(PHOP,*,*,*)**

Parameters:

In structure identifier I

Effect: All the elements of the specified structure are deleted. References to this now empty structure remain intact. If the specified structure is the open structure, the 'element pointer' is set to 0. If the specified structure does not exist, a new empty structure is created.

References: 4.4.4

Errors:

002 *Ignoring function, function requires state (PHOP,*,*,*)*

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5.7 Structure manipulation functions

DELETE STRUCTURE **(PHOP,*,*,*)**

Parameters:

In	structure identifier	I

Effect: The specified structure is deleted; its identifier, its contents and all references to it are removed from PHIGS. It is unposted from all workstations to which it is posted. In the event the specified structure is the open structure, the resulting functionality is equivalent to the following sequence:

```
CLOSE STRUCTURE
DELETE STRUCTURE (structure identifier)
OPEN STRUCTURE   (structure identifier)
```

If the specified structure does not exist, no action is taken.

References: 4.4.5

Errors:

002 Ignoring function, function requires state (PHOP,,*,*)*

DELETE STRUCTURE NETWORK **(PHOP,*,*,*)**

Parameters:

In	structure identifier		I
In	reference handling flag	(DELETE,KEEP)	E

Effect: The specified structure network is deleted.

If the reference handling flag is KEEP, those structures of the specified structure network that are referenced by other structures outside of the specified structure network are not deleted. Those structures that are not referenced outside the specified structure network are deleted as if DELETE STRUCTURE were called to delete each structure individually.

If the reference handling flag is DELETE, each structure of the specified network is deleted as if DELETE STRUCTURE were called to delete each structure individually.

The specified structure is always deleted. If the specified structure does not exist, no action is taken.

References: 4.4.5

Errors:

002 Ignoring function, function requires state (PHOP,,*,*)*

DELETE ALL STRUCTURES **(PHOP,*,*,*)**

Parameters:

none

Effect: The DELETE STRUCTURE function is executed for all existent structures in PHIGS.

References: 4.4.5

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Errors:
002 Ignoring function, function requires state (PHOP,,*,*)*

CHANGE STRUCTURE IDENTIFIER **(PHOP,*,*,*)**

Parameters:

In	original structure identifier	I
In	resulting structure identifier	I

Effect: This function changes the identifier of the structure identified by original structure identifier to resulting structure identifier, but does not change references to original structure. As a result of invoking this function, the structure associated with original structure identifier will no longer exist unless there are references to this structure, it is posted, or this structure is open. In those cases, the original structure will continue to exist but will be empty. The resulting structure always exists at the completion of this function. If the resulting structure previously existed then its contents are replaced by the contents of the original structure. If the original structure did not exist, then the resulting structure is empty.

If the original and the resulting structure identifier are the same, two cases can occur. If this common structure exists, then no action is performed; otherwise, if this structure does not exist, an empty structure is created.

If the original structure identifier was posted, it remains posted, but will be empty. The resulting structure is posted after this function if and only if it was posted prior to this function.

If the original structure is open, it is closed, this function is executed and then the structure identified by original structure identifier is reopened. The original structure will continue to exist but will be empty. It is open at the completion of the CHANGE STRUCTURE IDENTIFIER function. The 'element pointer' is set to 0.

If the resulting structure is open, it is closed, this function is executed, and then reopened. The 'element pointer' is set to point to the last element.

References: 4.4.5

Errors:
002 Ignoring function, function requires state (PHOP,,*,*)*

CHANGE STRUCTURE REFERENCES **(PHOP,*,*,*)**

Parameters:

In	original structure identifier	I
In	resulting structure identifier	I

Effect: This function replaces all "execute structure" elements which reference original structure identifier with elements which reference resulting structure identifier.

Any references to resulting structure identifier that existed before the call are not affected. If there were references to original structure identifier and resulting structure identifier does not exist, an empty structure named resulting structure identifier is created. If original structure identifier and resulting structure identifier are identical, then no action is taken.

On all workstations where the resulting structure is posted, the resulting structure remains posted with unchanged priority, and the original structure, if posted there, is unposted. On all workstations where the resulting structure is not posted and the original structure is posted, the resulting

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structure is posted with the priority of the original structure and the original structure is unposted.

If the original structure does not exist or if there are no references to the original structure identifier, no action is taken.

References: 4.4.5

Errors:

002 Ignoring function, function requires state (PHOP,,*,*)*

CHANGE STRUCTURE IDENTIFIER AND REFERENCES (PHOP,*,*,*)

Parameters:

In	original structure identifier	I
In	resulting structure identifier	I

Effect: The effect is as if CHANGE STRUCTURE REFERENCES were called and then CHANGE STRUCTURE IDENTIFIER were called, but with no intermediate effects since both actions are performed as one action.

If the original structure is open, it is closed, this function is executed and then the structure identified by original structure identifier is reopened. The original structure will continue to exist but will be empty. It is open at the completion of the CHANGE STRUCTURE IDENTIFIER function. The 'element pointer' is set to 0.

On all workstations where the resulting structure is posted, the resulting structure remains posted with unchanged priority, and the original structure, if posted there, is unposted. On all workstations where the resulting structure is not posted and the original structure is posted, the resulting structure is posted with the priority of the original structure and the original structure is unposted.

References: 4.4.5

Errors:

002 Ignoring function, function requires state (PHOP,,*,*)*

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5.8 Structure display functions

POST STRUCTURE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	structure identifier		I
In	display priority	[0,1]	R

Effect: The specified structure is added to the 'list of posted structures' in the workstation state list of the specified workstation. The workstation identifier is added to the 'list of workstations to which posted' in the structure state list. If the specified structure does not exist, a new empty structure is created.

References: 4.4.3

Errors:

003 *Ignoring function, function requires state (PHOP,WSOP,*,*)*
054 *Ignoring function, the specified workstation is not open*
059 *Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)*
208 *Ignoring function, the display priority is out of range*

UNPOST STRUCTURE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier	WI
In	structure identifier	I

Effect: The specified structure is unposted from the specified workstation by removing the structure from the 'list of posted structures' from the workstation state list of the specified workstation. The workstation identifier is deleted from the 'list of workstations to which posted' in the structure state list. If the specified structure does not exist, no action takes place. Note that unposting a structure does not delete the structure.

References: 4.4.3

Errors:

003 *Ignoring function, function requires state (PHOP,WSOP,*,*)*
054 *Ignoring function, the specified workstation is not open*
059 *Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)*

UNPOST ALL STRUCTURES **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier	WI

Effect: All structures are unposted from the specified workstation by removing all structures from the 'list of posted structures' from the workstation state list of the specified workstation. The workstation identifier is deleted from the 'list of workstations to which posted' in the structure state list. Note that unposting a structure does not delete the structure.

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References: 4.4.3

Errors:

003 *Ignoring function, function requires state (PHOP,WSOP,*,*)*

054 *Ignoring function, the specified workstation is not open*

059 *Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)*

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5.9 Structure archiving functions

OPEN ARCHIVE FILE **(PHOP,*,*,*)**

Parameters:

In	archive file identifier	AI
In	archive file name	F

Effect: The specified archive file is opened and the 'archive state' is set to AROP. The archive file identifier is added to the 'set of open archive files' in the PHIGS state list. The archive file identifier is used to reference the open archive file.

References: 4.4.7

Errors:

002 *Ignoring function, function requires state (PHOP,*,*,*)*
402 *Ignoring function, archive file identifier already in use*
400 *Ignoring function, the archive file cannot be opened*
401 *Ignoring function, opening this archive file would exceed the maximum number of simultaneously open archive files*
403 *Ignoring function, the archive file is not a PHIGS archive file*

CLOSE ARCHIVE FILE **(PHOP,*,*,AROP)**

Parameters:

In	archive file identifier	AI

Effect: The archive file associated with the specified archive file identifier is closed and the archive file identifier is removed from the 'set of open archive files' in the PHIGS state list. The 'archive state' is changed to ARCL if no archive files are open.

References: 4.4.7

Errors:

007 *Ignoring function, function requires state (PHOP,*,*,AROP)*
404 *Ignoring function, the specified archive file is not open*

ARCHIVE STRUCTURES **(PHOP,*,*,AROP)**

Parameters:

In	archive file identifier	AI
In	list of structure identifiers	L(I)

Effect: The specified structures are archived on the specified open archive file. If a specified structure currently exists in the archive file, the conflict will be resolved according to the value of the 'archival conflict resolution flag' in the PHIGS state list.

If the archive file becomes full during the archival process, as many structures as possible are archived.

If a specified structure does not exist in the CSS, a warning is generated and no action is taken for that structure.

References: 4.4.7

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Errors:
007 Ignoring function, function requires state (PHOP,,*,AROP)*
404 Ignoring function, the specified archive file is not open
200 Warning, ignoring structures that do not exist
405 Ignoring function, name conflict occured while conflict resolution flag has value ABANDON
406 Warning, the archive file is full. Any structures that were archived were archived in total

ARCHIVE STRUCTURE NETWORKS **(PHOP,*,*,AROP)**

Parameters:

In	archive file identifier	AI
In	list of structure identifiers	L(I)

Effect: The specified structure networks are archived in the specified open archive file. If a specified structure or any of its descendants currently exist in the specified open archive file, the conflict will be resolved according to the value of the 'archival conflict resolution flag' in the PHIGS state list.

If a specified structure does not exist in the CSS, a warning is generated and no action is taken for that structure network.

References: 4.4.7

Errors:
007 Ignoring function, function requires state (PHOP,,*,AROP)*
404 Ignoring function, the specified archive file is not open
200 Warning, ignoring structures that do not exist
405 Ignoring function, name conflict occured while conflict resolution flag has value ABANDON
406 Warning, the archive file is full. Any structures that were archived were archived in total

ARCHIVE ALL STRUCTURES **(PHOP,*,*,AROP)**

Parameters:

In	archive file identifier	AI

Effect: All structures are archived in the specified open archive file. If a structure known to PHIGS currently exists in the specified open archive file, the conflict is resolved according to the value of the 'archival conflict resolution flag' in the PHIGS state list.

References: 4.4.7

Errors:
007 Ignoring function, function requires state (PHOP,,*,AROP)*
404 Ignoring function, the specified archive file is not open
405 Ignoring function, name conflict occured while conflict resolution flag has value ABANDON
406 Warning, the archive file is full. Any structures that were archived were archived in total

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SET CONFLICT RESOLUTION **(PHOP,*,*,*)**

Parameters:

In	archival conflict resolution	(MAINTAIN,ABANDON,UPDATE)	E
In	retrieval conflict resolution	(MAINTAIN,ABANDON,UPDATE)	E

Effect: The respective 'conflict resolution flags' in the PHIGS state list are set to respective conflict resolution values. They apply when conflicts occur when using the archival and retrieval facilities.

References: 4.4.7

Errors:

002 Ignoring function, function requires state (PHOP,,*,*)*

RETRIEVE STRUCTURE IDENTIFIERS **(PHOP,*,*,AROP)**

Parameters:

In	archive file identifier	AI
Out	list of structure identifiers	L(I)

Effect: A list of archived structures in the specified open archive file is returned.

References: 4.4.7

Errors:

007 Ignoring function, function requires state (PHOP,,*,AROP)*
404 Ignoring function, the specified archive file is not open

RETRIEVE STRUCTURES **(PHOP,*,*,AROP)**

Parameters:

In	archive file identifier	AI
In	list of structure identifiers	L(I)

Effect: The specified archived structures are retrieved from the specified open archive file.

If a specified structure currently exists in the CSS, the conflict will be resolved according to the value of the 'retrieval conflict resolution flag' in the PHIGS state list. Then, if the structure is to be retrieved or updated the following action is taken.

If a specified structure does not exist in the archive file, an empty structure is created in the CSS and a warning is generated.

If a specified structure is the open structure, it is closed, retrieved or updated, and then re-opened.

References: 4.4.7

Errors:

007 Ignoring function, function requires state (PHOP,,*,AROP)*
404 Ignoring function, the specified archive file is not open
405 Ignoring function, name conflict occured while conflict resolution flag has value ABANDON
408 Warning, some of the specified structures do not exist on the archive file. PHIGS will create empty structure in their place

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RETRIEVE STRUCTURE NETWORKS **(PHOP,*,*,AROP)**

Parameters:

In	archive file identifier	AI
In	list of structure identifiers	L(I)

Effect: The specified archived structure networks are retrieved from the specified open archive file.

If the specified structure or any of its descendants currently exists in the CSS, the conflict will be resolved according to the value of the 'retrieval conflict resolution flag' in the PHIGS state list. Then, if the specified structure or any of its descendants are to be retrieved or updated the following action is taken.

If the specified structure does not exist in the archive file, an empty structure is created in the CSS and a warning is generated.

If the specified structure or any of its descendants is the open structure, it is closed, retrieved or updated, and then re-opened.

References: 4.4.7

Errors:

007 *Ignoring function, function requires state (PHOP,*,*,AROP)*
404 *Ignoring function, the specified archive file is not open*
405 *Ignoring function, name conflict occured while conflict resolution flag has value ABANDON*
408 *Warning, some of the specified structures do not exist on the archive file. PHIGS will create empty structure in their place*

RETRIEVE ALL STRUCTURES **(PHOP,*,*,AROP)**

Parameters:

In	archive file identifier	AI

Effect: All structures in the specified open archive file are retrieved.

If a structure in the archive currently exists in the CSS, the conflict will be resolved according to the value of the 'retrieval conflict resolution flag' in the PHIGS state list.

If one of the structures to be retrieved or updated is the open structure, it is closed, retrieved or updated, and then re-opened.

References: 4.4.7

Errors:

007 *Ignoring function, function requires state (PHOP,*,*,AROP)*
404 *Ignoring function, the specified archive file is not open*
405 *Ignoring function, name conflict occured while conflict resolution flag has value ABANDON*

RETRIEVE PATHS TO ANCESTORS **(PHOP,*,*,AROP)**

Parameters:

In	archive file identifier		AI
In	structure identifier		I
In	path order	(TOPFIRST,BOTTOMFIRST)	E
In	path depth	(0..n)	I
Out	paths		L(L(ER))

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Errors:
007 Ignoring function, function requires state (PHOP,,*,AROP)*
201 Ignoring function, the specified structure does not exist
207 Ignoring function, the specified path depth is less than zero (0)

DELETE STRUCTURES FROM ARCHIVE **(PHOP,*,*,AROP)**

Parameters:

In	archive file identifier	AI
In	list of structure identifiers	L(I)

Effect: The specified archived structures are deleted from the specified open archive file. No attempt is made to ensure that the deleted structures are not referenced from other structures in the archive file.

If a specified structure does not exist in the archive file, no action is taken for that structure.

References: 4.4.7

Errors:
007 Ignoring function, function requires state (PHOP,,*,AROP)*
404 Ignoring function, the specified archive file is not open
407 Warning, some of the specified structures do not exist on the archive file

DELETE STRUCTURE NETWORKS FROM ARCHIVE **(PHOP,*,*,AROP)**

Parameters:

In	archive file identifier	AI
In	list of structure identifiers	L(I)

Effect: The specified archived structure networks are deleted from the specified open archive file. No attempt is made to ensure that the deleted structures are not referenced from other structures in the archive file.

If a specified structure does not exist in the archive file, no action is taken for that structure network.

References: 4.4.7

Errors:
007 Ignoring function, function requires state (PHOP,,*,AROP)*
404 Ignoring function, the specified archive file is not open
407 Warning, some of the specified structures do not exist on the archive file

DELETE ALL STRUCTURES FROM ARCHIVE **(PHOP,*,*,AROP)**

Parameters:

In	archive file identifier	AI

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Effect: All structures in the specified open archive file are deleted. After the completion of this operation, the archive file will be in the same state as if it had just been opened.

References: 4.4.7

Errors:

007 *Ignoring function, function requires state (PHOP,*,*,AROP)*

404 *Ignoring function, the specified archive file is not open*

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5.10 Input functions

5.10.1 Pick identifier and filter

SET PICK IDENTIFIER **(PHOP,*,STOP,*)**

Parameters:

In	pick identifier	PI

Effect: Depending upon the 'edit mode', a "set pick identifier" element is inserted into the open structure after the 'element pointer' or replaces the element pointed at by the 'element pointer'. The 'element pointer' is then updated to point to this "set pick identifier" element. The value specified by the parameter is associated with the element.

When an element of this type is interpreted the "current pick identifier" entry in the PHIGS traversal state list is set to the value associated with the element. The "current pick identifier" in the PHIGS traversal state list is associated with subsequent primitives.

References: 4.8.4

Errors:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

SET PICK FILTER **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	pick device number	(1..n)	I
In	pick filter		FR

Effect: The 'pick filter' entry in the workstation state list of the specified PICK device of the specified workstation is set to the value specified by the parameter.

The new pick filter takes effect when the next PICK measure process comes into existence for the given pick device.

During picking, a conceptual traversal, the workstation processes the filter against the 'current name set' in the PHIGS traversal state list to determine whether subsequent primitives are pickable. Primitives will be pickable on a device when both the inclusion set of the 'pick filter', in the workstation state list, intersected with the 'current name set' is non-empty and the exclusion set of the 'pick filter', in the workstation state list, intersected with the 'current name set' is empty.

References: 4.5.15 4.8.4

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
060 Ignoring function, specified workstation is not of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

5.10.2 Initialization of input devices

The parameters which may be initialized are an initial measure value, prompt and echo type, echo area/volume, and a data record. These parameters play a similar role for all input classes. The final parameter of each INITIALIZE function is a data record which contains device specific information to control the logical input device. The form of the data record differs for each input class and can differ for different devices in the same class. Some devices have mandatory control values in the data record. These

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values are at the beginning of the data record. In addition to the mandatory data record contents, other data record contents are defined but need not be adhered to in realizing the prompt and echo type. For the defined, but non-required data record contents errors specific to the data records contents are not listed but may be reported.

INITIALIZE LOCATOR 3 **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier			WI
In	locator device number		(1..n)	I
In	initial view index		(0..n)	I
In	initial locator position		WC	P3
In	prompt and echo type			I
In	echo volume	XMIN<XMAX,YMIN<YMAX,ZMIN≤ZMAX	DC	3×B
In	locator data record			D

Effect: The initial locator position, initial view index, prompt and echo type, echo volume and locator data record are stored in the workstation state list entry for the specified LOCATOR device.

For some LOCATOR prompt and echo types, two positions are required. One of the positions, which remains fixed during the input operation, is the initial locator position. The other position is the current locator position that varies dynamically as the operator uses the LOCATOR.

Prompt and echo type:

≤0 prompting and echoing is LOCATOR device dependent.

1 designate the current position of the LOCATOR using an implementation-defined technique.

