**COMMITTEE DRAFT AMENDMENT****© ISO/IEC 2023 – All rights reserved****Text of ISO/IEC 23008-2:202x/CDAM 1** **63****Part 2: High efficiency video coding, AMENDMENT 1: New profiles, colour descriptors, and SEI messages****Information technology — High efficiency coding and media delivery in heterogeneous environments****Élément introductif — Élément central — Partie 2: Titre de la partie****Information technology — High efficiency coding and media delivery in heterogeneous environments — Part 2: High efficiency video coding, AMENDMENT 1: New profiles, colour descriptors, and SEI messages****E****2023-08-15****(30) Committee****ISO/IEC****ISO/IEC J****2023****2****Amendment****International Standard****202x****226****ISO/IEC 23008‑****ISO/IEC 23008‑2****ISO/IEC 23008-2:202x/CDAM 1****JISC****Coding of audio, picture, multimedia and hypermedia information****Information technology****5****29****1** **2****見出し 2****見出し 1****0****2****STD Version 2.1c2****30** **4** **ISO/IEC JTC 1/SC 29 /WG 5 N 226**

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Secretariat:  JISC

**Information technology — High efficiency coding and media delivery in heterogeneous environments — Part 2: High efficiency video coding, AMENDMENT 1: New profiles, colour descriptors, and SEI messages**

*Élément introductif — Élément central — Partie 2: Titre de la partie*

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Information technology — High efficiency coding and media delivery in heterogeneous environments — Part 2: High efficiency video coding, AMENDMENT 1: New profiles, colour descriptors, and SEI messages

*Subclause 2.3*

*Add the following reference:*

Rec. ITU-T H.274 | ISO/IEC 23002-7 (in force) Versatile supplemental enhancement information messages for coded video bitstreams

*Subclause A.4.1*

*In Table A.8, make the following changes:*

1. *Replace "Max slice segments per picture MaxSliceSegmentsPerPicture" with "Max # of slice segments per picture MaxSliceSegmentsPerPicture".*
2. *The global variable MaxTileRows should be on a new line - the same way that MaxTileCols is on a new line. Similarly for other global variables defined in this table, particularly MaxSliceSegmentsPerPicture, which itself in the ISO text is split into two lines. Note that this table is actually the place in the specification where these global variables are defined.*

*Subclause A.4.2*

*In Table A.9, make the following changes:*

1. *MinCrBase in Table A.9 should be on a new line. Similarly for other global variables defined in this table Note that this table is actually the place in the specification where these global variables are defined.*

*Make the following change:*

Min( ~~(~~Max( 1, MaxSliceSegmentsPerPicture \* MaxLumaSr / MaxLumaPs \* ( AuCpbRemovalTime[ n ] − AuCpbRemovalTime[ n − 1 ] ) ), MaxSliceSegmentsPerPicture )

*Subclause D.1*

*Replace the context of subclause D.1 with the following:*

This annex specifies 1) syntax and semantics for the SEI message payload, which is the container of SEI messages, 2) the syntax and semantics for ~~SEI message payloads~~ some SEI messages, and 3) the use of the SEI messages for which the payload type values are specified in this document and the syntax and semantics are specified in Rec. ITU-T H.274 | ISO/IEC 23002-7.

SEI messages assist in processes related to decoding, display or other purposes. However, SEI messages are not required for constructing the luma or chroma samples by the decoding process. Conforming decoders are not required to process this information for output order conformance to this document (see Annex C and F.13 for the specification of conformance). Some SEI message information is required to check bitstream conformance and for output timing decoder conformance.

In C.5.2 and in F.13 including its subclauses, specification for presence of SEI messages are also satisfied when those messages (or some subset of them) are conveyed to decoders (or to the HRD) by other means not specified in this document. When present in the bitstream, SEI messages for which the syntax and semantics are specified in this document shall obey the syntax and semantics specified in 7.3.5 and this annex, and SEI messages for which the payload type values are specified in this document and the syntax and semantics are specified in Rec. ITU-T H.274 | ISO/IEC 23002-7 shall obey the syntax and semantics specified in ITU-T H.274 | ISO/IEC 23002-7. When the content of an SEI message is conveyed for the application by some means other than presence within the bitstream, the representation of the content of the SEI message is not required to use the same syntax specified in this annex or ITU-T H.274 | ISO/IEC 23002-7. For the purpose of counting bits, only the appropriate bits that are actually present in the bitstream are counted.

