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**AMENDMENT 1**  
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## **Information technology — Computer graphics — Programmer's Hierarchical Interactive Graphics System (PHIGS) language bindings —**

**Part 4:**  
**C**

**AMENDMENT 1**

*Technologies de l'information — Infographie — Interfaces langage entre un  
programme d'application et son support graphique —*

*Partie 4: C*

*AMENDEMENT 1*



Reference number  
ISO/IEC 9593-4:1991/Amd.1:1994(E)

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## Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. 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 voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

Amendment 1 to International Standard ISO/IEC 9593-4:1991 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*.

## Introduction

*Replace the current text with the following:*

Part 1 of the Programmer's Hierarchical Interactive Graphics System (PHIGS) functional description is registered as ISO/IEC 9592-1:1989. Part 1 is extended by part 4, ISO/IEC 9592-4:1991 to incorporate the effects of lighting, shading and other properties important for the display of surfaces and multidimensional data. The purpose of this part of ISO/IEC 9593 is to define a standard binding for the C computer programming language to the functionality defined in ISO/IEC 9592-1:1989 and ISO/IEC 9592-4:1991.

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# Information technology — Computer graphics — Programmer's Hierarchical Interactive Graphics System (PHIGS) language bindings —

## Part 4: C

### AMENDMENT 1

#### 1 Scope

*Replace the text with the following:*

Part 1 of the Programmer's Hierarchical Interactive Graphics System (PHIGS), ISO/IEC 9592-1, and part 4 (PHIGS PLUS), ISO/IEC 9592-4, specify a language independent nucleus of a graphics system. For integration into a programming language, PHIGS and PHIGS PLUS are embedded in a language dependent layer obeying the particular conventions of that language. This part of ISO/IEC 9593 specifies such a language dependent layer for the C language.

## 2 Normative references

Add the following reference:

ISO/IEC 9592-4:1992, *Information processing systems — Computer graphics — Programmer's Hierarchical Interactive Graphics System (PHIGS) — Part 4: Plus Lumière und Surfaces, PHIGS PLUS*.

STANDARDSISO.COM : Click to view the full PDF of ISO/IEC 9593-4:1991/AMD1:1994

### 3 The C language binding of PHIGS

*Change the clause heading to The C language binding of PHIGS and PHIGS PLUS.*

#### 3.1 Conformance

*Replace the last two paragraphs with the following text:*

In order to conform, an implementation of the C binding of PHIGS shall implement those functions specified in ISO/IEC 9592-1. The implementation shall make visible all of the declarations in the C binding specified in clauses 5 to 7 in this part of ISO/IEC 9593.

In order to conform, an implementation of the C binding of PHIGS PLUS shall implement those functions specified in ISO/IEC 9592-1 and also those functions specified in ISO/IEC 9592-4. The implementation shall make visible all of the declarations in the C binding specified in clauses 5 to 10 in this part of ISO/IEC 9593.

Thus, for example, the syntax of the function names shall be precisely as specified in this part of ISO/IEC 9593 and the parameters shall be of the data types stated in this part of ISO/IEC 9593.

#### 3.2 Functions versus macros

*No changes.*

#### 3.3 Character strings

*No changes.*

#### 3.4 Function identifiers

*No changes.*

#### 3.5 Registration

*No changes.*

### **3.6 Identifiers for graphical items**

*No changes.*

### **3.7 Return values**

*No changes.*

### **3.8 Header files**

*No changes.*

### **3.9 Memory management**

*No changes.*

#### **3.9.1 Inquiry functions which return simple lists**

*No changes.*

#### **3.9.2 Inquiry functions which return complex data structures**

*No changes.*

#### **3.9.3 Meaning of the size of an element**

*No changes.*

### **3.10 Inquiries returning structure elements**

*No changes.*

### 3.11 Error handling

#### 3.11.1 Application defined error handlers

*No changes.*

#### 3.11.2 Error codes

*No changes.*

#### 3.11.3 C specific PHIGS errors

*Change the heading to **C binding specific errors** and add the following binding specific errors:*

- |      |                                                                                                                                                                                                                                                                                                   |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2207 | Ignoring function, two or more vertices do not contain the same type of data<br>Is issued when an output primitive is created in which one or more of the vertices are specified with a particular type of data, such as normals, and other vertices are specified without the same type of data. |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### 3.12 Storage of two-dimensional data

*No changes.*

#### 3.12.1 Storage of matrices

*No changes.*

### 3.12.2 Storage of colour arrays

*Change the heading to be Storage of arrays and replace the text with the following:*

The entries of the Ppat\_rep and Px\_array data types (where x is one of colrv, colrv\_ctrl\_point, ctrl\_point3, data\_ctrl\_point, edge\_flag, facet, float, vertex, and vertex3) shall be stored such that the  $(i,j)^{\text{th}}$  element in the array is given by the following expression:

$$i + j * DX$$

where:

$$i = 0, \dots, DX-1,$$

$$j = 0, \dots, DY-1,$$

DX = the size\_x value of the array's Pint\_size field, and

DY = the size\_y value of the array's Pint\_size field.

### 3.13 Data type descriptions

*Add the clause with the following text:*

The Pedge\_flag\_array data type defines an edge visibility flag for each edge of the quadrilateral mesh. The edge visibility flags are arranged in a  $MXN$  array of Pedge\_flag\_pairs. For each  $(ij)$  Pedge\_flag\_pair, the first element specifies the edge flag for the edge between the  $ij$  and  $i+1j$  vertices and the second element specifies the edge flag for the edge between the  $ij$  and  $ij+1$  vertices. The first element of the  $(M,j)$  Pedge\_flag\_pair, where  $1 \leq j \leq N$ , and second element of the  $(i,N)$  Pedge\_flag\_pair, where  $1 \leq i \leq M$ , are not used.

The Pedge\_flag\_triplet\_list data type consists of a list of Pedge\_flag\_triplets; one for each triangle in a triangle set. The first element of a Pedge\_flag\_triplet specifies the edge flag between the first and the second vertices of the triangle, the second element specifies the edge flag between the second and third vertices of the triangle. The third element specifies the edge flag between the third and first vertices of the triangle.

The Px\_set data types (where x is one of colrv, contour, edge\_flag, float, vertex, and vertex3) contain a list of Px\_lists.

The Px\_set\_list data types (where x is one of contour and edge\_flag) contains a list of Px\_sets.

## 4 Tables

### 4.1 Abbreviation policy for construction of identifiers

*No changes.*

### 4.2 Table of abbreviations

*Add alphabetically, to table 1, the following abbreviations:*

**Table 1 - Abbreviations ordered alphabetically**

| Word or Phrase  | Abbreviation |
|-----------------|--------------|
| activation      | act          |
| ambient         | amb          |
| approximation   | approx       |
| attenuation     | atten        |
| between         | NULL         |
| characteristics | chars        |
| coefficient     | coeff        |
| concentration   | conc         |
| constant        | const        |
| compute         | comp         |
| criteria        | crit         |
| culling         | cull         |
| deactivate      | deact        |
| deactivation    | deact        |
| deviation       | dev          |
| diffuse         | diff         |
| directional     | dir          |
| distinguishing  | disting      |
| exponent        | exp          |
| geometric       | geom         |
| homogeneous     | homo         |
| isoparametric   | isoparam     |
| parametric      | param        |
| positional      | pos          |
| product         | prod         |
| properties      | props        |
| quadrilateral   | quad         |

**Table 1 - Abbreviations ordered alphabetically**

| Word or Phrase | Abbreviation |
|----------------|--------------|
| reflectance    | refl         |
| rendering      | rend         |
| shading        | shad         |
| specular       | spec         |
| subdivision    | subd         |
| triangle       | tri          |
| triangular     | tri          |
| trimming       | trim         |
| with           | NULL         |

### 4.3 Function names

#### 4.3.1 List ordered alphabetically by bound name

*In table 2 change the column heading PHIGS Name to PHIGS and PHIGS PLUS Name and merge alphabetically by bound name, the following function names:*

**Table 2 - Function names ordered by bound name**

| C Name                     | PHIGS and PHIGS PLUS Name                |
|----------------------------|------------------------------------------|
| pcell_array3_plus          | CELL ARRAY 3 PLUS                        |
| pfill_area_set_data        | FILL AREA SET WITH DATA                  |
| pfill_area_set3_data       | FILL AREA SET 3 WITH DATA                |
| pinq_b_spline_surf_fac     | INQUIRE B-SPLINE SURFACE FACILITIES      |
| pinq_colr_map_fac          | INQUIRE COLOUR MAPPING FACILITIES        |
| pinq_colr_map_method_fac   | INQUIRE COLOUR MAPPING METHOD FACILITIES |
| pinq_colr_map_rep          | INQUIRE COLOUR MAPPING REPRESENTATION    |
| pinq_colr_map_st           | INQUIRE COLOUR MAPPING STATE             |
| pinq_curve_fac             | INQUIRE CURVE FACILITIES                 |
| pinq_data_map_fac          | INQUIRE DATA MAPPING FACILITIES          |
| pinq_data_map_rep          | INQUIRE DATA MAPPING REPRESENTATION      |
| pinq_depth_cue_fac         | INQUIRE DEPTH CUE FACILITIES             |
| pinq_depth_cue_rep         | INQUIRE DEPTH CUE REPRESENTATION         |
| pinq_direct_colr_model_fac | INQUIRE DIRECT COLOUR MODEL FACILITIES   |
| pinq_dyns_ws_plus          | INQUIRE DYNAMICS OF WORKSTATION PLUS     |
| pinq_edge_rep_plus         | INQUIRE EDGE REPRESENTATION PLUS         |
| pinq_int_fac_plus          | INQUIRE INTERIOR FACILITIES PLUS         |
| pinq_int_rep_plus          | INQUIRE INTERIOR REPRESENTATION PLUS     |
| pinq_light_source_fac      | INQUIRE LIGHT SOURCE FACILITIES          |
| pinq_light_source_rep      | INQUIRE LIGHT SOURCE REPRESENTATION      |
| pinq_line_fac_plus         | INQUIRE POLYLINE FACILITIES PLUS         |
| pinq_line_rep_plus         | INQUIRE POLYLINE REPRESENTATION PLUS     |
| pinq_list_colr_map_inds    | INQUIRE LIST OF COLOUR MAPPING INDICES   |

Table 2 - Function names ordered by bound name

| C Name                            | PHIGS and PHIGS PLUS Name                            |
|-----------------------------------|------------------------------------------------------|
| pinq_list_data_map_inds           | INQUIRE LIST OF DATA MAPPING INDICES                 |
| pinq_list_depth_cue_inds          | INQUIRE LIST OF DEPTH CUE INDICES                    |
| pinq_list_light_source_inds       | INQUIRE LIST OF LIGHT SOURCE INDICES                 |
| pinq_list_param_surf_inds         | INQUIRE LIST OF PARAMETRIC SURFACE INDICES           |
| pinq_list_refl_inds               | INQUIRE LIST OF REFLECTANCE INDICES                  |
| pinq_marker_rep_plus              | INQUIRE POLYMARKER REPRESENTATION PLUS               |
| pinq_param_surf_fac               | INQUIRE PARAMETRIC SURFACE FACILITIES                |
| pinq_param_surf_rep               | INQUIRE PARAMETRIC SURFACE REPRESENTATION            |
| pinq_pat_rep_plus                 | INQUIRE PATTERN REPRESENTATION PLUS                  |
| pinq_pred_colr_map_rep            | INQUIRE PREDEFINED COLOUR MAPPING REPRESENTATION     |
| pinq_pred_data_map_rep            | INQUIRE PREDEFINED DATA MAPPING REPRESENTATION       |
| pinq_pred_depth_cue_rep           | INQUIRE PREDEFINED DEPTH CUE REPRESENTATION          |
| pinq_pred_edge_rep_plus           | INQUIRE PREDEFINED EDGE REPRESENTATION PLUS          |
| pinq_pred_int_rep_plus            | INQUIRE PREDEFINED INTERIOR REPRESENTATION PLUS      |
| pinq_pred_light_source_rep        | INQUIRE PREDEFINED LIGHT SOURCE REPRESENTATION       |
| pinq_pred_line_rep_plus           | INQUIRE PREDEFINED POLYLINE REPRESENTATION PLUS      |
| pinq_pred_marker_rep_plus         | INQUIRE PREDEFINED POLYMARKER REPRESENTATION PLUS    |
| pinq_pred_param_surf_rep          | INQUIRE PREDEFINED PARAMETRIC SURFACE REPRESENTATION |
| pinq_pred_pat_rep_plus            | INQUIRE PREDEFINED PATTERN REPRESENTATION PLUS       |
| pinq_pred_refl_rep                | INQUIRE PREDEFINED REFLECTANCE REPRESENTATION        |
| pinq_pred_text_rep_plus           | INQUIRE PREDEFINED TEXT REPRESENTATION PLUS          |
| pinq_refl_fac                     | INQUIRE REFLECTANCE FACILITIES                       |
| pinq_refl_rep                     | INQUIRE REFLECTANCE REPRESENTATION                   |
| pinq_rend_colr_model_fac          | INQUIRE RENDERING COLOUR MODEL FACILITIES            |
| pinq_text_rep_plus                | INQUIRE TEXT REPRESENTATION PLUS                     |
| pinq_trim_curve_fac               | INQUIRE TRIMMING CURVE FACILITIES                    |
| pinq_ws_st_table_length_plus      | INQUIRE WORKSTATION STATE TABLE LENGTHS PLUS         |
| pnon_uniform_b_spline_curve3      | NON-UNIFORM B-SPLINE CURVE 3                         |
| pnon_uniform_b_spline_curve3_colr | NON-UNIFORM B-SPLINE CURVE 3 WITH COLOUR             |
| pnon_uniform_b_spline_surf3       | NON-UNIFORM B-SPLINE SURFACE 3                       |
| pnon_uniform_b_spline_surf3_data  | NON-UNIFORM B-SPLINE SURFACE 3 WITH DATA             |
| ppolyline_set3_colr               | POLYLINE SET 3 WITH COLOUR                           |
| pquad_mesh_data                   | QUADRILATERAL MESH WITH DATA                         |
| pquad_mesh3_data                  | QUADRILATERAL MESH 3 WITH DATA                       |
| pset_back_data_map_ind            | SET BACK DATA MAPPING INDEX                          |
| pset_back_data_map_method         | SET BACK DATA MAPPING METHOD                         |
| pset_back_int_colr                | SET BACK INTERIOR COLOUR                             |
| pset_back_int_ind                 | SET BACK INTERIOR INDEX                              |
| pset_back_int_shad_method         | SET BACK INTERIOR SHADING METHOD                     |
| pset_back_int_style               | SET BACK INTERIOR STYLE                              |
| pset_back_int_style_ind           | SET BACK INTERIOR STYLE INDEX                        |
| pset_back_refl_ind                | SET BACK REFLECTANCE INDEX                           |
| pset_back_refl_model              | SET BACK REFLECTANCE MODEL                           |
| pset_back_refl_props              | SET BACK REFLECTANCE PROPERTIES                      |
| pset_colr_map_ind                 | SET COLOUR MAPPING INDEX                             |
| pset_colr_map_rep                 | SET COLOUR MAPPING REPRESENTATION                    |
| pset_curve_approx_crit            | SET CURVE APPROXIMATION CRITERIA                     |

**Table 2 - Function names ordered by bound name**

| <b>C Name</b>                | <b>PHIGS and PHIGS PLUS Name</b>       |
|------------------------------|----------------------------------------|
| pset_data_map_ind            | SET DATA MAPPING INDEX                 |
| pset_data_map_method         | SET DATA MAPPING METHOD                |
| pset_data_map_rep            | SET DATA MAPPING REPRESENTATION        |
| pset_depth_cue_ind           | SET DEPTH CUE INDEX                    |
| pset_depth_cue_rep           | SET DEPTH CUE REPRESENTATION           |
| pset_edge_colr               | SET EDGE COLOUR                        |
| pset_edge_rep_plus           | SET EDGE REPRESENTATION PLUS           |
| pset_facet_cull_mode         | SET FACET CULLING MODE                 |
| pset_facet_disting_mode      | SET FACET DISTINGUISHING MODE          |
| pset_int_colr                | SET INTERIOR COLOUR                    |
| pset_int_rep_plus            | SET INTERIOR REPRESENTATION PLUS       |
| pset_int_shad_method         | SET INTERIOR SHADING METHOD            |
| pset_light_source_rep        | SET LIGHT SOURCE REPRESENTATION        |
| pset_light_source_st         | SET LIGHT SOURCE STATE                 |
| pset_line_colr               | SET POLYLINE COLOUR                    |
| pset_line_rep_plus           | SET POLYLINE REPRESENTATION PLUS       |
| pset_line_shad_method        | SET POLYLINE SHADING METHOD            |
| pset_marker_colr             | SET POLYMARKER COLOUR                  |
| pset_marker_rep_plus         | SET POLYMARKER REPRESENTATION PLUS     |
| pset_of_fill_area_sets_data  | SET OF FILL AREA SETS WITH DATA        |
| pset_of_fill_area_sets3_data | SET OF FILL AREA SETS 3 WITH DATA      |
| pset_param_surf_chars        | SET PARAMETRIC SURFACE CHARACTERISTICS |
| pset_param_surf_ind          | SET PARAMETRIC SURFACE INDEX           |
| pset_param_surf_rep          | SET PARAMETRIC SURFACE REPRESENTATION  |
| pset_pat_rep_plus            | SET PATTERN REPRESENTATION PLUS        |
| pset_refl_ind                | SET REFLECTANCE INDEX                  |
| pset_refl_model              | SET REFLECTANCE MODEL                  |
| pset_refl_props              | SET REFLECTANCE PROPERTIES             |
| pset_refl_rep                | SET REFLECTANCE REPRESENTATION         |
| pset_rend_colr_model         | SET RENDERING COLOUR MODEL             |
| pset_surf_approx_crit        | SET SURFACE APPROXIMATION CRITERIA     |
| pset_text_colr               | SET TEXT COLOUR                        |
| pset_text_rep_plus           | SET TEXT REPRESENTATION PLUS           |
| ptri_set_data                | TRIANGLE SET WITH DATA                 |
| ptri_set3_data               | TRIANGLE SET 3 WITH DATA               |
| ptri_strip_data              | TRIANGLE STRIP WITH DATA               |
| ptri_strip3_data             | TRIANGLE STRIP 3 WITH DATA             |

**4.3.2 List ordered alphabetically by PHIGS function name**

*In table 3 change the clause heading to List ordered alphabetically by PHIGS and PHIGS PLUS function name, change the table caption to Table 3 - Function names ordered by PHIGS and PHIGS PLUS names,*

change the column heading PHIGS Name to PHIGS and PHIGS PLUS Name and merge alphabetically by function name the following function names:

**Table 3 - Function names ordered by PHIGS and PHIGS PLUS function name**

| PHIGS and PHIGS PLUS Name                            | C Name                      |
|------------------------------------------------------|-----------------------------|
| CELL ARRAY 3 PLUS                                    | pcell_array3_plus           |
| FILL AREA SET WITH DATA                              | pfill_area_set_data         |
| FILL AREA SET 3 WITH DATA                            | pfill_area_set3_data        |
| INQUIRE B-SPLINE SURFACE FACILITIES                  | pinq_b_spline_surf_fac      |
| INQUIRE COLOUR MAPPING FACILITIES                    | pinq_colr_map_fac           |
| INQUIRE COLOUR MAPPING METHOD FACILITIES             | pinq_colr_map_method_fac    |
| INQUIRE COLOUR MAPPING REPRESENTATION                | pinq_colr_map_rep           |
| INQUIRE COLOUR MAPPING STATE                         | pinq_colr_map_st            |
| INQUIRE CURVE FACILITIES                             | pinq_curve_fac              |
| INQUIRE DATA MAPPING FACILITIES                      | pinq_data_map_fac           |
| INQUIRE DATA MAPPING REPRESENTATION                  | pinq_data_map_rep           |
| INQUIRE DEPTH CUE FACILITIES                         | pinq_depth_cue_fac          |
| INQUIRE DEPTH CUE REPRESENTATION                     | pinq_depth_cue_rep          |
| INQUIRE DIRECT COLOUR MODEL FACILITIES               | pinq_direct_colr_model_fac  |
| INQUIRE DYNAMICS OF WORKSTATION PLUS                 | pinq_dyns_ws_plus           |
| INQUIRE EDGE REPRESENTATION PLUS                     | pinq_edge_rep_plus          |
| INQUIRE INTERIOR FACILITIES PLUS                     | pinq_int_fac_plus           |
| INQUIRE INTERIOR REPRESENTATION PLUS                 | pinq_int_rep_plus           |
| INQUIRE LIGHT SOURCE FACILITIES                      | pinq_light_source_fac       |
| INQUIRE LIGHT SOURCE REPRESENTATION                  | pinq_light_source_rep       |
| INQUIRE LIST OF COLOUR MAPPING INDICES               | pinq_list_colr_map_inds     |
| INQUIRE LIST OF DATA MAPPING INDICES                 | pinq_list_data_map_inds     |
| INQUIRE LIST OF DEPTH CUE INDICES                    | pinq_list_depth_cue_inds    |
| INQUIRE LIST OF LIGHT SOURCE INDICES                 | pinq_list_light_source_inds |
| INQUIRE LIST OF PARAMETRIC SURFACE INDICES           | pinq_list_param_surf_inds   |
| INQUIRE LIST OF REFLECTANCE INDICES                  | pinq_list_refl_inds         |
| INQUIRE PARAMETRIC SURFACE FACILITIES                | pinq_param_surf_fac         |
| INQUIRE PARAMETRIC SURFACE REPRESENTATION            | pinq_param_surf_rep         |
| INQUIRE PATTERN REPRESENTATION PLUS                  | pinq_pat_rep_plus           |
| INQUIRE POLYLINE FACILITIES PLUS                     | pinq_line_fac_plus          |
| INQUIRE POLYLINE REPRESENTATION PLUS                 | pinq_line_rep_plus          |
| INQUIRE POLYMARKER REPRESENTATION PLUS               | pinq_marker_rep_plus        |
| INQUIRE PREDEFINED COLOUR MAPPING REPRESENTATION     | pinq_pred_colr_map_rep      |
| INQUIRE PREDEFINED DATA MAPPING REPRESENTATION       | pinq_pred_data_map_rep      |
| INQUIRE PREDEFINED DEPTH CUE REPRESENTATION          | pinq_pred_depth_cue_rep     |
| INQUIRE PREDEFINED EDGE REPRESENTATION PLUS          | pinq_pred_edge_rep_plus     |
| INQUIRE PREDEFINED INTERIOR REPRESENTATION PLUS      | pinq_pred_int_rep_plus      |
| INQUIRE PREDEFINED LIGHT SOURCE REPRESENTATION       | pinq_pred_light_source_rep  |
| INQUIRE PREDEFINED PARAMETRIC SURFACE REPRESENTATION | pinq_pred_param_surf_rep    |
| INQUIRE PREDEFINED PATTERN REPRESENTATION PLUS       | pinq_pred_pat_rep_plus      |
| INQUIRE PREDEFINED POLYLINE REPRESENTATION PLUS      | pinq_pred_line_rep_plus     |
| INQUIRE PREDEFINED POLYMARKER REPRESENTATION PLUS    | pinq_pred_marker_rep_plus   |
| INQUIRE PREDEFINED REFLECTANCE REPRESENTATION        | pinq_pred_refl_rep          |
| INQUIRE PREDEFINED TEXT REPRESENTATION PLUS          | pinq_pred_text_rep_plus     |