2 crosshair, namely designate the current position of the LOCATOR using a vertical line and a horizontal line spanning over the display surface or the workstation viewport intersecting at the current locator position.

3 designate the current position of the LOCATOR using a tracking cross.

4 designate the current position of the LOCATOR using a rubber band line connecting the initial LOCATOR position given by this function and the current locator position.

5 designate the current position of the LOCATOR using a rectangle. The diagonal of the rectangle is the line connecting the initial LOCATOR position given by this function and the current locator position.

6 display a digital representation of the current LOCATOR position in LOCATOR device dependent coordinates within the echo volume.

≥7 reserved for registration.

NOTE - LOCATOR prompt and echo type values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a LOCATOR prompt and echo type has been approved by ISO, the LOCATOR prompt and echo type value will be assigned by the Registration Authority.

References: 4.7.7 4.8.2 4.8.6

Data Record:

Prompt and echo type = 4

1	unused		
2	linetype ASF	(BUNDLED, INDIVIDUAL)	E

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3	linewidth scale factor ASF	(BUNDLED, INDIVIDUAL)	E
4	polyline colour index ASF	(BUNDLED, INDIVIDUAL)	E
5	polyline index	(1..n)	I
6	linetype		I
7	linewidth scale factor		R
8	polyline colour index	(0..n)	I

Prompt and echo type = 5

1	polyline/fill area control flag	(POLYLINE, FILL_AREA, FILL_AREA_SET)	E
2	unused		

if polyline/fill area control flag = POLYLINE

3	linetype ASF	(BUNDLED, INDIVIDUAL)	E
4	linewidth scale factor ASF	(BUNDLED, INDIVIDUAL)	E
5	polyline colour index ASF	(BUNDLED, INDIVIDUAL)	E
6	polyline index	(1..n)	I
7	linetype		I
8	linewidth scale factor		R
9	polyline colour index	(0..n)	I

if polyline/fill area control flag = FILL_AREA or FILL_AREA_SET

3	interior style ASF	(BUNDLED, INDIVIDUAL)	E
4	interior style index ASF	(BUNDLED, INDIVIDUAL)	E
5	interior colour index ASF	(BUNDLED, INDIVIDUAL)	E
6	interior index	(1..n)	I
7	interior style	(HOLLOW, SOLID, PATTERN, HATCH, EMPTY)	E
8	interior style index		I
9	interior colour index	(0..n)	I

if polyline/fill area control flag = FILL_AREA_SET

10	edge flag ASF	(BUNDLED, INDIVIDUAL)	E
11	edge type ASF	(BUNDLED, INDIVIDUAL)	E
12	edgewidth scale factor ASF	(BUNDLED, INDIVIDUAL)	E
13	edge colour index ASF	(BUNDLED, INDIVIDUAL)	E
14	edge index	(1..n)	I
15	edge flag	(OFF, ON)	E
16	edgetype		I
17	edgewidth scale factor		R
18	edge colour index	(0..n)	I

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Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation
251 Ignoring function, the function requires the input device to be in REQUEST mode
254 Ignoring function, invalid echo area/volume; XMIN≥XMAX, YMIN≥YMAX or ZMIN>ZMAX
255 Ignoring function, one of the echo area/volume boundary points is outside the range of the device
253 Ignoring function, the specified prompt/echo type is not available on the specified workstation
260 Ignoring function, one of the fields within the input device data record is in error
261 Ignoring function, initial value is invalid
114 Ignoring function, the view index value is less than zero

INITIALIZE LOCATOR **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	locator device number	(1..n)	I
In	initial view index	(0..n)	I
In	initial locator position	WC	P2
In	prompt and echo type		I
In	echo area	XMIN<XMAX,YMIN<YMAX. DC	2×B
In	locator data record		D

Effect: The initial locator position, initial view index, prompt and echo type, echo area and locator data record are stored in the workstation state list entry for the specified LOCATOR device. The z-coordinates of the echo volume and initial locator position remain unchanged.

For some LOCATOR prompt and echo types, two positions are required. One of the positions, which remains fixed during the input operation, is the initial locator position. The other position is the current locator position that varies dynamically as the operator uses the LOCATOR.

Prompt and echo type:

≤0 prompting and echoing is LOCATOR device dependent.

1 designate the current position of the LOCATOR using an implementation-defined technique.

2 crosshair, namely designate the current position of the LOCATOR using a vertical line and a horizontal line spanning over the display surface or the workstation viewport intersecting at the current locator position.

3 designate the current position of the LOCATOR using a tracking cross.

4 designate the current position of the LOCATOR using a rubber band line connecting the initial LOCATOR position given by this function and the current locator position.

5 designate the current position of the LOCATOR using a rectangle. The diagonal of the rectangle is the line connecting the initial LOCATOR position given by this function and the current locator position.

6 display a digital representation of the current LOCATOR position in LOCATOR device dependent coordinates within the echo area.

≥7 reserved for registration.

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NOTE - LOCATOR prompt and echo type values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a LOCATOR prompt and echo type has been approved by ISO, the LOCATOR prompt and echo type value will be assigned by the Registration Authority.

References: 4.7.7 4.8.2 4.8.6

Data Record:

Prompt and echo type = 4

1	unused		
2	linetype ASF	(BUNDLED, INDIVIDUAL)	E
3	linewidth scale factor ASF	(BUNDLED, INDIVIDUAL)	E
4	polyline colour index ASF	(BUNDLED, INDIVIDUAL)	E
5	polyline index	(1..n)	I
6	linetype		I
7	linewidth scale factor		R
8	polyline colour index	(0..n)	I

Prompt and echo type = 5

1	polyline/fill area control flag	(POLYLINE, FILL_AREA, FILL_AREA_SET)	E
2	unused		

if polyline/fill area control flag = POLYLINE

3	linetype ASF	(BUNDLED, INDIVIDUAL)	E
4	linewidth scale factor ASF	(BUNDLED, INDIVIDUAL)	E
5	polyline colour index ASF	(BUNDLED, INDIVIDUAL)	E
6	polyline index	(1..n)	I
7	linetype		I
8	linewidth scale factor		R
9	polyline colour index	(0..n)	I

if polyline/fill area control flag = FILL_AREA or FILL_AREA_SET

3	interior style ASF	(BUNDLED, INDIVIDUAL)	E
4	interior style index ASF	(BUNDLED, INDIVIDUAL)	E
5	interior colour index ASF	(BUNDLED, INDIVIDUAL)	E
6	interior index	(1..n)	I
7	interior style	(HOLLOW, SOLID, PATTERN, HATCH, EMPTY)	E
8	interior style index		I
9	interior colour index	(0..n)	I

if polyline/fill area control flag = FILL_AREA_SET

10	edge flag ASF	(BUNDLED, INDIVIDUAL)	E
11	edge type ASF	(BUNDLED, INDIVIDUAL)	E
12	edgewidth scale factor ASF	(BUNDLED, INDIVIDUAL)	E
13	edge colour index ASF	(BUNDLED, INDIVIDUAL)	E
14	edge index	(1..n)	I
15	edge flag	(OFF, ON)	E
16	edgetype		I
17	edgewidth scale factor		R
18	edge colour index	(0..n)	I

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Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation
251 Ignoring function, the function requires the input device to be in REQUEST mode
254 Ignoring function, invalid echo area/volume; XMIN≥XMAX, YMIN≥YMAX or ZMIN>ZMAX
255 Ignoring function, one of the echo area/volume boundary points is outside the range of the device
253 Ignoring function, the specified prompt/echo type is not available on the specified workstation
260 Ignoring function, one of the fields within the input device data record is in error
261 Ignoring function, initial value is invalid
114 Ignoring function, the view index value is less than zero

INITIALIZE STROKE 3 (PHOP,WSOP,*,*)

Parameters:

In	workstation identifier			WI
In	stroke device number		(1..n)	I
In	initial view index		(0..n)	I
In	coordinates of initial stroke		WC	L(P3)
In	prompt and echo type			I
In	echo volume	XMIN<XMAX,YMIN<YMAX,ZMIN≤ZMAX	DC	3×B
In	stroke data record			D

Effect: The initial stroke, initial view index, prompt and echo type, echo volume and stroke data record are stored in the workstation state list entry for the specified STROKE device.

For all prompt and echo types, the first entry in the stroke data record is the input buffer size which is an integer in the range (1..n). This is compared against an implementation defined 'available input buffer size' (contained in the workstation description table). If the requested buffer size is greater, the 'available input buffer size' for stroke devices is substituted in the stored data record. If the initial stroke is longer than the buffer size, an error is issued.

When a STROKE measure process comes into existence, it obtains a buffer of the size defined by 'input buffer size'. The initial stroke is copied into the buffer, and the editing position is placed at the initial editing position within it. Replacement of points begins at this initial position.

Prompt and echo types:

≤0 prompting and echoing is STROKE device dependent.

1 display the current STROKE using an implementation defined technique.

2 display a digital representation of the current STROKE position in stroke device-dependent coordinates within the echo volume.

3 display a marker at each point of the current STROKE.

4 display a line joining successive points of the current STROKE.

≥5 reserved for registration.

NOTE - For all prompt and echo types, the stroke data record may contain an initial editing position, which may range from 1 to length of initial stroke plus 1.

If the operator enters more points than the 'input buffer size' (in the workstation state list for this device), the additional points are lost. The operator should be informed of this situation.

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An implementation may use the stroke data record entries for X, Y, Z intervals or time interval to define the points delivered by the stroke.

STROKE prompt and echo type values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a STROKE prompt and echo type has been approved by ISO, the STROKE prompt and echo type value will be assigned by the Registration Authority.

References: 4.7.8 4.8.2 4.8.6

Data Record:

1	input buffer size (number of points)	(1..n)	I
2	initial editing position	(1..n)	I
3	x,y,z interval between points	WC > 0	3×R
4	time interval between points (seconds)		R

Prompt and echo type = 3

5	unused		
6	marker type ASF	(BUNDLED, INDIVIDUAL)	E
7	marker size scale factor ASF	(BUNDLED, INDIVIDUAL)	E
8	polymarker colour index ASF	(BUNDLED, INDIVIDUAL)	E
9	polymarker index	(1..n)	I
10	marker type		I
11	marker size scale factor		R
12	polymarker colour index	(0..n)	I

Prompt and echo type = 4

5	unused		
6	linetype ASF	(BUNDLED, INDIVIDUAL)	E
7	linewidth scale factor ASF	(BUNDLED, INDIVIDUAL)	E
8	polyline colour index ASF	(BUNDLED, INDIVIDUAL)	E
9	polyline index	(1..n)	I
10	linetype		I
11	linewidth scale factor		R
12	polyline colour index	(0..n)	I

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation
251 Ignoring function, the function requires the input device to be in REQUEST mode
254 Ignoring function, invalid echo area/volume; XMIN≥XMAX, YMIN≥YMAX or ZMIN>ZMAX
255 Ignoring function, one of the echo area/volume boundary points is outside the range of the device
253 Ignoring function, the specified prompt/echo type is not available on the specified workstation
260 Ignoring function, one of the fields within the input device data record is in error
261 Ignoring function, initial value is invalid
262 Ignoring function, number of points in the initial stroke is greater than the buffer size
114 Ignoring function, the view index value is less than zero

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INITIALIZE STROKE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier			WI
In	stroke device number		(1..n)	I
In	initial view index		(0..n)	I
In	coordinates of initial stroke		WC	L(P2)
In	prompt and echo type			I
In	echo area	XMIN<XMAX,YMIN<YMAX	DC	2×B
In	stroke data record			D

Effect: The initial stroke, initial view index, prompt and echo type, echo area and stroke data record are stored in the workstation state list entry for the specified STROKE device. The z-coordinates of the echo volume remain unchanged.

For all prompt and echo types, the first entry in the stroke data record is the input buffer size which is an integer in the range (1..n). This is compared against an implementation defined 'available input buffer size' (contained in the workstation description table). If the requested buffer size is greater, the 'available input buffer size' for stroke devices is substituted in the stored data record. If the initial stroke is longer than the buffer size, an error is issued.

When a STROKE measure process comes into existence, it obtains a buffer of the size defined by 'input buffer size'. The initial stroke is copied into the buffer, and the editing position is placed at the initial editing position within it. Replacement of points begins at this initial position.

Prompt and echo types:

≤0 prompting and echoing is STROKE device dependent.

1 display the current STROKE using an implementation defined technique.

2 display a digital representation of the current STROKE position in stroke device-dependent coordinates within the echo area.

3 display a marker at each point of the current STROKE.

4 display a line joining successive points of the current STROKE.

≥5 reserved for registration.

NOTE - For all prompt and echo types, the stroke data record may contain an initial editing position, which may range from 1 to length of initial stroke plus 1.

If the operator enters more points than the 'input buffer size' (in the workstation state list for this device), the additional points are lost. The operator should be informed of this situation.

An implementation may use the stroke data record entries for X, Y intervals or time interval to define the points delivered by the stroke.

STROKE prompt and echo type values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a STROKE prompt and echo type has been approved by ISO, the STROKE prompt and echo type value will be assigned by the Registration Authority.

References: 4.7.8 4.8.2 4.8.6

Data Record:

1	input buffer size (number of points)	(1..n)	I
2	initial editing position	(1..n)	I
3	x,y interval between points	WC > 0	2×R
4	time interval between points (seconds)		R

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Prompt and echo type = 3

5	unused		
6	marker type ASF	(BUNDLED, INDIVIDUAL)	E
7	marker size scale factor ASF	(BUNDLED, INDIVIDUAL)	E
8	polymarker colour index ASF	(BUNDLED, INDIVIDUAL)	E
9	polymarker index	(1..n)	I
10	marker type		I
11	marker size scale factor		R
12	polymarker colour index	(0..n)	I

Prompt and echo type = 4

5	unused		
6	linetype ASF	(BUNDLED, INDIVIDUAL)	E
7	linewidth scale factor ASF	(BUNDLED, INDIVIDUAL)	E
8	polyline colour index ASF	(BUNDLED, INDIVIDUAL)	E
9	polyline index	(1..n)	I
10	linetype		I
11	linewidth scale factor		R
12	polyline colour index	(0..n)	I

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation
251 Ignoring function, the function requires the input device to be in REQUEST mode
254 Ignoring function, invalid echo area/volume; XMIN≥XMAX, YMIN≥YMAX or ZMIN>ZMAX
255 Ignoring function, one of the echo area/volume boundary points is outside the range of the device
253 Ignoring function, the specified prompt/echo type is not available on the specified workstation
260 Ignoring function, one of the fields within the input device data record is in error
261 Ignoring function, initial value is invalid
262 Ignoring function, number of points in the initial stroke is greater than the buffer size
114 Ignoring function, the view index value is less than zero

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INITIALIZE VALUATOR 3 (PHOP,WSOP,*,*)

Parameters:

In	workstation identifier			WI
In	valuator device number		(1..n)	I
In	initial value			R
In	prompt and echo type			I
In	echo volume	XMIN<XMAX,YMIN<YMAX,ZMIN≤ZMAX	DC	3×B
In	valuator data record			D

Effect: The initial value, prompt and echo type, echo volume, and valuator data record are stored in the workstation state list entry for the specified VALUATOR device.

For all VALUATOR prompt and echo types, the valuator data record includes a low value and a high value in that order, specifying the range. The values from the device's measure will be transformed to the specified range. The only constraint is that the resulting values are

monotonically increasing with the smallest measure value transformed to the low value and the largest measure value transformed to high value.

Prompt and echo types:

≤0 prompting and echoing is VALUATOR device dependent.

1 designate the current VALUATOR value using an implementation defined technique.

2 display a graphical representation of the current VALUATOR value within the echo volume (for example, a dial or a pointer).

3 display a digital representation of the current VALUATOR value within the echo volume.

≥4 reserved for registration.

NOTE - VALUATOR prompt and echo type values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a VALUATOR prompt and echo type has been approved by ISO, the VALUATOR prompt and echo type value will be assigned by the Registration Authority.

References: 4.8.2 4.8.6

Data Record:

1	low value of valuator range	R
2	high value of valuator range	R

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation
251 Ignoring function, the function requires the input device to be in REQUEST mode
254 Ignoring function, invalid echo area/volume; XMIN≥XMAX, YMIN≥YMAX or ZMIN>ZMAX
255 Ignoring function, one of the echo area/volume boundary points is outside the range of the device
253 Ignoring function, the specified prompt/echo type is not available on the specified workstation
260 Ignoring function, one of the fields within the input device data record is in error
253 Ignoring function, the specified prompt/echo type is not available on the specified workstation
261 Ignoring function, initial value is invalid

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INITIALIZE VALUATOR **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	valuator device number	(1..n)	I
In	initial value		R
In	prompt and echo type		I
In	echo area	XMIN<XMAX,YMIN<YMAX DC	2×B
In	valuator data record		D

Effect: The initial value, prompt and echo type, echo area, and valuator data record are stored in the workstation state list entry for the specified VALUATOR device. The z-coordinates of the echo volume remain unchanged.

For all VALUATOR prompt and echo types, the valuator data record includes a low value and a high value in that order, specifying the range. The values from the device's measure will be

transformed to the specified range. The only constraint is that the resulting values are monotonically increasing with the smallest measure value transformed to the low value and the largest measure value transformed to high value.

Prompt and echo types:

≤0prompting and echoing is VALUATOR device dependent.

1 designate the current VALUATOR value using an implementation defined technique.

2 display a graphical representation of the current VALUATOR value within the echo area (for example, a dial or a pointer).

3 display a digital representation of the current VALUATOR value within the echo area.

≥4reserved for registration.

NOTE - VALUATOR prompt and echo type values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a VALUATOR prompt and echo type has been approved by ISO, the VALUATOR prompt and echo type value will be assigned by the Registration Authority.

References: 4.8.2 4.8.6

Data Record:

1	low value of valuator range	R
2	high value of valuator range	R

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation
251 Ignoring function, the function requires the input device to be in REQUEST mode
254 Ignoring function, invalid echo area/volume; XMIN≥XMAX, YMIN≥YMAX or ZMIN>ZMAX
255 Ignoring function, one of the echo area/volume boundary points is outside the range of the device
253 Ignoring function, the specified prompt/echo type is not available on the specified workstation
260 Ignoring function, one of the fields within the input device data record is in error
261 Ignoring function, initial value is invalid

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INITIALIZE CHOICE 3 (PHOP,WSOP,*,*)

Parameters:

In	workstation identifier		WI
In	choice device number	(1..n)	I
In	initial status	(OK,NOCHOICE)	E
In	initial choice number	(1..n)	I
In	prompt and echo type		I
In	echo volume	XMIN<XMAX,YMIN<YMAX,ZMIN≤ZMAX DC	3×B
In	choice data record		D

Effect: The initial status, initial choice number, prompt and echo type, echo volume, and data record are stored in the workstation state list entry for the specified CHOICE device.

