TECHNICAL SPECIFICATION

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Document management — Portable document format — RichMedia annotations conforming to the ISO 10303-242 (STEP AP 242) specification

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Foreword

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This document was prepared by Technical Committee ISO/TC 171, *Document management applications*, Subcommittee SC 2, *Document file formats, EDMS systems and authenticity of information*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

0.1 PDF: ISO 32000

ISO 32000-2 is able to embed 3D CAD models as either 3D or RichMedia annotations. 3D node, stream and view dictionaries can only reference data saved in either the ECMA-363, Universal 3D (U3D) file format or ISO 14739-1, Product Representation Compact (PRC) file format. This often requires the authoritative CAD data to be translated to either U3D or PRC solely to embed the data in a PDF file.

0.2 STEP: ISO 10303

STEP is a set of specifications and methods that enable the exchange and sharing of enterprise engineering information. It is an international standard (ISO 10303) with many *application protocols* (APs) that have a common core data definition. For example, AP 203, AP 214, and AP 242 use the same definitions for three-dimensional geometry, assembly data and basic product information. ISO 10303-42 and ISO 10303-46 are the key standard parts for geometry representation and visual presentation. Most 3D design, engineering and manufacturing software can read and/or write data stored in the STEP format.

The latest AP of STEP, AP 242, was developed to converge the AP 203 and AP 214 standards. STEP AP 242 contains all the functionality covered by the AP 203 and AP 214. In addition, it adds new functionality including 3D tessellated geometry, composites and 3D product and manufacturing information (PMI). The major technical impact of the STEP AP 242 standard covers the areas of:

— model based definition (MBD);

— long term archiving (LTA);

— engineering data exchange including composites;

— manufacturing data exchange including PMI.

0.3 Extending PDF to support STEP

The purpose of this document is to extend the PDF specification to allow RichMedia annotations to include 3D assets saved in the STEP AP 242 (ISO 10303-242) format.

Document management — Portable document format — RichMedia annotations conforming to the ISO 10303-242 (STEP AP 242) specification

1 Scope

This document specifies how to extend the ISO 32000-2 specification by adding the ISO 10303-242 (STEP AP 242) format as a valid format for 3D assets contained in a RichMedia annotation. It is intended for:

— developers of software that creates PDF files (PDF writers);

— software that reads existing PDF files and usually interprets their contents for display (PDF readers);

— software that reads and displays PDF content and interacts with the computer users to possibly modify and save the PDF file (PDF processors);

— PDF products that read and/or write PDF files for a variety of other purposes (PDF processors).

Note PDF writers and PDF readers are more specialised classifications of PDF processors.

This document does not specify the following:

— specific processes for converting paper or electronic documents to the PDF file format;

— specific technical design, user interface implementation, or operational details of rendering;

— specific physical methods of storing these documents such as media and storage conditions;

— methods for validating the conformance of PDF files or PDF processors;

— required computer hardware and/or operating system.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10303-242, *Industrial automation systems and integration — Product data representation and exchange — Part 242: Application protocol: Managed model-based 3D engineering*

ISO 32000-2:2020, *Document management — Portable document format — Part 2: PDF 2.0*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
portable document format
PDF
file format defined in ISO 32000-2

3.2
STEP AP 242
file format defined in ISO 10303-242

4 RichMedia annotations conforming to the ISO 10303-242 (STEP AP 242) specification

4.1 Document requirements

4.1.1 General

Document requirements identify PDF features that are required for correct handling of a document. Requirements shall be stored as requirement dictionaries in accordance with ISO 32000-2:2020, 12.11.

4.1.2 Requirement types

Requirements types shall be as defined in ISO 32000-2:2020, 12.11.2.

4.1.3 STEP requirement

ISO 32000-2:2020, Table 275, lists requirement types that have been defined through PDF 2.0. As shown in Table 1, a new requirement type STEP specifies that a STEP AP 242 RichMedia annotation is stored in a PDF file.

Table 1 — ISO 32000-2:2020, Table 275 — Requirement types

Type	Description
STEP	Requires support for RichMedia annotations (ISO 32000-2, :2020, 13.7.2.2) conforming to the ISO 10303-242 (STEP AP 242) specification. This also includes support for associated ECMAScripts. If a V key is present in its requirement dictionary, it shall represent the version of the STEP AP 242 data in the PDF file and not the PDF version.

4.1.4 Identifying STEP AP 242 3D Artwork in a requirement dictionary

PDF documents containing RichMedia annotations with assets conforming to the STEP AP 242 specification shall have a requirement dictionary containing an S key with the value of STEP.