Table 3 - Function names ordered by PHIGS and PHIGS PLUS function name

| PHIGS and PHIGS PLUS Name                    | C Name                            |
|----------------------------------------------|-----------------------------------|
| INQUIRE REFLECTANCE FACILITIES               | pinq_refl_fac                     |
| INQUIRE REFLECTANCE REPRESENTATION           | pinq_refl_rep                     |
| INQUIRE RENDERING COLOUR MODEL FACILITIES    | pinq_rend_colr_model_fac          |
| INQUIRE TEXT REPRESENTATION PLUS             | pinq_text_rep_plus                |
| INQUIRE TRIMMING CURVE FACILITIES            | pinq_trim_curve_fac               |
| INQUIRE WORKSTATION STATE TABLE LENGTHS PLUS | pinq_ws_st_table_length_plus      |
| NON-UNIFORM B-SPLINE CURVE 3                 | pnon_uniform_b_spline_curve3      |
| NON-UNIFORM B-SPLINE SURFACE 3               | pnon_uniform_b_spline_surf3       |
| NON-UNIFORM B-SPLINE SURFACE 3 WITH DATA     | pnon_uniform_b_spline_surf3_data  |
| NON-UNIFORM B-SPLINE CURVE 3 WITH COLOUR     | pnon_uniform_b_spline_curve3_colr |
| POLYLINE SET 3 WITH COLOUR                   | ppolyline_set3_colr               |
| QUADRILATERAL MESH WITH DATA                 | pquad_mesh_data                   |
| QUADRILATERAL MESH 3 WITH DATA               | pquad_mesh3_data                  |
| SET BACK DATA MAPPING INDEX                  | pset_back_data_map_ind            |
| SET BACK DATA MAPPING METHOD                 | pset_back_data_map_method         |
| SET BACK INTERIOR COLOUR                     | pset_back_int_colr                |
| SET BACK INTERIOR INDEX                      | pset_back_int_ind                 |
| SET BACK INTERIOR SHADING METHOD             | pset_back_int_shad_method         |
| SET BACK INTERIOR STYLE INDEX                | pset_back_int_style_ind           |
| SET BACK INTERIOR STYLE                      | pset_back_int_style               |
| SET BACK REFLECTANCE INDEX                   | pset_back_refl_ind                |
| SET BACK REFLECTANCE MODEL                   | pset_back_refl_model              |
| SET BACK REFLECTANCE PROPERTIES              | pset_back_refl_props              |
| SET COLOUR MAPPING INDEX                     | pset_colr_map_ind                 |
| SET COLOUR MAPPING REPRESENTATION            | pset_colr_map_rep                 |
| SET CURVE APPROXIMATION CRITERIA             | pset_curve_approx_crit            |
| SET DATA MAPPING INDEX                       | pset_data_map_ind                 |
| SET DATA MAPPING METHOD                      | pset_data_map_method              |
| SET DATA MAPPING REPRESENTATION              | pset_data_map_rep                 |
| SET DEPTH CUE INDEX                          | pset_depth_cue_ind                |
| SET DEPTH CUE REPRESENTATION                 | pset_depth_cue_rep                |
| SET EDGE COLOUR                              | pset_edge_colr                    |
| SET EDGE REPRESENTATION PLUS                 | pset_edge_rep_plus                |
| SET FACET CULLING MODE                       | pset_facet_cull_mode              |
| SET FACET DISTINGUISHING MODE                | pset_facet_disting_mode           |
| SET INTERIOR COLOUR                          | pset_int_colr                     |
| SET INTERIOR REPRESENTATION PLUS             | pset_int_rep_plus                 |
| SET INTERIOR SHADING METHOD                  | pset_int_shad_method              |
| SET LIGHT SOURCE REPRESENTATION              | pset_light_source_rep             |
| SET LIGHT SOURCE STATE                       | pset_light_source_st              |
| SET OF FILL AREA SETS WITH DATA              | pset_of_fill_area_sets_data       |
| SET OF FILL AREA SETS 3 WITH DATA            | pset_of_fill_area_sets3_data      |
| SET PARAMETRIC SURFACE CHARACTERISTICS       | pset_param_surf_chars             |
| SET PARAMETRIC SURFACE INDEX                 | pset_param_surf_ind               |
| SET PARAMETRIC SURFACE REPRESENTATION        | pset_param_surf_rep               |
| SET PATTERN REPRESENTATION PLUS              | pset_pat_rep_plus                 |
| SET POLYLINE COLOUR                          | pset_line_colr                    |

**Table 3 - Function names ordered by PHIGS and PHIGS PLUS function name**

| <b>PHIGS and PHIGS PLUS Name</b>   | <b>C Name</b>         |
|------------------------------------|-----------------------|
| SET POLYLINE REPRESENTATION PLUS   | pset_line_rep_plus    |
| SET POLYLINE SHADING METHOD        | pset_line_shad_method |
| SET POLYMARKER COLOUR              | pset_marker_colr      |
| SET POLYMARKER REPRESENTATION PLUS | pset_marker_rep_plus  |
| SET REFLECTANCE INDEX              | pset_refl_ind         |
| SET REFLECTANCE MODEL              | pset_refl_model       |
| SET REFLECTANCE PROPERTIES         | pset_refl_props       |
| SET REFLECTANCE REPRESENTATION     | pset_refl_rep         |
| SET RENDERING COLOUR MODEL         | pset_rend_colr_model  |
| SET SURFACE APPROXIMATION CRITERIA | pset_surf_approx_crit |
| SET TEXT COLOUR                    | pset_text_colr        |
| SET TEXT REPRESENTATION PLUS       | pset_text_rep_plus    |
| TRIANGLE SET WITH DATA             | ptri_set_data         |
| TRIANGLE SET 3 WITH DATA           | ptri_set3_data        |
| TRIANGLE STRIP WITH DATA           | ptri_strip_data       |
| TRIANGLE STRIP 3 WITH DATA         | ptri_strip3_data      |

## 5 Type definitions

*Change the clause heading to C PHIGS type definitions.*

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## 6 Macro definitions

*Change the clause heading to C PHIGS macro definitions.*

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## 7 C PHIGS functions

*Change the following function definitions:*

### INQUIRE GENERALIZED DRAWING PRIMITIVE 3

```
void pinq_gdp3 (
    Pint          ws_type,      /* workstation type */
    Pint          gdp,          /* GDP function identifier */
    Pint          *err_ind,      /* OUT error indicator */
    Pint          *num_attr,     /* OUT number of attributes used */
    Pattrs        attr[7]       /* OUT list of attributes used */
);
```

### INQUIRE GENERALIZED DRAWING PRIMITIVE

```
void pinq_gdp (
    Pint          ws_type,      /* workstation type */
    Pint          gdp,          /* GDP function identifier */
    Pint          *err_ind,      /* OUT error indicator */
    Pint          *num_attr,     /* OUT number of attributes used */
    Pattrs        attr[7]       /* OUT list of attributes used */
);
```

## 8 C PHIGS PLUS type definitions

### 8.1 Mapping of PHIGS PLUS data types

ISO/IEC 9592-4 specifies a set of abstract data types beyond the types defined in ISO/IEC 9592-1. Table 4 - gives the mapping from those additional data types defined in ISO/IEC 9592-4 to the data types defined later in this binding.

**Table 4 - Mapping of PHIGS PLUS data types to C**

| PHIGS PLUS data type |                          | C binding data type |
|----------------------|--------------------------|---------------------|
| COLRV                | colour value             | Pcolrv              |
| COLRVH               | homogeneous colour value | Phomo_colr_rep_ptr  |
| GCOLOR               | general colour           | Pgcolr              |
| NORM                 | normal vector            | Pvec3               |
| P3H                  | 3D homogeneous point     | Phomo_point3        |
| P4H                  | 4D homogeneous point     | Phomo_point4        |

## 8.2 Modifications to PHIGS data types

---

### Paspect ASPECT

```
typedef enum {
    /* start of PHIGS enumerations */
    ...,
    /* end of PHIGS enumerations */
    /* start of PHIGS PLUS enumerations */
    PASPECT_LINE_COLR,
    PASPECT_MARKER_COLR,
    PASPECT_TEXT_COLR,
    PASPECT_INT_COLR,
    PASPECT_EDGE_COLR,
    PASPECT_LINE_SHAD_METHOD,
    PASPECT_INT_SHAD_METHOD,
    PASPECT_DATA_MAP_METHOD,
    PASPECT_REFL_PROPS,
    PASPECT_REFL_MODEL,
    PASPECT_BACK_INT_STYLE,
    PASPECT_BACK_INT_STYLE_IND,
    PASPECT_BACK_INT_COLR,
    PASPECT_BACK_INT_SHAD_METHOD,
    PASPECT_BACK_DATA_MAP_METHOD,
    PASPECT_BACK_REFL_PROPS,
    PASPECT_BACK_REFL_MODEL,
    PASPECT_CURVE_APPROX_CRIT,
    PASPECT_SURF_APPROX_CRIT,
    PASPECT_PARAM_SURF_CHARS
    /* end of PHIGS PLUS enumerations */
} Paspect;
```

---

### Pattrrs ATTRIBUTES USED

```
typedef enum {
    /* start of PHIGS enumerations */
    ...,
    /* end of PHIGS enumerations */
    /* start of PHIGS PLUS enumerations */
    PATTR_REFL,
    PATTR_PARAM_SURF
    /* end of PHIGS PLUS enumerations */
} Pattrrs;
```

---

Pelem\_data **ELEMENT DATA**

```

typedef union {
    /* start of PHIGS element data */
    ...,
    /* end of PHIGS element data */
    /* start of PHIGS PLUS element data */
    struct Pelem_polyline_set3_colr {
        Pint          colr_type;          /* colour type          */
        Pvertex3_set   vertex_data;        /* list of vertex lists */
    } polyline_set3_colr;
    struct Pelem_fill_area_set3_data {
        Pint          colr_type;          /* colour type          */
        Pfacet        *facet_data;        /* facet data           */
        Pedge_flag_set *edge_flags;        /* list of edge flag lists */
        Pvertex3_set   vertex_data;        /* list of vertex lists */
    } fill_area_set3_data;
    struct Pelem_fill_area_set_data {
        Pint          colr_type;          /* colour type          */
        Pfacet        *facet_data;        /* facet data           */
        Pedge_flag_set *edge_flags;        /* list of edge flag lists */
        Pvertex_set    vertex_data;        /* list of vertex lists */
    } fill_area_set_data;
    struct Pelem_cell_array3_plus {
        Pparal        paral;              /* parallelogram P, Q, R */
        Ppat_rep_plus pattern;             /* pattern colour array */
    } cell_array3_plus;
    struct Pelem_set_of_fill_area_sets3_data {
        Pint          colr_type;          /* colour type          */
        Pset_of_fill_area_sets_data *set_data; /* fill area sets data */
        Pedge_flag_set_list *edge_flags;    /* list of edge flag sets */
        Pvertex3_list   vertex_data;        /* list of vertices      */
        Pcontour_set_list contours;          /* list of contour sets  */
    } set_of_fill_area_sets3_data;
    struct Pelem_set_of_fill_area_sets_data {
        Pint          colr_type;          /* colour type          */
        Pset_of_fill_area_sets_data *set_data; /* fill area sets data */
        Pedge_flag_set_list *edge_flags;    /* list of edge flag sets */
        Pvertex_list    vertex_data;        /* list of vertices      */
        Pcontour_set_list contours;          /* list of contour sets  */
    } set_of_fill_area_sets_data;
    struct Pelem_tri_set3_data {
        Pint          colr_type;          /* colour type          */
        Ptri_set_data *set_data;          /* triangle set data     */
        Pedge_flag_triplet_list *edge_flags; /* list of triangle edge flag */
                                                /* triplets              */
        Pvertex3_list   vertex_data;        /* list of vertices      */
        Pvertex_ind_triplet_list triplets;   /* list of triangle vertex index */
                                                /* triplets              */
    }

```

```

} tri_set3_data;
struct Pelem_tri_set_data {
    Pint          colr_type;      /* colour type          */
    Ptri_set_data *set_data;      /* triangle set data    */
    Pedge_flag_triplet_list *edge_flags; /* list of triangle edge flag */
                                /* triplets              */
    Pvertex_list   vertex_data;   /* list of vertices     */
    Pvertex_ind_triplet_list triplets; /* list of triangle vertex index */
                                /* triplets              */
} tri_set_data;
struct Pelem_tri_strip3_data {
    Pint          colr_type;      /* colour type          */
    Pfacet_list   *facet_data;    /* list of facet data    */
    Pedge_flag_list *edge_flags;  /* list of edge flags    */
    Pvertex3_list  vertex_data;   /* list of vertex data   */
} tri_strip3_data;
struct Pelem_tri_strip_data {
    Pint          colr_type;      /* colour type          */
    Pfacet_list   *facet_data;    /* list of facet data    */
    Pedge_flag_list *edge_flags;  /* list of edge flags    */
    Pvertex_list   vertex_data;   /* list of vertex data   */
} tri_strip_data;
struct Pelem_quad_mesh3_data {
    Pint          colr_type;      /* colour type          */
    Pfacet_array   *facet_data;    /* array of facet data   */
    Pedge_flag_array *edge_flags;  /* array of edge flags   */
    Pvertex3_array  vertex_data;   /* array of vertex data  */
} quad_mesh3_data;
struct Pelem_quad_mesh_data {
    Pint          colr_type;      /* colour type          */
    Pfacet_array   *facet_data;    /* array of facet data   */
    Pedge_flag_array *edge_flags;  /* array of edge flags   */
    Pvertex_array   vertex_data;   /* array of vertex data  */
} quad_mesh_data;
struct Pelem_non_uniform_b_spline_curve3 {
    Pcurve_geom_spline geom_spline; /* geometry spline      */
} non_uniform_b_spline_curve3;
struct Pelem_non_uniform_b_spline_curve3_colr {
    Pcurve_geom_spline geom_spline; /* geometry spline      */
    Pcurve_colr_spline *colr_spline; /* colour spline        */
} non_uniform_b_spline_curve3_colr;
struct Pelem_non_uniform_b_spline_surf3 {
    Psurf_geom_spline geom_spline; /* geometry spline      */
    Ptrim_curve_loop_list *trim_loops; /* list of trimming curve loops */
} non_uniform_b_spline_surf3;
struct Pelem_non_uniform_b_spline_surf3_data {
    Psurf_geom_spline geom_spline; /* geometry spline      */
    Ptrim_curve_loop_list *trim_loops; /* list of trimming curve loops */
    Psurf_colr_spline *colr_spline; /* colour spline        */
    Psurf_data_spline_list *data_spline; /* data spline          */
} non_uniform_b_spline_surf3_data;

```

```

Pgcolr          colr;          /* general colour          */
Pfacet_disting_mode facet_disting_mode; /*facet distinguishing mode */
Pfacet_cull_mode  facet_cull_mode; /* facet culling mode      */
Pdata_map_rep     data_map_method; /* data mapping method     */
Prefl_prop        refl_prop;    /* reflectance property data */
struct Pelem_light_source_st {
    Pint_list      act_list;     /* activation list          */
    Pint_list      deact_list;   /* deactivation list        */
} light_source_st;
Pcurve_approx_crit curve_approx_crit; /* curve approximation criteria */
/* data record */
Psurf_approx_crit  surf_approx_crit; /* surface approximation criteria */
/* data record */
Pparam_surf_chars  param_surf_chars; /* parametric surface       */
/* characteristics data record */
/* end of PHIGS PLUS element data */
} Pelem_data;

```

NOTE — A NULL value for the facet\_data, edge\_flags, set\_data, colr\_spline, trim\_loops, or data\_spline fields indicates the corresponding optional data is not defined.

---

Pelem\_type **ELEMENT TYPE**

```

typedef enum {
    /* start of PHIGS enumerations */
    ...,
    /* end of PHIGS enumerations */
    /* start of PHIGS PLUS enumerations */
    PELEM_POLYLINE_SET3_COLR,
    PELEM_FILL_AREA_SET3_DATA,
    PELEM_FILL_AREA_SET_DATA,
    PELEM_CELL_ARRAY3_PLUS,
    PELEM_SET_OF_FILL_AREA_SETS3_DATA,
    PELEM_SET_OF_FILL_AREA_SETS_DATA,
    PELEM_TRI_SET3_DATA,
    PELEM_TRI_SET_DATA,
    PELEM_TRI_STRIP3_DATA,
    PELEM_TRI_STRIP_DATA,
    PELEM_QUAD_MESH3_DATA,
    PELEM_QUAD_MESH_DATA,
    PELEM_NON_UNIFORM_B_SPLINE_CURVE3,
    PELEM_NON_UNIFORM_B_SPLINE_CURVE3_COLR,
    PELEM_NON_UNIFORM_B_SPLINE_SURF3,
    PELEM_NON_UNIFORM_B_SPLINE_SURF3_DATA,
    PELEM_DATA_MAP_IND,
    PELEM_REFL_IND,
    PELEM_BACK_INT_IND,
    PELEM_BACK_DATA_MAP_IND,
    PELEM_BACK_REFL_IND,
    PELEM_PARAM_SURF_IND,
    PELEM_LINE_COLR,
    PELEM_LINE_SHAD_METHOD,
    PELEM_MARKER_COLR,
    PELEM_TEXT_COLR,
    PELEM_FACET_DISTING_MODE,
    PELEM_FACET_CULL_MODE,
    PELEM_INT_COLR,
    PELEM_INT_SHAD_METHOD,
    PELEM_DATA_MAP_METHOD,
    PELEM_REFL_PROPS,
    PELEM_REFL_MODEL,
    PELEM_BACK_INT_STYLE,
    PELEM_BACK_INT_STYLE_IND,
    PELEM_BACK_INT_COLR,
    PELEM_BACK_INT_SHAD_METHOD,
    PELEM_BACK_DATA_MAP_METHOD,
    PELEM_BACK_REFL_PROPS,
    PELEM_BACK_REFL_MODEL,
    PELEM_LIGHT_SOURCE_ST,
    PELEM_EDGE_COLR,

```

```

PELEM_CURVE_APPROX_CRIT,
PELEM_SURF_APPROX_CRIT,
PELEM_PARAM_SURF_CHARS,
PELEM_REND_COLR_MODEL,
PELEM_DEPTH_CUE_IND,
PELEM_COLR_MAP_IND
/* end of PHIGS PLUS enumerations */

} Pelem_type;

```

### 8.3 Implementation dependent PHIGS PLUS type definitions

The following type definitions may be modified by the implementation. If the implementation adds new fields to the unions, the convention specified in clause 5.3 shall be used for naming the new field with the following addition:

For the name of a new field in a PHIGS PLUS implementation dependent type, called “xxx” in clause 5.3, use “type.”

---

#### Pcolr\_map\_method COLOUR MAPPING METHOD

```

typedef struct {
    Pint      method;          /* colour mapping method      */
    union Pcolr_map_method_data {
        Pint      num_true_colrs;    /* number of true colours      */
        Pint      max_num_pseudo_colrs; /* maximum number of pseudo */
        ...          /* colours                      */
        ...          /* implementation defined      */
    } data;
} Pcolr_map_method;

```

---

**Pcolr\_map\_rep COLOUR MAPPING REPRESENTATION**

```

typedef struct {
    Pint          method;                /* colour mapping method */
    union Pcolr_map_rep_data {
        struct Pcolr_map_rep_pseudo {
            Pint          model;          /* colour model */
            Pfloat_list   weight_vector; /* list of weight vector */
            Pcolrv_list   colrs;         /* list of colour values */
        } pseudo;
        struct Pcolr_map_rep_pseudo_N {
            Pint          model;          /* colour model */
            Pfloat_set    colrs;         /* list of lists of colour
                                         /* coordinates
            } pseudo_N;
        ...                /* implementation defined
    } data;
} Pcolr_map_rep;

```

---

**Pcolr\_map\_st COLOUR MAPPING STATE**

```

typedef struct {
    Pint          method;                /* colour mapping method */
    union Pcolr_map_st_data {
        Pint          num_true_colrs;    /* number of available true
                                         /* colours
        Pint          max_num_pseudo_colrs; /* maximum number of pseudo
                                         /* colour entries
        ...                /* implementation defined
    } data;
} Pcolr_map_st;

```

---

**Pcolr\_rep\_ptr COLOUR REPRESENTATION POINTER**

```
typedef union {  
    Prgb          *rgb;          /* pointer to RGB colour values */  
    Pcielv        *cielv;        /* pointer to CIELUV colour values */  
    Phls          *hls;          /* pointer to HLS colour values */  
    Phsv          *hsv;          /* pointer to HSV colour values */  
    Pdata         *unsupp;       /* pointer to unsupported colour */  
    ...           /* values */  
    ...           /* implementation defined */  
} Pcolr_rep_ptr;
```

Pcurve\_approx\_crit **CURVE APPROXIMATION CRITERIA**

```

typedef struct {
    Pint          type;                /* curve approximation criteria */
                                         /* type */
    union Pcurve_approx_crit_data {
        struct Pcurve_approx_const_param_subd {
            Pint    count;              /* count */
        } const_param_subd;
        struct Pcurve_approx_chordal_size_wc {
            Pfloat   approx;            /* approximation value */
        } chordal_size_wc;
        struct Pcurve_approx_chordal_size_npc {
            Pfloat   approx;            /* approximation value */
        } chordal_size_npc;
        struct Pcurve_approx_chordal_size_dc {
            Pfloat   approx;            /* approximation value */
        } chordal_size_dc;
        struct Pcurve_approx_chordal_dev_wc {
            Pfloat   approx;            /* approximation value */
        } chordal_dev_wc;
        struct Pcurve_approx_chordal_dev_npc {
            Pfloat   approx;            /* approximation value */
        } chordal_dev_npc;
        struct Pcurve_approx_chordal_dev_dc {
            Pfloat   approx;            /* approximation value */
        } chordal_dev_dc;
        struct Pcurve_approx_rel_wc {
            Pfloat   approx;            /* approximation value */
        } rel_wc;
        struct Pcurve_approx_rel_npc {
            Pfloat   approx;            /* approximation value */
        } rel_npc;
        struct Pcurve_approx_rel_dc {
            Pfloat   approx;            /* approximation value */
        } rel_dc;
        Pdata       unsupp;            /* unsupported curve approximation */
                                         /* criteria data */
        ...         /* implementation defined */
    } data;
} Pcurve_approx_crit;

```

# Pdata\_map\_rep DATA MAPPING REPRESENTATION

```

typedef struct {
    Pint          method;          /* data mapping method          */
    Psource_select_list selectors;  /* list of source selectors     */
    union Pdata_map_rep_data {
        struct Pdata_map_rep_single_uniform {
            Pint          ind;      /* data value index            */
            Pfloat        lower_limit; /* lower range limit          */
            Pfloat        upper_limit; /* upper range limit          */
            Pint          colr_type; /* colour type                 */
            Pcolrv_list   colr_values; /* list of colour values      */
        } single_uniform;
        struct Pdata_map_rep_single_non_uniform {
            Pint          ind;      /* data value index            */
            Pfloat_list   range;    /* range boundaries            */
            Pint          colr_type; /* colour type                 */
            Pcolrv_list   colr_values; /* list of colour values      */
        } single_non_uniform;
        struct Pdata_map_rep_bi_uniform {
            Pint          inds[2];  /* data value indices          */
            Pfloat        lower_limit_a; /* lower limit of Ra range    */
            Pfloat        upper_limit_a; /* upper limit of Ra range    */
            Pfloat        lower_limit_b; /* lower limit of Rb range    */
            Pfloat        upper_limit_b; /* upper limit of Rb range    */
            Pint          colr_type; /* colour type                 */
            Pcolrv_set    colr_values; /* list of colour value lists */
        } bi_uniform;
        struct Pdata_map_rep_bi_non_uniform {
            Pint          inds[2];  /* data value indices          */
            Pfloat_list   range_a;  /* Ra range boundaries         */
            Pfloat_set    range_b;  /* Rb range boundaries         */
            Pint          colr_type; /* colour type                 */
            Pcolrv_set    colr_values; /* array of colour values     */
        } bi_non_uniform;
        ... /* implementation defined */
    } data;
} Pdata_map_rep;

```

NOTE — The indexing of data mapping values is 1 based.