*Subclause D.2.1*

*Replace the general SEI message syntax with the following:*

|  |  |
| --- | --- |
| sei\_payload( payloadType, payloadSize ) { | **Descriptor** |
| if( nal\_unit\_type = = PREFIX\_SEI\_NUT ) |  |
| if( payloadType = = 0 ) |  |
| buffering\_period( payloadSize ) |  |
| else if( payloadType = = 1 ) |  |
| pic\_timing( payloadSize ) |  |
| else if( payloadType = = 2 ) |  |
| pan\_scan\_rect( payloadSize ) |  |
| else if( payloadType = = 3 ) |  |
| filler\_payload( payloadSize ) |  |
| else if( payloadType = = 4 ) |  |
| user\_data\_registered\_itu\_t\_t35( payloadSize ) |  |
| else if( payloadType = = 5 ) |  |
| user\_data\_unregistered( payloadSize ) |  |
| else if( payloadType = = 6 ) |  |
| recovery\_point( payloadSize ) |  |
| else if( payloadType = = 9 ) |  |
| scene\_info( payloadSize ) |  |
| else if( payloadType = = 15 ) |  |
| picture\_snapshot( payloadSize ) |  |
| else if( payloadType = = 16 ) |  |
| progressive\_refinement\_segment\_start( payloadSize ) |  |
| else if( payloadType = = 17 ) |  |
| progressive\_refinement\_segment\_end( payloadSize ) |  |
| else if( payloadType = = 19 ) |  |
| film\_grain\_characteristics( payloadSize ) |  |
| else if( payloadType = = 22 ) |  |
| post\_filter\_hint( payloadSize ) |  |
| else if( payloadType = = 23 ) |  |
| tone\_mapping\_info( payloadSize ) |  |
| else if( payloadType = = 45 ) |  |
| frame\_packing\_arrangement( payloadSize ) |  |
| else if( payloadType = = 47 ) |  |
| display\_orientation( payloadSize ) |  |
| else if( payloadType = = 56 ) |  |
| green\_metadata( payloadsize ) /\* specified in ISO/IEC 23001-11 \*/ |  |
| else if( payloadType = = 128 ) |  |
| structure\_of\_pictures\_info( payloadSize ) |  |
| else if( payloadType = = 129 ) |  |
| active\_parameter\_sets( payloadSize ) |  |
| else if( payloadType = = 130 ) |  |
| decoding\_unit\_info( payloadSize ) |  |
| else if( payloadType = = 131 ) |  |
| temporal\_sub\_layer\_zero\_idx( payloadSize ) |  |
| else if( payloadType = = 133 ) |  |
| scalable\_nesting( payloadSize ) |  |
| else if( payloadType = = 134 ) |  |
| region\_refresh\_info( payloadSize ) |  |
| else if( payloadType = = 135 ) |  |
| no\_display( payloadSize ) |  |
| else if( payloadType = = 136 ) |  |
| time\_code( payloadSize ) |  |
| else if( payloadType = = 137 ) |  |
| mastering\_display\_colour\_volume( payloadSize ) |  |
| else if( payloadType = = 138 ) |  |
| segmented\_rect\_frame\_packing\_arrangement( payloadSize ) |  |
| else if( payloadType = = 139 ) |  |
| temporal\_motion\_constrained\_tile\_sets( payloadSize ) |  |
| else if( payloadType = = 140 ) |  |
| chroma\_resampling\_filter\_hint( payloadSize ) |  |
| else if( payloadType = = 141 ) |  |
| knee\_function\_info( payloadSize ) |  |
| else if( payloadType = = 142 ) |  |
| colour\_remapping\_info( payloadSize ) |  |
| else if( payloadType = = 143 ) |  |
| deinterlaced\_field\_identification( payloadSize ) |  |
| else if( payloadType = = 144 ) |  |
| content\_light\_level\_info( payloadSize ) |  |
| else if( payloadType = = 145 ) |  |
| dependent\_rap\_indication( payloadSize ) |  |
| else if( payloadType = = 146 ) |  |
| coded\_region\_completion( payloadSize ) |  |
| else if( payloadType = = 147 ) |  |
| alternative\_transfer\_characteristics( payloadSize ) |  |
| else if( payloadType = = 148 ) |  |
| ambient\_viewing\_environment( payloadSize ) |  |
| else if( payloadType  = =  149 ) |  |
| content\_colour\_volume( payloadSize ) |  |
| else if( payloadType  = =  150 ) |  |
| equirectangular\_projection( payloadSize ) |  |
| else if( payloadType  = =  151 ) |  |
| cubemap\_projection( payloadSize ) |  |
| else if( payloadType  = =  152 ) |  |
| fisheye\_video\_info( payloadSize ) |  |
| else if( payloadType  = =  154 ) |  |
| sphere\_rotation( payloadSize ) |  |
| else if( payloadType  = =  155 ) |  |
| regionwise\_packing( payloadSize ) |  |
| else if( payloadType  = =  156 ) |  |
| omni\_viewport( payloadSize ) |  |
| else if( payloadType  = =  157 ) |  |
| regional\_nesting( payloadSize ) |  |
| else if( payloadType  = =  158 ) |  |
| mcts\_extraction\_info\_sets( payloadSize ) |  |
| else if( payloadType  = =  159 ) |  |
| mcts\_extraction\_info\_nesting( payloadSize ) |  |
| else if( payloadType = = 160 ) |  |
| layers\_not\_present( payloadSize ) /\* specified in Annex F \*/ |  |
| else if( payloadType = = 161 ) |  |
| inter\_layer\_constrained\_tile\_sets( payloadSize ) /\* specified in Annex F \*/ |  |
| else if( payloadType = = 162 ) |  |
| bsp\_nesting( payloadSize ) /\* specified in Annex F \*/ |  |
| else if( payloadType = = 163 ) |  |
| bsp\_initial\_arrival\_time( payloadSize ) /\* specified in Annex F \*/ |  |
| else if( payloadType = = 164 ) |  |
| sub\_bitstream\_property( payloadSize ) /\* specified in Annex F \*/ |  |
| else if( payloadType = = 165 ) |  |
| alpha\_channel\_info( payloadSize ) /\* specified in Annex F \*/ |  |
| else if( payloadType = = 166 ) |  |
| overlay\_info( payloadSize ) /\* specified in Annex F \*/ |  |
| else if( payloadType = = 167 ) |  |
| temporal\_mv\_prediction\_constraints( payloadSize ) /\* specified in Annex F \*/ |  |
| else if( payloadType = = 168 ) |  |
| frame\_field\_info( payloadSize ) /\* specified in Annex F \*/ |  |
| else if( payloadType = = 176 ) |  |
| three\_dimensional\_reference\_displays\_info( payloadSize ) /\* specified in Annex G \*/ |  |
| else if( payloadType = = 177 ) |  |
| depth\_representation\_info( payloadSize ) /\* specified in Annex G \*/ |  |
| else if( payloadType = = 178 ) |  |
| multiview\_scene\_info( payloadSize ) /\* specified in Annex G \*/ |  |
| else if( payloadType = = 179 ) |  |
| multiview\_acquisition\_info( payloadSize ) /\* specified in Annex G \*/ |  |
| else if( payloadType = = 180 ) |  |
| multiview\_view\_position( payloadSize ) /\* specified in Annex G \*/ |  |
| else if( payloadType = = 181 ) |  |
| alternative\_depth\_info( payloadSize ) /\* specified in Annex I \*/ |  |
| else if( payloadType = = 200 ) |  |
| sei\_manifest( payloadSize ) |  |
| else if( payloadType = = 201 ) |  |
| sei\_prefix\_indication( payloadSize ) |  |
| else if( payloadType = = 202 ) |  |
| annotated\_regions( payloadSize ) |  |
| else if( payloadType = = 205 ) |  |
| shutter\_interval\_info( payloadSize ) |  |
| else if( payloadType = = 210 ) /\* Specified in Rec. ITU-T H.274 | ISO/IEC 23002-7 \*/ |  |
| nn\_post\_filter\_characteristics( payloadSize ) |  |
| else if( payloadType = = 211 ) /\* Specified in Rec. ITU-T H.274 | ISO/IEC 23002-7 \*/ |  |
| nn\_post\_filter\_activation( payloadSize ) |  |
| else if( payloadType = = 212 ) /\* Specified in Rec. ITU-T H.274 | ISO/IEC 23002-7 \*/ |  |
| phase\_indication( payloadSize ) |  |
| else |  |
| reserved\_sei\_message( payloadSize ) |  |
| else /\* nal\_unit\_type = = SUFFIX\_SEI\_NUT \*/ |  |
| if( payloadType = = 3 ) |  |
| filler\_payload( payloadSize ) |  |
| else if( payloadType = = 4 ) |  |
| user\_data\_registered\_itu\_t\_t35( payloadSize ) |  |
| else if( payloadType = = 5 ) |  |
| user\_data\_unregistered( payloadSize ) |  |
| else if( payloadType = = 17 ) |  |
| progressive\_refinement\_segment\_end( payloadSize ) |  |
| else if( payloadType = = 22 ) |  |
| post\_filter\_hint( payloadSize ) |  |
| else if( payloadType = = 132 ) |  |
| decoded\_picture\_hash( payloadSize ) |  |
| else if( payloadType = = 146 ) |  |
| coded\_region\_completion( payloadSize ) |  |
| else if( payloadType = = 210 ) /\* Specified in Rec. ITU-T H.274 | ISO/IEC 23002-7 \*/ |  |
| nn\_post\_filter\_characteristics( payloadSize ) |  |
| else if( payloadType = = 211 ) /\* Specified in Rec. ITU-T H.274 | ISO/IEC 23002-7 \*/ |  |
| nn\_post\_filter\_activation( payloadSize ) |  |
| else |  |
| reserved\_sei\_message( payloadSize ) |  |
| if( more\_data\_in\_payload( ) ) { |  |
| if( payload\_extension\_present( ) ) |  |
| **reserved\_payload\_extension\_data** | u(v) |
| **payload\_bit\_equal\_to\_one** /\* equal to 1 \*/ | f(1) |
| while( !byte\_aligned( ) ) |  |
| **payload\_bit\_equal\_to\_zero** /\* equal to 0 \*/ | f(1) |
| } |  |
| } |  |