A V key in a requirement dictionary is used to specify the version number for a specific technology related to the requirement in question (see ISO 32000-2:2020, 12.11.4).

RichMedia annotations with assets conforming to the STEP AP 242 specification shall have a V key that specifies the version of ISO 10303-242 used by the asset, represented as a year (decimal integer) followed by a period and a zero. For example, “2014.0” or "/2020.0" for edition 1 or 2 respectively.

4.2 3D views

4.2.1 General

3D views shall be as defined in ISO 32000-2:2020, 13.6.4.

Named views are specified in PDF as 3D view dictionaries.

4.2.2 Changes to the MS key in a 3D view dictionary

The MS key in a 3D view dictionaries specifies how the 3D camera-to-world transformation matrix is determined. The description of this key is modified to include the STEP AP 242 format as shown in Table 2.

Table 2 — ISO 32000-2:2020, Table 315 — Entries in a 3D view dictionary

Key	Type	Description
MS	name	(Optional) A name specifying how the 3D camera-to-world transformation matrix shall be determined. The following values are valid: M — Indicates that the C2W entry shall specify the matrix. U3D — Indicates that the view node selected by the U3DPath entry in the 3D stream object shall specify the matrix. NOTE 1 There is no corresponding MS field value that would correspond to a 3D stream object of type PRC or STEP AP 242. M is the only valid entry for 3D stream objects of type PRC or STEP AP 242 (or it can be omitted). If omitted, the view specified in the 3D artwork shall be used.

4.3 3D node dictionaries

4.3.1 General

The PDF interface to 3D geometry is through 3D node dictionaries (see ISO 32000-2:2020, 13.6.4.7).

4.3.2 Changes to the N key in a 3D node dictionary

An N key in a 3D node dictionary specifies the unique name of the node being described by the node dictionary (see ISO 32000-2:2020, Table 323). The description of this key is modified to include the STEP AP 242 format as shown in Table 3.

Table 3 — ISO 32000-2:2020, Table 323 — Entries in a 3D node dictionary

Key	Type	Description
N	text string	(Required) The name of the node being described by the node dictionary. All names in the node dictionary shall be unique. Interpretation of this entry shall depend upon the 3D format specified in the Subtype entry in "Table 311 — Entries in a 3D stream dictionary" as described below: U3D — If the Subtype of the corresponding 3D Stream is U3D, this entry shall correspond to the field Node block name, specified in the Universal 3D file format. PRC — (PDF 2.0) If the Subtype of the corresponding 3D Stream is PRC, this entry shall be the unique identifier (UUID), specified in section 5.3, Unique identifiers, of ISO 14739-1. STEP — If the Subtype of the corresponding 3D Stream is STEP, this entry shall be the unique identifier (UUID), specified in the STEP AP 242 stream. NOTE 1 When comparing this entry to node names, PDF processors will need to translate between the PDF text encoding used by PDF and the character encoding specified in the 3D stream. NOTE 2 The description of the value of the N key was clarified in this document (2020).

4.3.3 Creating an N key for a STEP AP 242 node

If the asset of a RichMedia annotation corresponding to a 3D node dictionary is STEP AP 242, the N entry shall be constructed from fields stored in the STEP AP 242 asset. PDF processors shall translate

between the PDF text encoding used by PDF and the character encoding specified in the STEP AP 242 asset.

NOTE For information on deriving unique names from STEP AP 242 data, see Annex A.

4.4 Marking the extension level in PDF

ISO 32000-2:2020, Annex E defines a mechanism and process for the addition of new keys to PDF and a way to document their usage in a PDF (see ISO 32000-2:2020, 7.12.2 and 7.12.3).

PDF documents containing RichMedia annotations with assets conforming to the STEP AP 242 specification shall have an extensions dictionary that is a direct object (i.e. the information shall be nested directly within the catalog dictionary). This extensions dictionary shall be added to an array object that is the value of the ISO_ key in a document's extensions dictionary and adhere to the following requirements.

— The value of BaseVersion shall be 2.0.

— The value of ExtensionLevel shall be this document, i.e. ISO 24064:2023.

— The value of ExtensionRevision shall be the text string "1:2023".

— The value of Type shall be DeveloperExtensions.

— The value of URL shall be the URL to the ISO page for this document, https://www.iso.org/standard/77686.html.