---

Phomo\_colr\_rep\_ptr **HOMOGENEOUS COLOUR REPRESENTATION POINTER**

```
typedef union {  
    Phomo_rgb          *rgb;          /* pointer to homogeneous rgb */  
                                /* colour value */  
    Phomo_cieluv       *cieluv;       /* pointer to homogeneous cieluv */  
                                /* colour value */  
    Phomo_hls          *hls;          /* pointer to homogeneous hls */  
                                /* colour value */  
    Phomo_hsv          *hsv;          /* pointer to homogeneous hsv */  
                                /* colour value */  
    ...                /* implementation defined */  
} Phomo_colr_rep_ptr;
```

---

Plight\_source\_rep **LIGHT SOURCE REPRESENTATION**

```

typedef struct {
    Pint                type;                /* light source type */
    union Plight_source_rep_data {
        struct Plight_source_rep_amb {
            Pcolour      colour;            /* light source colour */
        } amb;
        struct Plight_source_rep_dir {
            Pcolour      colour;            /* light source colour */
            Pvec3         dir;              /* light source direction */
        } dir;
        struct Plight_source_rep_pos {
            Pcolour      colour;            /* light source colour */
            Ppoint3       pos;              /* light source position */
            Pfloat        c1;              /* light source attenuation */
            Pfloat        c2;              /* coefficient */
            Pfloat        c2;              /* light source attenuation */
            Pfloat        c2;              /* coefficient */
        } pos;
        struct Plight_source_rep_spot {
            Pcolour      colour;            /* light source colour */
            Ppoint3       pos;              /* light source position */
            Pvec3         dir;              /* light source direction */
            Pfloat        concent_exp;      /* concentration exponent */
            Pfloat        c1;              /* light source attenuation */
            Pfloat        c1;              /* coefficient */
            Pfloat        c2;              /* light source attenuation */
            Pfloat        c2;              /* coefficient */
            Pfloat        spread_angle;     /* light source spread angle */
        } spot;
        ...
    } data;
} Plight_source_rep;

```

---

**Pparam\_surf\_chars PARAMETRIC SURFACE CHARACTERISTICS**

```

typedef struct {
    Pint          type;          /* parametric surface */
                                /* characteristics type */
    union Pparam_surf_chars_data {
        struct Pparam_surf_isoparam {
            Pplacement    placement;    /* curve placement: UNIFORM OVER */
                                        /* SURFACE, UNIFORM BETWEEN KNOTS */
            Pint          num_u_curves; /* curve count in u direction */
            Pint          num_v_curves; /* curve count in v direction */
        } isoparam;
        struct Pparam_surf_level_mc {
            Ppoint3        origin;       /* origin point */
            Pvec3          dir;          /* direction vector */
            Pfloat_list    params;       /* parameter list */
        } level_mc;
        struct Pparam_surf_level_wc {
            Ppoint3        origin;       /* origin point */
            Pvec3          dir;          /* direction vector */
            Pfloat_list    params;       /* parameter list */
        } level_wc;
        Pdata             unsupp;       /* unsupported parametric */
                                /* surface characteristics data */
        ...               /* implementation defined */
    } data;
} Pparam_surf_chars;

```

---

**Prefl\_prop REFLECTANCE PROPERTY**

```

typedef struct {
    Pint          type;                /* reflectance property type */
    union Prefl_prop_data {
        struct Prefl_prop_simple_refl {
            Pfloat    amb_coeff;        /* ambient reflection */
            Pfloat    diff_coeff;       /* diffuse reflection */
            Pfloat    spec_coeff;       /* specular reflection */
            Pcolr     spec_colr;        /* specular colour */
            Pfloat    spec_exp;         /* specular exponent */
        } simple_refl;
        Pdata        unsupp;           /* unsupported reflectance */
        ...           /* implementation defined */
    } data;
} Prefl_prop;

```

---

**Psurf\_approx\_crit SURFACE APPROXIMATION CRITERIA**

```

typedef struct {
    Pint          type;          /* surface approximation criteria */
                                /* type */
    union Psurf_approx_crit_data {
        struct Psurf_approx_const_param_subd {
            Pint    u_count;      /* u count */
            Pint    v_count;      /* v count */
        } const_param_subd;
        struct Psurf_approx_chordal_size_wc {
            Pfloat   u_approx;     /* u approximation value */
            Pfloat   v_approx;     /* v approximation value */
        } chordal_size_wc;
        struct Psurf_approx_chordal_size_npc {
            Pfloat   u_approx;     /* u approximation value */
            Pfloat   v_approx;     /* v approximation value */
        } chordal_size_npc;
        struct Psurf_approx_chordal_aize_dc {
            Pfloat   u_approx;     /* u approximation value */
            Pfloat   v_approx;     /* v approximation value */
        } chordal_size_dc;
        struct Psurf_approx_planar_dev_wc {
            Pfloat   approx;       /* approximation value */
        } planar_dev_wc;
        struct Psurf_approx_planar_dev_npc {
            Pfloat   approx;       /* approximation value */
        } planar_dev_npc;
        struct Psurf_approx_planar_dev_dc {
            Pfloat   approx;       /* approximation value */
        } planar_dev_dc;
        struct Psurf_approx_rel_wc {
            Pfloat   approx;       /* approximation value */
        } rel_wc;
        struct Psurf_approx_rel_npc {
            Pfloat   approx;       /* approximation value */
        } rel_npc;
        struct Psurf_approx_rel_dc {
            Pfloat   approx;       /* approximation value */
        } rel_dc;
        Pdata       unsupp;       /* unsupported surface */
                                /* approximation criteria data */
        ...         /* implementation defined */
    } data;
} Psurf_approx_crit;

```

## 8.4 Implementation independent PHIGS PLUS type definitions

---

### Pcolr\_ctrl\_point\_array COLOUR CONTROL POINT ARRAY

```
typedef struct {
    Prationality      rationality;    /* control point rationality */
    Pint_size         dims;           /* dimensions of control point */
                                /* array */
    Pcolr_ctrl_point_ptr colr_points; /* array of colour control points */
} Pcolr_ctrl_point_array;
```

---

### Pcolr\_ctrl\_point\_list COLOUR CONTROL POINT LIST

```
typedef struct {
    Prationality      rationality;    /* control point rationality */
    Pint              num_points;     /* number of control points */
    Pcolr_ctrl_point_ptr points;      /* list of colour control points */
} Pcolr_ctrl_point_list;
```

---

### Pcolr\_ctrl\_point\_ptr COLOUR CONTROL POINT POINTER

```
typedef union {
    Pcolr_rep_ptr      points;        /* pointer to colour points */
    Phomo_colr_rep_ptr homo_points;    /* pointer to homogeneous colour */
                                /* points */
} Pcolr_ctrl_point_ptr;
```

---

### Pcolrv COLOUR VALUE

```
typedef union {
    Pint              colr_ind;       /* colour index */
    Pcolr_rep         colr_rep;       /* colour representation */
} Pcolrv;
```

---

**Pcolrv\_array COLOUR VALUE ARRAY**

```

typedef struct {
    Pint_size      dims;           /* colour value array dimensions */
    Pcolrv_ptr     colrs;         /* array of colour values */
} Pcolrv_array;

```

---

**Pcolrv\_list COLOUR VALUE LIST**

```

typedef struct {
    Pint           num_colrs;      /* number of colours */
    Pcolrv_ptr     colrs;         /* list of colour values */
} Pcolrv_list;

```

---

**Pcolrv\_ptr COLOUR VALUE POINTER**

```

typedef union {
    Pint           *colr_inds;     /* pointer to colour indices */
    Pcolrv_rep_ptr colr_reps;     /* pointer to colour */
                                /* representations */
} Pcolrv_ptr;

```

---

**Pcolrv\_set COLOUR VALUE SET**

```

typedef struct {
    Pint           num_lists;     /* number of colour value lists */
    Pcolrv_list    *colrs;       /* list of colour value lists */
} Pcolrv_set;

```

---

**Pcontour\_set CONTOUR SET**

```

typedef struct {
    Pint          num_lists;          /* number of contour lists */
    Pint_list     *contours;         /* list of contour lists */
} Pcontour_set;

```

---

**Pcontour\_set\_list CONTOUR SET LIST**

```

typedef struct {
    Pint          num_contour_sets;   /* number of contour sets */
    Pcontour_set  *contours;         /* list of contour sets */
} Pcontour_set_list;

```

---

**Pctrl\_point3\_array CONTROL POINT 3 ARRAY**

```

typedef struct {
    Prationality  rationality;        /* control point rationality */
    Pint_size     dims;               /* control point array u,v */
                                   /* dimensions */
    Ppoint3_ptr   points;             /* array of control points */
} Pctrl_point3_array;

```

---

**Pctrl\_point\_list CONTROL POINT LIST**

```

typedef struct {
    Prationality  rationality;        /* control point rationality */
    Pint         num_points;         /* number of control points */
    Ppoint_ptr    points;             /* list of control points */
} Pctrl_point_list;

```

---

**Pctrl\_point3\_list CONTROL POINT 3 LIST**

```

typedef struct {
    Prationality    rationality;    /* control point rationality */
    Pint           num_points;      /* number of control points */
    Ppoint3_ptr    points;          /* list of control points */
} Pctrl_point3_list;

```

---

**Pcurve\_colr\_spline CURVE COLOUR SPLINE**

```

typedef struct {
    Pint           order;           /* spline order */
    Pfloat_list    knots;          /* list of knot values */
    Pint           colr_type;       /* colour type */
    Pcolr_ctrl_point_list colrs;    /* list of colour control points */
} Pcurve_colr_spline;

```

---

**Pcurve\_geom\_spline CURVE GEOMETRY SPLINE**

```

typedef struct {
    Pint           order;           /* spline order */
    Pfloat_list    knots;          /* knots */
    Pfloat         low_limit;       /* lower parameter range limit */
    Pfloat         high_limit;      /* high parameter range limit */
    Pctrl_point3_list ctrl_points;  /* list of control points */
} Pcurve_geom_spline;

```

---

**Pdata\_ctrl\_point\_array DATA CONTROL POINT ARRAY**

```
typedef struct {
    Prationality    rationality;    /* control point rationality    */
    Pint_size      dims;           /* control point array u,v      */
                                /* dimensions                    */
    Pint           points_dims;    /* control point dimensionality */
    Pfloat         *ctrl_points;   /* array of control points      */
} Pdata_ctrl_point_array;
```

---

**Pdepth\_cue\_mode DEPTH CUE MODE**

```
typedef enum {
    PDEPTH_CUE_SUPPR,
    PDEPTH_CUE_ALLOWED
} Pdepth_cue_mode;
```

---

**Pdepth\_cue\_mode\_list DEPTH CUE MODE LIST**

```
typedef struct {
    Pint          num_modes;       /* number of depth cue modes    */
    Pdepth_cue_mode *modes;       /* list of depth cue modes      */
} Pdepth_cue_mode_list;
```

---

**Pdepth\_cue\_rep DEPTH CUE REPRESENTATION**

```
typedef struct {
    Pdepth_cue_mode mode;         /* depth cue mode                */
    Pfloat          ref_planes[2]; /* depth cue reference planes    */
                                /* (min, max)                    */
    Pfloat          scale[2];     /* depth cue scale factors       */
                                /* (min, max)                    */
    Pgcolr          gcolr;       /* depth cue colour              */
} Pdepth_cue_rep;
```

---

**Pdyn\_ws\_attrs\_plus DYNAMICS OF WORKSTATION ATTRIBUTES PLUS**

```

typedef struct {
    Pdyn_mod      data_map;           /* data mapping representation */
    Pdyn_mod      refl;              /* reflectance representation */
    Pdyn_mod      param_surf;        /* parametric surface */
    Pdyn_mod      representation    /* representation */
    Pdyn_mod      light_source;      /* light source representation */
    Pdyn_mod      depth_cue;         /* depth cue representation */
    Pdyn_mod      colr_map;          /* colour mapping representation */
} Pdyn_ws_attrs_plus;

```

---

**Pedge\_bundle\_plus EDGE BUNDLE PLUS**

```

typedef struct {
    Pedge_flag    flag;              /* edge flag */
    Pint          type;              /* edgetype */
    Pfloat        width;             /* edgewidth scale factor */
    Pgcolr        colr;              /* edge colour */
} Pedge_bundle_plus;

```

---

**Pedge\_flag\_array EDGE FLAG ARRAY**

```

typedef struct {
    Pint_size     dims;              /* edge flag array dimensions */
    Pedge_flag_pair *edge_flags;     /* array of edge flag pairs */
} Pedge_flag_array;

```

---

**Pedge\_flag\_list EDGE FLAG LIST**

```

typedef struct {
    Pint          num_edges;         /* number of edges in list */
    Pedge_flag     *edge_flags;      /* list of edge flags */
} Pedge_flag_list;

```

---

**Pedge\_flag\_pair EDGE FLAG PAIR**

```
typedef Pedge_flag Pedge_flag_pair[2];
```

---

**Pedge\_flag\_set EDGE FLAG SET**

```
typedef struct {
    Pint          num_lists;          /* number of edge flag lists */
    Pedge_flag_list *edge_flags;      /* list of edge flag lists */
} Pedge_flag_set;
```

---

**Pedge\_flag\_set\_list EDGE FLAG SET LIST**

```
typedef struct {
    Pint          num_edge_flag_sets; /* number of edge flag sets */
    Pedge_flag_set *edge_flag_sets;   /* list of edge flag sets */
} Pedge_flag_set_list;
```

---

**Pedge\_flag\_triplet EDGE FLAG TRIPLET**

```
typedef Pedge_flag Pedge_flag_triplet[3];
```

---

**Pedge\_flag\_triplet\_list EDGE FLAG TRIPLET LIST**

```
typedef struct {
    Pint          num_edge_flag_triplets; /* number of edge flag triplets */
    Pedge_flag_triplet *edge_flag_triplets; /* list of edge flag triplets */
} Pedge_flag_triplet_list;
```

**Pfacet FACET**

```
typedef struct {
    Pint          num_data_per_facet; /* number of data values per-facet */
    Pcolrv        *facet_colrv;      /* facet colour */
    Pvec3         *facet_norm;       /* facet normal */
    Pfloat        *facet_data;       /* list of facet data */
} Pfacet;
```

NOTE — A NULL value for the facet\_colrv, facet\_norm, or facet\_data fields indicates the corresponding optional data is not supplied.

**Pfacet\_array FACET ARRAY**

```
typedef struct {
    Pint_size      dims;             /* facet array dimensions */
    Pint          num_data_per_facet; /* number of data values per-facet */
    Pcolrv_ptr     facet_colrvs;      /* array of facet colour values */
    Pvec3          *facet_norms;      /* array of facet normals */
    Pfloat         *facet_data;       /* array of facet data lists */
} Pfacet_array;
```

NOTE — A NULL value for the facet\_colrvs, facet\_norms, or facet\_data fields indicates the corresponding optional data is not supplied.

**Pfacet\_cull\_mode FACET CULLING MODE**

```
typedef enum {
    PFACET_CULL_NONE,
    PFACET_CULL_BACKFACING,
    PFACET_CULL_FRONTFACING
} Pfacet_cull_mode;
```

---

**Pfacet\_disting\_mode FACET DISTINGUISHING MODE**

```
typedef enum {
    PFACET_DISTING_OFF,
    PFACET_DISTING_ON
} Pfacet_disting_mode;
```

---

**Pfacet\_list FACET LIST**

```
typedef struct {
    Pint          num_facets;           /* number of facets */
    Pint          num_data_per_facet;  /* number of data values per-facet */
    Pcolrv_ptr    facet_colrvs;        /* list of facet colour values */
    Pvec3         *facet_norms;        /* list of facet normals */
    Pfloat        *facet_data;         /* list of facet data lists */
} Pfacet_list;
```

---

**NOTE** — A NULL value for the facet\_colrvs, facet\_norms, or facet\_data fields indicates the corresponding optional data is not supplied.

---

**Pfloat\_list FLOAT LIST**

```
typedef struct {
    Pint          num_floats;           /* number of floats in list */
    Pfloat        *floats;             /* list of floats */
} Pfloat_list;
```

---

**Pfloat\_set FLOAT SET**

```
typedef struct {
    Pint          num_lists;           /* number of float lists */
    Pfloat_list   *floats;            /* list of float lists */
} Pfloat_set;
```

---

**Pgcolr GENERAL COLOUR**

```
typedef struct {
    Pint          colr_type;          /* colour type */
    Pcolrv        colr_value;        /* colour value */
} Pgcolr;
```

---

**Phomo\_cieluv HOMOGENEOUS CIEL\*U\*V\***

```
typedef struct {
    Pfloat        cieluv_x;          /* x coefficient */
    Pfloat        cieluv_y;          /* y coefficient */
    Pfloat        cieluv_y_lum;      /* y luminance */
    Pfloat        w;                /* homogeneous coordinate */
} Phomo_cieluv;
```

---

**Phomo\_hls HOMOGENEOUS HUE LIGHTNESS SATURATION**

```
typedef struct {
    Pfloat        hue;              /* hue */
    Pfloat        lightness;        /* lightness */
    Pfloat        satur;            /* saturation */
    Pfloat        w;                /* homogeneous coordinate */
} Phomo_hls;
```

---

**Phomo\_hsv HOMOGENEOUS HUE SATURATION VALUE**

```
typedef struct {
    Pfloat        hue;              /* hue */
    Pfloat        satur;            /* saturation */
    Pfloat        value;            /* value */
    Pfloat        w;                /* homogeneous coordinate */
} Phomo_hsv;
```

---

**Phomo\_point3 HOMOGENEOUS POINT 3**

```

typedef struct {
    Pfloat      wx;           /* wx coordinate */
    Pfloat      wy;           /* wy coordinate */
    Pfloat      w;            /* homogeneous coordinate */
} Phomo_point3;

```

---

**Phomo\_point4 HOMOGENEOUS POINT 4**

```

typedef struct {
    Pfloat      wx;           /* wx coordinate */
    Pfloat      wy;           /* wy coordinate */
    Pfloat      wz;           /* wz coordinate */
    Pfloat      w;            /* homogeneous coordinate */
} Phomo_point4;

```

---

**Phomo\_rgb HOMOGENEOUS RED GREEN BLUE**

```

typedef struct {
    Pfloat      red;          /* red */
    Pfloat      green;        /* green */
    Pfloat      blue;         /* blue */
    Pfloat      w;            /* homogeneous coordinate */
} Phomo_rgb;

```

---

**Pint\_bundle\_plus INTERIOR BUNDLE PLUS**

```

typedef struct {
    Pint_style   style;       /* interior style */
    Pint         style_ind;    /* interior style index */
    Pgcolr      colr;         /* interior colour */
    Pint         shad_method;  /* shading method */
} Pint_bundle_plus;

```

---

**Pint\_facst\_plus INTERIOR FACILITIES PLUS**

```

typedef struct {
    Pint          num_int_styles;      /* number of interior styles */
    Pint_style    int_styles[5];      /* list of available interior */
                                      /* styles */
    Pint          num_hatch_styles;    /* number of available hatch */
                                      /* styles */
    Pint_list     hatch_styles;        /* list of available hatch styles */
    Pint_list     shad_methods;        /* list of available shading */
                                      /* methods */
    Pint          num_pred_int_inds;   /* number of predefined interior */
                                      /* indices */
} Pint_facst_plus;

```

---

**Pline\_bundle\_plus POLYLINE BUNDLE PLUS**

```

typedef struct {
    Pint          type;                /* line type */
    Pfloat        width;               /* linewidth scale factor */
    Pgcclr        clr;                 /* polyline colour */
    Pint          shad_method;         /* polyline shading method */
    Pcurve_approx_crit approx_crit;   /* curve approximation criteria */
                                      /* data record */
} Pline_bundle_plus;

```

---

**Pline\_facst\_plus POLYLINE FACILITIES PLUS**

```

typedef struct {
    Pint          num_types;          /* number of available linetypes */
    Pint_list     types;              /* list of line types */
    Pint          num_widths;         /* number of available line widths */
    Pfloat        nom_width;          /* nominal linewidth */
    Pfloat        min_width;          /* minimum linewidth */
    Pfloat        max_width;          /* maximum linewidth */
    Pint_list     shad_methods;       /* list of available line shading */
                                           /* methods */
    Pint          num_inds;           /* number of predefined bundle */
                                           /* indices */
} Pline_facst_plus;

```

---

**Pmarker\_bundle\_plus POLYMARKER BUNDLE PLUS**

```

typedef struct {
    Pint          type;               /* marker type */
    Pfloat        size;               /* marker size scale factor */
    Pcolour       colour;             /* polymarker colour */
} Pmarker_bundle_plus;

```

---

**Pparam\_surf\_rep PARAMETRIC SURFACE REPRESENTATION**

```

typedef struct {
    Psurf_approx_crit    approx_crit; /* surface approximation criteria */
                                           /* data */
    Pparam_surf_chars    chars_data;  /* parametric surface */
                                           /* characteristics data */
} Pparam_surf_rep;

```

---

**Ppat\_rep\_plus PATTERN REPRESENTATION PLUS**

```
typedef struct {
    Pint          colr_type;      /* colour type */
    Pcolrv_array  colrs;         /* array of colour values */
} Ppat_rep_plus;
```

---

**Pplacement PLACEMENT**

```
typedef enum {
    PPLACE_UNIFORM_OVER_SURF,
    PPLACE_UNIFORM_BETWEEN_KNOTS
} Pplacement;
```

---

**Ppoint\_ptr POINT POINTER**

```
typedef union {
    Ppoint          *point;      /* pointer to 2D non-homogeneous */
                                /* points */
    Phomo_point3    *homo_point3; /* pointer to 3D homogeneous */
                                /* points */
} Ppoint_ptr;
```

---

**Ppoint3\_ptr POINT 3 POINTER**

```
typedef union {
    Ppoint3          *point3;    /* pointer to 3D non-homogeneous */
                                /* points */
    Phomo_point4     *homo_point4; /* pointer to 4D homogeneous */
                                /* points */
} Ppoint3_ptr;
```

---

**Prationality RATIONALITY**

```
typedef enum {
    PB_SPLINE_RATIONAL,
    PB_SPLINE_NON_RATIONAL
} Prationality;
```

---

**Prefl\_rep REFLECTANCE REPRESENTATION**

```
typedef struct {
    Pint          refl_model;          /* reflectance model          */
    Prefl_prop    refl_prop;          /* reflectance property data  */
} Prefl_rep;
```

---

**Pset\_of\_fill\_area\_sets\_data SET OF FILL AREA SETS DATA**

```
typedef struct {
    Pint          num_sets;            /* number of fill area sets    */
    Pint          num_data_per_facet; /* number of data values per facet */
    Pcolrv_ptr    facet_colrvs;       /* list of facet colours       */
    Pvec3         *facet_norms;       /* list of facet normals       */
    Pfloat        *facet_data;        /* list of facet data lists    */
} Pset_of_fill_area_sets_data;
```

---

**NOTE** — A NULL value for the facet\_colrvs, facet\_norms, or facet\_data fields indicates the corresponding optional data is not supplied.