*Subclause D.3.1*

*Make the following changes:*

…

**reserved\_payload\_extension\_data** shall not be present in bitstreams conforming to this version of this Specification. However, decoders conforming to this version of this Specification shall ignore the presence and value of reserved\_payload\_extension\_data. When present, the length, in bits, of reserved\_payload\_extension\_data is equal to 8 \* payloadSize − nEarlierBits − nPayloadZeroBits − 1, where nEarlierBits is the number of bits in the sei\_payload( ) syntax structure that precede the reserved\_payload\_extension\_data syntax element and nPayloadZeroBits is the number of payload\_bit\_equal\_to\_zero syntax elements at the end of the sei\_payload( ) syntax structure.

If more\_data\_in\_payload( ) is TRUE after the parsing of the SEI message syntax structure (e.g., the buffering\_period( ) syntax structure) and nPayloadZeroBits is not equal to 7, PayloadBits is set equal to 8 \* payloadSize − nPayloadZeroBits − 1; otherwise, PayloadBits is set equal to 8 \* payloadSize.

**payload\_bit\_equal\_to\_one** shall be equal to 1.

**payload\_bit\_equal\_to\_zero** shall be equal to 0.

NOTE 1 SEI messages with the same value of payloadType are conceptually the same SEI message regardless of whether they are contained in prefix or suffix SEI NAL units.

NOTE 2 For SEI messages with payloadType in the range of 0 to 47, inclusive, that are specified in this Specification, the payloadType values are aligned with similar SEI messages specified in Rec. ITU-T H.264 | ISO/IEC 14496-10.

The list SingleLayerSeiList is set to consist of the payloadType values 2, 3, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 129, 131, 132, 134 to 152, inclusive, 154 to 159, inclusive, 200 to 202, inclusive, ~~and~~ 205, and 210 to 212, inclusive.

The list VclAssociatedSeiList is set to consist of the payloadType values 2, 3, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 131, 132, 134 to 152, inclusive, 154 to 159, inclusive, 200 to 202, inclusive, ~~and~~ 205, and 210 to 212, inclusive.

The list PicUnitRepConSeiList is set to consist of the payloadType values 0, 1, 2, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 129, 131, 132, 133, 135 to 152, inclusive, 154 to 159, inclusive, 200 to 202, inclusive, ~~and~~ 205, and 210 to 212, inclusive.

NOTE 3 SingleLayerSeiList consists of the payloadType values of the SEI messages specified in Annex D excluding 0 (buffering period), 1 (picture timing), 4 (user data registered by Recommendation ITU-T T.35), 5 (user data unregistered), 130 (decoding unit information) and 133 (scalable nesting). VclAssociatedSeiList consists of the payloadType values of the SEI messages that, when non-scalable-nested and contained in an SEI NAL unit, infer constraints on the NAL unit header of the SEI NAL unit on the basis of the NAL unit header of the associated VCL NAL unit. PicUnitRepConSeiList consists of the payloadType values of the SEI messages that are subject to the restriction on 8 repetitions per picture unit.

…

*Subclause D.3.13*

*Replace the first sentence with the following:*

This SEI message provides the decoder with a parameterized model for a film grain synthesis process. The film grain synthesis process should be applied to the decoded pictures prior to their display.

*Replace formulae D-15 with the following:*

G[ c ][ x ][ y ] = ( comp\_model\_value[ c ][ sj ][ 0 ] \* n[ c ][ x ][ y ] +  
 comp\_model\_value[ c ][ sj ][ 1 ] \* ( G[ c ][ x − 1 ][ y ] +  
 ( ( comp\_model\_value[ c ][ s j ][ 4 ] \* G[ c ][ x ][ y − 1 ] ) >> (D-15)  
 log2\_scale\_factor ) ) + comp\_model\_value[ c ][ s j ][ 3 ] \*  
 ~~(~~ ( ( comp\_model\_value[ c ][ s j ][ 4 ] \* ( G[ c ][ x − 1 ][ y − 1 ] + G[ c ][ x + 1 ][ y − 1 ] ) >>  
 log2\_scale\_factor ) ~~+ G[ c ][ x + 1 ][ y − 1 ] )~~+  
 comp\_model\_value[ c ][ s j ][ 5 ] \* ( G[[ c ][ x − 2 ][ y ] +  
 ( ( comp\_model\_value[ c ][ s j ][ 4 ] \* comp\_model\_value[ c ][ s j ][ 4 ] \* G[ c ][ x ][ y − 2 ] ) >>  
 ( 2 \* log2\_scale\_factor ) ) ) +  
 comp\_model\_value[ c ][ s j ][ 2 ] \* G[ c − 1 ][ x ][ y ] ) >> log2\_scale\_factor

*New subclause D.4*

*Add subclause D.4 as follows:*

**D.4 Use of SEI messages specified in other specifications**

**D.4.1 General**

The SEI messages having syntax structures identified in subclause ‎D.2.1 that are specified in other specifications, including Rec. ITU-T H.274 | ISO/IEC 23002-7, may be used together with bitstreams specified by this Specification.

When any particular SEI message specified in Rec. ITU-T H.274 | ISO/IEC 23002-7 is included in a bitstream specified by this Specification, the SEI payload syntax shall be as specified in Rec. ITU-T H.274 | ISO/IEC 23002-7 that syntax shall be included into the sei\_payload( ) syntax structure as specified in subclause ‎D.2.1 ~~,~~ and shall use the payloadType value specified in clause ‎D.2.1, the corresponding semantics specified in Rec. ITU-T H.274 | ISO/IEC 23002-7 shall apply, and, additionally, any SEI-message-specific constraints, variables, and semantics specified in this annex for that particular SEI message shall apply.

The value of PayloadBits, as specified in subclause ‎D.2.2, is passed to the parser of the SEI message syntax structures specified in Rec. ITU-T H.274 | ISO/IEC 23002-7.

**D.4.2 Use of the neural network post-filter characteristics SEI message and the neural-network post-filter activation SEI message**

Let currPic be the cropped decoded output picture for which the neural-network post-processing filter (NNPF) defined by the neural-network post-filter characteristics (NNPFC) SEI message is activated by a neural-network post-filter activation (NNPFA) SEI message and currLayerId be the nuh\_layer\_id value of currPic.