The PDF markup for PDF documents containing RichMedia annotations with assets conforming to the STEP AP 242 specification is as follows:

```
%PDF-2.0
<</Type /Catalog
    /Extensions
    <</ISO_
       << /Type /DeveloperExtensions
          /BaseVersion /2.0
          /ExtensionLevel 24064
          /ExtensionRevision (1:2023)
          /URL (https://www.iso.org/standard/77686.html)
       >>
    >>
>>
```

4.5 Example

See the following example of a RichMedia annotation with STEP AP 242 assets.

```
%PDF-2.0
%Â¾Â¿Ã□Ã,
%
% This PDF 2.0 uses a number of PDF 2.0 specific features: UTF-8 text strings, Associated
Files, RichMedia annotations,
% STEP, array of Extensions dictionaries, etc.
%
1 0 obj % Document catalog (see Table 29 in ISO 32000-2)
<<
   /Type /Catalog
   /Metadata    2 0 R
   /Pages       3 0 R
   /Names       << /EmbeddedFiles 5 0 R >>
   /Requirements     % An array of Requirement dictionaries (see clause 12.11 in ISO
32000-2)
   [
      <<
         /Type /Requirement
         /S    /RichMedia     % requires RichMedia annotation support
      >>
```

```
      <<
         /Type /Requirement
         /S    /Attachment    % STEP AP 242 data file is an Associated File
(EmbeddedFiles) attachment
      >>
      <<
         /Type /Requirement
         /S    /3DMarkup      % many 3D PDF files may also need 3DMarkup support
      >>
      <<
         /Type /Requirement
         /S    /STEP
         /V    /2020.0        % STEP AP 242 as defined by ISO 10303-242:2020 support is
required
      >>

   ]
   /Extensions   % direct object PDF extensions dictionary (see Table 48 in ISO 32000-2)
   <<
      /Type /Extensions
      /ISO_   % See clause 4.4 in ISO/TS 24064 and Table 49 in ISO 32000-2
      [
          <<
         /Type              /DeveloperExtensions
         /BaseVersion       /2.0
         /ExtensionLevel    24064
         /ExtensionRevision (1:2023)
         /URL               (https://www.iso.org/standard/77686.html)
          >>
          % any other ISO PDF 2.0 extensions would be here
      ]
      % other vendor-specific extensions would be here
   >>
>>
endobj

2 0 obj % XMP Metadata stream (see clause 14.3.2 in ISO 32000-2)
<<
   /Type /Metadata
   /Subtype /XML
   /Length 51
>>
stream
%... uncompressed XMP Metadata stream for PDF 2.0 document (not shown)
endstream
endobj

3 0 obj % Page tree root node (see Table 30 in ISO 32000-2)
<<
   /Type  /Pages
   /Kids  [ 4 0 R ]
   /Count 1
>>
endobj

4 0 obj % Page (see Table 31 in ISO 32000-2)
<<
   /Type /Page
   /Parent 3 0 R
   /Resources << >>      % Required key
   /Annots   [ 8 0 R ]   % A single RichMedia annotation that uses STEP as defined in ISO/
TS 24064
   /MediaBox [ 0 0 842 595 ]
   % The PDF page is blank (i.e. has no content and thus no /Contents entry)
>>
endobj

5 0 obj % EmbeddedFiles (from Catalog) and RichMediaContent Assets Name tree (see Table 32
in ISO 32000-2)
<<
   /Names [ (example.stp) 6 0 R ]
```

```
>>
endobj

6 0 obj % File Specification dictionary (see Table 43 in ISO 32000-2)
<<
   /Type /Filespec
   /F    (example.stp)
   /UF   (\357\273\277example.stp)                % UTF-8 text string
   /Desc (\357\273\277An example ISO 10303-242:2020 STEP AP 242 model) % UTF-8 text string
   /EF  << /F 7 0 R >>
   /AFRelationship /Source      % Associated File relationship for RichMedia annotation
>>
endobj

7 0 obj % Embedded file stream (see Table 44 in ISO 32000-2)
<<
   /Type    /EmbeddedFile
   /Subtype /model#2Fstep                  % must be a valid MIME media type (RFC 2046) -
see https://www.iana.org/assignments/media-types/model/step
   /Params % Embedded file parameter dictionary (see Table 45 in ISO 32000-2)
      <<
         /ModDate      (D:20230110180404)
         /CreationDate (D:20230110130404)
         /Size         12345
      >>
   /Filter [/FlateDecode]
   /Length 0
>>