---

**Psource\_select SOURCE SELECT**

```
typedef enum {  
    PSOURCE_SELECT_COLR_ASPECT,  
    PSOURCE_SELECT_VERT_COLR,  
    PSOURCE_SELECT_VERT_DATA,  
    PSOURCE_SELECT_FACET_COLR,  
    PSOURCE_SELECT_FACET_DATA  
} Psource_select;
```

---

**Psource\_select\_list SOURCE SELECT LIST**

```
typedef struct {  
    Pint          num_selectors;      /* number of selectors      */  
    Psource_select *selectors;        /* list of source selectors */  
} Psource_select_list;
```

---

**Psurf\_colr\_spline SURFACE COLOUR SPLINE**

```
typedef struct {  
    Pint          u_order;           /* u spline order           */  
    Pint          v_order;           /* v spline order           */  
    Pfloat_list   u_knots;           /* list of u knot values    */  
    Pfloat_list   v_knots;           /* list of v knot values    */  
    Pint          colr_type;         /* colour type              */  
    Pcolr_ctrl_point_array colrs;    /* array of colour control points */  
} Psurf_colr_spline;
```

---

**Psurf\_data\_spline SURFACE DATA SPLINE**

```

typedef struct {
    Pint          u_order;      /* u spline order          */
    Pint          v_order;      /* v spline order          */
    Pfloat_list   u_knots;      /* list of u knot values   */
    Pfloat_list   v_knots;      /* list of v knot values   */
    Pdata_ctrl_point_array data_points; /* array of data control
                                     /* points                  */
} Psurf_data_spline;

```

---

**Psurf\_data\_spline\_list SURFACE DATA SPLINE LIST**

```

typedef struct {
    Pint          num_data_spline; /* number of data splines */
    Psurf_data_spline *data_splines; /* list of data splines */
} Psurf_data_spline_list;

```

---

**Psurf\_geom\_spline SURFACE GEOMETRY SPLINE**

```

typedef struct {
    Pint          u_order;      /* u spline order          */
    Pint          v_order;      /* v spline order          */
    Pfloat_list   u_knots;      /* u knots                 */
    Pfloat_list   v_knots;      /* v knots                 */
    Pctrl_point3_array ctrl_points; /* array of control points */
} Psurf_geom_spline;

```

---

**Ptext\_bundle\_plus TEXT BUNDLE PLUS**

```

typedef struct {
    Pint          font;          /* text font */
    Ptext_prec    precision;     /* text precision */
    Pfloat        char_expan;    /* character expansion factor */
    Pfloat        char_space;    /* character spacing */
    Pcolr         colr;          /* text colour */
} Ptext_bundle_plus;

```

---

**Ptri\_set\_data TRIANGLE SET DATA**

```

typedef struct {
    Pint          num_sets;      /* number of triangle sets */
    Pint          num_data_per_facet; /* number of data values per facet */
    Pcolrv_ptr    facet_colrvs;  /* list of facet colours */
    Pvec3         *facet_norms;  /* list of facet normals */
    Pfloat        *facet_data;   /* list of facet data lists */
} Ptri_set_data;

```

**NOTE** — A NULL value for the facet\_colrvs, facet\_norms, facet\_data, or edge\_flags fields indicates the corresponding optional data is not supplied.

---

**Ptrim\_curve TRIMMING CURVE**

```

typedef struct {
    Pcurve_approx_crit approx_crit; /* trimming curve approx. criteria data record */
    Pvis_flag          visibility_flag; /* curve visibility flag */
    Pint               order;          /* curve order */
    Pfloat_list        knots;          /* curve knot vector */
    Pfloat             low_limit;      /* curve parameter range lower limit */
    Pfloat             high_limit;     /* curve parameter range upper limit */
    Pctrl_point_list   ctrl_points;   /* curve control points */
} Ptrim_curve;

```

---

**Ptrim\_curve\_loop TRIMMING CURVE LOOP**

```
typedef struct {
    Pint          num_trim_curves;    /* number of trimming curves */
    Ptrim_curve    *trim_curves;      /* list of trimming curves forming */
                                      /* a closed loop */
} Ptrim_curve_loop;
```

---

**Ptrim\_curve\_loop\_list TRIMMING CURVE LOOP LIST**

```
typedef struct {
    Pint          num_trim_loops;    /* number of trimming curve loops */
    Ptrim_curve_loop *trim_loops;    /* list of trimming curve loops */
} Ptrim_curve_loop_list;
```

---

**Pvertex\_array VERTEX ARRAY**

```
typedef struct {
    Pint_size      dims;              /* dimensions of vertex array */
    Pint           num_data_per_vertex; /* number of data values */
                                      /* per-vertex */
    Ppoint          *vertex_points;    /* array of vertex points */
    Pcolrv_ptr      vertex_colrvs;     /* array of vertex colours */
    Pvec3           *vertex_norms;     /* array of vertex normals */
    Pfloat          *vertex_data;      /* array of vertex data lists */
} Pvertex_array;
```

---

**NOTE** — A NULL value for the `vertex_colrvs`, `vertex_norms`, or `vertex_data` fields indicates the corresponding optional data is not supplied.

---

**Pvertex\_ind\_triplet VERTEX INDEX TRIPLET**

```
typedef Pint Pvertex_ind_triplet[3];
```

---

**Pvertex\_ind\_triplet\_list VERTEX INDEX TRIPLET LIST**

```
typedef struct {
    Pint          num_vertex_ind_triplets; /* number of vertex index */
                                           /* triplets */
    Pvertex_ind_triplets*vertex_ind_triplets; /*list of vertex index triplets */
} Pvertex_ind_triplet_list;
```

---

**Pvertex\_list VERTEX LIST**

```
typedef struct {
    Pint          num_vertices;           /* number of vertices */
    Pint          num_data_per_vertex; /* number of data values */
                                           /* per-vertex */
    Ppoint        *vertex_points;         /* list of vertex points */
    Pcolrv_ptr    vertex_colrvs;          /* list of vertex colours */
    Pvec3         *vertex_norms;          /* list of vertex normals */
    Pfloat        *vertex_data;           /* list of vertex data lists */
} Pvertex_list;
```

---

NOTE — A NULL value for the vertex\_colrvs, vertex\_norms, or vertex\_data fields indicates the corresponding optional data is not supplied.

---

**Pvertex\_set VERTEX SET**

```
typedef struct {
    Pint          num_lists;              /* number of vertex lists */
    Pvertex_list  *vertices;              /* list of vertex lists */
} Pvertex_set;
```

---

**Pvertex3\_array VERTEX 3 ARRAY**

```

typedef struct {
    Pint_size      dims;          /* dimensions of vertex array */
    Pint           num_data_per_vertex; /* number of data values */
                                /* per-vertex */
    Ppoint3        *vertex_points; /* array of vertex points */
    Pcolrv_ptr     vertex_colrvs; /* array of vertex colours */
    Pvec3          *vertex_norms; /* array of vertex normals */
    Pfloat         *vertex_data; /* array of vertex data lists */
} Pvertex3_array;

```

**NOTE —** A NULL value for the `vertex_colrvs`, `vertex_norms`, or `vertex_data` fields indicates the corresponding optional data is not supplied.

---

**Pvertex3\_list VERTEX 3 LIST**

```

typedef struct {
    Pint           num_vertices; /* number of vertices */
    Pint           num_data_per_vertex; /* number of data values */
                                /* per-vertex */
    Ppoint3        *vertex_points; /* list of vertex points */
    Pcolrv_ptr     vertex_colrvs; /* list of vertex colours */
    Pvec3          *vertex_norms; /* list of vertex normals */
    Pfloat         *vertex_data; /* list of vertex data lists */
} Pvertex3_list;

```

**NOTE —** A NULL value for the `vertex_colrvs`, `vertex_norms`, or `vertex_data` fields indicates the corresponding optional data is not supplied.

---

**Pvertex3\_set VERTEX 3 SET**

```

typedef struct {
    Pint           num_lists; /* number of vertex lists */
    Pvertex3_list *vertices; /* list of vertex lists */
} Pvertex3_set;

```

---

**Pvis\_flag VISIBILITY FLAG**

```
typedef enum {  
    PVIS_OFF,  
    PVIS_ON  
} Pvis_flag;
```

---

**Pws\_st\_tables\_plus LENGTHS OF WORKSTATION STATE TABLES**

```
typedef struct {  
    Pint          data_map_rep;          /* max. # of data mapping table */  
                                           /* entries */  
    Pint          refl_rep;              /* max. # of reflectance table */  
                                           /* entries */  
    Pint          param_surf_rep;         /* max. # of param. surface table */  
                                           /* entries */  
    Pint          light_source_rep;       /* max. # of light source table */  
                                           /* entries */  
    Pint          depth_cue_rep;          /* max. # of depth cue table */  
                                           /* entries */  
    Pint          colr_map_rep;           /* max. # of colour mapping table */  
                                           /* entries */  
} Pws_st_tables_plus;
```

## 9 C PHIGS PLUS macro definitions

### 9.1 Function identifiers

The error functions require a unique mapping of the PHIGS PLUS functions to a set of numbers. The names for these function identifiers are the same as the bound PHIGS PLUS function names except that the sentinel character has been replaced by Pfn\_.

| Function Name Macro                          | Function Number |
|----------------------------------------------|-----------------|
| #define Pfn_polyline_set3_colr               | (183)           |
| #define Pfn_fill_area_set3_data              | (184)           |
| #define Pfn_fill_area_set_data               | (185)           |
| #define Pfn_cell_array3_plus                 | (186)           |
| #define Pfn_set_of_fill_area_sets3_data      | (187)           |
| #define Pfn_set_of_fill_area_sets_data       | (188)           |
| #define Pfn_tri_set3_data                    | (189)           |
| #define Pfn_tri_set_data                     | (190)           |
| #define Pfn_tri_strip3_data                  | (191)           |
| #define Pfn_tri_strip_data                   | (192)           |
| #define Pfn_quad_mesh3_data                  | (193)           |
| #define Pfn_quad_mesh_data                   | (194)           |
| #define Pfn_non_uniform_b_spline_curve3      | (195)           |
| #define Pfn_non_uniform_b_spline_curve3_colr | (196)           |
| #define Pfn_non_uniform_b_spline_surf3       | (197)           |
| #define Pfn_non_uniform_b_spline_surf3_data  | (198)           |
| #define Pfn_set_data_map_ind                 | (199)           |
| #define Pfn_set_refl_ind                     | (200)           |
| #define Pfn_set_back_int_ind                 | (201)           |
| #define Pfn_set_back_data_map_ind            | (202)           |
| #define Pfn_set_back_refl_ind                | (203)           |
| #define Pfn_set_param_surf_ind               | (204)           |
| #define Pfn_set_line_colr                    | (205)           |
| #define Pfn_set_line_shad_method             | (206)           |
| #define Pfn_set_marker_colr                  | (207)           |
| #define Pfn_set_text_colr                    | (208)           |
| #define Pfn_set_facet_disting_mode           | (209)           |
| #define Pfn_set_facet_cull_mode              | (210)           |
| #define Pfn_set_int_colr                     | (211)           |
| #define Pfn_set_int_shad_method              | (212)           |
| #define Pfn_set_data_map_method              | (213)           |
| #define Pfn_set_refl_props                   | (214)           |
| #define Pfn_set_refl_model                   | (215)           |
| #define Pfn_set_back_int_style               | (216)           |
| #define Pfn_set_back_int_style_ind           | (217)           |
| #define Pfn_set_back_int_colr                | (218)           |
| #define Pfn_set_back_int_shad_method         | (219)           |

```

#define Pfn_set_back_data_map_method (220)
#define Pfn_set_back_refl_props (221)
#define Pfn_set_back_refl_model (222)
#define Pfn_set_light_source_st (223)
#define Pfn_set_edge_colr (224)
#define Pfn_set_curve_approx_crit (225)
#define Pfn_set_surf_approx_crit (226)
#define Pfn_set_param_surf_chars (227)
#define Pfn_set_rend_colr_model (228)
#define Pfn_set_depth_cue_ind (229)
#define Pfn_set_colr_map_ind (230)
#define Pfn_set_line_rep_plus (231)
#define Pfn_set_marker_rep_plus (232)
#define Pfn_set_text_rep_plus (233)
#define Pfn_set_int_rep_plus (234)
#define Pfn_set_edge_rep_plus (235)
#define Pfn_set_data_map_rep (236)
#define Pfn_set_refl_rep (237)
#define Pfn_set_param_surf_rep (238)
#define Pfn_set_pat_rep_plus (239)
#define Pfn_set_light_source_rep (240)
#define Pfn_set_depth_cue_rep (241)
#define Pfn_set_colr_map_rep (242)

```

## 9.2 Error codes

```

/* Output Attribute Errors */
#define PE_BAD_DEPTH_CUE_MODE (119) /* Ignoring function, the spec-
                                     igned depth cue mode is not
                                     available on the workstation
                                     */

#define PE_DEPTH_CUE_INDX_LT_1 (120) /* Ignoring function, the
                                     depth cue index is less
                                     than one */

#define PE_COLR_MAP_INDX_LT_1 (121) /* Ignoring function, the
                                     colour mapping index is
                                     less than one */

#define PE_BAD_LINE_SHAD_METHOD (122) /* Ignoring function, the spec-
                                     igned polyline shading
                                     method is not available on
                                     the workstation */

#define PE_BAD_INT_SHAD_METHOD (123) /* Ignoring function, the spec-
                                     igned interior shading
                                     method is not available on
                                     the workstation */

#define PE_BAD_REFL_MODEL (124) /* Ignoring function, the spec-
                                     igned reflectance model is

```

```

not available on the work-
station */
#define PE_TOTAL_COLR_RANGE_FIELDS_TOO_LARGE (125)
/* Ignoring function, the
total of the colour range
fields in all the table
entries is too large */
#define PE_BAD_COLR_MAP_METHOD (126) /* Ignoring function, the spec-
ified colour mapping method
is not available on the
specified workstation */
#define PE_BAD_APPROX_CRIT_TYPE (127) /* Ignoring function, the spec-
ified approximation crite-
ria type is not available
on the specified workstation
*/
#define PE_BAD_PARAM_SURF_CHAR_TYPE (128) /* Ignoring function, the spec-
ified parametric surface
characteristics type is not
available on the specified
workstation */
#define PE_LIGHT_SOURCE_INDX_LT_1 (129) /* Ignoring function, the
light source index is less
than one */
#define PE_INVALID_REF_PLANES (130) /* Ignoring function, invalid
reference planes; DQMIN >
DQMAX */
#define PE_BAD_LIGHT_SOURCE_TYPE (131) /* Ignoring function, the spec-
ified light source type is
not available on the work-
station */
#define PE_SPOTLIGHT_SPREAD_ANGLE_RANGE (132) /* Ignoring function, the spec-
ified spot light spread
angle is out of range */
#define PE_BAD_ACTIVATION_LIST (133) /* Ignoring function, one of
the entries in the activa-
tion list or deactivation
list is less than one */
#define PE_GEN_COLR_NOT_INDIRECT (134) /* Ignoring function, the
requested entry contains a
general colour specifica-
tion with colour type other
than INDIRECT */
#define PE_SAME_ACTIVATION_DEACTIVATION_ENTRY (135)
/* Ignoring function, the same
entry exists in both the
activation and the deactiva-
tion list */
#define PE_COLR_COMPONENT_RANGE (136) /* Ignoring function, one of
the components of the

```

colour specification is out of range \*/

#define PE\_BAD\_DATA\_MAP\_METHOD (137) /\* Ignoring function, the specified data mapping method is not available on the specified workstation \*/

#define PE\_BAD\_DATA\_RECORD\_FIELD (138) /\* Ignoring function, one or more of the fields within the specified data record is in error \*/

#define PE\_BAD\_REFL\_PROP\_TYPE (139) /\* Ignoring function, the specified reflectance property type is not available on the specified workstation \*/

#define PE\_INVALID\_DEPTH\_CUE\_SCALE (140) /\* Ignoring function, one of the depth cue scale factors is not in the required range \*/

/\* Output Primitive Errors \*/

#define PE\_ORDER\_LT\_1 (500) /\* Ignoring function, the order of a spline is less than one \*/

#define PE\_INSUFF\_CTRL\_POINTS\_FOR\_ORDER (501) /\* Ignoring function, a spline does not contain enough control points for its specified order \*/

#define PE\_ORDER\_INCONSISTENT\_KNOTS\_CTRL\_POINTS (502) /\* Ignoring function, the order of a spline is inconsistent with number of knots and control points \*/

#define PE\_KNOT\_SEQUENCE\_NOT\_NONDECREASING (503) /\* Ignoring function, the knot sequence for a spline is not non-decreasing \*/

#define PE\_VERTEX\_INDX\_OUT\_OF\_RANGE (504) /\* Ignoring function, one or more of the vertex indices is out of range \*/

#define PE\_PARAM\_RANGE\_INCONSISTENT\_KNOTS (506) /\* Ignoring function, the parameter range for a spline is inconsistent with its knots \*/

#define PE\_W\_VALUE\_LE\_0 (507) /\* Ignoring function, the fourth coordinate of a rational control point is less than or equal to zero \*/

#define PE\_TRIM\_CURVE\_ORDER\_LT\_2 (508) /\* Ignoring function, a trimming curve's order is less than two \*/

```

#define PE_INCONSISTENT_EDGE_FLAG_SPEC    (513) /* Ignoring function, the num-
                                                    ber of edge visibility
                                                    flags is inconsistent with
                                                    the number of edges in the
                                                    primitive */
#define PE_DATA_LIST_LENGTH_NOT_SAME      (514) /* Ignoring function, the data
                                                    lists do not all contain
                                                    the same number of entries */
#define PE_INCONSISTENT_FACET_SPEC        (516) /* Ignoring function, the
                                                    facet data is inconsistent
                                                    with the number of facets
                                                    in the primitive */
#define PE_PARAM_RANGE_COLR_SPLINE        (517) /* Ignoring function, the
                                                    parameter range of the
                                                    colour spline does not
                                                    include the effective param-
                                                    eter range of the geometry
                                                    spline */
#define PE_PARAM_RANGE_DATA_SPLINE        (518) /* Ignoring function, the
                                                    parameter range of the data
                                                    spline does not include the
                                                    effective parameter range
                                                    of the geometry spline */
#define PE_BAD_VERTEX_DATA_TYPE           (2207) /* Ignoring function, two or
                                                    more vertices do not con-
                                                    tain the same type of data*/

```

### 9.3 Miscellaneous

#### 9.3.1 Colour mapping methods

```

#define PCOLR_MAP_METHOD_TRUE              (1)
#define PCOLR_MAP_METHOD_PSEUDO            (2)
#define PCOLR_MAP_METHOD_PSEUDO_N         (3)

```

#### 9.3.2 Colour types

```

#define PCOLR_INDIRECT                     (0)
#define PCOLR_RGB                          (1)
#define PCOLR_CIELUV                       (2)
#define PCOLR_HSV                          (3)
#define PCOLR_HLS                          (4)

```

**9.3.3 Curve approximation criteria types**

```

#define PCURVE_APPROX_WS_DEP (1)
#define PCURVE_APPROX_CONST_PARAM_SUBD (2)
#define PCURVE_APPROX_CHORDAL_SIZE_WC (3)
#define PCURVE_APPROX_CHORDAL_SIZE_NPC (4)
#define PCURVE_APPROX_CHORDAL_SIZE_DC (5)
#define PCURVE_APPROX_CHORDAL_DEV_WC (6)
#define PCURVE_APPROX_CHORDAL_DEV_NPC (7)
#define PCURVE_APPROX_CHORDAL_DEV_DC (8)
#define PCURVE_APPROX_REL_WC (9)
#define PCURVE_APPROX_REL_NPC (10)
#define PCURVE_APPROX_REL_DC (11)

```

**9.3.4 Data mapping methods**

```

#define PDATA_MAP_METHOD_COLR (1)
#define PDATA_MAP_METHOD_SINGLE_UNIFORM (2)
#define PDATA_MAP_METHOD_SINGLE_NON_UNIFORM (3)
#define PDATA_MAP_METHOD_BI_UNIFORM (4)
#define PDATA_MAP_METHOD_BI_NON_UNIFORM (5)

```

**9.3.5 Interior shading method**

```

#define PINT_SHAD_METHOD_NONE (1)
#define PINT_SHAD_METHOD_COLR (2)
#define PINT_SHAD_METHOD_DATA (3)
#define PINT_SHAD_METHOD_DATA_DOT (4)
#define PINT_SHAD_METHOD_DATA_NORM (5)

```

**9.3.6 Light source types**

```

#define PLIGHT_SOURCE_AMB (1)
#define PLIGHT_SOURCE_DIR (2)
#define PLIGHT_SOURCE_POS (3)
#define PLIGHT_SOURCE_SPOT (4)

```

**9.3.7 Parametric surface characteristic types**

```

#define PPARAM_SURF_CHARS_NONE (1)
#define PPARAM_SURF_CHARS_WS_DEP (2)
#define PPARAM_SURF_CHARS_ISOPARAM (3)
#define PPARAM_SURF_CHARS_LEVEL_MC (4)
#define PPARAM_SURF_CHARS_LEVEL_WC (5)

```

**9.3.8 Polyline shading method**

```
#define PLINE_SHAD_METHOD_NONE (1)
#define PLINE_SHAD_METHOD_COLR (2)
```

**9.3.9 Reflectance models**

```
#define PREFL_MODEL_NO_REFL (1)
#define PREFL_MODEL_AMB_REFL (2)
#define PREFL_MODEL_AMB_DIFF_REFL (3)
#define PREFL_MODEL_AMB_DIFF_SPEC_REFL (4)
```

**9.3.10 Reflectance properties**

```
#define PREFL_PROPS_SIMPLE_REFL (1)
```

**9.3.11 Rendering Colour Model**

```
#define PREND_COLR_MODEL_WS_DEP (0)
#define PREND_COLR_MODEL_RGB (1)
#define PREND_COLR_MODEL_CIELUV (2)
#define PREND_COLR_MODEL_HSV (3)
#define PREND_COLR_MODEL_HLS (4)
```

**9.3.12 Surface approximation criteria types**

```
#define PSURF_APPROX_WS_DEP (1)
#define PSURF_APPROX_CONST_PARAM_SUBD (2)
#define PSURF_APPROX_CHORDAL_SIZE_WC (3)
#define PSURF_APPROX_CHORDAL_SIZE_NPC (4)
#define PSURF_APPROX_CHORDAL_SIZE_DC (5)
#define PSURF_APPROX_PLANAR_DEV_WC (6)
#define PSURF_APPROX_PLANAR_DEV_NPC (7)
#define PSURF_APPROX_PLANAR_DEV_DC (8)
#define PSURF_APPROX_REL_WC (9)
#define PSURF_APPROX_REL_NPC (10)
#define PSURF_APPROX_REL_DC (11)
```

**9.3.13 Element enumeration**

```
#define PFIRST_PHIGS_PLUS_ELEM (PELEM_POLYLINE_SET3_COLR)
#define PLAST_PHIGS_PLUS_ELEM (PELEM_COLR_MAP_IND)
```

## 10 C PHIGS PLUS functions

### 10.1 Output primitive functions

---

#### POLYLINE SET 3 WITH COLOUR

```
void ppolyline_set3_colr (
    Pint                colr_type,          /* colour type          */
    const Pvertex3_set *vertex_data        /* list of vertex lists */
);
```

NOTE — Only the vertex points and colour portions of the data pointed to by the vertex\_data parameter are used. All other data is ignored.