It is a requirement of bitstream conformance that when a picture unit contains an NNPFA SEI message, the value of pic\_output\_flag in the slice headers of that picture unit shall be equal to 1.

NOTE Since only cropped decoded output pictures are used as input pictures of the NNPF, the value of pic\_output\_flag in the slice headers of the coded picture corresponding to each input picture of the NNPF is equal to 1.

The variable pictureRateUpsamplingFlag is set equal to ( ( nnpfc\_purpose & 0x08 ) > 0 ) ? 1 : 0.

The variable numInputPics is set equal to nnpfc\_num\_input\_pics\_minus1 + 1.

The variable numInferences is derived as follows:

— If all of the following conditions are true, the variable numPostRoll is set equal to the value of i such that nnpfc\_interpolated\_pics[ i ] is greater than 0 and the variable numInferences is set equal to 1 + numPostRoll:

— nnpfc\_purpose is equal to 8 (i.e., the only purpose for the NNPF is picture rate upsampling).

— The NNPFA SEI message that activated this NNPF has nnpfa\_persistence\_flag equal to 1.

— nnpfc\_interpolated\_pics[ i ] is greater than 0 only for a single value of i that is greater than 0.

— Either of the following conditions is true:

— currPic is the last picture of the bitstream in output order that has nuh\_layer\_id equal to currLayerId.

— currPic is the last picture in the CLVS in output order and nnpfa\_no\_foll\_clvs\_flag is equal to 1.

— Otherwise, if all of the following conditions are true, the variable numPostRoll is set equal to InpIdx[ I ] for the value of i such that nnpfa\_output\_flag[ i ] is equal to 1, and the variable numInferences is set equal to 1 + numPostRoll:

— pictureRateUpsamplingFlag is equal to 0.

— numInputPics is greater than 1.

— The NNPFA SEI message that activated this NNPF has nnpfa\_persistence\_flag equal to 1, nnpfa\_output\_flag[ idx ] is equal to 1 for a single value of idx in the range of 0 to NumInpPicsInOutputTensor – 1, inclusive, and for that single value of idx, InpIdx[ idx ] is greater than 0.

— Either of the following conditions is true:

— currPic is the last picture of the bitstream in output order that has nuh\_layer\_id equal to currLayerId.

— currPic is the last picture in the CLVS in output order and nnpfa\_no\_foll\_clvs\_flag is equal to 1.

— Otherwise, the variable numInferences is set equal to 1.

For each value of j in the range of 0 to numInferences − 1, inclusive, the following applies:

— The arrays inputPic[ i ] and inputPresentFlag[ i ] for i in the range of 0 to numInputPics − 1, inclusive, representing all the input pictures and the presence of input pictures, respectively, are specified as follows:

— When j is greater than 0, for each value of k in the range of 0 to j − 1, inclusive, inputPic[ k ] is set to be currPic and inputPresentFlag[ k ] is set equal to 0.

— The j-th input picture, inputPic[ j ], is set to be currPic and inputPresentFlag[ j ] is set equal to 1.

— When numInputPics is greater than 1, the following applies for each value of i in the range of j + 1 to numInputPics − 1, inclusive, in increasing order of i:

— If both of the following conditions are true, and, inputPic[ i ] is set to be prevPic and inputPresentFlag[ i ] is set equal to 1.

— Either of the following conditions is true:

— pictureRateUpsamplingFlag is equal to 1 and currPic is associated with a frame packing arrangement SEI message with frame\_packing\_arrangement\_type equal to 5 and a particular value of fp\_current\_frame\_is\_frame0\_flag, and there is a cropped decoded output picture prevPic that is the last picture in output order among all cropped decoded output pictures that have nuh\_layer\_id equal to currLayerId, precede inputPic[ i − 1 ] in output order, and are associated with a frame packing arrangement SEI message with frame\_packing\_arrangement\_type equal to 5 and the same value of fp\_current\_frame\_is\_frame0\_flag.

— pictureRateUpsamplingFlag is equal to 0 or currPic is not associated with a frame packing arrangement SEI message with frame\_packing\_arrangement\_type equal to 5, and there is a cropped decoded output picture prevPic that is the last picture in output order among all cropped decoded output pictures that have nuh\_layer\_id equal to currLayerId and precede inputPic[ i − 1 ] in output order.

— nnpfa\_no\_prev\_clvs\_flag is equal to 0 or the coded picture corresponding to prevPic and the current picture are present in the same CLVS.

— Otherwise, the following applies:

— inputPic[ i ] is set to be the same picture as inputPic[ i − 1 ] and inputPresentFlag[ i ] is set equal to 0.

— It is a requirement of bitstream conformance that, when pictureRateUpsamplingFlag is equal to 1, nnpfc\_interpolated\_pics[ i − 1 ] shall be equal to 0.

— It is a requirement of bitstream conformance that when inputPresentFlag[ i ] is equal to 0 and nnpfc\_input\_pic\_output\_flag[ i ] is equal to 1, the value of nnpfa\_output\_flag[ idx ] shall be equal to 0 for the value of idx such that InpIdx[ idx ] is equal to i.

— For purposes of interpretation of the NNPFC SEI message, the following variables are specified:

— If numInputPics is greater than 1 and there is a second NNPF that is defined by at least one NNPFC SEI message, is activated by an NNPFA SEI message for currPic, and has nnpfc\_purpose equal to 4, the following applies:

— CroppedWidth is set equal to nnpfcOutputPicWidth defined for the second NNPF.

— CroppedHeight is set equal to nnpfcOutputPicHeight defined for the second NNPF.

— Otherwise, the following applies:

— CroppedWidth is set equal to the value of pic\_width\_in\_luma\_samples − ‌SubWidthC \* ‌ ( conf\_win\_left\_offset + conf\_win\_right\_offset ) for currPic.

— CroppedHeight is set equal to the value of pic\_height\_in\_luma\_samples − ‌SubHeightC \* ‌ ( conf\_win\_top\_offset + conf\_win\_bottom\_offset ) for currPic.

— The luma sample arrays CroppedYPic[ i ] and the chroma sample arrays CroppedCbPic[ i ] and CroppedCrPic[ i ], when present, are derived as follows for each value of i in the range of 0 to numInputPics − 1, inclusive:

— The variable sourcePic is derived as follows:

— If inputPresentFlag[ i ] is equal to 1 or nnpfc\_absent\_input\_pic\_zero\_flag is equal to 0, sourcePic is set to be inputPic[ i ].

— Otherwise(inputPresentFlag[ i ] is equal to 0 and nnpfc\_absent\_input\_pic\_zero\_flag is equal to 1), sourcePic is set to be a picture with a luma sample array of CroppedWidth × CroppedHeight samples equal to 0 and Cb and Cr sample arrays of ( CroppedWidth / SubWidthC ) × ( CroppedHeight / SubHeightC ) samples equal to 0.