stream %... FLATE-compressed ISO 10303 STEP AP 242 data stream ...
endstream
endobj

8 0 obj % RichMedia annotation (see Tables 166 and 333 in ISO 32000-2)
<<
   /Type     /Annot
   /Subtype  /RichMedia
   /AP     << % Appearance dictionary (see Table 170 in ISO 32000-2)
         /N 9 0 R   % normal appearance content stream (Form XObject)
      >>
   /Rect             [ 40 40 802 555 ] % in default user space
   /P                 4 0 R            % parent page
   /RichMediaContent  10 0 R
   /RichMediaSettings 11 0 R
   /AF                [ 6 0 R ]
   /NM                (\357\273\277An example STEP AP 242 RichMedia annotation)  % UTF-8
text string
   /M                 (D:20230110180404)    % Date matches EmbeddedFile Params ModDate
   /F                 4                     % Print flag enabled
>>
endobj

9 0 obj % RichMedia annotation normal appearance Form XObject (content stream)
<<
   /Subtype  /Form
   /Resources << >>
   /BBox     [ 40 40 802 555 ]
   /AF       [ 6 0 R ]          % Associated File referencing the STEP AP 242 3D data (see
clause 14.13 in ISO 32000-2)
   /Length    372
>>
stream
% ... content stream for display when RichMedia annotation is not active
%     or legacy PDF processors that do not support RichMedia annotations.
%     The embedded STEP AP 242 data stream is linked as the Associated File
%     with a Source relationship implying this content stream was generated
%     from the STEP 3D data.
1 0 0 rg 50 50 500 500 re f  % red rectangle
endstream
endobj

10 0 obj % RichMediaContent dictionary (see Table 341 in ISO 32000-2)
```

```
<<
   /Type /RichMediaContent
   /Configurations [ 12 0 R ]
   /Assets         5 0 R
   /Views          [ 14 0 R ]
>>
endobj

11 0 obj % RichMediaSettings dictionary (see Table 334 in ISO 32000-2)
<<
   /Type /RichMediaSettings
   /Activation % RichMediaActivation dictionary (see Table 335 in ISO 32000-2)
   <<
      /Type          /RichMediaActivation
      /Condition     /XA     % annotation is explicitly activated by a user action
      /Configuration 12 0 R
      /View          14 0 R
      /Presentation  % RichMediaPresentation dictionary (see Table 338 in ISO 32000-2)
      <<
         /Type           /RichMediaPresentation
         /Style          /Embedded
         /NavigationPane true
         /Toolbar        true
         /Transparent    false
      >>
   >>
   /Deactivation % RichMediaDeactivation dictionary (see Table 336 in ISO 32000-2)
   <<
      /Type      /RichMediaDeactivation
      /Condition /XD     % RichMedia annotation is explicitly deactivated by a user action
   >>
>>
endobj

12 0 obj % RichMediaConfiguration dictionary (see Table 342 in ISO 32000-2)
<<
   /Type      /RichMediaConfiguration
   /Subtype   /3D
   /Name      (\357\273\277Main configuration)   % UTF-8 text string
   /Instances [ 13 0 R ]
>>
endobj

13 0 obj % RichMediaInstance dictionary (see Table 343 in ISO 32000-2)
<<
   /Type    /RichMediaInstance
   /Subtype /3D
   /Asset   6 0 R % File Specification dictionary for the 3D STEP data
>>
endobj

14 0 obj % 3D View dictionary (see Table 315 in ISO 32000-2)
<<
   /Type /3DView
   /XN   (\357\273\277Primary view)   % UTF-8 text string
   /MS   /M                           % C2W entry specifies camera-to-world transformation
matrix
   /C2W  [ -0.829 -0.559 0.0 -0.167 0.247 0.954 -0.533 0.7910 -0.2989 149.9 -219.791
140.546 ]
   % ...
>>
endobj

xref
0 15
0000000000 65536 f
0000000191 00000 n
0000001441 00000 n
0000001652 00000 n
0000001769 00000 n
0000002093 00000 n
```

```
0000002246 00000 n
0000002633 00000 n
0000003174 00000 n
0000003880 00000 n
0000004563 00000 n
0000004751 00000 n
0000005561 00000 n
0000005793 00000 n
0000005991 00000 n

trailer
<<
   /Root 1 0 R
   /Size 15
   /ID [ <38df5dc7f8b2f6458953ae881ff3e4db> <9d90eb933955284b867b9f8b314398b6> ]
>>
startxref
6333
%%EOF
```