---

#### FILL AREA SET 3 WITH DATA

```
void pfill_area_set3_data (
    Pint                colr_type,          /* colour type          */
    const Pfacet        *facet_data,       /* facet data           */
    const Pedge_flag_set *edge_flags,      /* list of edge flag lists */
    const Pvertex3_set *vertex_data        /* list of vertex lists  */
);
```

NOTE — A NULL value for the facet\_data or edge\_flags parameters indicates the corresponding optional data is not supplied.

## FILL AREA SET WITH DATA

```
void pfill_area_set_data (
    Pint                colr_type,      /* colour type          */
    const Pfacet        *facet_data,    /* facet data           */
    const Pedge_flag_set *edge_flags,   /* list of edge flag lists */
    const Pvertex_set   *vertex_data    /* list of vertex lists  */
);
```

NOTE — A NULL value for the facet\_data or edge\_flags parameters indicates the corresponding optional data is not supplied.

## CELL ARRAY 3 PLUS

```
void pcell_array3_plus (
    const Pparal        *paral,         /* parallelogram P, Q, R */
    const Ppat_rep_plus *pat            /* pattern colour array   */
);
```

## SET OF FILL AREA SETS 3 WITH DATA

```
void pset_of_fill_area_sets3_data (
    Pint                colr_type,      /* colour type          */
    const Pset_of_fill_area_sets_data *set_data, /* fill area set data    */
    const Pedge_flag_set_list *edge_flags, /* list of edge flag sets */
    const Pvertex3_list   *vertex_data, /* list of vertices      */
    const Pcontour_set_list *contours    /* list of contour sets  */
);
```

NOTE — A NULL value for the set\_data or edge\_flags parameters indicates the corresponding optional data is not supplied.

**SET OF FILL AREA SETS WITH DATA**

```

void pset_of_fill_area_sets_data (
    Pint                colr_type,      /* colour type          */
    const Pset_of_fill_area_sets_data *set_data, /* fill area set data  */
    const Pedge_flag_set_list *edge_flags, /* list of edge flag sets */
    const Pvertex_list *vertex_data, /* list of vertices     */
    const Pcontour_set_list *contours  /* list of contour sets */
);

```

NOTE — A NULL value for the set\_data or edge\_flags parameters indicates the corresponding optional data is not supplied.

**TRIANGLE SET 3 WITH DATA**

```

void ptri_set3_data (
    Pint                colr_type,      /* colour type          */
    const Ptri_set_data *set_data,      /* triangle set data    */
    const Pedge_flag_triplet_list *edge_flags, /* list of triangle edge flag triplets */
    const Pvertex3_list *vertex_data, /* list of vertices     */
    const Pvertex_ind_triplet_list *triplets /* list of triangle vertex index triplets */
);

```

NOTE — A NULL value for the set\_data or edge\_flags parameters indicates the corresponding optional data is not supplied.

**TRIANGLE SET WITH DATA**

```

void ptri_set_data (
    Pint          colr_type,      /* colour type */
    const Ptri_set_data *set_data, /* triangle set data */
    const Pedge_flag_triplet_list *edge_flags, /* list of triangle edge flag triplets */
    const Pvertex_list *vertex_data, /* list of vertices */
    const Pvertex_ind_triplet_list *vertex_inds, /* list of triangle vertex index triplets */
);

```

NOTE — A NULL value for the set\_data or edge\_flags parameters indicates the corresponding optional data is not supplied.

**TRIANGLE STRIP 3 WITH DATA**

```

void ptri_strip3_data (
    Pint          colr_type,      /* colour type */
    const Pfacet_list *facet_data, /* list of facet data */
    const Pedge_flag_list *edge_flags, /* list of edge flags */
    const Pvertex3_list *vertex_data /* list of vertex data */
);

```

NOTE — A NULL value for the facet\_data or edge\_flags parameters indicates the corresponding optional data is not supplied.

**TRIANGLE STRIP WITH DATA**

```

void ptri_strip_data (
    Pint          colr_type,      /* colour type */
    const Pfacet_list *facet_data, /* list of facet data */
    const Pedge_flag_list *edge_flags, /* list of edge flags */
    const Pvertex_list *vertex_data /* list of vertex data */
);

```

NOTE — A NULL value for the facet\_data or edge\_flags parameters indicates the corresponding optional data is not supplied.

## QUADRILATERAL MESH 3 WITH DATA

```
void pquad_mesh3_data (
    Pint          colr_type,          /* colour type          */
    const Pfacet_array *facet_data,   /* array of facet data  */
    const Pedge_flag_array *edge_flags, /* array of edge flags  */
    const Pvertex3_array *vertex_data /* array of vertex data */
);
```

NOTE — A NULL value for the facet\_data or edge\_flags parameters indicates the corresponding optional data is not supplied.

## QUADRILATERAL MESH WITH DATA

```
void pquad_mesh_data (
    Pint          colr_type,          /* colour type          */
    const Pfacet_array *facet_data,   /* array of facet data  */
    const Pedge_flag_array *edge_flags, /* array of edge flags  */
    const Pvertex_array *vertex_data /* array of vertex data */
);
```

NOTE — A NULL value for the facet\_data or edge\_flags parameters indicates the corresponding optional data is not supplied.

## NON-UNIFORM B-SPLINE CURVE 3

```
void pnon_uniform_b_spline_curve3 (
    const Pcurve_geom_spline *geom_spline /* curve geometry spline */
);
```

---

### NON-UNIFORM B-SPLINE CURVE 3 WITH COLOUR

```
void pnon_uniform_b_spline_curve3_colr (
    const Pcurve_geom_spline *geom_spline /* curve geometry spline */
    const Pcurve_colr_spline *colr_spline /* curve colour spline */
);
```

NOTE — A NULL value for the colr\_spline parameter indicates the corresponding optional data is not supplied.

---

### NON-UNIFORM B-SPLINE SURFACE 3

```
void pnon_uniform_b_spline_surf3 (
    const Psurf_geom_spline *geom_spline /* surface geometry spline */
    const Ptrim_curve_loop_list *trim_loops /* list of trimming curve loops */
);
```

NOTE — A NULL value for the trim\_loops parameter indicates the corresponding optional data is not supplied.

---

### NON-UNIFORM B-SPLINE SURFACE 3 WITH DATA

```
void pnon_uniform_b_spline_surf3_data (
    const Psurf_geom_spline *geom_spline /* surface geometry spline */
    const Ptrim_curve_loop_list *trim_loops /* list of trimming curve loops */
    const Psurf_colr_spline *colr_spline /* colour spline */
    const Psurf_data_spline_list *data_splines /* list of data splines */
);
```

NOTE — A NULL value for the trim\_loops, colr\_spline, and data\_splines parameters indicates the corresponding optional data is not supplied.

## 10.2 Attribute specification functions

### 10.2.1 Bundled attribute selection

---

#### SET DATA MAPPING INDEX

```
void pset_data_map_ind (  
    Pint                index                /* data mapping index          */  
);
```

---

#### SET REFLECTANCE INDEX

```
void pset_refl_ind (  
    Pint                index                /* reflectance index              */  
);
```

---

#### SET BACK INTERIOR INDEX

```
void pset_back_int_ind (  
    Pint                index                /* back interior index            */  
);
```

---

#### SET BACK DATA MAPPING INDEX

```
void pset_back_data_map_ind (  
    Pint                index                /* back data mapping index        */  
);
```

---

**SET BACK REFLECTANCE INDEX**

```
void pset_back_refl_ind (
    Pint          index          /* back reflectance index */
);
```

---

**SET PARAMETRIC SURFACE INDEX**

```
void pset_param_surf_ind (
    Pint          index          /* parametric surface index */
);
```

---

**10.2.2 Individual attribute selection**

---

**SET POLYLINE COLOUR**

```
void pset_line_colr (
    const Pgcolr  *colr          /* polyline colour */
);
```

---

**SET POLYLINE SHADING METHOD**

```
void pset_line_shad_method (
    Pint          method          /* polyline shading method */
);
```

---

**SET POLYMARKER COLOUR**

```
void pset_marker_colr (
    const Pgcolr      *colr           /* polymarker colour */
);
```

---

**SET TEXT COLOUR**

```
void pset_text_colr (
    const Pgcolr      *colr           /* text colour */
);
```

---

**SET FACET DISTINGUISHING MODE**

```
void pset_facet_disting_mode (
    Pfacet_disting_mode mode          /* distinguishing mode */
);
```

---

**SET FACET CULLING MODE**

```
void pset_facet_cull_mode (
    Pfacet_cull_mode   mode           /* facet culling mode */
);
```

---

**SET INTERIOR COLOUR**

```
void pset_int_colr (
    const Pgcolr      *colr           /* interior colour */
);
```

---

**SET INTERIOR SHADING METHOD**

```
void pset_int_shad_method (  
    Pint                method          /* interior shading method */  
);
```

---

**SET DATA MAPPING METHOD**

```
void pset_data_map_method (  
    const Pdata_map_rep *method        /* data mapping method */  
);
```

---

**SET REFLECTANCE PROPERTIES**

```
void pset_refl_props (  
    const Prefl_prop    *refl_prop     /* reflectance property data */  
);
```

---

**SET REFLECTANCE MODEL**

```
void pset_refl_model (  
    Pint                model          /* reflectance model */  
);
```

---

**SET BACK INTERIOR STYLE**

```
void pset_back_int_style (  
    Pint_style          style          /* back interior style */  
);
```

---

**SET BACK INTERIOR STYLE INDEX**

```
void pset_back_int_style_ind (
    Pint          index          /* back interior style index */
);
```

---

**SET BACK INTERIOR COLOUR**

```
void pset_back_int_colr (
    const Pgcldr   *colr         /* back interior colour */
);
```

---

**SET BACK INTERIOR SHADING METHOD**

```
void pset_back_int_shad_method (
    Pint          method        /* interior shading method */
);
```

---

**SET BACK DATA MAPPING METHOD**

```
void pset_back_data_map_method (
    const Pdata_map_rep *method /* data mapping method */
);
```

---

**SET BACK REFLECTANCE PROPERTIES**

```
void pset_back_refl_props (
    const Prefl_prop   *refl_data /* reflectance property data */
);
```

---

**SET BACK REFLECTANCE MODEL**

```
void pset_back_refl_model (  
    Pint                model          /* reflectance model */  
);
```

---

**SET LIGHT SOURCE STATE**

```
void pset_light_source_st (  
    const Pint_list     *act_list,      /* activation list      */  
    const Pint_list     *deact_list    /* deactivation list    */  
);
```

---

**SET EDGE COLOUR**

```
void pset_edge_colr (  
    const Pgcolr        *colr          /* edge colour         */  
);
```

---

**SET CURVE APPROXIMATION CRITERIA**

```
void pset_curve_approx_crit (  
    const Pcurve_approx_crit *data      /* curve approximation criteria */  
                                         /* data record                  */  
);
```

---

**SET SURFACE APPROXIMATION CRITERIA**

```
void pset_surf_approx_crit (  
    const Psurf_approx_crit    *data          /* surface approximation criteria */  
                                     /* data record */  
);
```

---

**SET PARAMETRIC SURFACE CHARACTERISTICS**

```
void pset_param_surf_chars (  
    const Pparam_surf_chars    *data          /* parametric surface */  
                                     /* characteristics data record */  
);
```

---

**SET RENDERING COLOUR MODEL**

```
void pset_rend_colr_model (  
    Pint                        model          /* rendering colour model */  
);
```

---

**SET DEPTH CUE INDEX**

```
void pset_depth_cue_ind (  
    Pint                        index          /* depth cue index */  
);
```

---

## SET COLOUR MAPPING INDEX

```
void pset_colr_map_ind (
    Pint          index          /* colour mapping index */
);
```

### 10.2.3 Workstation attribute table definition

---

## SET POLYLINE REPRESENTATION PLUS

```
void pset_line_rep_plus (
    Pint          ws_id,          /* workstation identifier */
    Pint          index,          /* polyline bundle index */
    const Pline_bundle_plus *rep /* polyline representation */
);
```

---

## SET POLYMARKER REPRESENTATION PLUS

```
void pset_marker_rep_plus (
    Pint          ws_id,          /* workstation identifier */
    Pint          index,          /* polymarker bundle index */
    const Pmarker_bundle_plus *rep /* polymarker representation */
);
```

---

## SET TEXT REPRESENTATION PLUS

```
void pset_text_rep_plus (
    Pint          ws_id,          /* workstation identifier */
    Pint          index,          /* text bundle index */
    const Ptext_bundle_plus *rep /* text representation */
);
```

---

**SET INTERIOR REPRESENTATION PLUS**

```

void pset_int_rep_plus (
    Pint          ws_id,      /* workstation identifier */
    Pint          index,      /* interior bundle index */
    const Pint_bundle_plus *rep /* interior representation */
);

```

---

**SET EDGE REPRESENTATION PLUS**

```

void pset_edge_rep_plus (
    Pint          ws_id,      /* workstation identifier */
    Pint          index,      /* edge bundle index */
    const Pedge_bundle_plus *rep /* edge representation */
);

```

---

**SET DATA MAPPING REPRESENTATION**

```

void pset_data_map_rep (
    Pint          ws_id,      /* workstation identifier */
    Pint          index,      /* data mapping index */
    const Pdata_map_rep *rep /* data mapping representation */
);

```

---

**SET REFLECTANCE REPRESENTATION**

```

void pset_refl_rep (
    Pint          ws_id,      /* workstation identifier */
    Pint          index,      /* reflectance index */
    const Prefl_rep *rep      /* reflectance representation */
);

```

---

## SET PARAMETRIC SURFACE REPRESENTATION

```
void pset_param_surf_rep (
    Pint          ws_id,      /* workstation identifier */
    Pint          index,      /* parametric surface rep. index */
    const Pparam_surf_rep *rep /* parametric surface
                                representation */
);
```

---

## SET PATTERN REPRESENTATION PLUS

```
void pset_pat_rep_plus (
    Pint          ws_id,      /* workstation identifier */
    Pint          index,      /* pattern index */
    const Ppat_rep_plus *rep /* pattern representation plus */
);
```

---

## SET LIGHT SOURCE REPRESENTATION

```
void pset_light_source_rep (
    Pint          ws_id,      /* workstation identifier */
    Pint          index,      /* light source index */
    const Plight_source_rep *rep /* light source representation */
);
```

---

## SET DEPTH CUE REPRESENTATION

```
void pset_depth_cue_rep (
    Pint          ws_id,      /* workstation identifier */
    Pint          index,      /* depth cue index */
    const Pdepth_cue_rep *rep /* depth cue representation */
);
```

---

## SET COLOUR MAPPING REPRESENTATION

```
void pset_colr_map_rep (
    Pint          ws_id,          /* workstation identifier */
    Pint          index,          /* colour mapping index   */
    const Pcolr_map_rep *rep      /* colour mapping representation */
);
```

### 10.3 Inquiry functions

#### 10.3.1 Inquiry functions for the workstation state list

---

## INQUIRE POLYLINE REPRESENTATION PLUS

```
void pinq_line_rep_plus (
    Pint          ws_id,          /* workstation identifier */
    Pint          index,          /* polyline index         */
    Pinq_type     type,           /* type of returned values */
    Pint          *err_ind,       /* OUT error indicator     */
    Pline_bundle_plus *rep        /* OUT polyline representation */
);
```

---

## INQUIRE POLYMARKER REPRESENTATION PLUS

```
void pinq_marker_rep_plus (
    Pint          ws_id,          /* workstation identifier */
    Pint          index,          /* polymarker index       */
    Pinq_type     type,           /* type of returned values */
    Pint          *err_ind,       /* OUT error indicator     */
    Pmarker_bundle_plus *rep      /* OUT polymarker representation */
);
```

**INQUIRE TEXT REPRESENTATION PLUS**


---

```

void pinq_text_rep_plus (
    Pint          ws_id,          /* workstation identifier */
    Pint          index,          /* text index */
    Pinq_type     type,           /* type of returned values */
    Pint          *err_ind,        /* OUT error indicator */
    Ptext_bundle_plus *rep        /* OUT text representation */
);

```

---

**INQUIRE INTERIOR REPRESENTATION PLUS**

```

void pinq_int_rep_plus (
    Pint          ws_id,          /* workstation identifier */
    Pint          index,          /* interior index */
    Pinq_type     type,           /* type of returned values */
    Pint          *err_ind,        /* OUT error indicator */
    Pint_bundle_plus *rep        /* OUT interior representation */
);

```

---

**INQUIRE EDGE REPRESENTATION PLUS**

```

void pinq_edge_rep_plus (
    Pint          ws_id,          /* workstation identifier */
    Pint          index,          /* edge index */
    Pinq_type     type,           /* type of returned values */
    Pint          *err_ind,        /* OUT error indicator */
    Pedge_bundle_plus *rep        /* OUT edge representation */
);

```

---

## INQUIRE LIST OF DATA MAPPING INDICES

```
void ping_list_data_map_inds (
    Pint          ws_id,          /* workstation identifier */
    Pint          num_elems_appl_list, /* # elems in appl list */
    Pint          start_ind,       /* starting index */
    Pint          *err_ind,        /* OUT error indicator */
    Pint_list     *indices,        /* OUT list of defined data
                                   /* mapping indices */
    Pint          *num_elems_impl_list /* OUT # elems in impl list */
);
```

## INQUIRE DATA MAPPING REPRESENTATION

```
void ping_data_map_rep (
    Pint          ws_id,          /* workstation identifier */
    Pint          index,          /* data mapping index */
    Ping_type     type,           /* type of returned values */
    Pstore        store,          /* handle to Store object */
    Pint          *err_ind,        /* OUT error indicator */
    Pdata_map_rep **rep           /* OUT data mapping representation*/
);
```

NOTE — The memory referenced by \*rep is managed by store.

## INQUIRE LIST OF REFLECTANCE INDICES

```
void ping_list_refl_inds (
    Pint          ws_id,          /* workstation identifier */
    Pint          num_elems_appl_list, /* # elems in appl list */
    Pint          start_ind,       /* starting index */
    Pint          *err_ind,        /* OUT error indicator */
    Pint_list     *indices,        /* OUT list of defined reflectance
                                   /* indices */
    Pint          *num_elems_impl_list /* OUT # elems in impl list */
);
```

---

## INQUIRE REFLECTANCE REPRESENTATION

```
void pinq_refl_rep (
    Pint          ws_id,          /* workstation identifier */
    Pint          index,          /* reflectance index */
    Pinq_type     type,           /* type of returned values */
    Pstore        store,          /* handle to Store object */
    Pint          *err_ind,       /* OUT error indicator */
    Prefl_rep     **rep           /* OUT reflectance representation */
);
```

NOTE — The memory referenced by \*rep is managed by store.

---

## INQUIRE LIST OF PARAMETRIC SURFACE INDICES

```
void pinq_list_param_surf_inds (
    Pint          ws_id,          /* workstation identifier */
    Pint          num_elems_appl_list, /* # elems in appl list */
    Pint          start_ind,       /* starting index */
    Pint          *err_ind,       /* OUT error indicator */
    Pint_list     *indices,       /* OUT list of defined parametric */
                                /* surface indices */
    Pint          *num_elems_impl_list /* OUT # elems in impl list */
);
```

---

## INQUIRE PARAMETRIC SURFACE REPRESENTATION

```
void pinq_param_surf_rep (
    Pint          ws_id,          /* workstation identifier */
    Pint          index,          /* parametric surface bundle index */
    Pinq_type     type,           /* type of returned values */
    Pstore        store,          /* handle to Store object */
    Pint          *err_ind,       /* OUT error indicator */
    Pparam_surf_rep **rep         /* OUT parametric surface */
                                /* representation */
);
```

NOTE — The memory referenced by \*rep is managed by store.

---

## INQUIRE PATTERN REPRESENTATION PLUS

```
void pinq_pat_rep_plus (
    Pint          ws_id,          /* workstation identifier */
    Pint          index,          /* pattern index          */
    Pint_type     type,           /* type of returned values */
    Pstore        store,          /* handle to Store object  */
    Pint          *err_ind,        /* OUT error indicator     */
    Ppat_rep_plus **rep           /* OUT pattern representation plus */
);
```

NOTE — The memory referenced by \*rep is managed by store.

---

## INQUIRE LIST OF LIGHT SOURCE INDICES

```
void pinq_list_light_source_inds (
    Pint          ws_id,          /* workstation identifier */
    Pint          num_elems_appl_list, /* # elems in appl list */
    Pint          start_ind,        /* starting index         */
    Pint          *err_ind,        /* OUT error indicator     */
    Pint_list     *indices,         /* OUT list of defined light source indices */
    Pint          *num_elems_impl_list /* OUT # elems in impl list */
);
```

---

## INQUIRE LIGHT SOURCE REPRESENTATION

```
void pinq_light_source_rep (
    Pint          ws_id,          /* workstation identifier */
    Pint          index,          /* light source index      */
    Pint_type     type,           /* type of returned values */
    Pint          *err_ind,        /* OUT error indicator     */
    Plight_source_rep *rep        /* OUT light source representation */
);
```

---

## INQUIRE LIST OF DEPTH CUE INDICES

```
void pinq_list_depth_cue_inds (
    Pint          ws_id,          /* workstation identifier */
    Pint          num_elems_appl_list, /* # elems in appl list */
    Pint          start_ind,       /* starting index */
    Pint          *err_ind,        /* OUT error indicator */
    Pint_list     *indices,        /* OUT list of defined depth cue */
                                /* indices */
    Pint          *num_elems_impl_list /* OUT # elems in impl list */
);
```

---

## INQUIRE DEPTH CUE REPRESENTATION

```
void pinq_depth_cue_rep (
    Pint          ws_id,          /* workstation identifier */
    Pint          index,          /* depth cue index */
    Pinq_type     type,           /* type of returned values */
    Pint          *err_ind,        /* OUT error indicator */
    Pdepth_cue_rep *rep           /* OUT depth cue representation */
);
```

---

## INQUIRE COLOUR MAPPING STATE

```
void pinq_colr_map_st (
    Pint          ws_id,          /* workstation identifier */
    Pint          method,         /* colour mapping method */
    Pstore        store,          /* handle to Store object */
    Pint          *err_ind,        /* OUT error indicator */
    Pcolr_map_st  **data          /* OUT data record */
);
```

---

NOTE — The memory referenced by \*data is managed by store.

## INQUIRE LIST OF COLOUR MAPPING INDICES

```
void pinq_list_colr_map_inds (
    Pint          ws_id,          /* workstation identifier */
    Pint          num_elems_appl_list, /* # elems in appl list */
    Pint          start_ind,       /* starting index */
    Pint          *err_ind,        /* OUT error indicator */
    Pint_list     *indices,        /* OUT list of defined colour */
                                /* mapping indices */
    Pint          *num_elems_impl_list /* OUT # elems in impl list */
);
```

## INQUIRE COLOUR MAPPING REPRESENTATION

```
void pinq_colr_map_rep (
    Pint          ws_id,          /* workstation identifier */
    Pint          index,          /* colour mapping index */
    Pint_type     type,           /* type of returned values */
    Pstore        store,         /* handle to Store object */
    Pint          *err_ind,       /* OUT error indicator */
    Pcolr_map_rep **rep          /* OUT colour mapping */
                                /* representation */
);
```

NOTE — The memory referenced by \*rep is managed by store.