Prompt and echo types:

≤0prompting and echoing is CHOICE device dependent.

1 designate the current CHOICE number using an implementation defined technique

2 the physical input devices that are most commonly used to implement a CHOICE logical input device normally have a built-in prompting capability. This prompt and echo type allows the application program to invoke this prompting capability. If the value of the i-th element of 'prompt array' in the choice data record is OFF, prompting of the i-th alternative of the specified choice input device is turned off. An ON value indicates that prompting for that alternative is turned on. The first entry in the choice data record is the list of choice prompts.

3 allow the operator to indicate a CHOICE number by selecting, using an appropriate technique, one of a set of CHOICE strings. The CHOICE strings are contained in the choice data record and are displayed within the echo volume. The logical input value is the number of the string selected. The first entry in the choice data record is the list of choice strings.

4 allow the operator to indicate a CHOICE number by selecting via an alphanumeric keyboard, one of a set of CHOICE strings. The CHOICE strings are contained in the data record and may be displayed in the echo volume as a prompt. The string typed in by the operator is echoed in the echo volume. The logical input value is the number of the string that has been typed in by the operator.

5 The structure named by the choice data record is interpreted during execution of INITIALIZE CHOICE for later use as a prompt of the specified CHOICE device. It will be displayed within the echo volume as if the workstation transformation were mapping the unit NPC space to the echo volume and the specified structure were posted to the workstation. The pick identifiers in the structure are mapped to CHOICE numbers in a CHOICE device dependent fashion. Picking these primitives selects the corresponding CHOICE value. After the interpretation, no logical connection between the specified CHOICE device and the specified structure exists. The first entry in the choice data record is the structure identifier.

≥6reserved for registration.

NOTE - CHOICE prompt and echo type values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a CHOICE prompt and echo type has been approved by ISO, the CHOICE prompt and echo type value will be assigned by the Registration Authority.

References: 4.8.2 4.8.6

Data Record:

Prompt and echo type = 2

1	list of prompts	(OFF, ON)	L(E)

Prompt and echo type = 3

1	list of strings	L(S)

Prompt and echo type = 4

1	array of strings	L(S)

Prompt and echo type = 5

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1	structure identifier	I
2	list of pick identifiers	L(PI)

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation
251 Ignoring function, the function requires the input device to be in REQUEST mode
254 Ignoring function, invalid echo area/volume; XMIN≥XMAX, YMIN≥YMAX or ZMIN≥ZMAX
255 Ignoring function, one of the echo area/volume boundary points is outside the range of the device
253 Ignoring function, the specified prompt/echo type is not available on the specified workstation
260 Ignoring function, one of the fields within the input device data record is in error
261 Ignoring function, initial value is invalid

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INITIALIZE CHOICE (PHOP,WSOP,*,*)

Parameters:

In	workstation identifier		WI
In	choice device number	(1..n)	I
In	initial status	(OK,NOCHOICE)	E
In	initial choice number	(1..n)	I
In	prompt and echo type		I
In	echo area	XMIN<XMAX,YMIN<YMAX DC	2×B
In	choice data record		D

Effect: The initial status, initial choice number, prompt and echo type, echo area, and data record are stored in the workstation state list entry for the specified CHOICE device. The z-coordinates of the echo volume remain unchanged.

Prompt and echo types:

≤0 prompting and echoing is CHOICE device dependent.

1 designate the current CHOICE number using an implementation defined technique

2 the physical input devices that are most commonly used to implement a CHOICE logical input device normally have a built-in prompting capability. This prompt and echo type allows the application program to invoke this prompting capability. If the value of the i-th element of 'prompt array' in the choice data record is OFF, prompting of the i-th alternative of the specified choice input device is turned off. An ON value indicates that prompting for that alternative is turned on. The first entry in the choice data record is the list of choice prompts.

3 allow the operator to indicate a CHOICE number by selecting, using an appropriate technique, one of a set of CHOICE strings. The CHOICE strings are contained in the choice data record and are displayed within the echo area. The logical input value is the number of the string selected. The first entry in the choice data record is the list of choice strings.

4 allow the operator to indicate a CHOICE number by selecting via an alphanumeric keyboard, one of a set of CHOICE strings. The CHOICE strings are contained in the data record and may be displayed in the echo area as a prompt. The string typed in by the operator is echoed in the echo area. The logical input value is the number of the string that has been typed in by the operator.

5 The structure named by the choice data record is interpreted during execution of INITIALIZE CHOICE for later use as a prompt of the specified CHOICE device. It will be displayed within the echo area as if the workstation transformation were mapping the unit NPC space to the echo area and the specified structure were posted to the workstation. The pick identifiers in the structure are mapped to CHOICE numbers in a CHOICE device dependent fashion. Picking these primitives selects the corresponding CHOICE value. After the interpretation, no logical connection between the specified CHOICE device and the specified structure exists. The first entry in the choice data record is the structure identifier.

≥6reserved for registration.

NOTE - CHOICE prompt and echo type values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a CHOICE prompt and echo type has been approved by ISO, the CHOICE prompt and echo type value will be assigned by the Registration Authority.

References: 4.8.2 4.8.6

Data Record:

Prompt and echo type = 2			
1	list of prompts	(OFF, ON)	L(E)
Prompt and echo type = 3			
1	list of strings		L(S)
Prompt and echo type = 4			
1	array of strings		L(S)
Prompt and echo type = 5			
1	structure identifier		I
2	list of pick identifiers		L(PI)

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation
251 Ignoring function, the function requires the input device to be in REQUEST mode
254 Ignoring function, invalid echo area/volume; XMIN≥XMAX, YMIN≥YMAX or ZMIN>ZMAX
255 Ignoring function, one of the echo area/volume boundary points is outside the range of the device
253 Ignoring function, the specified prompt/echo type is not available on the specified workstation
260 Ignoring function, one of the fields within the input device data record is in error
261 Ignoring function, initial value is invalid

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INITIALIZE PICK 3 **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	pick device number	(1..n)	I
In	initial status	(OK,NOPICK)	E
In	initial pick path		L(PP)
In	prompt and echo type		I
In	echo volume	XMIN<XMAX,YMIN<YMAX,ZMIN≤ZMAX DC	3×B
In	pick data record		D
In	pick path order	(TOPFIRST, BOTTOMFIRST)	E

Effect: The prompt and echo type, echo volume, initial status, initial pick path, pick data record and the pick path order are stored in the workstation state list entry for the specified PICK device.

Prompt and echo types:

≤0 prompting and echoing is PICK device dependent.

1 use an implementation-defined technique that at least highlights the "picked" primitive for a short period of time.

2 echo the contiguous group of primitives with the same pick identifier as the "picked" primitive, or all primitives of the structure with the same pick identifier as the "picked" primitive.

3 echo the whole posted structure network containing the "picked" primitive.

≥4 reserved for registration.

The pick path order is the order in which elements of the pick path are to be returned. If the pick path order is TOPFIRST, then the structure specified in any pick path element is a parent of the structure specified in the subsequent pick path element. If the pick path order is BOTTOMFIRST, then the structure specified in any pick path element is a child of the structure specified in the subsequent pick path element.

NOTE - PICK prompt and echo type values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a PICK prompt and echo type has been approved by ISO, the PICK prompt and echo type value will be assigned by the Registration Authority.

References: 4.8.2 4.8.6

Data Record:

No predefined entries for Prompt and Echo types 1 through 3, device-dependent for types 4 and higher.

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
060 Ignoring function, specified workstation is not of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation
251 Ignoring function, the function requires the input device to be in REQUEST mode
254 Ignoring function, invalid echo area/volume; XMIN≥XMAX, YMIN≥YMAX or ZMIN>ZMAX
255 Ignoring function, one of the echo area/volume boundary points is outside the range of the device
253 Ignoring function, the specified prompt/echo type is not available on the specified workstation
260 Ignoring function, one of the fields within the input device data record is in error
261 Ignoring function, initial value is invalid

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Input functions **PHIGS Functional Specification**

INITIALIZE PICK **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	pick device number	(1..n)	I
In	initial status	(OK,NOPICK)	E
In	initial pick path		L(PP)
In	prompt and echo type		I
In	echo area	XMIN<XMAX,YMIN<YMAX DC	2×B
In	pick data record		D
In	pick path order	(TOPFIRST, BOTTOMFIRST)	E

Effect: The prompt and echo type, echo area, initial status, initial pick path, pick data record and the pick path order are stored in the workstation state list entry for the specified PICK device. The z-coordinates of the echo volume remain unchanged.

Prompt and echo types:

≤0prompting and echoing is PICK device dependent.

1 use an implementation-defined technique that at least highlights the "picked" primitive for a short period of time.

2 echo the contiguous group of primitives with the same pick identifier as the "picked" primitive, or all primitives of the structure with the same pick identifier as the "picked" primitive.

3 echo the whole posted structure network containing the "picked" primitive.

≥4reserved for registration.

The pick path order is the order in which elements of the pick path are to be returned. If the pick path order is TOPFIRST, then the structure specified in any pick path element is a parent of the structure specified in the subsequent pick path element. If the pick path order is BOTTOMFIRST, then the structure specified in any pick path element is a child of the structure specified in the subsequent pick path element.

NOTE - PICK prompt and echo type values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a PICK prompt and echo type has been approved by ISO, the PICK prompt and echo type value will be assigned by the Registration Authority.

References: 4.8.2 4.8.6

Data Record:

No predefined entries for Prompt and Echo types 1 through 3, device-dependent for types 4 and higher.

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
060 Ignoring function, specified workstation is not of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation
251 Ignoring function, the function requires the input device to be in REQUEST mode
254 Ignoring function, invalid echo area/volume; XMIN≥XMAX, YMIN≥YMAX or ZMIN>ZMAX
255 Ignoring function, one of the echo area/volume boundary points is outside the range of the device
253 Ignoring function, the specified prompt/echo type is not available on the specified workstation
260 Ignoring function, one of the fields within the input device data record is in error
261 Ignoring function, initial value is invalid

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PHIGS Functional Specification **Input functions**

INITIALIZE STRING 3 **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier			WI
In	string device number		(1..n)	I
In	initial string			S
In	prompt and echo type			I
In	echo volume	XMIN<XMAX,YMIN<YMAX,ZMIN≤ZMAX	DC	3×B
In	string data record			D

Effect: The initial string, prompt and echo type, echo volume and string data record are stored in the workstation state list entry for the specified STRING device.

For all prompt and echo types, the first entry of the string data record is the input buffer size, which is an integer in the range (1..n). This is compared against an implementation defined 'available input buffer size' for string devices (contained in the workstation description table). If the requested buffer size is greater, the 'available input buffer size' is substituted in the stored record. If the initial string is longer than the buffer size, an error is issued.

When a STRING measure process comes into existence, it obtains a buffer of the size defined by 'input buffer size'. The initial string is copied into the buffer, and the cursor is placed at the initial editing position within it. Replacement of characters begins at this initial position.

Prompt and echo types:

≤0 prompting and echoing is STRING device dependent.

1 display the current STRING value within the echo volume.

≥2 reserved for registration.

NOTE - If the operator enters more characters than the 'input buffer size' (in the workstation state list for this device), the additional characters are lost. The operator should be informed of this situation.

For all prompt and echo types, the string data record contains an initial cursor position, which may range from 1 to length of initial string plus 1.

STRING prompt and echo type values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a STRING prompt and echo type has been approved by ISO, the STRING prompt and echo type value will be assigned by the Registration Authority.

References: 4.8.2 4.8.6

Data Record:

1	Input buffer size (number of characters)	(1..n)	I
2	Initial editing position	(1..n)	I

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Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation
251 Ignoring function, the function requires the input device to be in REQUEST mode
254 Ignoring function, invalid echo area/volume; XMIN≥XMAX, YMIN≥YMAX or ZMIN>ZMAX
255 Ignoring function, one of the echo area/volume boundary points is outside the range of the device
253 Ignoring function, the specified prompt/echo type is not available on the specified workstation
260 Ignoring function, one of the fields within the input device data record is in error
261 Ignoring function, initial value is invalid
263 Ignoring function, length of the initial string is greater than the buffer size

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INITIALIZE STRING (PHOP,WSOP,*,*)

Parameters:

In	workstation identifier			WI
In	string device number		(1..n)	I
In	initial string			S
In	prompt and echo type			I
In	echo area	XMIN<XMAX,YMIN<YMAX	DC	2×B
In	string data record			D

Effect: The initial string, prompt and echo type, echo area and string data record are stored in the workstation state list entry for the specified STRING device. The z-coordinates of the echo volume remain unchanged.

For all prompt and echo types, the first entry of the string data record is the input buffer size, which is an integer in the range (1..n). This is compared against an implementation defined 'available input buffer size' for string devices (contained in the workstation description table). If the requested buffer size is greater, the 'available input buffer size' is substituted in the stored record. If the initial string is longer than the buffer size, an error is issued.

When a STRING measure process comes into existence, it obtains a buffer of the size defined by 'input buffer size'. The initial string is copied into the buffer, and the cursor is placed at the initial editing position within it. Replacement of characters begins at this initial position.

Prompt and echo types:

≤0 prompting and echoing is STRING device dependent.
1 display the current STRING value within the echo area.
≥2 reserved for registration.

NOTE - If the operator enters more characters than the 'input buffer size' (in the workstation state list for this device), the additional characters are lost. The operator should be informed of this situation.

For all prompt and echo types, the string data record contains an initial cursor position, which may range from 1 to length of initial string plus 1.

STRING prompt and echo type values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a STRING prompt and echo type has been approved by ISO, the STRING prompt and echo type value will be assigned by the Registration Authority.

References: 4.8.2 4.8.6

Data Record:

1	Input buffer size (number of characters)	(1..n)	I
2	Initial editing position	(1..n)	I

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation
251 Ignoring function, the function requires the input device to be in REQUEST mode
254 Ignoring function, invalid echo area/volume; XMIN≥XMAX, YMIN≥YMAX or ZMIN>ZMAX
255 Ignoring function, one of the echo area/volume boundary points is outside the range of the device
253 Ignoring function, the specified prompt/echo type is not available on the specified workstation
260 Ignoring function, one of the fields within the input device data record is in error
261 Ignoring function, initial value is invalid
263 Ignoring function, length of the initial string is greater than the buffer size

5.10.3 Setting the mode of input devices

SET LOCATOR MODE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	locator device number	(1..n)	I
In	operating mode	(REQUEST,SAMPLE,EVENT)	E
In	echo switch	(ECHO,NOECHO)	E

Effect: The given LOCATOR device is set to the specified operating mode and its echoing state is set to ECHO or NOECHO. Depending on the specified operating mode, an interaction with the given device may begin or end. The input device state defined by operating mode and echo switch is stored in the workstation state list for the given LOCATOR device.

References: 4.8.1 4.8.3

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

SET STROKE MODE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	stroke device number	(1..n)	I
In	operating mode	(REQUEST,SAMPLE,EVENT)	E
In	echo switch	(ECHO,NOECHO)	E

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Effect: The given STROKE device is set to the specified operating mode and its echoing state is set to ECHO or NOECHO. Depending on the specified operating mode, an interaction with the given device may begin or end. The input device state defined by the operating mode and the echo switch is stored in the workstation state list for the given STROKE device.

References: 4.8.1 4.8.3

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

SET VALUATOR MODE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	valuator device number	(1..n)	I
In	operating mode	(REQUEST,SAMPLE,EVENT)	E
In	echo switch	(ECHO,NOECHO)	E

Effect: The given VALUATOR device is set to the specified operating mode and its echoing state is set to ECHO or NOECHO. Depending on the specified operating mode, an interaction within the given device may begin or end. The input device state defined by operating mode and echo switch is stored in the workstation state list for the given VALUATOR device.

References: 4.8.1 4.8.3

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

SET CHOICE MODE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	choice device number	(1..n)	I
In	operating mode	(REQUEST,SAMPLE,EVENT)	E
In	echo switch	(ECHO,NOECHO)	E

Effect: The given CHOICE device is set to the specified operating mode and its echoing state is set to ECHO or NOECHO. Depending on the specified operating mode, an interaction with the given device may begin or end. The input device state defined by operating mode and echo switch is stored in the workstation state list for the given CHOICE device.

References: 4.8.1 4.8.3

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Errors:
003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

SET PICK MODE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	pick device number	(1..n)	I
In	operating mode	(REQUEST,SAMPLE,EVENT)	E
In	echo switch	(ECHO,NOECHO)	E

Effect: The given PICK device is set to the specified operating mode and its echoing state is set to ECHO or NOECHO. Depending on the specified operating mode, and interaction with the given device may begin or end. The input device state defined by operating mode and echo switch is stored in the workstation state list for the given PICK device.

References: 4.8.1 4.8.3

Errors:
003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
060 Ignoring function, specified workstation is not of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

SET STRING MODE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	string device number	(1..n)	I
In	operating mode	(REQUEST,SAMPLE,EVENT)	E
In	echo switch	(ECHO,NOECHO)	E

Effect: The given STRING device is set to the specified operating mode and its echoing state is set to ECHO or NOECHO. Depending on the specified operating mode, an interaction with the given device may begin or end. The input device state defined by operating mode and echo switch is stored in the workstation state list for the given STRING device.

References: 4.8.1 4.8.3

Errors:
003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

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5.10.4 Request input functions

REQUEST LOCATOR 3 **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	locator device number	(1..n)	I
Out	status	(OK,NONE)	E
Out	view index	(0..n)	I
Out	locator position	WC	P3

Effect: PHIGS performs a REQUEST on the specified LOCATOR device. If the break action is performed by the operator, status will return NONE; otherwise, status will return OK together with the logical input value which is the current measure of the LOCATOR device. This measure consists of locator position in world coordinates and view index of the view which was used in the conversion to world coordinates. Locator position is within the view clipping limits of this view.

References: 4.7.7 4.8.1 4.8.2 4.8.3 4.8.4 4.8.7

Errors:

003 *Ignoring function, function requires state (PHOP,WSOP,*,*)*
054 *Ignoring function, the specified workstation is not open*
061 *Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN*
250 *Ignoring function, the specified device is not available on the specified workstation*
251 *Ignoring function, the function requires the input device to be in REQUEST mode*

REQUEST LOCATOR **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	locator device number	(1..n)	I
Out	status	(OK,NONE)	E
Out	view index	(0..n)	I
Out	locator position	WC	P2

Effect: PHIGS performs a REQUEST on the specified LOCATOR device. If the break action is performed by the operator, status will return NONE; otherwise, status will return OK together with the logical input value which is the current measure of the LOCATOR device. This measure consists of locator position in world coordinates and view index of the view which was used in the conversion to world coordinates. Locator position is within the view clipping limits of this view.