— If numInputPics is equal to 1, the following applies:

— The luma sample array CroppedYPic[ i ] and the chroma sample arrays CroppedCbPic[ i ] and CroppedCrPic[ i ], when present, are set to be the 2-dimensional arrays of decoded sample values of the Y, Cb and Cr components, respectively, of sourcePic.

— Otherwise (numInputPics is greater than 1), the following applies:

— The variable sourceWidth is set equal to the value of pps\_pic\_width\_in\_luma\_samples − ‌SubWidthC \* ( pps\_conf\_win\_left\_offset + pps\_conf\_win\_right\_offset ) for sourcePic.

— The variable sourceHeight is set equal to the value of pps\_pic\_height\_in\_luma\_samples − ‌SubHeightC \* ( pps\_conf\_win\_top\_offset + pps\_conf\_win\_bottom\_offset ) for sourcePic.

— If sourceWidth is equal to CroppedWidth and sourceHeight is equal to CroppedHeight, resampledPic is set to be the same as sourcePic.

— Otherwise (sourceWidth is not equal to CroppedWidth or sourceHeight is not equal to CroppedHeight), the following applies:

— There shall be an NNPF, hereafter referred to as the super resolution NNPF, that is defined by at least one NNPFC SEI message, is activated by an NNPFA SEI message for sourcePic, and has nnpfc\_purpose equal to 4, nnpfcOutputPicWidth equal to CroppedWidth and nnpfcOutputPicHeight equal to CroppedHeight.

— resampledPic is set to be the output of the neural-network inference of the super resolution NNPF with sourcePic being an input.

— The luma sample array CroppedYPic[ i ] and the chroma sample arrays CroppedCbPic[ i ] and CroppedCrPic[ i ], when present, are set to be the 2-dimensional arrays of decoded sample values of the Y, Cb and Cr components, respectively, of resampledPic.

— BitDepthY and BitDepthC are set equal to BitDepthY and BitDepthC, respectively.

— ChromaFormatIdc is set equal to chroma\_format\_idc.

— The array StrengthControlVal[ i ] for all values of i in the range of 0 to numInputPics − 1, inclusive, specifying the filtering strength control value for the input pictures for the NNPF, is derived as follows:

— StrengthControlVal[ i ] is set equal to the value of ( firstSliceQpY + QpBdOffsetY ) ÷ ( 51 + QpBdOffsetY ), where firstSliceQpY is equal to SliceQpY of the first slice of inputPic[ i ].

There shall not be more than two NNPFC SEI messages present in a picture unit with the same value of nnpfc\_id. When there are two NNPFC SEI messages present in a picture unit with the same value of nnpfc\_id, these SEI messages shall have different content. When two NNPFC SEI messages with the same nnpfc\_id and different content are present in the same picture unit, both of these NNPFC SEI messages shall be in the same SEI NAL unit.

**D.4.3. Use of the phase indication SEI message**

For purposes of interpretation of the phase indication SEI message, the following variables are specified:

– CroppedWidth is set equal to pic\_width\_in\_luma\_samples − SubWidthC \* ( conf\_win\_left\_offset + conf\_win\_right\_offset ).

– CroppedHeight is set equal to pic\_height\_in\_luma\_samples − SubHeightC \* ( conf\_win\_top\_offset + conf\_win\_bottom\_offset ).

*Subclause E.3.1*

*Starting with the sentence that begins with “The application of the transfer characteristics function is denoted by ( x )*′ *for an argument x.”, replace the remainder of the semantics of the matrix\_coeffs syntax element with the following:*

The application of the transfer characteristics function is denoted by ( x )′ for an argument x.

— If matrix\_coeffs is not equal to 14 or 15, the signals E′R, E′G, and E′B are determined by application of the transfer characteristics function as follows:

E′R = ( ER )′ (E‑1)

E′G = ( EG )′ (E‑2)

E′B = ( EB )′ (E‑3)

In this case, the range of E′R, E′G, and E′B is specified as follows:

— If transfer\_characteristics is not equal to 11 or 12, E′R, E′G, and E′B are real numbers with values in the range of 0 to 1, inclusive.

— Otherwise, (transfer\_characteristics is equal to 11 or 12), E′R, E′G, and E′B are real numbers with a larger range not specified in this document.

— Otherwise (matrix\_coeffs is equal to 14 or 15), the signals E′L, E′M, and E′S are determined by the following ordered steps:

a) The "linear-domain" real-valued signals EL, EM, and ES are determined as follows:

— If matrix\_coeffs is equal to 14, the signals EL, EM, and ES are determined as follows:

EL = ( 1 688 \* ER + 2 146 \* EG + 262 \* EB ) ÷ 4 096 (E‑4)

EM = ( 683 \* ER + 2 951 \* EG + 462 \* EB ) ÷ 4 096 (E‑5)

ES = ( 99 \* ER + 309 \* EG + 3 688 \* EB ) ÷ 4 096 (E‑6)

— Otherwise (matrix\_coeffs is equal to 15), the signals EL, EM, and ES are determined as follows:

EL = ( 1 747 \* ER + 2 169 \* EG + 180 \* EB ) ÷ 4 096 (E‑7)

EM = ( 673 \* ER + 3 029 \* EG + 394 \* EB ) ÷ 4 096 (E‑8)

ES = ( 50 \* ER + 207 \* EG + 3 839 \* EB ) ÷ 4 096 (E‑9)

b) The signals E′L, E′M, and E′S are determined by application of the transfer characteristics function as follows:

E′L = ( EL )′ (E‑10)

E′M = ( EM )′ (E‑11)

E′S = ( ES )′ (E‑12)

When matrix\_coeffs is equal to 0, 8, 16, or 17, the variables bitDepthRGB and maxValRGB are derived using the following ordered steps:

a) The variable bitDepthRGB is derived as follows:

— If matrix\_coeffs is equal to 0 or 8, the following applies:

bitDepthRGB = BitDepthY (E‑13)

— Otherwise, if matrix\_coeffs is equal to 16, the following applies:

bitDepthRGB = BitDepthY + 2 (E‑14)

— Otherwise (matrix\_coeffs is equal to 17), the following applies:

bitDepthRGB = BitDepthY + 1 (E‑15)

b) The variable maxValRGB is derived as follows:

maxValRGB = ( 1 << bitDepthRGB ) − 1 (E‑16)

The interpretation of matrix\_coeffs is specified as follows:

— If video\_full\_range\_flag is equal to 0, the following applies:

— If matrix\_coeffs is equal to 1, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, or 15, the following formulae apply:

Y = Clip1Y( Round( ( 1 << ( BitDepthY − 8 ) ) \* ( 219 \* E′Y + 16 ) ) ) (E‑17)

Cb = Clip1C( Round( ( 1 << ( BitDepthC − 8 ) ) \* ( 224 \* E′PB + 128 ) ) ) (E‑18)

Cr = Clip1C( Round( ( 1 << ( BitDepthC − 8 ) ) \* ( 224 \* E′PR + 128 ) ) ) (E‑19)

— Otherwise, if matrix\_coeffs is equal to 0, 8, 16, or 17, the following formulae apply:

R = Clip3( 0, maxValRGB, ( 1 << ( bitDepthRGB − 8 ) ) \* ( 219 \* E′R + 16 ) ) (E‑20)

G = Clip3( 0, maxValRGB, ( 1 << ( bitDepthRGB − 8 ) ) \* ( 219 \* E′G + 16 ) ) (E‑21)

B = Clip1Y( 0, maxValRGB, ( 1 << ( bitDepthRGB − 8 ) ) \* ( 219 \* E′B + 16 ) ) (E‑22)

— Otherwise, if matrix\_coeffs is equal to 2, the interpretation of the matrix\_coeffs syntax element is unknown or is determined by the application.