### 10.3.2 Inquiry functions for the workstation description table

---

#### INQUIRE DIRECT COLOUR MODEL FACILITIES

```
void pinq_direct_colr_model_facs (
    Pint          ws_type,          /* workstation type          */
    Pint          num_elems_appl_list, /* # elems in appl list     */
    Pint          start_ind,         /* starting index            */
    Pint          *err_ind,          /* OUT error indicator       */
    Pint_list     *models,           /* OUT list of directly
                                     /* specifiable colour models */
    Pint          *num_elems_impl_list /* OUT # elems in impl list */
);
```

---

#### INQUIRE RENDERING COLOUR MODEL FACILITIES

```
void pinq_rend_colr_model_facs (
    Pint          ws_type,          /* workstation type          */
    Pint          num_elems_appl_list, /* # elems in appl list     */
    Pint          start_ind,         /* starting index            */
    Pint          *err_ind,          /* OUT error indicator       */
    Pint_list     *models,           /* OUT list of available rendering
                                     /* colour models             */
    Pint          *num_elems_impl_list /* OUT # elems in impl list */
);
```

---

#### INQUIRE DYNAMICS OF WORKSTATION ATTRIBUTES PLUS

```
void pinq_dyns_ws_attrs_plus (
    Pint          ws_type,          /* workstation type          */
    Pint          *err_ind,          /* OUT error indicator       */
    Pdyn_ws_attrs_plus *attr        /* OUT dynamics of workstation
                                     /* attributes plus           */
);
```

**INQUIRE POLYLINE FACILITIES PLUS**

```

void pinq_line_facs_plus (
    Pint          ws_type,          /* workstation type          */
    Pstore        store,           /* handle to Store object    */
    Pint          *err_ind,        /* OUT error indicator       */
    Pline_facs_plus **facs         /* OUT list of polyline     */
                                /* facilities plus           */
);

```

NOTE — The memory referenced by \*facs is managed by store.

**INQUIRE PREDEFINED POLYLINE REPRESENTATION PLUS**

```

void pinq_pred_line_rep_plus (
    Pint          ws_type,          /* workstation type          */
    Pint          index,           /* predefined polyline index  */
    Pint          *err_ind,        /* OUT error indicator       */
    Pline_bundle_plus *rep         /* OUT predefined polyline   */
                                /* representation            */
);

```

**INQUIRE PREDEFINED POLYMARKER REPRESENTATION PLUS**

```

void pinq_pred_marker_rep_plus (
    Pint          ws_type,          /* workstation type          */
    Pint          index,           /* predefined polymarker index */
    Pint          *err_ind,        /* OUT error indicator       */
    Pmarker_bundle_plus *rep       /* OUT predefined polymarker  */
                                /* representation            */
);

```

---

## INQUIRE PREDEFINED TEXT REPRESENTATION PLUS

```
void pinq_pred_text_rep_plus (
    Pint          ws_type,          /* workstation type          */
    Pint          index,            /* predefined text index      */
    Pint          *err_ind,         /* OUT error indicator        */
    Ptext_bundle_plus *rep          /* OUT predefined text        */
                                /* representation              */
);
```

---

## INQUIRE INTERIOR FACILITIES PLUS

```
void pinq_int_fac_plus (
    Pint          ws_type,          /* workstation type          */
    Pstore        store,            /* handle to Store object     */
    Pint          *err_ind,         /* OUT error indicator        */
    Pint_fac_plus **fac            /* OUT list of interior      */
                                /* facilities plus              */
);
```

---

NOTE — The memory referenced by \*fac is managed by store.

---

## INQUIRE PREDEFINED INTERIOR REPRESENTATION PLUS

```
void pinq_pred_int_rep_plus (
    Pint          ws_type,          /* workstation type          */
    Pint          index,            /* predefined interior index   */
    Pint          *err_ind,         /* OUT error indicator        */
    Pint_bundle_plus *rep          /* OUT predefined interior    */
                                /* representation              */
);
```

---

## INQUIRE PREDEFINED EDGE REPRESENTATION PLUS

```
void ping_pred_edge_rep_plus (
    Pint          ws_type,          /* workstation type          */
    Pint          index,            /* predefined edge index     */
    Pint          *err_ind,         /* OUT error indicator       */
    Pedge_bundle_plus *rep          /* OUT predefined edge       */
                                /* representation            */
);
```

---

## INQUIRE DATA MAPPING FACILITIES

```
void ping_data_map_fac (
    Pint          ws_type,          /* workstation type          */
    Pint          num_elems_appl_list, /* # elems in appl list     */
    Pint          start_ind,        /* starting index            */
    Pint          *err_ind,         /* OUT error indicator       */
    Pint_list     *methods,         /* OUT list of available data */
                                /* mapping methods           */
    Pint          *num_inds,        /* OUT number of predefined data */
                                /* mapping indices           */
    Pint          *num_elems_impl_list /* OUT # elems in impl list  */
);
```

---

## INQUIRE PREDEFINED DATA MAPPING REPRESENTATION

```
void ping_pred_data_map_rep (
    Pint          ws_type,          /* workstation type          */
    Pint          index,            /* predefined data mapping index */
    Pstore        store,           /* handle to Store object     */
    Pint          *err_ind,         /* OUT error indicator       */
    Pdata_map_rep *rep             /* OUT data mapping representation */
);
```

---

NOTE — The memory referenced by \*rep is managed by store.

## INQUIRE REFLECTANCE FACILITIES

```
void ping_refl_facs (
    Pint          ws_type,          /* workstation type */
    Pstore        store,            /* handle to Store object */
    Pint          *err_ind,         /* OUT error indicator */
    Pint_list     **models,         /* OUT list of available
                                   /* reflectance models */
    Pint_list     **refl_props,     /* OUT list of available
                                   /* reflectance properties */
    Pint          *refl_indices     /* OUT number of predefined
                                   /* reflectance indices */
);
```

NOTE — The memory referenced by \*models and \*refl\_props is managed by store.

## INQUIRE PREDEFINED REFLECTANCE REPRESENTATION

```
void ping_pred_refl_rep (
    Pint          ws_type,          /* workstation type */
    Pint          index,            /* predefined reflectance index */
    Pstore        store,            /* handle to Store object */
    Pint          *err_ind,         /* OUT error indicator */
    Prefl_rep     **rep            /* OUT predefined reflectance
                                   /* representation */
);
```

NOTE — The memory referenced by \*rep is managed by store.

## INQUIRE CURVE AND SURFACE FACILITIES

The **INQUIRE CURVE AND SURFACE FACILITIES** is broken into four related functions: **INQUIRE CURVE FACILITIES**, **INQUIRE PARAMETRIC SURFACE FACILITIES**, **INQUIRE B-SPLINE SURFACE FACILITIES**, and **INQUIRE TRIMMING CURVE FACILITIES**.

**INQUIRE CURVE FACILITIES**

```

void ping_curve_facs (
    Pint          ws_type,          /* workstation type */
    Pint          num_elems_appl_list, /* # elems in appl list */
    Pint          start_ind,        /* starting index */
    Pint          *err_ind,         /* OUT error indicator */
    Pint          *max_order,       /* OUT maximum non-uniform
                                   /* b-spline */
                                   /* curve order supported */
    Pint_list     *types,          /* OUT list of available curve
                                   /* approximation criteria types */
    Pint          *num_elems_impl_list /* OUT # elems in impl list */
);

```

**INQUIRE PARAMETRIC SURFACE FACILITIES**

```

void ping_param_surf_facs (
    Pint          ws_type,          /* workstation type */
    Pint          num_elems_appl_list, /* # elems in appl list */
    Pint          start_ind,        /* starting index */
    Pint          *err_ind,         /* OUT error indicator */
    Pint_list     *types,          /* OUT list of available
                                   /* parametric surface
                                   /* characteristic types */
    Pint          *num_elems_impl_list, /* OUT # elems in impl list */
    Pint          *num_indices       /* OUT number of predefined
                                   /* parametric surface indices */
);

```

**INQUIRE B-SPLINE SURFACE FACILITIES**

```

void ping_b_spline_surf_facs (
    Pint          ws_type,          /* workstation type */
    Pint          num_elems_appl_list, /* # elems in appl list */
    Pint          start_ind,        /* starting index */
    Pint          *err_ind,         /* OUT error indicator */
    Pint          *max_order,       /* OUT maximum non-uniform
                                   /* b-spline surface order
                                   /* supported */
    Pint_list     *types,          /* OUT list of available surface
                                   /* approximation criteria types */
    Pint          *num_elems_impl_list /* OUT # elems in impl list */
);

```

**INQUIRE TRIMMING CURVE FACILITIES**

```

void ping_trim_curve_facs (
    Pint          ws_type,          /* workstation type          */
    Pint          num_elems_appl_list, /* # elems in appl list     */
    Pint          start_ind,        /* starting index            */
    Pint          *err_ind,         /* OUT error indicator       */
    Pint          *max_order,       /* OUT maximum trimming curve */
                                /* order supported           */
    Pint_list     *types,           /* OUT list of available trimming */
                                /* curve approximation criteria */
                                /* types                     */
    Pint          *num_elems_impl_list /* OUT # elems in impl list  */
);

```

---

**INQUIRE PREDEFINED PARAMETRIC SURFACE REPRESENTATION**

```

void ping_pred_param_surf_rep (
    Pint          ws_type,          /* workstation type          */
    Pint          index,           /* predefined parametric surface */
                                /* index                     */
    Pstore        store,           /* handle to Store object     */
    Pint          *err_ind,         /* OUT error indicator        */
    Pparam_surf_rep **rep          /* OUT parametric surface     */
                                /* representation             */
);

```

---

NOTE — The memory referenced by \*rep is managed by store.

**INQUIRE PREDEFINED PATTERN REPRESENTATION PLUS**

```

void ping_pred_pat_rep_plus (
    Pint          ws_type,          /* workstation type          */
    Pint          index,           /* predefined pattern index   */
    Pstore        store,           /* handle to Store object     */
    Pint          *err_ind,         /* OUT error indicator        */
    Ppat_rep_plus **rep            /* OUT pattern representation plus */
);

```

---

NOTE — The memory referenced by \*rep is managed by store.

---

## INQUIRE LIGHT SOURCE FACILITIES

```

void ping_light_source_facs (
    Pint          ws_type,          /* workstation type */
    Pint          num_elems_appl_list, /* # elems in appl list */
    Pint          start_ind,        /* starting index */
    Pint          *err_ind,         /* OUT error indicator */
    Pint_list     *types,           /* OUT list of available light
                                   /* source types */
    Pint          *num_elems_impl_list, /* OUT # elems in impl list */
    Pint          *max_lights,       /* OUT maximum number of
                                   /* simultaneously active
                                   /* non-ambient lights */
    Pint          *num_indices      /* OUT number of predefined light
                                   /* source indices */
);

```

---

## INQUIRE PREDEFINED LIGHT SOURCE REPRESENTATION

```

void ping_pred_light_source_rep (
    Pint          ws_type,          /* workstation type */
    Pint          index,           /* predefined light source index */
    Pint          *err_ind,         /* OUT error indicator */
    Plight_source_rep *rep         /* OUT light source representation */
);

```

---

## INQUIRE DEPTH CUE FACILITIES

```

void ping_depth_cue_facs (
    Pint          ws_type,          /* workstation type */
    Pint          num_elems_appl_list, /* # elems in appl list */
    Pint          start_ind,        /* starting index */
    Pint          *err_ind,         /* OUT error indicator */
    Pint          *num_indices      /* OUT number of predefined depth
                                   /* cue indices */
    Pdepth_cue_mode_list *modes,    /* OUT list of available depth
                                   /* cue modes */
    Pint          *num_elems_impl_list /* OUT # elems impl list */
);

```

---

## INQUIRE PREDEFINED DEPTH CUE REPRESENTATION

```
void ping_pred_depth_cue_rep (
    Pint          ws_type,          /* workstation type */
    Pint          index,            /* predefined depth cue index */
    Pint          *err_ind,         /* OUT error indicator */
    Pdepth_cue_rep *rep             /* OUT depth cue representation */
);
```

---

## INQUIRE COLOUR MAPPING FACILITIES

```
void ping_colr_map_fac (
    Pint          ws_type,          /* workstation type */
    Pint          num_elems_appl_list, /* # elems in appl list */
    Pint          start_ind,        /* starting index */
    Pint          *err_ind,         /* OUT error indicator */
    Pint_list     *methods,         /* OUT list of available colour mapping methods */
    Pint          *num_elems_impl_list, /* OUT # elems in impl list */
    Pint          *num_indices      /* OUT number of predefined colour mapping indices */
);
```

---

## INQUIRE COLOUR MAPPING METHOD FACILITIES

```
void ping_colr_map_method_fac (
    Pint          ws_type,          /* workstation type */
    Pint          method,          /* colour mapping methods */
    Pstore        store,          /* handle to Store object */
    Pint          *err_ind,         /* OUT error indicator */
    Pcolr_map_method **data        /* OUT data record */
);
```

---

NOTE — The memory referenced by \*data is managed by store.

**INQUIRE PREDEFINED COLOUR MAPPING REPRESENTATION**

```

void pinq_pred_colr_map_rep (
    Pint          ws_type,          /* workstation type */
    Pint          index,            /* predefined colour mapping index */
    Pstore        store,            /* handle to Store object */
    Pint          *err_ind,         /* OUT error indicator */
    Pcolr_map_rep **rep            /* OUT colour mapping representation */
);

```

NOTE — The memory referenced by \*rep is managed by store.

**INQUIRE WORKSTATION STATE TABLE LENGTHS PLUS**

```

void pinq_ws_st_table_length_plus (
    Pint          ws_type,          /* workstation type */
    Pint          *err_ind,         /* OUT error indicator */
    Pws_st_tables_plus *lengths    /* OUT lengths of workstation tables */
);

```

## Annex A

### (informative)

#### Data types in compilation order and external functions

##### A.1 Macro definitions

Clause A.1, add the following macro definitions after the macro definition for PE\_BAD\_COLR:

```

/* Output Attribute Errors */
#define PE_BAD_DEPTH_CUE_MODE (119) /* Ignoring function, the spec-
                                     igned depth cue mode is not
                                     available on the workstation
                                     */

#define PE_DEPTH_CUE_INDX_LT_1 (120) /* Ignoring function, the
                                     igned depth cue index is less
                                     than one */

#define PE_COLR_MAP_INDX_LT_1 (121) /* Ignoring function, the
                                     igned colour mapping index is
                                     less than one */

#define PE_BAD_LINE_SHAD_METHOD (122) /* Ignoring function, the spec-
                                     igned polyline shading
                                     method is not available on
                                     the workstation */

#define PE_BAD_INT_SHAD_METHOD (123) /* Ignoring function, the spec-
                                     igned interior shading
                                     method is not available on
                                     the workstation */

#define PE_BAD_REFL_MODEL (124) /* Ignoring function, the spec-
                                     igned reflectance model is
                                     not available on the work-
                                     station */

#define PE_TOTAL_COLR_RANGE_FIELDS_TOO_LARGE (125)
                                     /* Ignoring function, the
                                     total of the colour range
                                     fields in all the table
                                     entries is too large */

#define PE_BAD_COLR_MAP_METHOD (126) /* Ignoring function, the spec-
                                     igned colour mapping method
                                     is not available on the
                                     specified workstation */

#define PE_BAD_APPROX_CRIT_TYPE (127) /* Ignoring function, the spec-
                                     igned approximation crite-
                                     ria type is not available
                                     on the specified workstation
                                     */

```

#define PE\_BAD\_PARAM\_SURF\_CHAR\_TYPE (128) /\* Ignoring function, the specified parametric surface characteristics type is not available on the specified workstation \*/  
 #define PE\_LIGHT\_SOURCE\_INDX\_LT\_1 (129) /\* Ignoring function, the light source index is less than one \*/  
 #define PE\_INVALID\_REF\_PLANES (130) /\* Ignoring function, invalid reference planes: DQMIN > DQMAX \*/  
 #define PE\_BAD\_LIGHT\_SOURCE\_TYPE (131) /\* Ignoring function, the specified light source type is not available on the workstation \*/  
 #define PE\_SPOTLIGHT\_SPREAD\_ANGLE\_RANGE (132) /\* Ignoring function, the specified spot light spread angle is out of range \*/  
 #define PE\_BAD\_ACTIVATION\_LIST (133) /\* Ignoring function, one of the entries in the activation list or deactivation list is less than one \*/  
 #define PE\_GEN\_COLR\_NOT\_INDIRECT (134) /\* Ignoring function, the requested entry contains a general colour specification with colour type other than INDIRECT \*/  
 #define PE\_SAME\_ACTIVATION\_DEACTIVATION\_ENTRY (135) /\* Ignoring function, the same entry exists in both the activation and the deactivation list \*/  
 #define PE\_COLR\_COMPONENT\_RANGE (136) /\* Ignoring function, one of the components of the colour specification is out of range \*/  
 #define PE\_BAD\_DATA\_MAP\_METHOD (137) /\* Ignoring function, the specified data mapping method is not available on the specified workstation \*/  
 #define PE\_BAD\_DATA\_RECORD\_FIELD (138) /\* Ignoring function, one or more of the fields within the specified data record is in error \*/  
 #define PE\_BAD\_REFL\_PROP\_TYPE (139) /\* Ignoring function, the specified reflectance property type is not available on the specified workstation \*/  
 #define PE\_INVALID\_DEPTH\_CUE\_SCALE (140) /\* Ignoring function, one of the depth cue scale factors

is not in the required range  
\*/

Clause A.1, add the following macro definitions after the macro definition for PE\_BAD\_ERROR\_FILE:

```

/* Output Primitive Errors */
#define PE_ORDER_LT_1 (500) /* Ignoring function, the
                             order of a spline is less
                             than one */
#define PE_INSUFF_CTRL_POINTS_FOR_ORDER (501) /* Ignoring function, a spline
                                                does not contain enough con-
                                                trol points for its speci-
                                                fied order */
#define PE_ORDER_INCONSISTENT_KNOTS_CTRL_POINTS (502)
                                                /* Ignoring function, the
                                                order of a spline is incon-
                                                sistent with number of
                                                knots and control points */
#define PE_KNOT_SEQUENCE_NOT_NONDECREASING (503)
                                                /* Ignoring function, the knot
                                                sequence for a spline is
                                                not non-decreasing */
#define PE_VERTEX_INDX_OUT_OF_RANGE (504) /* Ignoring function, one or
                                                more of the vertex indices
                                                is out of range */
#define PE_PARAM_RANGE_INCONSISTENT_KNOTS (506)
                                                /* Ignoring function, the
                                                parameter range for a
                                                spline is inconsistent with
                                                its knots */
#define PE_W_VALUE_LE_0 (507) /* Ignoring function, the
                                fourth coordinate of a
                                rational control point is
                                less than or equal to zero */
#define PE_TRIM_CURVE_ORDER_LT_2 (508) /* Ignoring function, a trim-
                                          ming curve's order is less
                                          than two */
#define PE_INCONSISTENT_EDGE_FLAG_SPEC (513) /* Ignoring function, the num-
                                                ber of edge visibility
                                                flags is inconsistent with
                                                the number of edges in the
                                                primitive */
#define PE_DATA_LIST_LENGTH_NOT_SAME (514) /* Ignoring function, the data
                                                lists do not all contain
                                                the same number of entries */
#define PE_INCONSISTENT_FACET_SPEC (516) /* Ignoring function, the
                                          facet data is inconsistent
                                          with the number of facets
                                          in the primitive */

```

```

#define PE_PARAM_RANGE_COLR_SPLINE      (517) /* Ignoring function, the
                                              parameter range of the
                                              colour spline does not
                                              include the effective param-
                                              eter range of the geometry
                                              spline */
#define PE_PARAM_RANGE_DATA_SPLINE      (518) /* Ignoring function, the
                                              parameter range of the data
                                              spline does not include the
                                              effective parameter range
                                              of the geometry spline */
#define PE_BAD_VERTEX_DATA_TYPE         (2207) /* Ignoring function, two or
                                              more vertices do not con-
                                              tain the same type of data*/

```

Clause A.1, add the following macro definitions after the macro definition for Pfn\_set\_err\_hand:

```

#define Pfn_polyline_set3_colr           (183)
#define Pfn_fill_area_set3_data         (184)
#define Pfn_fill_area_set_data          (185)
#define Pfn_cell_array3_plus            (186)
#define Pfn_set_of_fill_area_sets3_data (187)
#define Pfn_set_of_fill_area_sets_data  (188)
#define Pfn_tri_set3_data               (189)
#define Pfn_tri_set_data                (190)
#define Pfn_tri_strip3_data             (191)
#define Pfn_tri_strip_data              (192)
#define Pfn_quad_mesh3_data             (193)
#define Pfn_quad_mesh_data              (194)
#define Pfn_non_uniform_b_spline_curve3 (195)
#define Pfn_non_uniform_b_spline_curve3_colr (196)
#define Pfn_non_uniform_b_spline_surf3  (197)
#define Pfn_non_uniform_b_spline_surf3_data (198)
#define Pfn_set_data_map_ind            (199)
#define Pfn_set_refl_ind                (200)
#define Pfn_set_back_int_ind            (201)
#define Pfn_set_back_data_map_ind       (202)
#define Pfn_set_back_refl_ind           (203)
#define Pfn_set_param_surf_ind          (204)
#define Pfn_set_line_colr               (205)
#define Pfn_set_line_shad_method        (206)
#define Pfn_set_marker_colr             (207)
#define Pfn_set_text_colr               (208)
#define Pfn_set_facet_disting_mode      (209)
#define Pfn_set_facet_cull_mode         (210)
#define Pfn_set_int_colr                (211)
#define Pfn_set_int_shad_method         (212)
#define Pfn_set_data_map_method         (213)
#define Pfn_set_refl_props              (214)
#define Pfn_set_refl_model              (215)

```

```

#define Pfn_set_back_int_style (216)
#define Pfn_set_back_int_style_ind (217)
#define Pfn_set_back_int_colr (218)
#define Pfn_set_back_int_shad_method (219)
#define Pfn_set_back_data_map_method (220)
#define Pfn_set_back_refl_props (221)
#define Pfn_set_back_refl_model (222)
#define Pfn_set_light_source_st (223)
#define Pfn_set_edge_colr (224)
#define Pfn_set_curve_approx_crit (225)
#define Pfn_set_surf_approx_crit (226)
#define Pfn_set_param_surf_chars (227)
#define Pfn_set_rend_colr_model (228)
#define Pfn_set_depth_cue_ind (229)
#define Pfn_set_colr_map_ind (230)
#define Pfn_set_line_rep_plus (231)
#define Pfn_set_marker_rep_plus (232)
#define Pfn_set_text_rep_plus (233)
#define Pfn_set_int_rep_plus (234)
#define Pfn_set_edge_rep_plus (235)
#define Pfn_set_data_map_rep (236)
#define Pfn_set_refl_rep (237)
#define Pfn_set_param_surf_rep (238)
#define Pfn_set_pat_rep_plus (239)
#define Pfn_set_light_source_rep (240)
#define Pfn_set_depth_cue_rep (241)
#define Pfn_set_colr_map_rep (242)

```

Clause A.1, add the following macro definitions after the macro definition for PMODEL\_HLS:

```

#define PCOLR_MAP_METHOD_TRUE (1)
#define PCOLR_MAP_METHOD_PSEUDO (2)
#define PCOLR_MAP_METHOD_PSEUDO_N (3)

#define PCOLR_INDIRECT (0)
#define PCOLR_RGB (1)
#define PCOLR_CIELUV (2)
#define PCOLR_HSV (3)
#define PCOLR_HLS (4)

#define PCURVE_APPROX_WS_DEP (1)
#define PCURVE_APPROX_CONST_PARAM_SUBD (2)
#define PCURVE_APPROX_CHORDAL_SIZE_WC (3)
#define PCURVE_APPROX_CHORDAL_SIZE_NPC (4)
#define PCURVE_APPROX_CHORDAL_SIZE_DC (5)
#define PCURVE_APPROX_CHORDAL_DEV_WC (6)
#define PCURVE_APPROX_CHORDAL_DEV_NPC (7)
#define PCURVE_APPROX_CHORDAL_DEV_DC (8)
#define PCURVE_APPROX_REL_WC (9)
#define PCURVE_APPROX_REL_NPC (10)