While the LOCATOR measure process is conceptually a 3D process, this function returns a 2D result. The Z coordinate result of the measure process is discarded. The X and Y values of the locator position would be identical to those returned by the REQUEST LOCATOR 3 function for the same operator action.

References: 4.7.7 4.8.1 4.8.2 4.8.3 4.8.4 4.8.7

Errors:

003 *Ignoring function, function requires state (PHOP,WSOP,*,*)*
054 *Ignoring function, the specified workstation is not open*
061 *Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN*
250 *Ignoring function, the specified device is not available on the specified workstation*
251 *Ignoring function, the function requires the input device to be in REQUEST mode*

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REQUEST STROKE 3 **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	stroke device number	(1..n)	I
Out	status	(OK,NONE)	E
Out	view index	(0..n)	I
Out	coordinates of points in STROKE	WC	L(P3)

Effect: PHIGS performs a REQUEST on the specified STROKE device. If the break action is performed by the operator, the returned status will be NONE: otherwise, OK is returned together with the logical input value which is the current measure of the STROKE device. This consists of a sequence of positions in world coordinates, and the view index used in the conversion to world coordinates. All the stroke points are within the view clipping limits of the view identified by the view index.

NOTE - If an operator enters more points than the stroke 'input buffer size' (in the workstation state list for this device) allows, the additional points are lost. The operator should be informed of this situation.

References: 4.7.8 4.8.1 4.8.2 4.8.3 4.8.4 4.8.7

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation
251 Ignoring function, the function requires the input device to be in REQUEST mode

REQUEST STROKE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	stroke device number	(1..n)	I
Out	status	(OK,NONE)	E
Out	view index	(0..n)	I
Out	coordinates of points in STROKE	WC	L(P2)

Effect: PHIGS performs a REQUEST on the specified STROKE device. If the break action is performed by the operator, the returned status will be NONE: otherwise, OK is returned together with the logical input value which is the current measure of the STROKE device. This consists of a sequence of positions in world coordinates, and the view index used in the conversion to world coordinates. All the stroke points are within the view clipping limits of the view identified by the view index.

While the STROKE measure process is conceptually a 3D process, this function returns a 2D result. The Z coordinate result of the measure process is discarded. The X and Y values of the stroke position would be identical to those returned by the REQUEST STROKE 3 function for the same operator action.

NOTE - If an operator enters more points than the stroke 'input buffer size' (in the workstation state list for this device) allows, the additional points are lost. The operator should be informed of this situation.

References: 4.7.8 4.8.1 4.8.2 4.8.3 4.8.4 4.8.7

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Errors:
003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
060 Ignoring function, specified workstation is not of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation
251 Ignoring function, the function requires the input device to be in REQUEST mode

REQUEST VALUATOR (PHOP,WSOP,*,*)

Parameters:

In	workstation identifier		WI
In	valuator device number	(1..n)	I
Out	status	(OK,NONE)	E
Out	value		R

Effect: PHIGS performs a REQUEST on the specified VALUATOR device. If the break action is performed by the operator, the status returned will be NONE; otherwise, OK is returned together with the logical input value which is the current measure of the valuator device. The value delivered is in the range specified in the workstation state list entry (for this device) in the valuator data record.

References: 4.8.1 4.8.2 4.8.3 4.8.4

Errors:
003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation
251 Ignoring function, the function requires the input device to be in REQUEST mode

REQUEST CHOICE (PHOP,WSOP,*,*)

Parameters:

In	workstation identifier		WI
In	choice device number	(1..n)	I
Out	status	(OK,NOCHOICE,NONE)	E
Out	choice number	(1..n)	I

Effect: PHIGS performs a REQUEST on the specified CHOICE device. If the break facility is invoked by the operator, the status NONE is returned; if the measure of the CHOICE device indicates no choice, status NOCHOICE is returned; otherwise OK is returned together with a choice number which is set according to the current measure of the CHOICE device.

References: 4.8.1 4.8.2 4.8.3 4.8.4

Errors:
003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation
251 Ignoring function, the function requires the input device to be in REQUEST mode

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REQUEST PICK **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	pick device number	(1..n)	I
In	depth of pick path to return	(0..n)	I
Out	status	(OK,NOPICK,NONE)	E
Out	pick path		L(PP)

Effect: PHIGS performs a REQUEST on the specified PICK device. If the break facility is invoked by the operator the status returned will be NONE; if the measure of the PICK device indicates no pick, status NOPICK is returned; otherwise, OK is returned together with the pick path information. The pick path is returned in the order (TOPFIRST, or BOTTOMFIRST) as specified in the INITIALIZE PICK function.

References: 4.8.1 4.8.2 4.8.3 4.8.4

Errors:

003 *Ignoring function, function requires state (PHOP,WSOP,*,*)*
054 *Ignoring function, the specified workstation is not open*
060 *Ignoring function, specified workstation is not of category OUTIN*
250 *Ignoring function, the specified device is not available on the specified workstation*
251 *Ignoring function, the function requires the input device to be in REQUEST mode*

REQUEST STRING **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	string device number	(1..n)	I
Out	status	(OK,NONE)	E
Out	character string		S

Effect: PHIGS performs a REQUEST on the specified STRING device. If the break action is performed by the operator, the status returned will be NONE; otherwise, OK is returned together with the logical input value which is the current measure of the STRING device.

NOTE - If an operator enters more characters than the string 'input buffer size' (in the workstation state list for this device) allows, the additional characters are lost. The operator should be informed of this situation.

References: 4.8.1 4.8.2 4.8.3 4.8.4

Errors:

003 *Ignoring function, function requires state (PHOP,WSOP,*,*)*
054 *Ignoring function, the specified workstation is not open*
061 *Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN*
250 *Ignoring function, the specified device is not available on the specified workstation*
251 *Ignoring function, the function requires the input device to be in REQUEST mode*

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5.10.5 Sample input functions

SAMPLE LOCATOR 3 **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	locator device number	(1..n)	I
Out	view index	(0..n)	I
Out	locator position	WC	P3

Effect: The logical input value, which is the current measure of the specified LOCATOR device, is returned. The measure consists of a locator position in world coordinates and the view index which was used in the conversion to world coordinates. The locator position is within the view clipping limits of the view identified by the view index.

References: 4.7.7 4.8.1 4.8.2 4.8.3 4.8.4 4.8.7

Errors:

003 *Ignoring function, function requires state (PHOP,WSOP,*,*)*
054 *Ignoring function, the specified workstation is not open*
061 *Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN*
250 *Ignoring function, the specified device is not available on the specified workstation*
252 *Ignoring function, the function requires the input device to be in SAMPLE Mode*

SAMPLE LOCATOR **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	locator device number	(1..n)	I
Out	view index	(0..n)	I
Out	locator position	WC	P2

Effect: The logical input value, which is the current measure of the specified LOCATOR device, is returned. The measure consists of a locator position in world coordinates and the view index which was used in the conversion to world coordinates. The locator position is within the view clipping limits of the view identified by the view index.

While the LOCATOR measure process is conceptually a 3D process, this function returns a 2D result. The Z coordinate result of the measure process is discarded. The X and Y values of the locator position would be identical to those returned by the SAMPLE LOCATOR 3 function for the same operator action.

References: 4.7.7 4.8.1 4.8.2 4.8.3 4.8.4 4.8.7

Errors:

003 *Ignoring function, function requires state (PHOP,WSOP,*,*)*
054 *Ignoring function, the specified workstation is not open*
061 *Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN*
250 *Ignoring function, the specified device is not available on the specified workstation*
252 *Ignoring function, the function requires the input device to be in SAMPLE Mode*

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SAMPLE STROKE 3 **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	stroke device number	(1..n)	I
Out	view index	(0..n)	I
Out	coordinates of points in STROKE	WC	L(P3)

Effect: The logical input value, which is the current measure of the specified STROKE device, is returned. The measure consists of a sequence of positions in world coordinates and the view index used in the conversion to world coordinates. All the points are within the view clipping limits of the view identified by the view index.

NOTE - If an operator enters more points than the stroke 'input buffer size' (in the workstation state list for this device) allows, the additional points are lost. The operator should be informed of this situation.

References: 4.7.8 4.8.1 4.8.2 4.8.3 4.8.4 4.8.7

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation
252 Ignoring function, the function requires the input device to be in SAMPLE Mode

SAMPLE STROKE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	stroke device number	(1..n)	I
Out	view index	(0..n)	I
Out	coordinates of points in STROKE	WC	L(P2)

Effect: The logical input value, which is the current measure of the specified STROKE device, is returned. The measure consists of a sequence of positions in world coordinates and the view index used in the conversion to world coordinates. All the points are within the view clipping limits of the view identified by the view index.

While the STROKE measure process is conceptually a 3D process, this function returns a 2D result. The Z coordinate result of the measure process is discarded. The X and Y values of the stroke position would be identical to those returned by the SAMPLE STROKE 3 function for the same operator action.

NOTE - If an operator enters more points than the stroke 'input buffer size' (in the workstation state list for this device) allows, the additional points are lost. The operator should be informed of this situation.

References: 4.7.8 4.8.1 4.8.2 4.8.3 4.8.4 4.8.7

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation
252 Ignoring function, the function requires the input device to be in SAMPLE Mode

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SAMPLE VALUATOR **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	valuator device number	(1..n)	I
Out	value		R

Effect: The logical input value, which is the current measure of the specified VALUATOR device, is returned. The value delivered is in the range specified in the workstation state list entry (for this device) in the valuator data record.

References: 4.8.1 4.8.2 4.8.3 4.8.4

Errors:

003 *Ignoring function, function requires state (PHOP,WSOP,*,*)*
054 *Ignoring function, the specified workstation is not open*
061 *Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN*
250 *Ignoring function, the specified device is not available on the specified workstation*
252 *Ignoring function, the function requires the input device to be in SAMPLE Mode*

SAMPLE CHOICE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	choice device number	(1..n)	I
Out	status	(OK,NOCHOICE)	E
Out	choice number	(1..n)	I

Effect: If the current measure of the specified CHOICE device is indicating no choice, status NOCHOICE is returned; otherwise OK is returned together with a choice number which is set according to the current measure of the CHOICE device.

References: 4.8.1 4.8.2 4.8.3 4.8.4

Errors:

003 *Ignoring function, function requires state (PHOP,WSOP,*,*)*
054 *Ignoring function, the specified workstation is not open*
061 *Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN*
250 *Ignoring function, the specified device is not available on the specified workstation*
252 *Ignoring function, the function requires the input device to be in SAMPLE Mode*

SAMPLE PICK **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	pick device number	(1..n)	I
In	depth of path to return	(0..n)	I
Out	status	(OK,NOPICK)	E
Out	pick path		L(PP)

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Effect: If the current measure of the specified PICK device is indicating no pick, status NOPICK is returned; otherwise OK is returned together with the current pick path information. The pick path is returned in the order (TOPFIRST or BOTTOMFIRST) as specified in the INITIALIZE PICK function.

References: 4.8.1 4.8.2 4.8.3 4.8.4

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
060 Ignoring function, specified workstation is not of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation
252 Ignoring function, the function requires the input device to be in SAMPLE Mode

SAMPLE STRING **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	string device number	(1..n)	I
Out	character string		S

Effect: The logical input value, which is the current measure of the specified STRING device, is returned.

NOTE - If an operator enters more characters than the string 'input buffer size' (in the workstation state list for this device) allows, the additional characters are lost. The operator should be informed of this situation.

References: 4.8.1 4.8.2 4.8.3 4.8.4

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation
252 Ignoring function, the function requires the input device to be in SAMPLE Mode

5.10.6 Event input functions

AWAIT EVENT **(PHOP,WSOP,*,*)**

Parameters:

In	timeout (seconds)		R
Out	workstation identifier		WI
Out	input class (NONE,LOCATOR,STROKE,VALUATOR,CHOICE,PICK,STRING)		E
Out	logical input device number	(1..n)	I

Effect: If the input queue is empty, PHIGS is placed in a wait state until an input event is written into the queue or until the time specified in the timeout parameter has elapsed. If a timeout occurs and there is still no entry in the queue, a NONE value is returned for input class. If there is at least one entry in the queue, the oldest event report is moved from the event queue to the 'current event report' in the PHIGS state list. The workstation identifier, the input class, and the logical input device number are returned and the corresponding values are made available for subsequent interrogation by the GET <input class> functions.

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NOTE - The operation is performed even if error 256 has occurred. Note that a timeout of zero or less causes an immediate inspection of the queue, and a NONE value for input class is returned if the queue is empty. Note also that some operating systems may not provide a reliable timeout facility. In this case a timeout different from zero may never cause a timeout at all.

References: 4.8.1 4.8.2 4.8.3 4.8.5

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
256 Warning, the input queue has overflowed

FLUSH DEVICE EVENTS **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	input class (LOCATOR,STROKE,VALUATOR,CHOICE,PICK,STRING)		E
In	logical input device number	(1..n)	I

Effect: All entries in the input queue from the specified logical input device are removed.

NOTE - The operation is performed even if error 256 has occurred.

References: 4.8.1 4.8.2 4.8.3 4.8.5

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation
256 Warning, the input queue has overflowed

GET LOCATOR 3 **(PHOP,WSOP,*,*)**

Parameters:

Out	view index	(0..n)	I
Out	locator position	WC	P3

Effect: The LOCATOR logical input value in the current event report is returned. This consists of a locator position in world coordinates and the view index which was used in the conversion to world coordinates when the event report was enqueued.

References: 4.7.7 4.8.1 4.8.2 4.8.3 4.8.4 4.8.5 4.8.7

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
259 Ignoring function, the input device class of the current input report does not match the class being requested

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GET LOCATOR **(PHOP,WSOP,*,*)**

Parameters:

Out	view index	(0..n)	I
Out	locator position	WC	P2

Effect: The LOCATOR logical input value in the current event report is returned. This consists of a locator position in world coordinates and the view index which was used in the conversion to world coordinates when the event report was enqueued.

While the LOCATOR measure process is conceptually a 3D process, this function returns a 2D result. The Z coordinate result of the measure process is discarded. The X and Y values of the locator position would be identical to those returned by the GET LOCATOR 3 function for the same operator action.

References: 4.7.7 4.8.1 4.8.2 4.8.3 4.8.4 4.8.5 4.8.7

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*

259 Ignoring function, the input device class of the current input report does not match the class being requested

GET STROKE 3 **(PHOP,WSOP,*,*)**

Parameters:

Out	view index	(0..n)	I
Out	coordinates of points in STROKE	WC	L(P3)

Effect: The STROKE logical input value from the current event report is returned. This consists of a sequence of points in world coordinates, and the view index which was used in the conversion to world coordinates when the event report was enqueued. All the points are within the view clipping limits of the view indicated by the view index.

NOTE - The length of the sequence of points is less than or equal to the 'input buffer size' specified in the workstation state list entry (for the device that generated the event) in the stroke data record, at the time the device was placed in event mode.

If an operator enters more points than the 'stroke input buffer size' allows, the additional points are lost. The operator should be informed of this situation.

References: 4.7.8 4.8.1 4.8.2 4.8.3 4.8.4 4.8.5 4.8.7

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*

259 Ignoring function, the input device class of the current input report does not match the class being requested

GET STROKE **(PHOP,WSOP,*,*)**

Parameters:

Out	view index	(0..n)	I
Out	coordinates of points in STROKE	WC	L(P2)

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Effect: The STROKE logical input value from the current event report is returned. This consists of a sequence of points in world coordinates, and the view index which was used in the conversion to world coordinates when the event report was enqueued. All the points are within the view clipping limits of the view indicated by the view index.

While the STROKE measure process is conceptually a 3D process, this function returns a 2D result. The Z coordinate result of the measure process is discarded. The X and Y values of the stroke position would be identical to those returned by the GET STROKE 3 function for the same operator action.

NOTE - The length of the sequence of points is less than or equal to the 'input buffer size' specified in the workstation state list entry (for the device that generated the event) in the stroke data record, at the time the device was placed in event mode.

If an operator enters more points than the 'stroke input buffer size' allows, the additional points are lost. The operator should be informed of this situation.

References: 4.7.8 4.8.1 4.8.2 4.8.3 4.8.4 4.8.5 4.8.7

Errors:

003 *Ignoring function, function requires state (PHOP,WSOP,*,*)*

259 *Ignoring function, the input device class of the current input report does not match the class being requested*

GET VALUATOR **(PHOP,WSOP,*,*)**

Parameters:

Out	value		R

Effect: The VALUATOR logical input value in the current event report is returned. The value delivered is in the range specified in the workstation state list entry (for the device that generated the event) in the valuator data record at the time that the device was placed in event mode.

References: 4.8.1 4.8.2 4.8.3 4.8.4 4.8.5

Errors:

003 *Ignoring function, function requires state (PHOP,WSOP,*,*)*

259 *Ignoring function, the input device class of the current input report does not match the class being requested*

GET CHOICE **(PHOP,WSOP,*,*)**

Parameters:

Out	status	(OK,NOCHOICE)	E
Out	choice number	(1..n)	I

Effect: The CHOICE logical input value in the current event report is returned. This consists of a CHOICE status and a choice number.

References: 4.8.1 4.8.2 4.8.3 4.8.4 4.8.5

Errors:

003 *Ignoring function, function requires state (PHOP,WSOP,*,*)*

259 *Ignoring function, the input device class of the current input report does not match the class being requested*

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GET PICK **(PHOP,WSOP,*,*)**

Parameters:

In	depth of pick path to return	(0..n)	I
Out	status	(OK,NOPICK)	E
Out	pick path		L(PP)

Effect: The PICK logical input value in the current event report is returned. This consists of a pick status and pick path information describing the location of the picked primitive. The pick path is returned in the order (TOPFIRST or BOTTOMFIRST) specified by 'pick path order' in the workstation state list for the device which generated the event when that device was placed in event mode.

References: 4.8.1 4.8.2 4.8.3 4.8.4 4.8.5

Errors:

003 *Ignoring function, function requires state (PHOP,WSOP,*,*)*

259 *Ignoring function, the input device class of the current input report does not match the class being requested*

GET STRING **(PHOP,WSOP,*,*)**

Parameters:

Out	character string	S

Effect: The STRING logical input value in the current event report is returned.

NOTE - The length of the returned string is less than or equal to the 'input buffer size' specified in the workstation state list entry (for the device that generated the event) in the string data record, at the time the device was placed in event mode.