— Otherwise (matrix\_coeffs is not equal to 0, 1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, or 17), the interpretation of the matrix\_coeffs syntax element is reserved for future definition by ITU‑T | ISO/IEC.

— Otherwise (video\_full\_range\_flag is equal to 1), the following applies:

— If matrix\_coeffs is equal to 1, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, or 15, the following applies:

Y = Clip1Y( Round( ( ( 1 << BitDepthY ) − 1 ) \* E′Y ) ) (E‑23)

Cb = Clip1C( Round( ( ( 1 << BitDepthC ) − 1 ) \* E′PB + ( 1 << ( BitDepthC − 1 ) ) ) ) (E‑24)

Cr = Clip1C( Round( ( ( 1 << BitDepthC ) − 1 ) \* E′PR + ( 1 << ( BitDepthC − 1 ) ) ) ) (E‑25)

— Otherwise, if matrix\_coeffs is equal to 0 8, 16, or 17, the following applies:

R = Clip3( 0, maxValRGB, maxValRGB \* E′R ) (E‑26)

G = Clip3( 0, maxValRGB, maxValRGB \* E′G ) (E‑27)

B = Clip3( 0, maxValRGB, maxValRGB \* E′B ) (E‑28)

— Otherwise, if matrix\_coeffs is equal to 2, the interpretation of the matrix\_coeffs syntax element is unknown or is determined by the application.

— Otherwise (matrix\_coeffs is not equal to 0, 1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12 13, 14, 15, 16, or 17), the interpretation of the matrix\_coeffs syntax element is reserved for future definition by ITU‑T | ISO/IEC. Reserved values for matrix\_coeffs shall not be present in bitstreams conforming to this version of this document. Decoders shall interpret reserved values of matrix\_coeffs as equivalent to the value 2.

It is a requirement of bitstream conformance to this version of this document that when colour\_primaries is not equal to 1, 4, 5, 6, 7, 8, 9, 10, 11, 12, or 22, matrix\_coeffs shall not be equal to 12 or 13.

When matrix\_coeffs is equal to 1, 4, 5, 6, 7, 9, 10, 11, 12, or 13, the constants KB and KR are specified as follows:

— If matrix\_coeffs is not equal to 12 or 13, the constants KB and KR are specified in Table E.5.

— Otherwise (matrix\_coeffs is equal to 12 or 13), the constants KR and KB are computed as follows, using the chromaticity coordinates (xR, yR), (xG, yG), (xB, yB), and (xW, yW) specified by Table E.3 for the colour\_primaries syntax element for the red, green, blue, and white colour primaries, respectively.

KR =  (E‑29)

KB =  (E‑30)

where the values of zR, zG, zB, and zW, are given by:

zR = 1 − ( xR + yR ) (E‑31)

zG = 1 − ( xG + yG ) (E‑32)

zB = 1 − ( xB + yB ) (E‑33)

zW = 1 − ( xW + yW ) (E‑34)

The variables E′Y, E′PB, and E′PR (for matrix\_coeffs not equal to 0, 8, 16, or 17) or Y, Cb, and Cr (for matrix\_coeffs equal to 0, 8, 16, or 17) are specified as follows:

— If matrix\_coeffs is not equal to 0, 8, 10, 11, 13, 14, 15, 16, or 17, the following formulae apply:

E′Y = KR \* E′R + ( 1 − KR − KB ) \* E′G + KB \* E′B (E‑35)

E′PB = 0.5 \* ( E′B − E′Y ) ÷ ( 1 − KB ) (E‑36)

E′PR = 0.5 \* ( E′R − E′Y ) ÷ ( 1 − KR ) (E‑37)

NOTE 8 E′Y is a real number with the value 0 associated with nominal black and the value 1 associated with nominal white. E′PB and E′PR are real numbers with the value 0 associated with both nominal black and nominal white. When transfer\_characteristics is not equal to 11 or 12, E′Y is a real number with values in the range of 0 to 1, inclusive. When transfer\_characteristics is not equal to 11 or 12, E′PB and E′PR are real numbers with values in the range of −0.5 to 0.5, inclusive. When transfer\_characteristics is equal to 11 or 12, E′Y, E′PB, and E′PR are real numbers with a larger range not specified in this document.

— Otherwise, if matrix\_coeffs is equal to 0, the following formulae apply:

Y = Round( G ) (E‑38)

Cb = Round( B ) (E‑39)

Cr = Round( R ) (E‑40)

— Otherwise, if matrix\_coeffs is equal to 8 and BitDepthC is equal to BitDepthY, the following formulae apply:

Y = Round( 0.5 \* G + 0.25 \* ( R + B ) ) (E‑41)

Cb = Round( 0.5 \* G − 0.25 \* ( R + B ) ) + ( 1 << ( BitDepthC − 1 ) ) (E‑42)

Cr = Round( 0.5 \* (R − B ) ) + ( 1 << ( BitDepthC − 1 ) ) (E‑43)

NOTE 9 In this case, for purposes of the YCgCo nomenclature used in Table E.5, Cb and Cr of Formulae (E‑42) and (E‑43) may be referred to as Cg and Co, respectively. An appropriate inverse conversion for Formulae (E‑41) to (E‑43) is as follows:

t = Y − ( Cb − ( 1 << ( BitDepthC − 1 ) ) ) (E‑44)

G = Clip1Y( Y + ( Cb − ( 1 << ( BitDepthC − 1 ) ) ) ) (E‑45)

B = Clip1Y( t − ( Cr − ( 1 << ( BitDepthC − 1 ) ) ) ) (E‑46)

R = Clip1Y( t + ( Cr − ( 1 << ( BitDepthC − 1 ) ) ) ) (E‑47)

— Otherwise, if matrix\_coeffs is equal to 8, 16, or 17, the following formulae apply:

Cr = Round( R ) − Round( B ) + ( 1 << ( BitDepthC − 1 ) ) (E‑48)

t = Round( B ) + ( ( Cr − ( 1 << ( BitDepthC − 1 ) ) ) >> 1 ) (E‑49)

Cb = Round( G ) − t + ( 1 << ( BitDepthC − 1 ) ) (E‑50)