```

```

#define PCURVE_APPROX_REL_DC (11)

#define PDATA_MAP_METHOD_COLR (1)
#define PDATA_MAP_METHOD_SINGLE_UNIFORM (2)
#define PDATA_MAP_METHOD_SINGLE_NON_UNIFORM (3)
#define PDATA_MAP_METHOD_BI_UNIFORM (4)
#define PDATA_MAP_METHOD_BI_NON_UNIFORM (5)

#define PINT_SHAD_METHOD_NONE (1)
#define PINT_SHAD_METHOD_COLR (2)
#define PINT_SHAD_METHOD_DATA (3)
#define PINT_SHAD_METHOD_DATA_DOT (4)
#define PINT_SHAD_METHOD_DATA_NORM (5)

#define PLIGHT_SOURCE_AMB (1)
#define PLIGHT_SOURCE_DIR (2)
#define PLIGHT_SOURCE_POS (3)
#define PLIGHT_SOURCE_SPOT (4)

#define PPARAM_SURF_CHARS_NONE (1)
#define PPARAM_SURF_CHARS_WS_DEP (2)
#define PPARAM_SURF_CHARS_ISOPARAM (3)
#define PPARAM_SURF_CHARS_LEVEL_MC (4)
#define PPARAM_SURF_CHARS_LEVEL_WC (5)

#define PLINE_SHAD_METHOD_NONE (1)
#define PLINE_SHAD_METHOD_COLR (2)

#define PREFL_MODEL_NO_REFL (1)
#define PREFL_MODEL_AMB_REFL (2)
#define PREFL_MODEL_AMB_DIFF_REFL (3)
#define PREFL_MODEL_AMB_DIFF_SPEC_REFL (4)

#define PREFL_PROPS_SIMPLE_REFL (1)

#define PREND_COLR_MODEL_WS_DEP (0)
#define PREND_COLR_MODEL_RGB (1)
#define PREND_COLR_MODEL_CIELUV (2)
#define PREND_COLR_MODEL_HSV (3)
#define PREND_COLR_MODEL_HLS (4)

#define PSURF_APPROX_WS_DEP (1)
#define PSURF_APPROX_CONST_PARAM_SUBD (2)
#define PSURF_APPROX_CHORDAL_SIZE_WC (3)
#define PSURF_APPROX_CHORDAL_SIZE_NPC (4)
#define PSURF_APPROX_CHORDAL_SIZE_DC (5)
#define PSURF_APPROX_PLANAR_DEV_WC (6)
#define PSURF_APPROX_PLANAR_DEV_NPC (7)
#define PSURF_APPROX_PLANAR_DEV_DC (8)
#define PSURF_APPROX_REL_WC (9)
#define PSURF_APPROX_REL_NPC (10)

```

```
#define PSURF_APPROX_REL_DC (11)
```

Clause A.1, add the following macro definitions after the macro definition for PLAST\_PHIGS\_ELEM:

```
#define PFIRST_PHIGS_PLUS_ELEM (PELEM_POLYLINE_SET3_COLR)
#define PLAST_PHIGS_PLUS_ELEM (PELEM_COLR_MAP_IND)
```

## A.2 Types in compilation order

Clause A.2, modify the following PHIGS type definitions by adding the specified PHIGS PLUS enumerations:

```
typedef enum {
  /* start of PHIGS enumerations */
  ...,
  /* end of PHIGS enumerations */
  /* start of PHIGS PLUS enumerations */
  PASPECT_LINE_COLR,
  PASPECT_MARKER_COLR,
  PASPECT_TEXT_COLR,
  PASPECT_INT_COLR,
  PASPECT_EDGE_COLR,
  PASPECT_LINE_SHAD_METHOD,
  PASPECT_INT_SHAD_METHOD,
  PASPECT_DATA_MAP_METHOD,
  PASPECT_REFL_PROPS,
  PASPECT_REFL_MODEL,
  PASPECT_BACK_INT_STYLE,
  PASPECT_BACK_INT_STYLE_IND,
  PASPECT_BACK_INT_COLR,
  PASPECT_BACK_INT_SHAD_METHOD,
  PASPECT_BACK_DATA_MAP_METHOD,
  PASPECT_BACK_REFL_PROPS,
  PASPECT_BACK_REFL_MODEL,
  PASPECT_CURVE_APPROX_CRIT,
  PASPECT_SURF_APPROX_CRIT,
  PASPECT_PARAM_SURF_CHARS
  /* end of PHIGS PLUS enumerations */
} Paspect;
```

```
typedef enum {  
    /* start of PHIGS enumerations */  
    ...,  
    /* end of PHIGS enumerations */  
    /* start of PHIGS PLUS enumerations */  
    PATTR_REFL,  
    PATTR_PARAM_SURF  
    /* end of PHIGS PLUS enumerations */  
} Pattrs;
```

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```

typedef enum {
    /* start of PHIGS enumerations */
    ...,
    /* end of PHIGS enumerations */
    /* start of PHIGS PLUS enumerations */
    PELEM_POLYLINE_SET3_COLR,
    PELEM_FILL_AREA_SET3_DATA,
    PELEM_FILL_AREA_SET_DATA,
    PELEM_CELL_ARRAY3_PLUS,
    PELEM_SET_OF_FILL_AREA_SETS3_DATA,
    PELEM_SET_OF_FILL_AREA_SETS_DATA,
    PELEM_TRI_SET3_DATA,
    PELEM_TRI_SET_DATA,
    PELEM_TRI_STRIP3_DATA,
    PELEM_TRI_STRIP_DATA,
    PELEM_QUAD_MESH3_DATA,
    PELEM_QUAD_MESH_DATA,
    PELEM_NON_UNIFORM_B_SPLINE_CURVE3,
    PELEM_NON_UNIFORM_B_SPLINE_CURVE3_COLR,
    PELEM_NON_UNIFORM_B_SPLINE_SURF3,
    PELEM_NON_UNIFORM_B_SPLINE_SURF3_DATA,
    PELEM_DATA_MAP_IND,
    PELEM_REFL_IND,
    PELEM_BACK_INT_IND,
    PELEM_BACK_DATA_MAP_IND,
    PELEM_BACK_REFL_IND,
    PELEM_PARAM_SURF_IND,
    PELEM_LINE_COLR,
    PELEM_LINE_SHAD_METHOD,
    PELEM_MARKER_COLR,
    PELEM_TEXT_COLR,
    PELEM_FACET_DISTING_MODE,
    PELEM_FACET_CULL_MODE,
    PELEM_INT_COLR,
    PELEM_INT_SHAD_METHOD,
    PELEM_DATA_MAP_METHOD,
    PELEM_REFL_PROPS,
    PELEM_REFL_MODEL,
    PELEM_BACK_INT_STYLE,
    PELEM_BACK_INT_STYLE_IND,
    PELEM_BACK_INT_COLR,
    PELEM_BACK_INT_SHAD_METHOD,
    PELEM_BACK_DATA_MAP_METHOD,
    PELEM_BACK_REFL_PROPS,
    PELEM_BACK_REFL_MODEL,
    PELEM_LIGHT_SOURCE_ST,
    PELEM_EDGE_COLR,
    PELEM_CURVE_APPROX_CRIT,
    PELEM_SURF_APPROX_CRIT,
    PELEM_PARAM_SURF_CHARS,
    PELEM_REND_COLR_MODEL,

```

```

    PELEM_DEPTH_CUE_IND,
    PELEM_COLR_MAP_IND
    /* end of PHIGS PLUS enumerations */
} Pelem_type;

```

Clause A.2, add the following type definitions after the type definition for Pattrrs:

```

typedef enum {
    PDEPTH_CUE_SUPPR,
    PDEPTH_CUE_ALLOWED
} Pdepth_cue_mode;

```

```

typedef enum {
    PFACET_CULL_NONE,
    PFACET_CULL_BACKFACING,
    PFACET_CULL_FRONTFACING
} Pfacet_cull_mode;

```

```

typedef enum {
    PFACET_DISTING_OFF,
    PFACET_DISTING_ON
} Pfacet_disting_mode;

```

```

typedef enum {
    PPLACE_UNIFORM_OVER_SURF,
    PPLACE_UNIFORM_BETWEEN_KNOTS
} Pplacement;

```

```

typedef enum {
    PB_SPLINE_RATIONAL,
    PB_SPLINE_NON_RATIONAL
} Prationality;

```

```

typedef enum {
    PSOURCE_SELECT_COLR_ASPECT,
    PSOURCE_SELECT_VERT_COLR,
    PSOURCE_SELECT_VERT_DATA,
    PSOURCE_SELECT_FACET_COLR,
    PSOURCE_SELECT_FACET_DATA
} Psource_select;

```

```
typedef enum {
    PVIS_OFF,
    PVIS_ON
} Pvis_flag;
```

Clause A.2, add the following PHIGS PLUS types after the PHIGS type `Pescape_in_data`:

```
typedef struct {
    Pint          num_floats;          /* number of floats in list */
    Pfloat        *floats;            /* list of floats */
} Pfloat_list;
```

```
typedef struct {
    Pint          num_lists;           /* number of float lists */
    Pfloat_list   *floats;            /* list of float lists */
} Pfloat_set;
```

```
typedef union {
    Prgb          *rgb;               /* pointer to RGB colour values */
    Pcielv        *cielv;             /* pointer to CIELUV colour values */
    Phls          *hls;               /* pointer to HLS colour values */
    Phsv          *hsv;               /* pointer to HSV colour values */
    Pdata         *unsupp;            /* pointer to unsupported colour */
    /* values */
    int           impl_dep;           /* implementation defined */
} Pcolr_rep_ptr;
```

```
typedef union {
    Pint          *colr_inds;         /* pointer to colour indices */
    Pcolr_rep_ptr colr_reps;          /* pointer to colour */
    /* representations */
} Pcolrv_ptr;
```

```
typedef struct {
    Pint          num_colrs;          /* number of colours */
    Pcolrv_ptr    colrs;              /* list of colour values */
} Pcolrv_list;
```

```
typedef struct {
    Pint          num_lists;          /* number of colour value lists */
    Pcolrv_list   *colrs;            /* list of colour value lists */
} Pcolrv_set;
```

```

typedef struct {
    Pint          method;                /* colour mapping method          */
    union Pcolr_map_method_data {
        Pint      num_true_colrs;        /* number of true colours         */
        Pint      max_num_pseudo_colrs; /* maximum number of pseudo      */
                                           /* colours                         */
        int       impl_dep;             /* implementation defined         */
    } data;
} Pcolr_map_method;

```

```

typedef struct {
    Pint          method;                /* colour mapping method          */
    union Pcolr_map_rep_data {
        struct Pcolr_map_rep_pseudo {
            Pint      model;             /* colour model                   */
            Pfloat_list weight_vector;   /* list of weight vector          */
            Pcolrv_list colrs;          /* list of colour values          */
        } pseudo;
        struct Pcolr_map_rep_pseudo_N {
            Pint      model;             /* colour model                   */
            Pfloat_set colrs;           /* list of lists of colour        */
                                           /* coordinates                     */
        } pseudo_N;
        int         impl_dep;          /* implementation defined         */
    } data;
} Pcolr_map_rep;

```

```

typedef struct {
    Pint          method;                /* colour mapping method          */
    union Pcolr_map_st_data {
        Pint      num_true_colrs;        /* number of available true       */
                                           /* colours                         */
        Pint      max_num_pseudo_colrs; /* maximum number of pseudo      */
                                           /* colour entries                  */
        int       impl_dep;             /* implementation defined         */
    } data;
} Pcolr_map_st;

```

```

typedef struct {
    Pint          type;                /* curve approximation criteria */
                                        /* type */
    union Pcurve_approx_crit_data {
        struct Pcurve_approx_const_param_subd {
            Pint          count;        /* count */
        } const_param_subd;
        struct Pcurve_approx_chordal_size_wc {
            Pfloat        approx;       /* approximation value */
        } chordal_size_wc;
        struct Pcurve_approx_chordal_size_npc {
            Pfloat        approx;       /* approximation value */
        } chordal_size_npc;
        struct Pcurve_approx_chordal_size_dc {
            Pfloat        approx;       /* approximation value */
        } chordal_size_dc;
        struct Pcurve_approx_chordal_dev_wc {
            Pfloat        approx;       /* approximation value */
        } chordal_dev_wc;
        struct Pcurve_approx_chordal_dev_npc {
            Pfloat        approx;       /* approximation value */
        } chordal_dev_npc;
        struct Pcurve_approx_chordal_dev_dc {
            Pfloat        approx;       /* approximation value */
        } chordal_dev_dc;
        struct Pcurve_approx_rel_wc {
            Pfloat        approx;       /* approximation value */
        } rel_wc;
        struct Pcurve_approx_rel_npc {
            Pfloat        approx;       /* approximation value */
        } rel_npc;
        struct Pcurve_approx_rel_dc {
            Pfloat        approx;       /* approximation value */
        } rel_dc;
        Pdata            unsupp;       /* unsupported curve approximation */
                                        /* criteria data */
        int              impl_dep;     /* implementation defined */
    } data;
} Pcurve_approx_crit;

typedef struct {
    Pint          num_selectors;        /* number of selectors */
    Psource_select *selectors;         /* list of source selectors */
} Psource_select_list;

```

```

typedef struct {
    Pint          method;          /* data mapping method          */
    Psource_select_list selectors;  /* list of source selectors      */
    union Pdata_map_rep_data {
        struct Pdata_map_rep_single_uniform {
            Pint          ind;      /* data value index             */
            Pfloat        lower_limit; /* lower range limit           */
            Pfloat        upper_limit; /* upper range limit            */
            Pint          colr_type; /* colour type                   */
            Pcolrv_list   colr_values; /* list of colour values        */
        } single_uniform;
        struct Pdata_map_rep_single_non_uniform {
            Pint          ind;      /* data value index             */
            Pfloat_list   range;    /* range boundaries              */
            Pint          colr_type; /* colour type                   */
            Pcolrv_list   colr_values; /* list of colour values        */
        } single_non_uniform;
        struct Pdata_map_rep_bi_uniform {
            Pint          inds[2];  /* data value indices           */
            Pfloat        lower_limit_a; /* lower limit of Ra range      */
            Pfloat        upper_limit_a; /* upper limit of Ra range      */
            Pfloat        lower_limit_b; /* lower limit of Rb range      */
            Pfloat        upper_limit_b; /* upper limit of Rb range      */
            Pint          colr_type; /* colour type                   */
            Pcolrv_set    colr_values; /* list of colour value lists   */
        } bi_uniform;
        struct Pdata_map_rep_bi_non_uniform {
            Pint          inds[2];  /* data value indices           */
            Pfloat_list   range_a;  /* Ra range boundaries           */
            Pfloat_set    range_b;  /* Rb range boundaries           */
            Pint          colr_type; /* colour type                   */
            Pcolrv_set    colr_values; /* array of colour values       */
        } bi_non_uniform;
        int              impl_dep; /* implementation defined        */
    } data;
} Pdata_map_rep;

typedef struct {
    Pfloat          cieluv_x;      /* x coefficient                  */
    Pfloat          cieluv_y;      /* y coefficient                  */
    Pfloat          cieluv_y_lum;  /* y luminance                    */
    Pfloat          w;            /* homogeneous coordinate         */
} Phomo_cieluv;

```

```

typedef struct {
    Pfloat      hue;           /* hue                      */
    Pfloat      lightness;     /* lightness                */
    Pfloat      satur;         /* saturation                */
    Pfloat      w;             /* homogeneous coordinate   */
} Phomo_hls;

typedef struct {
    Pfloat      hue;           /* hue                      */
    Pfloat      satur;         /* saturation                */
    Pfloat      value;         /* value                    */
    Pfloat      w;             /* homogeneous coordinate   */
} Phomo_hsv;

typedef struct {
    Pfloat      red;           /* red                      */
    Pfloat      green;         /* green                    */
    Pfloat      blue;          /* blue                     */
    Pfloat      w;             /* homogeneous coordinate   */
} Phomo_rgb;

typedef union {
    Phomo_rgb      *rgb;       /* pointer to homogeneous rgb */
                                /* colour value                */
    Phomo_cieluv    *cieluv;    /* pointer to homogeneous cieluv */
                                /* colour value                */
    Phomo_hls       *hls;       /* pointer to homogeneous hls  */
                                /* colour value                */
    Phomo_hsv       *hsv;       /* pointer to homogeneous hsv  */
                                /* colour value                */
    int             impl_dep;   /* implementation defined     */
} Phomo_colr_rep_ptr;

typedef union {
    Pint           colr_ind;     /* colour index              */
    Pcolr_rep      colr_rep;     /* colour representation      */
} Pcolrv;

typedef struct {
    Pint           colr_type;    /* colour type                */
    Pcolrv         colr_value;   /* colour value                */
} Pgcolr;

```

```

typedef struct {
    Pint          type;          /* light source type          */
    union Plight_source_rep_data {
        struct Plight_source_rep_amb {
            Pgcclr      clr;      /* light source colour        */
        } amb;
        struct Plight_source_rep_dir {
            Pgcclr      clr;      /* light source colour        */
            Pvec3       dir;      /* light source direction     */
        } dir;
        struct Plight_source_rep_pos {
            Pgcclr      clr;      /* light source colour        */
            Ppoint3     pos;      /* light source position      */
            Pfloat      c1;      /* light source attenuation   */
                                /* coefficient                 */
            Pfloat      c2;      /* light source attenuation   */
                                /* coefficient                 */
        } pos;
        struct Plight_source_rep_spot {
            Pgcclr      clr;      /* light source colour        */
            Ppoint3     pos;      /* light source position      */
            Pvec3       dir;      /* light source direction     */
            Pfloat      concent_exp; /* concentration exponent     */
            Pfloat      c1;      /* light source attenuation   */
                                /* coefficient                 */
            Pfloat      c2;      /* light source attenuation   */
                                /* coefficient                 */
            Pfloat      spread_angle; /* light source spread angle  */
        } spot;
        int          impl_dep;   /* implementation defined     */
    } data;
} Plight_source_rep;

```

```

typedef struct {
    Pint          type;          /* parametric surface          */
                                /* characteristics type        */

    union Pparam_surf_chars_data {
        struct Pparam_surf_isoparam {
            Pplacement    placement; /* curve placement: UNIFORM OVER */
                                /* SURFACE, UNIFORM BETWEEN KNOTS */

            Pint          num_u_curves; /* curve count in u direction */
            Pint          num_v_curves; /* curve count in v direction */
        } isoparam;
        struct Pparam_surf_level_mc {
            Ppoint3        origin; /* origin point */
            Pvec3          dir; /* direction vector */
            Pfloat_list    params; /* parameter list */
        } level_mc;
        struct Pparam_surf_level_wc {
            Ppoint3        origin; /* origin point */
            Pvec3          dir; /* direction vector */
            Pfloat_list    params; /* parameter list */
        } level_wc;
        Pdata             unsupp; /* unsupported parametric */
                                /* surface characteristics data */
        int               impl_dep; /* implementation defined */
    } data;
} Pparam_surf_chars;

typedef struct {
    Pint          type;          /* reflectance property type */

    union Prefl_prop_data {
        struct Prefl_prop_simple_refl {
            Pfloat        amb_coeff; /* ambient reflection */
                                /* coefficient */
            Pfloat        diff_coeff; /* diffuse reflection */
                                /* coefficient */
            Pfloat        spec_coeff; /* specular reflection */
                                /* coefficient */
            Pcolour        spec_colr; /* specular colour */
            Pfloat        spec_exp; /* specular exponent */
        } simple_refl;
        Pdata             unsupp; /* unsupported reflectance */
                                /* property data */
        int               impl_dep; /* implementation defined */
    } data;
} Prefl_prop;

```

```

typedef struct {
    Pint          type;                /* surface approximation criteria */
                                        /* type                               */

    union Psurf_approx_crit_data {
        struct Psurf_approx_const_param_subd {
            Pint      u_count;          /* u count                          */
            Pint      v_count;          /* v count                          */
        } const_param_subd;
        struct Psurf_approx_chordal_size_wc {
            Pfloat     u_approx;         /* u approximation value           */
            Pfloat     v_approx;         /* v approximation value           */
        } chordal_size_wc;
        struct Psurf_approx_chordal_size_npc {
            Pfloat     u_approx;         /* u approximation value           */
            Pfloat     v_approx;         /* v approximation value           */
        } chordal_size_npc;
        struct Psurf_approx_chordal_aize_dc {
            Pfloat     u_approx;         /* u approximation value           */
            Pfloat     v_approx;         /* v approximation value           */
        } chordal_size_dc;
        struct Psurf_approx_planar_dev_wc {
            Pfloat     approx;           /* approximation value             */
        } planar_dev_wc;
        struct Psurf_approx_planar_dev_npc {
            Pfloat     approx;           /* approximation value             */
        } planar_dev_npc;
        struct Psurf_approx_planar_dev_dc {
            Pfloat     approx;           /* approximation value             */
        } planar_dev_dc;
        struct Psurf_approx_rel_wc {
            Pfloat     approx;           /* approximation value             */
        } rel_wc;
        struct Psurf_approx_rel_npc {
            Pfloat     approx;           /* approximation value             */
        } rel_npc;
        struct Psurf_approx_rel_dc {
            Pfloat     approx;           /* approximation value             */
        } rel_dc;
        Pdata         unsupp;           /* unsupported surface              */
                                        /* approximation criteria data     */
        int            impl_dep;        /* implementation defined          */
    } data;
} Psurf_approx_crit;

typedef union {
    Pcolr_rep_ptr     points;           /* pointer to colour points        */
    Phomo_colr_rep_ptr homo_points;     /* pointer to homogeneous colour   */
                                        /* points                          */
} Pcolr_ctrl_point_ptr;

```

```

typedef struct {
    Prationality      rationality; /* control point rationality */
    Pint_size         dims;        /* dimensions of control point */
                                /* array */
    Pcolr_ctrl_point_ptr colr_points; /* array of colour control points */
} Pcolr_ctrl_point_array;

```

```

typedef struct {
    Prationality      rationality; /* control point rationality */
    Pint             num_points;   /* number of control points */
    Pcolr_ctrl_point_ptr points;   /* list of colour control points */
} Pcolr_ctrl_point_list;

```

```

typedef struct {
    Pint_size         dims;        /* colour value array dimensions */
    Pcolrv_ptr        colrs;       /* array of colour values */
} Pcolrv_array;

```

```

typedef struct {
    Pint             num_lists;    /* number of contour lists */
    Pint_list        *contours;   /* list of contour lists */
} Pcontour_set;

```

```

typedef struct {
    Pint             num_contour_sets; /* number of contour sets */
    Pcontour_set     *contours;       /* list of contour sets */
} Pcontour_set_list;

```

```

typedef struct {
    Pfloat           wx;          /* wx coordinate */
    Pfloat           wy;          /* wy coordinate */
    Pfloat           wz;          /* wz coordinate */
    Pfloat           w;           /* homogeneous coordinate */
} Phomo_point4;

```

```

typedef union {
    Ppoint3          *point3;      /* pointer to 3D non-homogeneous */
                                /* points */
    Phomo_point4     *homo_point4; /* pointer to 4D homogeneous */
                                /* points */
} Ppoint3_ptr;

```