If the operator enters more characters than the 'input buffer size', the additional characters are lost. The operator should be informed of this situation.

References: 4.8.1 4.8.2 4.8.3 4.8.4 4.8.5

Errors:

003 *Ignoring function, function requires state (PHOP,WSOP,*,*)*

259 *Ignoring function, the input device class of the current input report does not match the class being requested*

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5.11 Metafile functions

WRITE ITEM TO METAFILE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	item type		I
In	item data record		D

Effect: An item containing data provided by the application program is written to the metafile. The parameter item data record defines the data to be output while item type specifies the type.

References: 4.9

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
056 Ignoring function, specified workstation is not of category MO
300 Ignoring function, item type is not allowed for user items
301 Ignoring function, item length is invalid

GET ITEM TYPE FROM METAFILE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
Out	item type		I
Out	item data record length	(0..n)	I

Effect: PHIGS inspects the type of the current item and the length of its data record in the metafile and returns the type and length to the application program.

References: 4.9

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
058 Ignoring function, specified workstation is not of category MI
302 Ignoring function, no item is left in metafile input
303 Ignoring function, metafile item is invalid

READ ITEM FROM METAFILE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	maximum item data record length	(0..n)	I
Out	item data record		D

Effect: PHIGS returns the current item of the metafile to the application program and then makes the next item in the metafile the current item. If the item data record length is greater than 'maximum item data record length', the excess parts of the item are lost.

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NOTE - By specifying 'maximum item data record length' = 0, the current item can be skipped.

Any program which makes use of the access that this function provides to the content of metafile items is using information that is not part of the standard, viz. the format and content of metafile items.

References: 4.9

Errors:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
058 Ignoring function, specified workstation is not of category MI
306 Ignoring function, maximum item data record length is invalid
302 Ignoring function, no item is left in metafile input
303 Ignoring function, metafile item is invalid

INTERPRET ITEM **(PHOP,*,*,*)**

Parameters:

In	item type	I
In	item data record	D

Effect: The supplied item is interpreted. This causes appropriate changes in the state lists defined in PHIGS (which includes the CSS) as determined by a mapping between the metafile and PHIGS. Annex H contains an example mapping between ISO 8632 and PHIGS.

NOTE - Apart from errors noted below, other PHIGS errors may occur as a result of interpreting the item.

References: 4.9

Errors:

002 Ignoring function, function requires state (PHOP,,*,*)*
301 Ignoring function, item length is invalid
304 Ignoring function, item type is unknown
303 Ignoring function, metafile item is invalid
305 Ignoring function, content of item data record is invalid for the specified item type
307 Ignoring function, user item cannot be interpreted

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5.12 Inquiry functions

5.12.1 Introduction

Inquiry functions return values from the various state lists. The data types of the values and the default values of the state list entries are summarized in 6.1 through 6.8. Errors detected by inquiry functions are reported through an error indicator parameter, see 4.11. The ERROR HANDLING function is not called. Some inquiry functions that retrieve values from the workstation state lists have an input parameter of type 'Enumeration' that can take the following values:

a) SET: the values returned are those specified by the application program.

b) REALIZED: the values returned are those used by the workstation when the specified values are mapped to the available values in the workstation.

Inquiries for predefined representations in the workstation description table (see 6.7) have no such parameter unlike the corresponding inquiries for the representations in the workstation state list. The values of predefined representations are available on the workstation. Thus all values returned from a predefined representation are such that, if used by an application program to set a representation, a subsequent inquiry for that representation in the workstation state list would return the same values whether SET or REALIZED was specified.

5.12.2 Inquiry functions for operating state values

INQUIRE SYSTEM STATE VALUE (*,*,*,*)

Parameters:

Out	system state value	(PHCL,PHOP)	E

Effect: The system state of PHIGS is returned.

References: 4.10 4.11

Errors:

none

INQUIRE WORKSTATION STATE VALUE (*,*,*,*)

Parameters:

Out	workstation state value	(WSCL,WSOP)	E

Effect: The workstation state of PHIGS is returned.

References: 4.10 4.11

Errors:

none

INQUIRE STRUCTURE STATE VALUE (*,*,*,*)

Parameters:

Out	structure state value	(STCL,STOP)	E

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Effect: The structure state of PHIGS is returned.

References: 4.10 4.11

Errors:

none

INQUIRE ARCHIVE STATE VALUE **(*,*,*,*)**

Parameters:

Out	archive state value	(ARCL,AROP)	E

Effect: The archive state of PHIGS is returned.

References: 4.10 4.11

Errors:

none

5.12.3 Inquiry functions for PHIGS description table

INQUIRE LIST OF AVAILABLE WORKSTATION TYPES **(PHOP,*,*,*)**

Parameters:

Out	error indicator	I
Out	list of available workstation types	L(W)

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

The workstation types returned in the 'list of available workstation types' are those which may be used as a workstation type parameter to OPEN WORKSTATION.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to the following error number to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.6.1 4.11

Errors:

none

INQUIRE PHIGS FACILITIES **(PHOP,*,*,*)**

Parameters:

Out	error indicator		I
Out	maximum number of simultaneously open workstations		I
Out	maximum number of simultaneously open archive files		I
Out	number of available names for name sets		I
Out	list of available character sets	(1..n)	L(I)
Out	maximum length of normal filter list for ISS		I
Out	maximum length of inverted filter list for ISS		I

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Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.5.1 4.6.1 4.11

Errors:

none

INQUIRE GENERALIZED STRUCTURE ELEMENT FACILITIES (PHOP,*,*,*)

Parameters:

Out	error indicator		I
Out	list of GSE identifiers		L(GS)
Out	list of workstation dependency indicators (WORKSTATION-INDEPENDENT,WORKSTATION-DEPENDENT)		L(E)

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

The function returns a list of GSE identifiers which are supported by the implementation. Specific GSEs may have actions which are either workstation independent or workstation dependent. The list of workstation dependency indicators is a list of values (WORKSTATION-INDEPENDENT,WORKSTATION-DEPENDENT), one for each GSE supported.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.4.8 4.11

Errors:

none

INQUIRE MODELLING CLIPPING FACILITIES (PHOP,*,*,*)

Parameters:

Out	error indicator		I
Out	number of distinct planes in modelling clipping volume	(6..n)	I
Out	list of modelling clipping operators		L(I)

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

The function returns a list of modelling clipping operators which are supported by the implementation. Operators 1 (replace) and 2 (intersect) are always returned.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to the following error number to indicate

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the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.7.2 4.11

Errors:

none

5.12.4 Inquiry functions for PHIGS state list

INQUIRE EDIT MODE **(PHOP,*,*,*)**

Parameters:

Out	error indicator		I
Out	edit mode	(INSERT,REPLACE)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and the value is returned in the output parameter.

If the inquired information is not available, the value returned in the output parameter is implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.4.4 4.11

Errors:

none

INQUIRE SET OF OPEN WORKSTATIONS **(PHOP,*,*,*)**

Parameters:

Out	error indicator	I
Out	set of open workstations	L(WI)

Effect: If the inquired information is available, the error indicator is returned as 0 and the values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.6.1 4.11

Errors:

none

INQUIRE STRUCTURE IDENTIFIERS **(PHOP,*,*,*)**

Parameters:

Out	error indicator	I
Out	list of structure identifiers	L(I)

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Effect: If the inquired information is available, the error indicator is returned as 0 and the values are returned in the output parameters.

A list of structures contained in the CSS is returned.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.4.6 4.11

Errors:

none

INQUIRE ARCHIVE FILES **(PHOP,*,*,*)**

Parameters:

Out	error indicator	I
Out	list of archive file identifiers	L(AI)
Out	list of archive file names	L(F)

Effect: If the inquired information is available, the error indicator is returned as 0 and the value is returned in the output parameters. In archive state ARCL, the lists will be empty.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.4.7 4.11

Errors:

none

INQUIRE CONFLICT RESOLUTION **(PHOP,*,*,*)**

Parameters:

Out	error indicator		I
Out	archival conflict resolution	(MAINTAIN,ABANDON,UPDATE)	E
Out	retrieval conflict resolution	(MAINTAIN,ABANDON,UPDATE)	E

Effect: The 'archival conflict resolution flag' and 'retrieval conflict resolution flag' are returned.

If the inquired information is available, the error indicator is returned as 0 and the value is returned in the output parameter.

If the inquired information is not available, the value returned in the output parameter is implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.4.7 4.11

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Errors:
none

INQUIRE ALL CONFLICTING STRUCTURES **(PHOP,*,*,AROP)**

Parameters:

In	archive file identifier		AI
Out	error indicator		I
Out	list of structure identifiers		L(I)

Effect: If the inquired information is available, the error indicator is returned as 0 and the values are returned in the output parameters.

The structure identifier list contains all of the structure identifiers of those structures which "exist" in both CSS and the archive file.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

007 Ignoring function, function requires state (PHOP,,*,AROP)*
404 Ignoring function, the specified archive file is not open

References: 4.4.7 4.11

Errors:
none

INQUIRE CONFLICTING STRUCTURES IN NETWORK **(PHOP,*,*,AROP)**

Parameters:

In	archive file identifier		AI
In	structure identifier		I
In	structure network source	(CSS,ARCHIVE)	E
Out	error indicator		I
Out	list of structure identifiers		L(I)

Effect: If the inquired information is available, the error indicator is returned as 0 and the values are returned in the output parameters.

If the structure network source is CSS, all the structure identifiers in the structure paths descending from the specified structure in the CSS are compared to all structure identifiers in the archive file. Those which are in both are returned in the structure identifier list. If the structure network source is ARCHIVE, all structure identifiers in the structure paths descending from the specified structure in the archive file are compared to all structure identifiers in the CSS. Those which are in both are returned in the structure identifier list.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

007 Ignoring function, function requires state (PHOP,,*,AROP)*
201 Ignoring function, the specified structure does not exist
404 Ignoring function, the specified archive file is not open

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References: 4.4.7 4.11

Errors:

none

INQUIRE MORE SIMULTANEOUS EVENTS (PHOP,*,*,*)

Parameters:

Out	error indicator		I
Out	more simultaneous events	(NOMORE,MORE)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and the value is returned in the output parameter.

If the inquired information is not available, the value returned in the output parameter is implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.8.5 4.11

Errors:

none

5.12.5 Inquiry functions for workstation state list

INQUIRE WORKSTATION CONNECTION AND TYPE (PHOP,WSOP,*,*)

Parameters:

In	workstation identifier	WI
Out	error indicator	I
Out	connection identifier	C
Out	workstation type	W

Effect: If the inquired information is available, the error indicator is returned as 0 and the values are returned in the output parameters.

This function always returns the workstation type of the specific device that has been opened corresponding to the workstation identifier.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open

References: 4.6.1 4.11

Errors:

none

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003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
057 Ignoring function, specified workstation is of category MI
114 Ignoring function, the view index value is less than zero
101 Ignoring function, the specified representation has not been defined

References: 4.5.13 4.7.4 4.11

Errors:
none

INQUIRE HLHSR MODE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
Out	error indicator		I
Out	HLHSR update state	(NOTPENDING,PENDING)	E
Out	current HLHSR mode		I
Out	requested HLHSR mode		I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

The HLHSR update state is PENDING if a HLHSR mode change has been requested, but not yet provided.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
057 Ignoring function, specified workstation is of category MI

References: 4.5.14 4.6.6 4.11

Errors:
none

INQUIRE POSTED STRUCTURES **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier	WI
Out	error indicator	I
Out	list of posted structure networks	L(PS)

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

The structures returned represent the topmost structures of the posted structure networks. INQUIRE DESCENDANTS OF STRUCTURES can be used to identify structures which are implicitly posted due to being referenced from within the posted structure network.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to

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indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)

References: 4.4.3 4.6.1 4.11

Errors:

none

INQUIRE DISPLAY UPDATE STATE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
Out	error indicator		I
Out	deferral mode	(ASAP,BNIG,BNIL,ASTI,WAIT)	E
Out	modification mode	(NIVE,UWOR,UQUM)	E
Out	display surface empty	(EMPTY,NOTEMPTY)	E
Out	state of visual representation	(CORRECT,DEFERRED,SIMULATED)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and the values are returned in the output parameters.

If there are currently both simulated and deferred actions, the state of visual representation is DEFERRED.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)

References: 4.6.3 4.6.4 4.11

Errors:

none

INQUIRE LIST OF POLYLINE INDICES **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
Out	error indicator		I
Out	list of defined polyline indices	(1..n)	L(I)

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

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003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)

References: 4.5.2 4.5.3 4.11

Errors:
none

INQUIRE POLYLINE REPRESENTATION **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	polyline index	(1..n)	I
In	type of returned values	(SET,REALIZED)	E
Out	error indicator		I
Out	linetype		I
Out	linewidth scale factor		R
Out	polyline colour index	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the specified polyline index is not present in the polyline bundle table on the workstation and the specified type of returned value is REALIZED, the representation for polyline index 1 is returned.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
100 Ignoring function, the bundle index value is less than one
101 Ignoring function, the specified representation has not been defined

References: 4.5.2 4.5.3 4.11

Errors:
none

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INQUIRE LIST OF POLYMARKER INDICES **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
Out	error indicator		I
Out	list of defined polymarker indices	(1..n)	L(I)

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)

References: 4.5.2 4.5.4 4.11

Errors:

none

INQUIRE POLYMARKER REPRESENTATION **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	polymarker index	(1..n)	I
In	type of returned values	(SET,REALIZED)	E
Out	error indicator		I
Out	marker type		I
Out	marker size scale factor		R
Out	polymarker colour index	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the specified polymarker index is not present in the polymarker bundle table on the workstation and the specified type of returned value is REALIZED, the representation for polymarker index 1 is returned.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
100 Ignoring function, the bundle index value is less than one
101 Ignoring function, the specified representation has not been defined

References: 4.5.2 4.5.4 4.11

Errors:

none

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INQUIRE LIST OF TEXT INDICES **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
Out	error indicator		I
Out	list of defined text indices	(1..n)	L(I)

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)

References: 4.5.2 4.5.5 4.11

Errors:

none

INQUIRE TEXT REPRESENTATION **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	text index	(1..n)	I
In	type of returned values	(SET,REALIZED)	E
Out	error indicator		I
Out	text font		I
Out	text precision	(STRING,CHAR,STROKE)	E
Out	character expansion factor		R
Out	character spacing		R
Out	text colour index	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the specified text index is not present in the text bundle table on the workstation and the specified type of returned value is REALIZED, the representation for text index 1 is returned.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
100 Ignoring function, the bundle index value is less than one
101 Ignoring function, the specified representation has not been defined

References: 4.5.2 4.5.5 4.5.6 4.11

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Errors:
none

INQUIRE LIST OF INTERIOR INDICES **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
Out	error indicator		I
Out	list of defined interior indices	(1..n)	L(I)

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator.is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)

References: 4.5.2 4.5.8 4.5.9 4.11

Errors:
none

INQUIRE INTERIOR REPRESENTATION **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	interior index	(1..n)	I
In	type of returned values	(SET,REALIZED)	E
Out	error indicator		I
Out	interior style	(HOLLOW,SOLID,PATTERN,HATCH,EMPTY)	E
Out	interior style index		I
Out	interior colour index	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the specified interior index is not present in the interior bundle table on the workstation and the specified type of returned value is REALIZED, the representation for interior index 1 is returned.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

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003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
100 Ignoring function, the bundle index value is less than one
101 Ignoring function, the specified representation has not been defined

References: 4.5.2 4.5.8 4.5.9 4.11

Errors:
none

INQUIRE LIST OF EDGE INDICES **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
Out	error indicator		I
Out	list of defined edge indices	(1..n)	L(I)

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)

References: 4.5.2 4.5.9 4.11

Errors:
none

INQUIRE EDGE REPRESENTATION **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	edge index	(1..n)	I
In	type of returned values	(SET,REALIZED)	E
Out	error indicator		I
Out	edge flag	(OFF,ON)	E
Out	edgetype		I
Out	edgewidth scale factor		R
Out	edge colour index	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the specified edge index is not present in the edge bundle table on the workstation and the specified type of returned value is REALIZED, the representation for edge index 1 is returned.

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If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
100 Ignoring function, the bundle index value is less than one
101 Ignoring function, the specified representation has not been defined

References: 4.5.2 4.5.9 4.11

Errors:

none

INQUIRE LIST OF PATTERN INDICES **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
Out	error indicator		I
Out	list of pattern indices	(1..n)	L(I)

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)

References: 4.5.2 4.5.8 4.5.9 4.11

Errors:

none

INQUIRE PATTERN REPRESENTATION **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	pattern index	(1..n)	I
In	type of returned values	(SET,REALIZED)	E
Out	error indicator		I
Out	pattern colour index array		A(I)

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the specified pattern index is not present in the pattern table on the workstation and the specified type of returned values is REALIZED, the representation for pattern index 1 is returned (pattern index 1 is present if interior style PATTERN is supported on the workstation).

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If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
112 Ignoring function, the pattern index value is less than one
101 Ignoring function, the specified representation has not been defined
109 Ignoring function, interior style PATTERN is not supported on the workstation

References: 4.5.2 4.5.8 4.5.9 4.11

Errors:

none

INQUIRE COLOUR MODEL **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier	WI
Out	error indicator	I
Out	current colour model	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)

References: 4.5.12 4.11

Errors:

none

INQUIRE LIST OF COLOUR INDICES **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
Out	error indicator		I
Out	list of colour indices	(0..n)	L(I)

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

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003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)

References: 4.5.12 4.11

Errors:
none

INQUIRE COLOUR REPRESENTATION **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	colour index	(0..n)	I
In	type of returned values	(SET,REALIZED)	E
Out	error indicator		I
Out	colour specification		CLR

Effect: If the colour associated with the colour index is available, the error indicator is returned as 0 and the values are returned in the colour specification parameter.

The colour specification parameters are the coordinates of the colour in the current colour model at the workstation (as defined by the 'current colour model' in the workstation state list).

If the type of returned values is REALIZED and the colour associated with the colour index has neither been predefined nor set, or the colour index is greater than the range of the colour table at the workstation, the output colour parameters are set to the colour associated with colour index 1.

If the type of returned values is SET and the colour associated with the colour index has been predefined or set, the output colour parameters are set as closely as possible to the the colour associated with the colour index as it was predefined or set. This may be the same as the case when the type of returned values is REALIZED.

If the type of returned values is SET and the colour associated with the colour index has neither been predefined nor set, the values returned in the output parameters are implementation dependent and the error indicator is set to error number 101.