Y = t + ( ( Cb − ( 1 << ( BitDepthC − 1 ) ) ) >> 1 ) (E‑51)

NOTE 10 In this case, for purposes of the YCgCo nomenclature used in Table E.5, Cb and Cr of Formulae (E‑50) and (E‑48) may be referred to as Cg and Co, respectively. An appropriate inverse conversion for Formulae (E‑48) to (E‑51) is as follows:

t = Y − ( ( Cb − ( 1 << ( BitDepthC − 1 ) ) ) >> 1 ) (E‑52)

G = Clip3( 0, maxValRGB, t + ( Cb − ( 1 << ( BitDepthC − 1 ) ) ) ) (E‑53)

B = Clip3( 0, maxValRGB, t − ( ( Cr − ( 1 << ( BitDepthC − 1 ) ) ) >> 1 ) ) (E‑54)

R = Clip3( 0, maxValRGB, B + ( Cr − ( 1 << ( BitDepthC − 1 ) ) ) ) (E‑55)

— Otherwise, if matrix\_coeffs is equal to 10 or 13, the signal E′Y is determined by application of the transfer characteristics function as follows, and Formulae (E‑58) to (E‑61) apply for specification of the signals E′PB and E′PR:

EY = KR \* ER + ( 1 − KR − KB ) \* EG + KB \* EB (E‑56)

E′Y = ( EY )′ (E‑57)

NOTE 11 In this case, EY is defined from the “linear-domain” signals for ER, EG, and EB, prior to application of the transfer characteristics function, which is then applied to produce the signal E′Y. EY and E′Y are real values with the value 0 associated with nominal black and the value 1 associated with nominal white.

while the signals E′PB and E′PR are determined as follows:

E′PB = ( E′B − E′Y ) ÷ ( 2 \* NB ) for −NB <= E′B − E′Y <= 0 (E‑58)

E′PB = ( E′B − E′Y ) ÷ ( 2 \* PB ) for 0 < E′B − E′Y <= PB (E‑59)

E′PR = ( E′R − E′Y ) ÷ ( 2 \* NR ) for −NR <= E′R − E′Y <= 0 (E‑60)

E′PR = ( E′R − E′Y ) ÷ ( 2 \* PR ) for 0 < E′R − E′Y <= PR (E‑61)

where the constants NB, PB, NR, and PR are determined by application of the transfer characteristics function to expressions involving the constants KB and KR as follows:

NB = ( 1 − KB )′ (E‑62)

PB = 1 − ( KB )′ (E‑63)

NR = ( 1 − KR )′ (E‑64)

PR = 1 − ( KR )′ (E‑65)

— Otherwise if matrix\_coeffs is equal to 11, the following formulae apply:

E′Y = E′G (E‑66)

E′PB = 0.5 \* ( 0.986 566 \* E′B − E′Y ) (E‑67)

E′PR = 0.5 \* ( E′R − 0.991 902 \* E′Y ) (E‑68)

NOTE 12 In this case, for purposes of the Y′D′ZD′X nomenclature used in Table E.5, E′PB may be referred to as D′Z and E′PR may be referred to as D′X.

— Otherwise, if matrix\_coeffs is equal to 14, the following formulae apply:

— If transfer\_characteristics is not equal to 18, the following formulae apply:

E′Y = 0.5 \* ( E′L + E′M ) (E‑69)

E′PB = ( 6 610 \* E′L − 13 613 \* E′M + 7 003 \* E′S ) ÷ 4 096 (E‑70)

E′PR = ( 17 933 \* E′L − 17 390 \* E′M − 543 \* E′S ) ÷ 4 096 (E‑71)

— Otherwise, the following formulae apply:

E′Y = 0.5 \* ( E′L + E′M ) (E‑72)

E′PB = ( 3 625 \* E′L − 7 465 \* E′M + 3 840 \* E′S ) ÷ 4 096 (E‑73)

E′PR = ( 9 500 \* E′L − 9 212 \* E′M − 288 \* E′S ) ÷ 4 096 (E‑74)

NOTE 13 In this case, for purposes of the ICTCP nomenclature used in Table E.5, E′Y, E′PB, and E′PR of Formulae (E‑69), (E‑70), and (E‑71) or Formulae (E‑72), (E‑73), and (E‑74) may be referred to as I, CT, and CP, respectively. Formulae (E‑69) to (E‑71) were designed specifically for use with transfer\_characteristics equal to 16 (PQ), and Formulae (E‑72) to (E‑74) were designed specifically for use with transfer\_characteristics equal to 18 (HLG).

— Otherwise (matrix\_coeffs is equal to 15), the following formulae apply:

E′Y = ( 1 638 \* E′L + 1 638 \* E′M + 820 \* E′S ) ÷ 4 096 (E‑75)

E′PB = ( 18 248 \* E′L − 19 870 \* E′M + 1 622 \* E′S ) ÷ 4 096 (E‑76)

E′PR = ( 3 300 \* E′L + 1 463 \* E′M − 4 763 \* E′S ) ÷ 4 096 (E‑77)

NOTE 14 In this case, for purposes of the IPT-C2 nomenclature used in Table E.5, E′Y, E′PB, and E′PR of Formulae (E‑75), (E‑76), and (E‑77) may be referred to as I, P, and T, respectively.