```

typedef struct {
    Prationality    rationality;    /* control point rationality */
    Pint_size      dims;           /* control point array u,v */
                                /* dimensions */
    Ppoint3_ptr    points;         /* array of control points */
} Pctrl_point3_array;

typedef struct {
    Pfloat          wx;           /* wx coordinate */
    Pfloat          wy;           /* wy coordinate */
    Pfloat          w;           /* homogeneous coordinate */
} Phomo_point3;

typedef union {
    Ppoint          *point;       /* pointer to 2D non-homogeneous */
                                /* points */
    Phomo_point3    *homo_point3; /* pointer to 3D homogeneous */
                                /* points */
} Ppoint_ptr;

typedef struct {
    Prationality    rationality;    /* control point rationality */
    Pint           num_points;     /* number of control points */
    Ppoint_ptr     points;         /* list of control points */
} Pctrl_point_list;

typedef struct {
    Prationality    rationality;    /* control point rationality */
    Pint           num_points;     /* number of control points */
    Ppoint3_ptr    points;         /* list of control points */
} Pctrl_point3_list;

typedef struct {
    Pint           order;         /* spline order */
    Pfloat_list    knots;        /* list of knot values */
    Pint          colr_type;     /* colour type */
    Pcolr_ctrl_point_list colrs; /* list of colour control points */
} Pcurve_colr_spline;

```

```
typedef struct {
    Pint          order;          /* spline order          */
    Pfloat_list   knots;          /* knots                  */
    Pfloat         low_limit;      /* lower parameter range limit */
    Pfloat         high_limit;     /* high parameter range limit  */
    Pctrl_point3_list ctrl_points; /* list of control points   */
} Pcurve_geom_spline;
```

```
typedef struct {
    Prationality   rationality;    /* control point rationality */
    Pint_size      dims;           /* control point array u,v    */
                                /* dimensions                  */
    Pint           points_dims;     /* control point dimensionality */
    Pfloat         *ctrl_points;    /* array of control points    */
} Pdata_ctrl_point_array;
```

```
typedef struct {
    Pint          num_modes;       /* number of depth cue modes */
    Pdepth_cue_mode *modes;        /* list of depth cue modes   */
} Pdepth_cue_mode_list;
```

```
typedef struct {
    Pdepth_cue_mode mode;          /* depth cue mode          */
    Pfloat           ref_planes[2]; /* depth cue reference planes */
                                /* (min, max)              */
    Pfloat           scale[2];      /* depth cue scale factors  */
                                /* (min, max)              */
    Pgcolr           gcolr;         /* depth cue colour         */
} Pdepth_cue_rep;
```

```
typedef struct {
    Pdyn_mod        data_map;       /* data mapping representation */
    Pdyn_mod        refl;          /* reflectance representation  */
    Pdyn_mod        param_surf;     /* parametric surface          */
                                /* representation              */
    Pdyn_mod        light_source;   /* light source representation */
    Pdyn_mod        depth_cue;      /* depth cue representation    */
    Pdyn_mod        colr_map;       /* colour mapping representation */
} Pdyn_ws_attrs_plus;
```

```

typedef struct {
    Pedge_flag      flag;           /* edge flag */
    Pint            type;           /* edgetype */
    Pfloat          width;         /* edgewidth scale factor */
    Pcolour         colr;          /* edge colour */
} Pedge_bundle_plus;

typedef Pedge_flag Pedge_flag_pair[2];

typedef Pedge_flag Pedge_flag_triplet[3];

typedef struct {
    Pint            num_edge_flag_triplets; /* number of edge flag triplets */
    Pedge_flag_triplet*edge_flag_triplets; /* list of edge flag triplets */
} Pedge_flag_triplet_list;

typedef struct {
    Pint_size      dims;           /* edge flag array dimensions */
    Pedge_flag_pair*edge_flags;    /* array of edge flag pairs */
} Pedge_flag_array;

typedef struct {
    Pint            num_edges;      /* number of edges in list */
    Pedge_flag      *edge_flags;    /* list of edge flags */
} Pedge_flag_list;

typedef struct {
    Pint            num_lists;      /* number of edge flag lists */
    Pedge_flag_list*edge_flags;    /* list of edge flag lists */
} Pedge_flag_set;

typedef struct {
    Pint            num_edge_flag_sets; /* number of edge flag sets */
    Pedge_flag_set *edge_flag_sets; /* list of edge flag sets */
} Pedge_flag_set_list;

typedef struct {
    Pint            num_data_per_facet; /* number of data values per-facet */
    Pcolour         *facet_colrv;      /* facet colour */
    Pvec3           *facet_norm;       /* facet normal */
    Pfloat          *facet_data;       /* list of facet data */
} Pfacet;

```

```

typedef struct {
    Pint_size      dims;                /* facet array dimensions      */
    Pint           num_data_per_facet;   /* number of data values per-facet */
    Pcolrv_ptr     facet_colrvs;        /* array of facet colour values */
    Pvec3          *facet_norms;        /* array of facet normals      */
    Pfloat         *facet_data;         /* array of facet data lists    */
} Pfacet_array;

```

```

typedef struct {
    Pint           num_facets;           /* number of facets            */
    Pint           num_data_per_facet;   /* number of data values per-facet */
    Pcolrv_ptr     facet_colrvs;        /* list of facet colour values */
    Pvec3          *facet_norms;        /* list of facet normals      */
    Pfloat         *facet_data;         /* list of facet data lists    */
} Pfacet_list;

```

```

typedef struct {
    Pint_style     style;               /* interior style              */
    Pint           style_ind;           /* interior style index        */
    Pgcolr         colr;               /* interior colour             */
    Pint           shad_method;         /* shading method              */
} Pint_bundle_plus;

```

```

typedef struct {
    Pint           num_int_styles;       /* number of interior styles   */
    Pint_style     int_styles[5];       /* list of available interior */
                                           /* styles                      */
    Pint           num_hatch_styles;     /* number of available hatch  */
                                           /* styles                      */
    Pint_list      hatch_styles;        /* list of available hatch styles */
    Pint_list      shad_methods;        /* list of available shading  */
                                           /* methods                    */
    Pint           num_pred_int_inds;    /* number of predefined interior */
                                           /* indices                    */
} Pint_facs_plus;

```

```

typedef struct {
    Pint           type;               /* line type                  */
    Pfloat         width;              /* linewidth scale factor     */
    Pgcolr         colr;               /* polyline colour            */
    Pint           shad_method;        /* polyline shading method    */
    Pcurve_approx_crit approx_crit;    /* curve approximation criteria */
                                           /* data record                */
} Pline_bundle_plus;

```

```

typedef struct {
    Pint          num_types;          /* number of available linetypes */
    Pint_list     types;              /* list of line types */
    Pint          num_widths;         /* number of available line widths */
    Pfloat        nom_width;          /* nominal linewidth */
    Pfloat        min_width;          /* minimum linewidth */
    Pfloat        max_width;          /* maximum linewidth */
    Pint_list     shad_methods;       /* list of available line shading */
                                           /* methods */
    Pint          num_inds;           /* number of predefined bundle */
                                           /* indices */
} Pline_facets_plus;

typedef struct {
    Pint          type;               /* marker type */
    Pfloat        size;               /* marker size scale factor */
    Pcolour       colour;             /* polymarker colour */
} Pmarker_bundle_plus;

typedef struct {
    Psurf_approx_crit approx_crit;    /* surface approximation criteria */
                                           /* data */
    Pparam_surf_chars chars_data;     /* parametric surface */
                                           /* characteristics data */
} Pparam_surf_rep;

typedef struct {
    Pint          colour_type;        /* colour type */
    Pcolour_array colour_vals;        /* array of colour values */
} Ppat_rep_plus;

typedef struct {
    Pint          refl_model;         /* reflectance model */
    Prefl_prop    refl_prop;          /* reflectance property data */
} Prefl_rep;

typedef struct {
    Pint          num_sets;           /* number of fill area sets */
    Pint          num_data_per_facet; /* number of data values per facet */
    Pcolour_ptr   facet_colours;      /* list of facet colours */
    Pvec3         *facet_norms;       /* list of facet normals */
    Pfloat        *facet_data;        /* list of facet data lists */
} Pset_of_fill_area_sets_data;

```

```
typedef struct {
    Pint          u_order;          /* u spline order          */
    Pint          v_order;          /* v spline order          */
    Pfloat_list   u_knots;          /* list of u knot values   */
    Pfloat_list   v_knots;          /* list of v knot values   */
    Pint          colr_type;        /* colour type             */
    Pcolr_ctrl_point_array colrs;   /* array of colour control points */
} Psurf_colr_spline;
```

```
typedef struct {
    Pint          u_order;          /* u spline order          */
    Pint          v_order;          /* v spline order          */
    Pfloat_list   u_knots;          /* list of u knot values   */
    Pfloat_list   v_knots;          /* list of v knot values   */
    Pdata_ctrl_point_array data_points; /* array of data control points */
} Psurf_data_spline;
```

```
typedef struct {
    Pint          num_data_spline;   /* number of data splines   */
    Psurf_data_spline *data_splines; /* list of data splines     */
} Psurf_data_spline_list;
```

```
typedef struct {
    Pint          u_order;          /* u spline order          */
    Pint          v_order;          /* v spline order          */
    Pfloat_list   u_knots;          /* u knots                 */
    Pfloat_list   v_knots;          /* v knots                 */
    Pctrl_point3_array ctrl_points; /* array of control points  */
} Psurf_geom_spline;
```

```
typedef struct {
    Pint          font;             /* text font               */
    Ptext_prec    precision;        /* text precision          */
    Pfloat        char_expan;       /* character expansion factor */
    Pfloat        char_space;       /* character spacing        */
    Pcolr         colr;             /* text colour             */
} Ptext_bundle_plus;
```

```

typedef struct {
    Pint          num_sets;          /* number of triangle sets      */
    Pint          num_data_per_facet; /* number of data values per    */
                                   /* facet                          */
    Pcolrv_ptr    facet_colrvs;      /* list of facet colours        */
    Pvec3         *facet_norms;      /* list of facet normals        */
    Pfloat        *facet_data;       /* list of facet data lists     */
} Ptri_set_data;

```

```

typedef struct {
    Pcurve_approx_crit approx_crit; /* trimming curve approx.      */
                                   /* criteria data record         */
    Pvis_flag        visibility_flag; /* curve visibility flag        */
    Pint             order;          /* curve order                  */
    Pfloat_list      knots;          /* curve knot vector           */
    Pfloat           low_limit;      /* curve parameter range lower */
                                   /* limit                        */
    Pfloat           high_limit;     /* curve parameter range upper */
                                   /* limit                        */
    Pctrl_point_list ctrl_points;    /* curve control points        */
} Ptrim_curve;

```

```

typedef struct {
    Pint          num_trim_curves; /* number of trimming curves    */
    Ptrim_curve   *trim_curves;   /* list of trimming curves forming */
                                   /* a closed loop                 */
} Ptrim_curve_loop;

```

```

typedef struct {
    Pint          num_trim_loops; /* number of trimming curve loops */
    Ptrim_curve_loop *trim_loops; /* list of trimming curve loops */
} Ptrim_curve_loop_list;

```

```

typedef struct {
    Pint_size      dims;          /* dimensions of vertex array    */
    Pint          num_data_per_vertex; /* number of data values      */
                                   /* per-vertex                   */
    Ppoint        *vertex_points; /* array of vertex points       */
    Pcolrv_ptr    vertex_colrvs; /* array of vertex colours      */
    Pvec3         *vertex_norms; /* array of vertex normals      */
    Pfloat        *vertex_data; /* array of vertex data lists   */
} Pvertex_array;

```

```

typedef Pint Pvertex_ind_triplet[3];

```

```
typedef struct {
    Pint          num_vertex_ind_triplets;    /* number of vertex index      */
                                                /* triplets                    */
    Pvertex_ind_triplets*vertex_ind_triplets; /* list of vertex index triplets */
} Pvertex_ind_triplet_list;
```

```
typedef struct {
    Pint          num_vertices;               /* number of vertices          */
    Pint          num_data_per_vertex;        /* number of data values      */
                                                /* per-vertex                  */
    Ppoint        *vertex_points;             /* list of vertex points      */
    Pcolrv_ptr    vertex_colrvs;             /* list of vertex colours     */
    Pvec3         *vertex_norms;             /* list of vertex normals     */
    Pfloat        *vertex_data;              /* list of vertex data lists  */
} Pvertex_list;
```

```
typedef struct {
    Pint          num_lists;                 /* number of vertex lists     */
    Pvertex_list  *vertices;                 /* list of vertex lists       */
} Pvertex_set;
```

```
typedef struct {
    Pint_size     dims;                     /* dimensions of vertex array */
    Pint          num_data_per_vertex;      /* number of data values      */
                                                /* per-vertex                  */
    Ppoint3       *vertex_points;           /* array of vertex points     */
    Pcolrv_ptr    vertex_colrvs;           /* array of vertex colours    */
    Pvec3         *vertex_norms;           /* array of vertex normals    */
    Pfloat        *vertex_data;            /* array of vertex data lists */
} Pvertex3_array;
```

```
typedef struct {
    Pint          num_vertices;             /* number of vertices          */
    Pint          num_data_per_vertex;      /* number of data values      */
                                                /* per-vertex                  */
    Ppoint3       *vertex_points;           /* list of vertex points      */
    Pcolrv_ptr    vertex_colrvs;           /* list of vertex colours     */
    Pvec3         *vertex_norms;           /* list of vertex normals     */
    Pfloat        *vertex_data;            /* list of vertex data lists  */
} Pvertex3_list;
```

```
typedef struct {
    Pint          num_lists;                 /* number of vertex lists     */
    Pvertex3_list *vertices;                 /* list of vertex lists       */
} Pvertex3_set;
```

```
typedef struct {
    Pint          data_map_rep;          /* max. # of data mapping table */
                                          /* entries */
    Pint          refl_rep;              /* max. # of reflectance table */
                                          /* entries */
    Pint          param_surf_rep;        /* max. # of param. surface table */
                                          /* entries */
    Pint          light_source_rep;      /* max. # of light source table */
                                          /* entries */
    Pint          depth_cue_rep;         /* max. # of depth cue table */
                                          /* entries */
    Pint          colr_map_rep;          /* max. # of colour mapping table */
                                          /* entries */
} Pws_st_tables_plus;
```

Clause A.2, modify the PHIGS Pelem\_data type definition by adding the specified PHIGS PLUS fields as defined below:

```
typedef union {
    /* start of PHIGS element data */
    ...,
    /* end of PHIGS element data */
    /* start of PHIGS PLUS element data */
    struct Pelem_polyline_set3_colr {
        Pint          colr_type;          /* colour type          */
        Pvertex3_set   vertex_data;        /* list of vertex lists */
    } polyline_set3_colr;
    struct Pelem_fill_area_set3_data {
        Pint          colr_type;          /* colour type          */
        Pfacet        *facet_data;        /* facet data           */
        Pedge_flag_set *edge_flags;        /* list of edge flag lists */
        Pvertex3_set   vertex_data;        /* list of vertex lists */
    } fill_area_set3_data;
    struct Pelem_fill_area_set_data {
        Pint          colr_type;          /* colour type          */
        Pfacet        *facet_data;        /* facet data           */
        Pedge_flag_set *edge_flags;        /* list of edge flag lists */
        Pvertex_set    vertex_data;        /* list of vertex lists */
    } fill_area_set_data;
    struct Pelem_cell_array3_plus {
        Pparal         paral;             /* parallelogram P, Q, R */
        Ppat_rep_plus   pattern;           /* pattern colour array  */
    } cell_array3_plus;
    struct Pelem_set_of_fill_area_sets3_data {
        Pint          colr_type;          /* colour type          */
        Pset_of_fill_area_sets_data *set_data; /* fill area sets data */
        Pedge_flag_set_list *edge_flags;    /* list of edge flag sets */
        Pvertex3_list   vertex_data;        /* list of vertices      */
        Pcontour_set_list contours;         /* list of contour sets  */
    } set_of_fill_area_sets3_data;
    struct Pelem_set_of_fill_area_sets_data {
        Pint          colr_type;          /* colour type          */
        Pset_of_fill_area_sets_data *set_data; /* fill area sets data */
        Pedge_flag_set_list *edge_flags;    /* list of edge flag sets */
        Pvertex_list    vertex_data;        /* list of vertices      */
        Pcontour_set_list contours;         /* list of contour sets  */
    } set_of_fill_area_sets_data;
    struct Pelem_tri_set3_data {
        Pint          colr_type;          /* colour type          */
        Ptri_set_data  *set_data;          /* triangle set data     */
        Pedge_flag_triplet_list *edge_flags; /* list of triangle edge flag */
                                                /* triplets              */
        Pvertex3_list   vertex_data;        /* list of vertices      */
        Pvertex_ind_triplet_list triplets;   /* list of triangle vertex index */
                                                /* triplets              */
    }
};
```

```

} tri_set3_data;
struct Pelem_tri_set_data {
    Pint          colr_type;          /* colour type */
    Ptri_set_data *set_data;          /* triangle set data */
    Pedge_flag_triplet_list *edge_flags; /* list of triangle edge flag */
                                          /* triplets */
    Pvertex_list  vertex_data;        /* list of vertices */
    Pvertex_ind_triplet_list triplets; /* list of triangle vertex index */
                                          /* triplets */
} tri_set_data;
struct Pelem_tri_strip3_data {
    Pint          colr_type;          /* colour type */
    Pfacet_list   *facet_data;        /* list of facet data */
    Pedge_flag_list *edge_flags;      /* list of edge flags */
    Pvertex3_list vertex_data;        /* list of vertex data */
} tri_strip3_data;
struct Pelem_tri_strip_data {
    Pint          colr_type;          /* colour type */
    Pfacet_list   *facet_data;        /* list of facet data */
    Pedge_flag_list *edge_flags;      /* list of edge flags */
    Pvertex_list  vertex_data;        /* list of vertex data */
} tri_strip_data;
struct Pelem_quad_mesh3_data {
    Pint          colr_type;          /* colour type */
    Pfacet_array  *facet_data;        /* array of facet data */
    Pedge_flag_array *edge_flags;     /* array of edge flags */
    Pvertex3_array vertex_data;       /* array of vertex data */
} quad_mesh3_data;
struct Pelem_quad_mesh_data {
    Pint          colr_type;          /* colour type */
    Pfacet_array  *facet_data;        /* array of facet data */
    Pedge_flag_array *edge_flags;     /* array of edge flags */
    Pvertex_array vertex_data;       /* array of vertex data */
} quad_mesh_data;
struct Pelem_non_uniform_b_spline_curve3 {
    Pcurve_geom_spline geom_spline;   /* geometry spline */
} non_uniform_b_spline_curve3;
struct Pelem_non_uniform_b_spline_curve3_colr {
    Pcurve_geom_spline geom_spline;   /* geometry spline */
    Pcurve_colr_spline *colr_spline;  /* colour spline */
} non_uniform_b_spline_curve3_colr;
struct Pelem_non_uniform_b_spline_surf3 {
    Psurf_geom_spline geom_spline;    /* geometry spline */
    Ptrim_curve_loop_list *trim_loops; /* list of trimming curve loops */
} non_uniform_b_spline_surf3;
struct Pelem_non_uniform_b_spline_surf3_data {
    Psurf_geom_spline geom_spline;    /* geometry spline */
    Ptrim_curve_loop_list *trim_loops; /* list of trimming curve loops */
    Psurf_colr_spline *colr_spline;   /* colour spline */
    Psurf_data_spline_list *data_spline; /* data spline */
} non_uniform_b_spline_surf3_data;

```

```

Pgcolr          colr;          /* general colour          */
Pfacet_disting_mode facet_disting_mode; /* facet distinguishing mode */
Pfacet_cull_mode  facet_cull_mode;  /* facet culling mode      */
Pdata_map_rep     data_map_method;   /* data mapping method     */
Prefl_prop        refl_prop;         /* reflectance property data */
struct Pelem_light_source_st {
    Pint_list      act_list;          /* activation list          */
    Pint_list      deact_list;        /* deactivation list        */
} light_source_st;
Pcurve_approx_crit curve_approx_crit; /* curve approximation criteria */
/* data record */
Psurf_approx_crit  surf_approx_crit; /* surface approximation criteria */
/* data record */
Pparam_surf_chars  param_surf_chars; /* parametric surface       */
/* characteristics data record */

/* end of PHIGS PLUS element data */
} Pelem_data;

```

### A.3 External functions

Clause A.3, change the following PHIGS external functions:

```

/* INQUIRE GENERALIZED DRAWING PRIMITIVE 3 */
extern void ping_gdp3 (
    Pint      ws_type,          /* workstation type          */
    Pint      gdp,             /* GDP function identifier    */
    Pint      *err_ind,         /* OUT error indicator       */
    Pint      *num_attr,        /* OUT number of attributes used */
    Pattrs    attr[7]          /* OUT list of attributes used */
);

/* INQUIRE GENERALIZED DRAWING PRIMITIVE */
extern void ping_gdp (
    Pint      ws_type,          /* workstation type          */
    Pint      gdp,             /* GDP function identifier    */
    Pint      *err_ind,         /* OUT error indicator       */
    Pint      *num_attr,        /* OUT number of attributes used */
    Pattrs    attr[7]          /* OUT list of attributes used */
);

```

Clause A.3, add the following PHIGS PLUS external functions after PHIGS external functions:

```

/* POLYLINE SET 3 WITH COLOUR */
extern void ppolyline_set3_colr (
    Pint      colr_type,        /* colour type               */
    const Pvertex3_set *vertex_data /* list of vertex lists      */
);

```

```

/* FILL AREA SET 3 WITH DATA */
extern void pfill_area_set3_data (
    Pint                colr_type,          /* colour type          */
    const Pfacet        *facet_data,       /* facet data           */
    const Pedge_flag_set *edge_flags,      /* list of edge flag lists */
    const Pvertex3_set  *vertex_data,      /* list of vertex lists  */
);

/* FILL AREA SET WITH DATA */
extern void pfill_area_set_data (
    Pint                colr_type,          /* colour type          */
    const Pfacet        *facet_data,       /* facet data           */
    const Pedge_flag_set *edge_flags,      /* list of edge flag lists */
    const Pvertex_set   *vertex_data,      /* list of vertex lists  */
);

/* CELL ARRAY 3 PLUS */
extern void pcell_array3_plus (
    const Pparal        *paral,            /* parallelogram P, Q, R */
    const Ppat_rep_plus *pat              /* pattern colour array   */
);

/* SET OF FILL AREA SETS 3 WITH DATA */
extern void pset_of_fill_area_sets3_data (
    Pint                colr_type,          /* colour type          */
    const Pset_of_fill_area_sets_data *set_data, /* fill area set data    */
    const Pedge_flag_set_list *edge_flags, /* list of edge flag sets */
    const Pvertex3_list    *vertex_data, /* list of vertices      */
    const Pcontour_set_list *contours,    /* list of contour sets  */
);

/* SET OF FILL AREA SETS WITH DATA */
extern void pset_of_fill_area_sets_data (
    Pint                colr_type,          /* colour type          */
    const Pset_of_fill_area_sets_data *set_data, /* fill area set data    */
    const Pedge_flag_set_list *edge_flags, /* list of edge flag sets */
    const Pvertex_list      *vertex_data, /* list of vertices      */
    const Pcontour_set_list *contours,    /* list of contour sets  */
);

/* TRIANGLE SET 3 WITH DATA */
extern void ptri_set3_data (
    Pint                colr_type,          /* colour type          */
    const Ptri_set_data *set_data,          /* triangle set data     */
    const Pedge_flag_triplet_list *edge_flags, /* list of triangle edge flag triplets */
    const Pvertex3_list    *vertex_data, /* list of vertices      */
    const Pvertex_ind_triplet_list *triplets, /* list of triangle vertex index triplets */
);

```