If the inquired information is not available for some other reason, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
113 Ignoring function, the colour index value is less than zero
101 Ignoring function, the specified representation has not been defined

References: 4.5.12 4.11

Errors:
none

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INQUIRE HIGHLIGHTING FILTER **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier	WI
Out	error indicator	I
Out	highlighting filter	FR

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)

References: 4.5.15 4.11

Errors:

none

INQUIRE INVISIBILITY FILTER **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier	WI
Out	error indicator	I
Out	invisibility filter	FR

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)

References: 4.5.15 4.11

Errors:

none

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INQUIRE WORKSTATION TRANSFORMATION 3 **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
Out	error indicator		I
Out	workstation transformation update state	(NOTPENDING,PENDING)	E
Out	requested workstation window limits	NPC	3×B
Out	current workstation window limits	NPC	3×B
Out	requested workstation viewport limits	DC	3×B
Out	current workstation viewport limits	DC	3×B

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters. The workstation transformation update state is PENDING if a workstation transformation change has been requested but not yet provided.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
057 Ignoring function, specified workstation is of category MI

References: 4.7.6 4.11

Errors:

none

INQUIRE WORKSTATION TRANSFORMATION **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
Out	error indicator		I
Out	workstation transformation update state	(NOTPENDING,PENDING)	E
Out	requested workstation window limits	NPC	2×B
Out	current workstation window limits	NPC	2×B
Out	requested workstation viewport limits	DC	2×B
Out	current workstation viewport limits	DC	2×B

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters. The workstation transformation update state is PENDING if a workstation transformation change has been requested but not yet provided.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
057 Ignoring function, specified workstation is of category MI

References: 4.7.6 4.11

Errors:

none

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INQUIRE LOCATOR DEVICE STATE 3 **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	locator device number	(1..n)	I
In	type of returned values	(SET,REALIZED)	E
Out	error indicator		I
Out	operating mode	(REQUEST,SAMPLE,EVENT)	E
Out	echo switch	(ECHO,NOECHO)	E
Out	initial view index	(0..n)	I
Out	initial locator position	WC	P3
Out	prompt and echo type		I
Out	echo volume	DC	3×B
Out	locator data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

References: 4.7.7 4.8 4.11

Errors:

none

INQUIRE LOCATOR DEVICE STATE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	locator device number	(1..n)	I
In	type of returned values	(SET,REALIZED)	E
Out	error indicator		I
Out	operating mode	(REQUEST,SAMPLE,EVENT)	E
Out	echo switch	(ECHO,NOECHO)	E
Out	initial view index	(0..n)	I
Out	initial locator position	WC	P2
Out	prompt and echo type		I
Out	echo area	DC	2×B
Out	locator data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

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003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

References: 4.7.7 4.8 4.11

Errors:

none

INQUIRE STROKE DEVICE STATE 3 **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	stroke device number	(1..n)	I
In	type of returned values	(SET,REALIZED)	E
Out	error indicator		I
Out	operating mode	(REQUEST,SAMPLE,EVENT)	E
Out	echo switch	(ECHO,NOECHO)	E
Out	initial view index	(0..n)	I
Out	list of initial points in STROKE	WC	L(P3)
Out	prompt and echo type		I
Out	echo volume	DC	3×B
Out	stroke data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

References: 4.7.8 4.8 4.11

Errors:

none

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INQUIRE STROKE DEVICE STATE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	stroke device number	(1..n)	I
In	type of returned values	(SET,REALIZED)	E
Out	error indicator		I
Out	operating mode	(REQUEST,SAMPLE,EVENT)	E
Out	echo switch	(ECHO,NOECHO)	E
Out	initial view index	(0..n)	I
Out	list of initial points in STROKE	WC	L(P2)
Out	prompt and echo type		I
Out	echo area	DC	2×B
Out	stroke data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

References: 4.7.8 4.8 4.11

Errors:

none

INQUIRE VALUATOR DEVICE STATE 3 **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	valuator device number	(1..n)	I
Out	error indicator		I
Out	operating mode	(REQUEST,SAMPLE,EVENT)	E
Out	echo switch	(ECHO,NOECHO)	E
Out	initial value		R
Out	prompt and echo type		I
Out	echo volume	DC	3×B
Out	valuator data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

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INQUIRE LIST OF VIEW INDICES (PHOP,WSOP,*,*)

Parameters:

In	workstation identifier	WI
Out	error indicator	I
Out	list of defined view indices	L(I)

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

The view indices are returned in a list, which is ordered by view transformation input priority, starting with the highest priority view.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
057 Ignoring function, specified workstation is of category MI

References: 4.5.13 4.7.4 4.11

Errors:

none

INQUIRE VIEW REPRESENTATION (PHOP,WSOP,*,*)

Parameters:

In	workstation identifier		WI
In	view index	(0..n)	I
Out	error indicator		I
Out	viewing transformation update state	(NOTPENDING,PENDING)	E
Out	requested view orientation matrix		4×4×R
Out	current view orientation matrix		4×4×R
Out	requested view mapping matrix		4×4×R
Out	current view mapping matrix		4×4×R
Out	requested view clipping limits	NPC	3×B
Out	current view clipping limits	NPC	3×B
Out	requested x-y clipping indicator	(CLIP,NOCLIP)	E
Out	current x-y clipping indicator	(CLIP,NOCLIP)	E
Out	requested back clipping indicator	(CLIP,NOCLIP)	E
Out	current back clipping indicator	(CLIP,NOCLIP)	E
Out	requested front clipping indicator	(CLIP,NOCLIP)	E
Out	current front clipping indicator	(CLIP,NOCLIP)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

The viewing transformation update state is PENDING if a view representation change has been requested, but not yet provided.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

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003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

References: 4.8 4.11

Errors:

none

INQUIRE VALUATOR DEVICE STATE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	valuator device number	(1..n)	I
Out	error indicator		I
Out	operating mode	(REQUEST,SAMPLE,EVENT)	E
Out	echo switch	(ECHO,NOECHO)	E
Out	initial value		R
Out	prompt and echo type		I
Out	echo area	DC	2×B
Out	valuator data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

References: 4.8 4.11

Errors:

none

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INQUIRE CHOICE DEVICE STATE 3 **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	choice device number	(1..n)	I
Out	error indicator		I
Out	operating mode	(REQUEST,SAMPLE,EVENT)	E
Out	echo switch	(ECHO,NOECHO)	E
Out	initial status	(OK,NOCHOICE)	E
Out	initial choice number	(1..n)	I
Out	prompt and echo type		I
Out	echo volume	DC	3×B
Out	choice data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

References: 4.8 4.11

Errors:

none

INQUIRE CHOICE DEVICE STATE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	choice device number	(1..n)	I
Out	error indicator		I
Out	operating mode	(REQUEST,SAMPLE,EVENT)	E
Out	echo switch	(ECHO,NOECHO)	E
Out	initial status	(OK,NOCHOICE)	E
Out	initial choice number	(1..n)	I
Out	prompt and echo type		I
Out	echo area	DC	2×B
Out	choice data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

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003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

References: 4.8 4.11

Errors:

none

INQUIRE PICK DEVICE STATE 3 **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	pick device number	(1..n)	I
In	type of returned values	(SET,REALIZED)	E
Out	error indicator		I
Out	operating mode	(REQUEST,SAMPLE,EVENT)	E
Out	echo switch	(ECHO,NOECHO)	E
Out	pick filter		FR
Out	initial status	(OK,NOPICK)	E
Out	initial pick path		L(PP)
Out	prompt and echo type		I
Out	echo volume	DC	3×B
Out	pick data record		D
Out	pick path order	(TOPFIRST,BOTTOMFIRST)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
060 Ignoring function, specified workstation is not of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

References: 4.8 4.11

Errors:

none

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INQUIRE PICK DEVICE STATE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	pick device number	(1..n)	I
In	type of returned values	(SET,REALIZED)	E
Out	error indicator		I
Out	operating mode	(REQUEST,SAMPLE,EVENT)	E
Out	echo switch	(ECHO,NOECHO)	E
Out	pick filter		FR
Out	initial status	(OK,NOPICK)	E
Out	initial pick path		L(PP)
Out	prompt and echo type		I
Out	echo area	DC	2×B
Out	pick data record		D
Out	pick path order	(TOPFIRST,BOTTOMFIRST)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
060 Ignoring function, specified workstation is not of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

References: 4.8 4.11

Errors:

none

INQUIRE STRING DEVICE STATE 3 **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	string device number	(1..n)	I
Out	error indicator		I
Out	operating mode	(REQUEST,SAMPLE,EVENT)	E
Out	echo switch	(ECHO,NOECHO)	E
Out	initial string		S
Out	prompt and echo type		I
Out	echo volume	DC	3×B
Out	string data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

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003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

References: 4.8 4.11

Errors:

none

INQUIRE STRING DEVICE STATE **(PHOP,WSOP,*,*)**

Parameters:

In	workstation identifier		WI
In	string device number	(1..n)	I
Out	error indicator		I
Out	operating mode	(REQUEST,SAMPLE,EVENT)	E
Out	echo switch	(ECHO,NOECHO)	E
Out	initial string		S
Out	prompt and echo type		I
Out	echo area	DC	2×B
Out	string data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
054 Ignoring function, the specified workstation is not open
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

References: 4.8 4.11

Errors:

none

5.12.6 Inquiry functions for workstation description table

INQUIRE WORKSTATION CATEGORY **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
Out	error indicator		I
Out	workstation category	(OUTPUT,INPUT,OUTIN,MO,MI)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

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002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type

References: 4.6.1 4.6.2 4.11

Errors:

none

INQUIRE DISPLAY SPACE SIZE 3 **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
Out	error indicator		I
Out	device coordinate units	(METRES,OTHER)	E
Out	maximum display volume size in device coordinate units	DC >0	3×R
Out	maximum display volume size in raster units	(1..n)	3×I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
057 Ignoring function, specified workstation is of category MI
062 Ignoring function, this information is not available for this MO workstation type

References: 4.6.1 4.6.2 4.11

Errors:

none

INQUIRE DISPLAY SPACE SIZE **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
Out	error indicator		I
Out	device coordinate units	(METRES,OTHER)	E
Out	maximum display space size in device coordinate units	DC >0	2×R
Out	maximum display space size in raster units	(1..n)	2×I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

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002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
057 Ignoring function, specified workstation is of category MI
062 Ignoring function, this information is not available for this MO workstation type

References: 4.6.1 4.6.2 4.11

Errors:

none

INQUIRE HLHSR FACILITIES **(PHOP,*,*,*)**

Parameters:

In	workstation type	W
Out	error indicator	I
Out	list of available HLHSR identifiers	L(I)
Out	list of available HLHSR modes	L(I)

Effect: If the inquired information is available, the error indicator is returned as 0 and the values are returned in the output parameter.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
057 Ignoring function, specified workstation is of category MI
062 Ignoring function, this information is not available for this MO workstation type

References: 4.6.1 4.6.2 4.6.6 4.11

Errors:

none

INQUIRE VIEW FACILITIES **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
Out	error indicator		I
Out	number of predefined view indices	(6..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and the value is returned in the output parameter.

If the inquired information is not available, the value returned in the output parameter is implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

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002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
057 Ignoring function, specified workstation is of category MI
062 Ignoring function, this information is not available for this MO workstation type

References: 4.6.1 4.6.2 4.7.4 4.11

Errors:
none

INQUIRE PREDEFINED VIEW REPRESENTATION (PHOP,*,*,*)

Parameters:

In	workstation type		W
In	predefined view index	(0..n)	I
Out	error indicator		I
Out	view orientation matrix		4×4×R
Out	view mapping matrix		4×4×R
Out	view clipping limits	NPC	3×B
Out	x-y clipping indicator	(CLIP,NOCLIP)	E
Out	back clipping indicator	(CLIP,NOCLIP)	E
Out	front clipping indicator	(CLIP,NOCLIP)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and the values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
057 Ignoring function, specified workstation is of category MI
114 Ignoring function, the view index value is less than zero
101 Ignoring function, the specified representation has not been defined
062 Ignoring function, this information is not available for this MO workstation type

References: 4.6.1 4.6.2 4.7.4 4.11

Errors:
none

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INQUIRE WORKSTATION CLASSIFICATION (PHOP,*,*,*)

Parameters:

In	workstation type		W
Out	error indicator		I
Out	workstation classification	(VECTOR,RASTER,OTHER)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type

References: 4.6.1 4.6.2 4.11

Errors:

none

INQUIRE DYNAMICS OF WORKSTATION ATTRIBUTES (PHOP,*,*,*)

Parameters:

In	workstation type		W
Out	error indicator		I
Out	polyline bundle representation changeable	(IRG,IMM,CBS)	E
Out	polymarker bundle representation changeable	(IRG,IMM,CBS)	E
Out	text bundle representation changeable	(IRG,IMM,CBS)	E
Out	interior bundle representation changeable	(IRG,IMM,CBS)	E
Out	edge bundle representation changeable	(IRG,IMM,CBS)	E
Out	pattern representation changeable	(IRG,IMM,CBS)	E
Out	colour representation changeable	(IRG,IMM,CBS)	E
Out	view representation changeable	(IRG,IMM,CBS)	E
Out	workstation transformation changeable	(IRG,IMM,CBS)	E
Out	highlighting filter change	(IRG,IMM,CBS)	E
Out	invisibility filter change	(IRG,IMM,CBS)	E
Out	HLHSR mode changeable	(IRG,IMM,CBS)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

IRG means that implicit regeneration is necessary; IMM means the action is performed immediately; CBS means that the change can be simulated.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

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002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type

References: 4.6.1 4.6.2 4.6.3 4.11

Errors:

none

INQUIRE DEFAULT DISPLAY UPDATE STATE **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
Out	error indicator		I
Out	default value for deferral mode	(ASAP,BNIG,BNIL,ASTI,WAIT)	E
Out	default value for modification mode	(NIVE,UWOR,UQUM)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type

References: 4.6.1 4.6.2 4.6.3 4.11

Errors:

none

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INQUIRE POLYLINE FACILITIES **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
Out	error indicator		I
Out	number of available linetypes	(-n..-4,4..n)	I
Out	list of available linetypes		L(I)
Out	number of available linewidths	(0..n)	I
Out	nominal linewidth	DC >0.0	R
Out	range of linewidths (minimum,maximum)	DC >0.0	B
Out	number of predefined polyline indices	(5..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the number of available linetypes is positive, the list of available linetypes contains all registered and implementation dependent linetypes supported. If the number of available linetypes is negative the following two conditions hold. The implementation dependent linetypes are derived directly from the value and the linetype aspect. The list of available linetypes contains the registered linetypes supported, the number of which is indicated by the absolute value of the number of available linetypes.

If the number of available linewidths is returned as 0, the workstation supports a continuous range of linewidths.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type

References: 4.5.1 4.5.3 4.6.1 4.6.2 4.11

Errors:

none

INQUIRE PREDEFINED POLYLINE REPRESENTATION **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
In	predefined polyline index	(1..n)	I
Out	error indicator		I
Out	linetype		I
Out	linewidth scale factor		R
Out	polyline colour index	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

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002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type
100 Ignoring function, the bundle index value is less than one
102 Ignoring function, the specified representation has not been predefined on this workstation

References: 4.5.1 4.5.3 4.6.1 4.6.2 4.11

Errors:

none

INQUIRE POLYMARKER FACILITIES **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
Out	error indicator		I
Out	number of available marker types	(-n..-5,5..n)	I
Out	list of available marker types		L(I)
Out	number of available marker sizes	(0..n)	I
Out	nominal marker size	DC >0.0	R
Out	range of marker sizes (minimum,maximum)	DC >0.0	B
Out	number of predefined polymarker indices	(5..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the number of available marker types is positive, the list of available marker types contains all registered and implementation dependent marker types supported. If the number of available marker types is negative the following two conditions hold. The implementation dependent marker types are derived directly from the value and the marker type aspect. The list of available marker types contains the registered marker types supported, the number of which is indicated by the absolute value of the number of available marker types.

If the number of available marker sizes is returned as 0, the workstation supports a continuous range of marker sizes.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type

References: 4.5.1 4.5.4 4.6.1 4.6.2 4.11

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Errors:

none

INQUIRE PREDEFINED POLYMARKER REPRESENTATION (PHOP,*,*,*)

Parameters:

In	workstation type		W
In	predefined polymarker index	(1..n)	I
Out	error indicator		I
Out	marker type		I
Out	marker size scale factor		R
Out	polymarker colour index	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type
100 Ignoring function, the bundle index value is less than one
102 Ignoring function, the specified representation has not been predefined on this workstation

References: 4.5.1 4.5.4 4.6.1 4.6.2 4.11

Errors:

none

INQUIRE TEXT FACILITIES (PHOP,*,*,*)

Parameters:

In	workstation type		W
Out	error indicator		I
Out	list of text font and precision pairs		L(FP)
Out	number of available character heights	(0..n)	I
Out	range of character heights	DC >0.0	B
Out	number of available character expansion factors	(0..n)	I
Out	range of character expansion factors	DC >0.0	B
Out	number of predefined text indices	(6..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

Only the highest supported precision for each font need be present in the list of text font and precision pairs. However, an implementation may return a list of all combinations of supported font

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and precision pairs.

If the number of available character heights is returned as zero (0), the workstation supports a continuous range of character heights. If the number of available character expansion factors is returned as zero (0), the workstation supports a continuous range of character expansion factors. If the range of character heights or range of character expansion factors vary between fonts, the ranges returned are for font 1.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type

References: 4.5.1 4.5.5 4.5.6 4.6.1 4.6.2 4.11

Errors:

none

INQUIRE PREDEFINED TEXT REPRESENTATION (PHOP,*,*,*)

Parameters:

In	workstation type		W
In	predefined text index	(1..n)	I
Out	error indicator		I
Out	text font		I
Out	text precision	(STRING,CHAR,STROKE)	E
Out	character expansion factor		R
Out	character spacing		R
Out	text colour index	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type
100 Ignoring function, the bundle index value is less than one
102 Ignoring function, the specified representation has not been predefined on this workstation

References: 4.5.1 4.5.5 4.5.6 4.6.1 4.6.2 4.11

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Errors:
none

INQUIRE ANNOTATION FACILITIES **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
Out	error indicator		I
Out	list of available annotation styles		L(I)
Out	number of available annotation text character heights	(0..n)	I
Out	range of annotation text character heights	DC >0.0	B

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type

References: 4.5.1 4.5.6 4.6.1 4.6.2 4.11

Errors:
none

INQUIRE TEXT EXTENT **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
In	text font		I
In	character expansion factor		R
In	character spacing		R
In	character height	TLC	R
In	text path	(RIGHT,LEFT,UP,DOWN)	E
In	text alignment horizontal	(NORMAL,LEFT,CENTRE,RIGHT)	E
In	text alignment vertical	(NORMAL,TOP,CAP,HALF,BASE,BOTTOM)	E
In	character string		S
Out	error indicator		I
Out	text extent rectangle		2×B
Out	concatenation offset	TLC	V2

Effect: If the inquired information is available, the error indicator is returned as zero and values are returned in the other output parameters.

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The extent of the specified character string in the local 2D text coordinate system is computed using the specified text attributes for the specified workstation type. STROKE precision is assumed. The text position is (0,0) in the local 2D text coordinate system.

The concatenation offset, with a suitable modelling transformation applied to account for the CHARACTER UP VECTOR, indicates the text position for the concatenation of a subsequent text output primitive in the local 2D text coordinate system. This includes, for TEXT PATHs RIGHT and LEFT, a suitable modification to adjust for the intercharacter spacing of the last character as specified by the character spacing parameter.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
062 Ignoring function, this information is not available for this MO workstation type
106 Ignoring function, the specified font is not available for the requested text precision on the specified workstation

References: 4.5.7 4.11

Errors:

none

INQUIRE INTERIOR FACILITIES **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
Out	error indicator		I
Out	list of available interior styles	(HOLLOW,SOLID,PATTERN,HATCH,EMPTY)	L(E)
Out	number of available hatch styles	(-n..-3,0,3..n)	I
Out	list of available hatch styles	(-n..n)	L(I)
Out	number of predefined interior indices	(5..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the number of available hatch styles is positive, the list of available hatch styles contains all registered and implementation dependent hatch styles supported. If the number of available hatch styles is negative the following two conditions hold. The implementation dependent hatch styles are derived directly from the value and the hatch style aspect. The list of available hatch styles contains the registered hatch styles supported, the number of which is indicated by the absolute value of the number of available hatch styles.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

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002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type

References: 4.5.1 4.5.8 4.5.9 4.6.1 4.6.2 4.11

Errors:
none

INQUIRE PREDEFINED INTERIOR REPRESENTATION (PHOP,*,*,*)

Parameters:

In	workstation type		W
In	predefined interior index	(1..n)	I
Out	error indicator		I
Out	interior style	(HOLLOW,SOLID,PATTERN,HATCH,EMPTY)	E
Out	interior style index		I
Out	interior colour index	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type
100 Ignoring function, the bundle index value is less than one
102 Ignoring function, the specified representation has not been predefined on this workstation

References: 4.5.1 4.5.8 4.5.9 4.6.1 4.6.2 4.11

Errors:
none

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INQUIRE EDGE FACILITIES **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
Out	error indicator		I
Out	number of available edgetypes	(-n..-4,4..n)	I
Out	list of available edgetypes		L(I)
Out	number of available edgewidths	(0..n)	I
Out	nominal edgewidth	DC >0.0	R
Out	range of edgewidths (minimum,maximum)	DC >0.0	B
Out	number of predefined edge indices	(5..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the number of available edgetypes is positive, the list of available edgetypes contains all registered and implementation dependent edgetypes supported. If the number of available edgetypes is negative the following two conditions hold. The implementation dependent edgetypes are derived directly from the value and the edgetype aspect. The list of available edgetypes contains the registered edgetypes supported, the number of which is indicated by the absolute value of the number of available edgetypes.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type

References: 4.5.1 4.5.9 4.6.1 4.6.2 4.11

Errors:

none

INQUIRE PREDEFINED EDGE REPRESENTATION **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
In	predefined edge index	(1..n)	I
Out	error indicator		I
Out	edge flag	(OFF,ON)	E
Out	edgetype		I
Out	edgewidth scale factor		R
Out	edge colour index	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to

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indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type
100 Ignoring function, the bundle index value is less than one
102 Ignoring function, the specified representation has not been predefined on this workstation

References: 4.5.1 4.5.9 4.6.1 4.6.2 4.11

Errors:

none

INQUIRE PATTERN FACILITIES **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
Out	error indicator		I
Out	number of predefined pattern indices	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and the value is returned in the output parameter.

If the inquired information is not available, the value returned in the output parameter is implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type

References: 4.5.1 4.5.8 4.5.9 4.6.1 4.6.2 4.11

Errors:

none

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INQUIRE PREDEFINED PATTERN REPRESENTATION **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
In	predefined pattern index	(1..n)	I
Out	error indicator		I
Out	pattern colour index array	(0..n)	A(I)

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type
112 Ignoring function, the pattern index value is less than one
102 Ignoring function, the specified representation has not been predefined on this workstation

References: 4.5.1 4.5.8 4.5.9 4.6.1 4.6.2 4.11

Errors:

none

INQUIRE COLOUR MODEL FACILITIES **(PHOP,*,*,*)**

Parameters:

In	workstation type	W
Out	error indicator	I
Out	list of available colour models	L(I)
Out	default colour model	I

Effect: If the inquired information is available, the error indicator is returned as 0 and a value is returned in the output parameter.

If the inquired information is not available, the value returned in the output parameter is implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type

References: 4.5.12 4.6.1 4.6.2 4.11

Errors:

none

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INQUIRE COLOUR FACILITIES

(PHOP,*,*,*)

Parameters:

In	workstation type		W
Out	error indicator		I
Out	number of colour indices	(0,2..n)	I
Out	colour available	(COLOUR,MONOCHROME)	E
Out	number of predefined colour indices	(2..n)	I
Out	primary colours		3×CC

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

The primary colours are returned as the CIELUV chromaticity coefficients u', v' and luminance value Y.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type

References: 4.5.12 4.6.1 4.6.2 4.11

Errors:

none

INQUIRE PREDEFINED COLOUR REPRESENTATION

(PHOP,*,*,*)

Parameters:

In	workstation type		W
In	predefined colour index	(0..n)	I
Out	error indicator		I
Out	colour specification		CLR

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

The colour specification parameters are the coordinates of the colour in the 'default colour model' as defined in the workstation description table.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

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002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type
113 Ignoring function, the colour index value is less than zero
102 Ignoring function, the specified representation has not been predefined on this workstation

References: 4.5.12 4.6.1 4.6.2 4.11

Errors:

none

INQUIRE LIST OF AVAILABLE GENERALIZED DRAWING PRIMITIVES 3

(PHOP,*,*,*)

Parameters:

In	workstation type	W
Out	error indicator	I
Out	list of GDP 3 identifiers	L(G3)

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type

References: 4.5.1 4.5.11 4.6.1 4.6.2 4.11

Errors:

none

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INQUIRE LIST OF AVAILABLE GENERALIZED DRAWING PRIMITIVES

(PHOP,*,*,*)

Parameters:

In	workstation type	W
Out	error indicator	I
Out	list of GDP identifiers	L(G2)

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type

References: 4.5.1 4.5.11 4.6.1 4.6.2 4.11

Errors:

none

INQUIRE GENERALIZED DRAWING PRIMITIVE 3 **(PHOP,*,*,*)**

Parameters:

In	workstation type	W
In	GDP 3 identifier	G3
Out	error indicator	I
Out	list of sets of attributes used (POLYLINE,POLYMARKER,TEXT,INTERIOR,EDGE)	L(E)

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

For registered GDP 3 identifiers the list of sets of attributes used is defined in the ISO International Register of Graphical Items. For implementation dependent GDP 3 identifiers the list of sets of attributes used is workstation dependent.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
064 Ignoring function, the specified workstation type is not able to generate the specified generalized drawing primitive
062 Ignoring function, this information is not available for this MO workstation type

References: 4.5.1 4.5.11 4.6.1 4.6.2 4.11

Errors:

none

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INQUIRE GENERALIZED DRAWING PRIMITIVE (PHOP,*,*,*)

Parameters:

In	workstation type	W
In	GDP identifier	G2
Out	error indicator	I
Out	list of sets of attributes used (POLYLINE,POLYMARKER,TEXT,INTERIOR,EDGE)	L(E)

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

For registered GDP identifiers the list of sets of attributes used is defined in the ISO International Register of Graphical Items. For implementation dependent GDP identifiers the list of sets of attributes used is workstation dependent.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN nor MO)
064 Ignoring function, the specified workstation type is not able to generate the specified generalized drawing primitive
062 Ignoring function, this information is not available for this MO workstation type

References: 4.5.1 4.5.11 4.6.1 4.6.2 4.11

Errors:

none

INQUIRE LIST OF AVAILABLE GENERALIZED STRUCTURE ELEMENTS (PHOP,*,*,*)

Parameters:

In	workstation type	W
Out	error indicator	I
Out	list of GSE identifiers	L(GS)

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

The information returned by this function is the list of workstation dependent generalized structure elements supported by this particular workstation type.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

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002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type

References: 4.5.1 4.4.8 4.6.1 4.6.2 4.11

Errors:

none

INQUIRE NUMBER OF DISPLAY PRIORITIES SUPPORTED (PHOP,*,*,*)

Parameters:

In	workstation type		W
Out	error indicator		I
Out	number of display priorities supported	(0,2..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and the value is returned in the output parameters.

If the inquired information is not available, the value returned in the output parameter is implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type

References: 4.4.3 4.6.1 4.6.2 4.11

Errors:

none

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INQUIRE WORKSTATION STATE TABLE LENGTHS **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
Out	error indicator		I
Out	maximum number of polyline bundle table entries	(20..n)	I
Out	maximum number of polymarker bundle table entries	(20..n)	I
Out	maximum number of text bundle table entries	(20..n)	I
Out	maximum number of interior bundle table entries	(20..n)	I
Out	maximum number of edge bundle table entries	(20..n)	I
Out	maximum number of pattern indices	(0,10..n)	I
Out	maximum number of colour indices	(2..n)	I
Out	maximum number of view table indices	(6..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type

References: 4.5.2 4.6.1 4.6.2 4.11

Errors:

none

INQUIRE DYNAMICS OF STRUCTURES **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
Out	error indicator		I
Out	structure content modification	(IRG,IMM,CBS)	E
Out	post structure	(IRG,IMM,CBS)	E
Out	unpost structure	(IRG,IMM,CBS)	E
Out	delete structure	(IRG,IMM,CBS)	E
Out	reference modification	(IRG,IMM,CBS)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

IRG means that implicit regeneration is necessary; IMM means the action is performed immediately; CBS means that the action can be simulated.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

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002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
059 Ignoring function, the specified workstation does not have output capability (i.e., the workstation category is neither OUTPUT, OUTIN, nor MO)
062 Ignoring function, this information is not available for this MO workstation type

References: 4.4.3 4.4.4 4.4.5 4.6.1 4.6.2 4.6.3 4.11

Errors:
none

INQUIRE NUMBER OF AVAILABLE LOGICAL INPUT DEVICES (PHOP,*,*,*)

Parameters:

In	workstation type		W
Out	error indicator		I
Out	number of locator devices	(0..n)	I
Out	number of stroke devices	(0..n)	I
Out	number of valuator devices	(0..n)	I
Out	number of choice devices	(0..n)	I
Out	number of pick devices	(0..n)	I
Out	number of string devices	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN

References: 4.6.1 4.6.2 4.8 4.11

Errors:
none

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INQUIRE DEFAULT LOCATOR DEVICE DATA 3 **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
In	logical input device number	(1..n)	I
Out	error indicator		I
Out	default initial locator position	WC	P3
Out	list of available prompt and echo types		L(I)
Out	default echo volume	DC	3×B
Out	default locator data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

References: 4.6.1 4.6.2 4.7.7 4.8 4.11

Errors:

none

INQUIRE DEFAULT LOCATOR DEVICE DATA **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
In	logical input device number	(1..n)	I
Out	error indicator		I
Out	default initial locator position	WC	P2
Out	list of available prompt and echo types		L(I)
Out	default echo area	DC	2×B
Out	default locator data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

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References: 4.6.1 4.6.2 4.7.7 4.8 4.11

Errors:

none

INQUIRE DEFAULT STROKE DEVICE DATA 3 **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
In	logical input device number	(1..n)	I
Out	error indicator		I
Out	available input buffer size (number of points)	(64..n)	I
Out	list of available prompt and echo types		L(I)
Out	default echo volume	DC	3×B
Out	default stroke data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

References: 4.6.1 4.6.2 4.7.8 4.8 4.11

Errors:

none

INQUIRE DEFAULT STROKE DEVICE DATA **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
In	logical input device number	(1..n)	I
Out	error indicator		I
Out	available input buffer size (number of points)	(64..n)	I
Out	list of available prompt and echo types		L(I)
Out	default echo area	DC	2×B
Out	default stroke data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

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002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

References: 4.6.1 4.6.2 4.7.8 4.8 4.11

Errors:

none

INQUIRE DEFAULT VALUATOR DEVICE DATA 3 **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
In	logical input device number	(1..n)	I
Out	error indicator		I
Out	default initial value		R
Out	list of available prompt and echo types		L(I)
Out	default echo volume	DC	3×B
Out	default valuator data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

References: 4.6.1 4.6.2 4.8 4.11

Errors:

none

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INQUIRE DEFAULT VALUATOR DEVICE DATA **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
In	logical input device number	(1..n)	I
Out	error indicator		I
Out	default initial value		R
Out	list of available prompt and echo types		L(I)
Out	default echo area	DC	2×B
Out	default valuator data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

References: 4.6.1 4.6.2 4.8 4.11

Errors:

none

INQUIRE DEFAULT CHOICE DEVICE DATA 3 **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
In	logical input device number	(1..n)	I
Out	error indicator		I
Out	maximum number of choice alternatives	(1..n)	I
Out	list of available prompt and echo types		L(I)
Out	default echo volume	DC	3×B
Out	default choice data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

References: 4.6.1 4.6.2 4.8 4.11

Errors:

none

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INQUIRE DEFAULT CHOICE DEVICE DATA **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
In	logical input device number	(1..n)	I
Out	error indicator		I
Out	maximum number of choice alternatives	(1..n)	I
Out	list of available prompt and echo types		L(I)
Out	default echo area	DC	2×B
Out	default choice data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

References: 4.6.1 4.6.2 4.8 4.11

Errors:

none

INQUIRE DEFAULT PICK DEVICE DATA 3 **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
In	logical input device number	(1..n)	I
Out	error indicator		I
Out	list of available prompt and echo types		L(I)
Out	default echo volume	DC	3×B
Out	default pick data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

References: 4.6.1 4.6.2 4.8 4.11

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Errors:
none

INQUIRE DEFAULT PICK DEVICE DATA **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
In	logical input device number	(1..n)	I
Out	error indicator		I
Out	list of available prompt and echo types		L(I)
Out	default echo area	DC	2×B
Out	default pick data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

References: 4.6.1 4.6.2 4.8 4.11

Errors:
none

INQUIRE DEFAULT STRING DEVICE DATA 3 **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
In	logical input device number	(1..n)	I
Out	error indicator		I
Out	available input buffer size (number of characters)	(72..n)	I
Out	list of available prompt and echo types		L(I)
Out	default echo volume	DC	3×B
Out	default string data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

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002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

References: 4.6.1 4.6.2 4.8 4.11

Errors:

none

INQUIRE DEFAULT STRING DEVICE DATA **(PHOP,*,*,*)**

Parameters:

In	workstation type		W
In	logical input device number	(1..n)	I
Out	error indicator		I
Out	available input buffer size (number of available characters)	(72..n)	I
Out	list of available prompt and echo types		L(I)
Out	default echo area	DC	2×B
Out	default string data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
052 Ignoring function, workstation type not recognized by the implementation
051 Ignoring function, this information is not yet available for this generic workstation type; open a workstation of this type and use the specific workstation type
061 Ignoring function, specified workstation is neither of category INPUT nor of category OUTIN
250 Ignoring function, the specified device is not available on the specified workstation

References: 4.6.1 4.6.2 4.8 4.11

Errors:

none

5.12.7 Inquiry function for structure state list

INQUIRE SET OF WORKSTATIONS TO WHICH POSTED **(PHOP,*,*,*)**

Parameters:

In	structure identifier	I
Out	error indicator	I
Out	set of workstation identifiers	L(WI)

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to

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indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
201 Ignoring function, the specified structure does not exist

References: 4.4.3 4.11

Errors:

none

5.12.8 Inquiry functions for structure content

INQUIRE OPEN STRUCTURE **(PHOP,*,*,*)**

Parameters:

Out	error indicator		I
Out	open structure status	(NONE, OPEN)	E
Out	structure identifier		I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If a structure is open the open structure status is OPEN and the identifier of the open structure is returned as structure identifier. If no structure is open the open structure status is returned as NONE and the structure identifier is undefined.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.4.4 4.11

Errors:

none

INQUIRE ELEMENT POINTER **(PHOP,*,STOP,*)**

Parameters:

Out	error indicator		I
Out	element position	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

References: 4.4.4 4.11

Errors:

none

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INQUIRE CURRENT ELEMENT TYPE AND SIZE **(PHOP,*,STOP,*)**

Parameters:

Out	error indicator		I
Out	element type	(*see below*)	E
Out	element size	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

The element type of the structure element pointed to by the 'element pointer' is returned. If elements of this type have no associated values, 0 is returned in the element size parameter. If the 'element pointer' is currently 0, a NIL value is returned in the element type parameter.

The element types are:

NIL,
POLYLINE_3,
POLYLINE,
POLYMARKER_3,
POLYMARKER,
TEXT_3,
TEXT,
ANNOTATION_TEXT_RELATIVE_3,
ANNOTATION_TEXT_RELATIVE,
FILL_AREA_3,
FILL_AREA,
FILL_AREA_SET_3,
FILL_AREA_SET,
CELL_ARRAY_3,
CELL_ARRAY,
GENERALIZED_DRAWING_PRIMITIVE_3,
GENERALIZED_DRAWING_PRIMITIVE,
SET_POLYLINE_INDEX,
SET_POLYMARKER_INDEX,
SET_TEXT_INDEX,
SET_INTERIOR_INDEX,
SET_EDGE_INDEX,
SET_LINETYPE,
SET_LINEWIDTH_SCALE_FACTOR,
SET_POLYLINE_COLOUR_INDEX,
SET_MARKER_TYPE,
SET_MARKER_SIZE_SCALE_FACTOR,
SET_POLYMARKER_COLOUR_INDEX,
SET_TEXT_FONT,
SET_TEXT_PRECISION,
SET_CHARACTER_EXPANSION_FACTOR,
SET_CHARACTER_SPACING,
SET_TEXT_COLOUR_INDEX,
SET_CHARACTER_HEIGHT,
SET_CHARACTER_UP_VECTOR,
SET_TEXT_PATH,
SET_TEXT_ALIGNMENT,
SET_ANNOTATION_TEXT_CHARACTER_HEIGHT,
SET_ANNOTATION_TEXT_CHARACTER_UP_VECTOR,

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SET_ANNOTATION_TEXT_PATH,
SET_ANNOTATION_TEXT_ALIGNMENT,
SET_ANNOTATION_STYLE,
SET_INTERIOR_STYLE,
SET_INTERIOR_STYLE_INDEX,
SET_INTERIOR_COLOUR_INDEX,
SET_EDGE_FLAG,
SET_EDGETYPE,
SET_EDGEWIDTH_SCALE_FACTOR,
SET_EDGE_COLOUR_INDEX,
SET_PATTERN_SIZE,
SET_PATTERN_REFERENCE_POINT_AND_VECTORS,
SET_PATTERN_REFERENCE_POINT,
ADD_NAMES_TO_SET,
REMOVE_NAMES_FROM_SET,
SET_INDIVIDUAL_ASF,
SET_HLHSR_IDENTIFIER,
SET_LOCAL_MODELLING_TRANSFORMATION_3,
SET_LOCAL_MODELLING_TRANSFORMATION,
SET_GLOBAL_MODELLING_TRANSFORMATION_3,
SET_GLOBAL_MODELLING_TRANSFORMATION,
SET_MODELLING_CLIPPING_VOLUME_3,
SET_MODELLING_CLIPPING_VOLUME,
SET_MODELLING_CLIPPING_INDICATOR,
RESTORE_MODELLING_CLIPPING_VOLUME,
SET_VIEW_INDEX,
EXECUTE_STRUCTURE,
LABEL,
APPLICATION_DATA,
GENERALIZED_STRUCTURE_ELEMENT,
SET_PICK_IDENTIFIER

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

References: 4.4.4 4.11

Errors:

none

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INQUIRE CURRENT ELEMENT CONTENT **(PHOP,*,STOP,*)**

Parameters:

Out	error indicator	I
Out	structure element record	D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

The values associated with the structure element pointed to by 'element pointer' are returned in the structure element record parameter.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

005 Ignoring function, function requires state (PHOP,,STOP,*)*

References: 4.4.4 4.11

Errors:

none

INQUIRE ELEMENT TYPE AND SIZE **(PHOP,*,*,*)**

Parameters:

In	structure identifier		I
In	element position	(0..n)	I
Out	error indicator		I
Out	element type	(*see below*)	E
Out	element size	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

The element type of the specified element is returned. If elements of this type have no associated values, 0 is returned in the element size parameter. If the 'element pointer' is currently 0, a NIL value is returned in the element type parameter.

The element types are:

NIL,
POLYLINE_3,
POLYLINE,
POLYMARKER_3,
POLYMARKER,
TEXT_3,
TEXT,
ANNOTATION_TEXT_RELATIVE_3,
ANNOTATION_TEXT_RELATIVE,
FILL_AREA_3,
FILL_AREA,
FILL_AREA_SET_3,
FILL_AREA_SET,
CELL_ARRAY_3,
CELL_ARRAY,
GENERALIZED_DRAWING_PRIMITIVE_3,
GENERALIZED_DRAWING_PRIMITIVE,
SET_POLYLINE_INDEX,
SET_POLYMARKER_INDEX,
SET_TEXT_INDEX,
SET_INTERIOR_INDEX,
SET_EDGE_INDEX,
SET_LINETYPE,
SET_LINEWIDTH_SCALE_FACTOR,
SET_POLYLINE_COLOUR_INDEX,
SET_MARKER_TYPE,

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SET_MARKER_SIZE_SCALE_FACTOR,
SET_POLYMARKER_COLOUR_INDEX,
SET_TEXT_FONT,
SET_TEXT_PRECISION,
SET_CHARACTER_EXPANSION_FACTOR,
SET_CHARACTER_SPACING,
SET_TEXT_COLOUR_INDEX,
SET_CHARACTER_HEIGHT,
SET_CHARACTER_UP_VECTOR,
SET_TEXT_PATH,
SET_TEXT_ALIGNMENT,
SET_ANNOTATION_TEXT_CHARACTER_HEIGHT,
SET_ANNOTATION_TEXT_CHARACTER_UP_VECTOR,
SET_ANNOTATION_TEXT_PATH,
SET_ANNOTATION_TEXT_ALIGNMENT,
SET_ANNOTATION_STYLE,
SET_INTERIOR_STYLE,
SET_INTERIOR_STYLE_INDEX,
SET_INTERIOR_COLOUR_INDEX,
SET_EDGE_FLAG,
SET_EDGETYPE,
SET_EDGEWIDTH_SCALE_FACTOR,
SET_EDGE_COLOUR_INDEX,
SET_PATTERN_SIZE,
SET_PATTERN_REFERENCE_POINT_AND_VECTORS,
SET_PATTERN_REFERENCE_POINT,
ADD_NAMES_TO_SET,
REMOVE_NAMES_FROM_SET,
SET_INDIVIDUAL_ASF,
SET_HLHSR_IDENTIFIER,
SET_LOCAL_MODELLING_TRANSFORMATION_3,
SET_LOCAL_MODELLING_TRANSFORMATION,
SET_GLOBAL_MODELLING_TRANSFORMATION_3,
SET_GLOBAL_MODELLING_TRANSFORMATION,
SET_MODELLING_CLIPPING_VOLUME_3,
SET_MODELLING_CLIPPING_VOLUME,
SET_MODELLING_CLIPPING_INDICATOR,
RESTORE_MODELLING_CLIPPING_VOLUME,
SET_VIEW_INDEX,
EXECUTE_STRUCTURE,
LABEL,
APPLICATION_DATA,
GENERALIZED_STRUCTURE_ELEMENT,
SET_PICK_IDENTIFIER

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
201 Ignoring function, the specified structure does not exist
202 Ignoring function, the specified element does not exist

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References: 4.4.4 4.11

Errors:

none

INQUIRE ELEMENT CONTENT **(PHOP,*,*,*)**

Parameters:

In	structure identifier		I
In	element position	(0..n)	I
Out	error indicator		I
Out	structure element record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

The values associated with the specified structure element are returned in the structure element record parameter.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
201 Ignoring function, the specified structure does not exist
202 Ignoring function, the specified element does not exist

References: 4.4.6 4.11

Errors:

none

INQUIRE STRUCTURE STATUS **(PHOP,*,*,*)**

Parameters:

In	structure identifier		I
Out	error indicator		I
Out	structure status indicator	(NON_EXISTENT,EMPTY,NOTEMPTY)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the specified structure does not exist, the structure status indicator is set to NON_EXISTENT. If the specified structure exists (i.e. its name is known to the system) and it contains no elements, the structure status indicator is set to EMPTY, otherwise it is set to NOTEMPTY.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.4.2 4.11

Errors:

none

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INQUIRE PATHS TO ANCESTORS **(PHOP,*,*,*)**

Parameters:

In	structure identifier		I
In	path order	(TOPFIRST,BOTTOMFIRST)	E
In	path depth	(0..n)	I
Out	error indicator		I
Out	paths		L(L(ER))

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

The function returns the maximal paths in the CSS which reference the specified structure. A maximal path of ancestors of a structure S is a path ((A1,E1), (A2,E2), ..., (S,0)), where A1 is not referenced in any EXECUTE STRUCTURE element in CSS. The path order and path depth determine the portion of each path to be returned. Path depth determines the maximum number of element references returned in any one path or portion of path. In case of truncation the path order determines whether the head or tail portion of the path is returned. The truncation may result in two or more portions of paths having the same set of element references. Only one such portion will be returned such that all of the returned path portions are distinct.

Specifying path depth = 0 would return each path in its entirety. Specifying path depth = 0 and path order = TOPFIRST would cause all distinct paths to the specified structure to be returned. Specifying path depth = 1 and path order = TOPFIRST would cause all element references heading a path to the specified structure to be returned. Specifying path depth = 2 and path order = BOTTOMFIRST would cause all element references referring to the specified structure to be returned. Specifying path depth = 1 and path order = BOTTOMFIRST could be used to determine whether the specified structure is referenced.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
201 Ignoring function, the specified structure does not exist
207 Ignoring function, the specified path depth is less than zero (0)

References: 4.4.6 4.11

Errors:

none

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INQUIRE PATHS TO DESCENDANTS **(PHOP,*,*,*)**

Parameters:

In	structure identifier		I
In	path order	(TOPFIRST,BOTTOMFIRST)	E
In	path depth	(0..n)	I
Out	error indicator		I
Out	paths		L(L(ER))

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

The function returns the maximal paths in the CSS which are referenced by the specified structure. A maximal path of descendants of a structure S is a path ((S,E0), (D1,E1), (D2,E2), ...,

(DN,0)), where DN contains no EXECUTE STRUCTURE element. The path order and path depth determine the portion of each path to be returned. Path depth determines the maximum number of element references returned in any one path or portion of path. In case of truncation the path order determines whether the head or tail portion of the path is returned. The truncation may result in two or more portions of paths having the same set of element references. Only one such portion will be returned such that all of the returned path portions are distinct.

Specifying path depth = 0 would return each path in its entirety. Specifying path depth = 0 and path order = TOPFIRST would cause all distinct paths from the specified structure to be returned. Specifying path depth = 1 and path order = TOPFIRST would cause element references in the specified structure to be returned as separate path lists. Specifying path depth = 1 and path order = BOTTOMFIRST could be used to determine all of the bottom-most structures of the structure network.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
201 Ignoring function, the specified structure does not exist
207 Ignoring function, the specified path depth is less than zero (0)

References: 4.4.6 4.11

Errors:

none

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ELEMENT SEARCH **(PHOP,*,*,*)**

Parameters:

In	structure identifier		I
In	start element position	(0..n)	I
In	search direction	(BACKWARD,FORWARD)	E
In	element inclusion set (see list below)		SET(E)
In	element exclusion set (see list below)		SET(E)
Out	error indicator		I
Out	status indicator	(FAILURE,SUCCESS)	E
Out	found element position	(0..n)	I

Effect: This function searches for the next matching element in the structure identified, beginning at the start element position and proceeding in the direction specified. The search terminates if an element is selected or if the limits of the structure are reached.

An element will be selected if the type of that element is not excluded by the element exclusion set and is included in the element inclusion set. The element type ALL is a shorthand for all possible element types. If an element type is specified in both the exclusion set and the inclusion set, it will be excluded.

If the start element position is less than 0, the search will begin at element 0; if the start element position is greater than the number of elements in the open structure, the search will begin at the last element in the open structure.

If the search is successful, the status indicator returns the value SUCCESS and found element position parameter is set to point at the matching element.

If the search is unsuccessful, the status indicator returns the value FAILURE and the value of found element position parameter value returned is implementation dependent.

The element types are:

ALL,
NIL,
POLYLINE_3,
POLYLINE,
POLYMARKER_3,
POLYMARKER,
TEXT_3,
TEXT,
ANNOTATION_TEXT_RELATIVE_3,
ANNOTATION_TEXT_RELATIVE,
FILL_AREA_3,
FILL_AREA,
FILL_AREA_SET_3,
FILL_AREA_SET,
CELL_ARRAY_3,
CELL_ARRAY,
GENERALIZED_DRAWING_PRIMITIVE_3,
GENERALIZED_DRAWING_PRIMITIVE,
SET_POLYLINE_INDEX,
SET_POLYMARKER_INDEX,
SET_TEXT_INDEX,
SET_INTERIOR_INDEX,
SET_EDGE_INDEX,
SET_LINETYPE,
SET_LINEWIDTH_SCALE_FACTOR,
SET_POLYLINE_COLOUR_INDEX,
SET_MARKER_TYPE,
SET_MARKER_SIZE_SCALE_FACTOR,
SET_POLYMARKER_COLOUR_INDEX,
SET_TEXT_FONT,
SET_TEXT_PRECISION,
SET_CHARACTER_EXPANSION_FACTOR,
SET_CHARACTER_SPACING,
SET_TEXT_COLOUR_INDEX,
SET_CHARACTER_HEIGHT,
SET_CHARACTER_UP_VECTOR,
SET_TEXT_PATH,
SET_TEXT_ALIGNMENT,
SET_ANNOTATION_TEXT_CHARACTER_HEIGHT,
SET_ANNOTATION_TEXT_CHARACTER_UP_VECTOR,
SET_ANNOTATION_TEXT_PATH,
SET_ANNOTATION_TEXT_ALIGNMENT,
SET_ANNOTATION_STYLE,
SET_INTERIOR_STYLE,
SET_INTERIOR_STYLE_INDEX,
SET_INTERIOR_COLOUR_INDEX,
SET_EDGE_FLAG,
SET_EDGETYPE,

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SET_EDGEWIDTH_SCALE_FACTOR,
SET_EDGE_COLOUR_INDEX,
SET_PATTERN_SIZE,
SET_PATTERN_REFERENCE_POINT_AND_VECTORS,
SET_PATTERN_REFERENCE_POINT,
ADD_NAMES_TO_SET,
REMOVE_NAMES_FROM_SET,
SET_INDIVIDUAL_ASF,
SET_HLHSR_IDENTIFIER,
SET_LOCAL_MODELLING_TRANSFORMATION_3,
SET_LOCAL_MODELLING_TRANSFORMATION,
SET_GLOBAL_MODELLING_TRANSFORMATION_3,
SET_GLOBAL_MODELLING_TRANSFORMATION,
SET_MODELLING_CLIPPING_VOLUME_3,
SET_MODELLING_CLIPPING_VOLUME,
SET_MODELLING_CLIPPING_INDICATOR,
RESTORE_MODELLING_CLIPPING_VOLUME,
SET_VIEW_INDEX,
EXECUTE_STRUCTURE,
LABEL,
APPLICATION_DATA,
GENERALIZED_STRUCTURE_ELEMENT,
SET_PICK_IDENTIFIER

If the inquired information is available, the error indicator is returned with value zero and values are returned in the output parameters. If the inquired information is not available, the values returned are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
201 Ignoring function, the specified structure does not exist

References: 4.4.6 4.11

Errors:

none

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INCREMENTAL SPATIAL SEARCH 3 **(PHOP,*,*,*)**

Parameters:

In	search reference point	WC	P3
In	search distance	WC	R
In	starting path		L(ER)
In	modelling clip flag	(CLIP,NOCLIP)	E
In	search ceiling index	(1..n)	I
In	normal filter list		L(FR)
In	inverted filter list		L(FR)
Out	error indicator		I
Out	found path		L(ER)

Effect: The search begins at the element following the position specified by the starting path. The search is conceptually a traversal as described in 4.4.6. As with all traversals, the initial state of the PHIGS traversal state list is defined in the PHIGS description table. Traversal through the starting path then further defines the PHIGS traversal state for the ISS traversal. The search terminates successfully if a graphical output structure element is encountered which both satisfies the search filter and some portion of the graphical output structure element lies within the world coordinate space search distance of the search reference point. If the modelling clip flag is set to NOCLIP, modelling clipping is disabled during the incremental spatial search. If the modelling clip flag is set to CLIP, modelling clipping is performed during incremental spatial search. If the search distance is less than or equal to zero, the graphical output structure element shall intersect the reference point. The complete path to the element is returned as the found path.

The search ceiling index defines a structure in the starting path. Traversal stops when the end of that structure is reached. A null path is returned as the found path if traversal stops due to encountering the search ceiling. If the ceiling index is 1, the top-most structure of the search path is the ceiling and the search operates without a ceiling.

If the inquired information is available, the error indicator is returned with value zero and values are returned in the output parameters. If the inquired information is not available, the values returned are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
203 Ignoring function, specified starting path not found in CSS
204 Ignoring function, specified search ceiling index out of range

References: 4.4.6 4.11

Errors:

none

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INCREMENTAL SPATIAL SEARCH **(PHOP,*,*,*)**

Parameters:

In	search reference point	WC	P2
In	search distance	WC	R
In	starting path		L(ER)
In	modelling clip flag	(CLIP,NOCLIP)	E
In	search ceiling index	(1..n)	I
In	normal filter list		L(FR)
In	inverted filter list		L(FR)
Out	error indicator		I
Out	found path		L(ER)

Effect: The search begins at the element following the position specified by the starting path. The search is conceptually a traversal as described in 4.4.6. As with all traversals, the initial state of the PHIGS traversal state list is defined in the PHIGS description table. Traversal through the starting path then further defines the PHIGS traversal state for the ISS traversal. The search terminates successfully if a graphical output structure element is encountered which both satisfies the search filter and some portion of the graphical output structure element lies within the world coordinate space search distance of the search reference point as expanded to 3D. Expansion of the search reference point to 3D occurs by adding a value of zero as the z-component of the resulting 3D coordinate. If the modelling clip flag is set to NOCLIP, modelling clipping is disabled during the incremental spatial search. If the modelling clip flag is set to CLIP, modelling clipping is

performed during incremental spatial search. If the search distance is less than or equal to zero, the graphical output structure element shall intersect the reference point. The complete path to the element is returned as the found path.

The search ceiling index defines a structure in the starting path. Traversal stops when the end of that structure is reached. A null path is returned as the found path if traversal stops due to encountering the search ceiling. If the ceiling index is 1, the top-most structure of the search path is the ceiling and the search operates without a ceiling.

If the inquired information is available, the error indicator is returned with value zero and values are returned in the output parameters. If the inquired information is not available, the values returned are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*
203 Ignoring function, specified starting path not found in CSS
204 Ignoring function, specified search ceiling index out of range

References: 4.4.6 4.11

Errors:

none

5.12.9 Inquiry functions for error state list

INQUIRE INPUT QUEUE OVERFLOW **(PHOP,WSOP,*,*)**

Parameters:

Out	error indicator		I
Out	workstation identifier		WI
Out	input class (LOCATOR,STROKE,VALUATOR,CHOICE,PICK,STRING)		E
Out	input device number	(1..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters. If the input queue has overflowed, since OPEN PHIGS or the last invocation of INQUIRE INPUT QUEUE OVERFLOW, the identification of the logical input device that caused the overflow is returned. The entry is removed from the error state list.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

003 Ignoring function, function requires state (PHOP,WSOP,,*)*
257 Ignoring function, input queue has not overflowed, since OPEN PHIGS or last invocation of INQUIRE INPUT QUEUE OVERFLOW
258 Ignoring function, input queue has overflowed, but associated workstation has been closed

References: 4.8.5 4.11 4.12

Errors:

none

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INQUIRE ERROR HANDLING MODE **(PHOP,*,*,*)**

Parameters:

Out	error indicator		I
Out	error handling mode	(OFF,ON)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and the value is returned in the output parameter.

If the inquired information is not available, the value returned in the output parameter is implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

002 Ignoring function, function requires state (PHOP,,*,*)*

References: 4.11 4.12

Errors:

none

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