**Table E.5 — Matrix coefficients interpretation using the matrix\_coeffs syntax element**

|  |  |  |
| --- | --- | --- |
| **Value** | **Matrix** | **Informative remark** |
| 0 | Identity | The identity matrix.  Typically used for GBR (often referred to as RGB); however, may also be used for YZX (often referred to as XYZ)  IEC 61966-2-1 sRGB  SMPTE ST 428-1 (2006)  See Formulae (E‑38) to (E‑40) |
| 1 | KR = 0.212 6; KB = 0.072 2 | ITU‑R Rec. BT.709-6  ITU‑R Rec. BT.1361-0 conventional colour gamut system and extended colour gamut system (historical)  IEC 61966-2-4 xvYCC709  SMPTE RP 177 (1993) Annex B  See Formulae (E‑35) to (E‑37) |
| 2 | Unspecified | Image characteristics are unknown or are determined by the application. |
| 3 | Reserved | For future use by ITU‑T | ISO/IEC |
| 4 | KR = 0.30; KB = 0.11 | FCC Title 47 Code of Federal Regulations (2003) 73.682 (a) (20)  See Formulae (E‑35) to (E‑37) |
| 5 | KR = 0.299; KB = 0.114 | ITU‑R Rec. BT.470‑6 System B, G (historical)  ITU‑R Rec. BT.601‑7 625  ITU‑R Rec. BT.1358-0 625 (historical)  ITU‑R Rec. BT.1700-0 625 PAL and 625 SECAM  IEC 61966-2-1 sYCC  IEC 61966-2-4 xvYCC601  (functionally the same as the value 6)  See Formulae (E‑35) to (E‑37) |
| 6 | KR = 0.299; KB = 0.114 | ITU‑R Rec. BT.601‑7 525  ITU‑R Rec. BT.1358-1 525 or 625 (historical)  ITU‑R Rec. BT.1700-0 NTSC  SMPTE ST 170 (2004)  (functionally the same as the value 5)  See Formulae (E‑35) to (E‑37) |
| 7 | KR = 0.212; KB = 0.087 | SMPTE ST 240 (1999, historical)  See Formulae (E‑35) to (E‑37) |
| 8 | YCgCo or YCgCo-R | See Formulae (E‑41) to (E‑47) for YCgCo (when BitDepthC is equal to BitDepthY)  See Formulae (E‑48) to (E‑55) for YCgCo-R (when BitDepthC is equal to BitDepthY + 1) |
| 9 | KR = 0.262 7; KB = 0.059 3 | Rec. ITU-R BT.2020-2 non-constant luminance system  Rec. ITU-R BT.2100-2 Y′CbCr  See Formulae (E‑35) to (E‑37) |
| 10 | KR = 0.262 7; KB = 0.059 3 | Rec. ITU-R BT.2020-2 constant luminance system  See Formulae (E‑56) to (E‑65) |
| 11 | Y′D′ZD′X | SMPTE ST 2085 (2015)  See Formulae (E‑66) to (E‑68) |
| 12 | See Formulae (E‑29) to (E‑34) | Chromaticity-derived non-constant luminance system  See Formulae (E‑35) to (E‑37) |
| 13 | See Formulae (E‑29) to (E‑34) | Chromaticity-derived constant luminance system  See Formulae (E‑56) to (E‑65) |
| 14 | ICTCP | Rec. ITU-R BT.2100-2 ICTCP  See Formulae (E‑69) to (E‑71) for transfer\_characteristics value 16 (PQ)  See Formulae (E-72) to (E-74) for transfer\_characteristics value 18 (HLG) |
| 15 | IPT-C2 | Society of Motion Picture and Television Engineers ST 2128  See Formulae (E‑75) to (E‑77) |
| 16 | YCgCo-Re | See Formulae (E‑41) to (E‑55) |
| 17 | YCgCo-Ro | See Formulae (E‑41) to (E‑55) |
| 18..255 | Reserved | For future use by ITU‑T | ISO/IEC |

*Subclause F.11.2*

*Replace Table F.3 with the following:*

Table F.3 — Specification of CompatibleProfileList

|  |  |
| --- | --- |
| **Profile to which  the decoder conforms** | **Profiles that the decoder shall support CompatibleProfileList** |
| Scalable Main | Scalable Main, Main, Main Still Picture |
| Scalable Main 10 | Scalable Main 10, Main, Main Still Picture, Main 10, Scalable Main |
| Scalable Monochrome | The compatible format range extensions profiles of the Monochrome profile, and the compatible scalable format range extensions profiles of the Scalable Monochrome profile |
| Scalable Monochrome 12 | The compatible format range extensions profiles of the Monochrome 12 profile, and the compatible scalable format range extensions profiles of the Scalable Monochrome 12 profile |
| Scalable Monochrome 16 | The compatible format range extensions profiles of the Monochrome 16 profile, and the compatible scalable format range extensions profiles of the Scalable Monochrome 16 profile |
| Scalable Main 4:4:4 | Scalable Main, Main, Main Still Picture, the compatible format range extensions profiles of the Main 4:4:4 profile, and the compatible scalable format range extensions profiles of the Scalable Main 4:4:4 profile |
| Multiview Main | Multiview Main, Main, Main Still Picture |
| Multiview Main 10 | Multiview Main 10, Main, Main Still Picture, Main 10, Multiview Main |
| Multiview Monochrome | Multiview Monochrome, Monochrome |
| Multiview Monochrome 10 | Multiview Monochrome 10, Multiview Monochrome, Monochrome 10, Monochrome |
| Multiview Monochrome 12 | Multiview Monochrome 12, Multiview Monochrome 10, Multiview Monochrome, Monochrome 12, Monochrome 10, Monochrome |
| 3D Main | 3D Main, Multiview Main, Main, Main Still Picture |

*Subclause F.14.3.1*

*Make the following changes:*

The general SEI payload semantics specified in subclause D.3.1 apply with the following modifications and additions:

The list VclAssociatedSeiList is set to consist of the payloadType values 2, 3, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 131, 132, 134 to 152, inclusive, 154 to 159, inclusive, 161, 165, 167, 168, 200 to 202, inclusive, ~~and~~ 205, and 210 to 212, inclusive.

The list PicUnitRepConSeiList is set to consist of the payloadType values 0, 1, 2, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 129, 131, 132, 133, 135 to 152, inclusive, 154 to 168, inclusive, 200 to 202, inclusive, ~~and~~ 205, and 210 to 212, inclusive.

…

*Subclause G.11.1.1*

*Make the following changes:*

G.11.1.1 Multiview Main and Multiview Main 10 profiles

For a layer in an output operation point associated with an OLS in a bitstream, the layer being conforming to the Multiview Main and Multiview Main 10 profile, the following applies:

— Let olsIdx be the OLS index of the OLS, the sub-bitstream subBitstream and the base layer sub-bitstream baseBitstream are derived as specified in F.11.3.

When vps\_base\_layer\_internal\_flag is equal to 1, the base layer sub-bitstream baseBitstream shall obey the following constraints:

— When the layer conforms to the Multiview Main profile, the base layer sub-bitstream baseBitstream shall be indicated to conform to the Main profile.

— When the layer conforms to the Multiview Main 10 profile, the base layer sub-bitstream baseBitstream shall be indicated to conform to the Main 10 or the Main profile.

The sub-bitstream subBitstream shall obey the following constraints:

— All active VPSs shall have vps\_num\_rep\_formats\_minus1 in the range of 0 to 15, inclusive.

— All active SPSs for layers in subBitstream shall have chroma\_format\_idc equal to 1 only.

— All active SPSs for layers in subBitstream shall have transform\_skip\_rotation\_enabled\_flag, transform\_skip\_context\_enabled\_flag, implicit\_rdpcm\_enabled\_flag, explicit\_rdpcm\_enabled\_flag, extended\_precision\_processing\_flag, intra\_smoothing\_disabled\_flag, high\_precision\_offsets\_enabled\_flag, persistent\_rice\_adaptation\_enabled\_flag, and cabac\_bypass\_alignment\_enabled\_flag, when present, equal to 0 only.

— CtbLog2SizeY derived from all active SPSs for layers in subBitstream shall be in the range of 4 to 6, inclusive.

— All active PPSs for layers in subBitstream shall have log2\_max\_transform\_skip\_block\_size\_minus2 and chroma\_qp\_offset\_list\_enabled\_flag, when present, equal to 0 only.

— ScalabilityId[ j ][ smIdx ] derived according to any active VPS shall be equal to 0 for any smIdx value not equal to 1 or 3 and for any value of j such that layer\_id\_in\_nuh[ j ] is among layerIdListTarget that was used to derive subBitstream.

— When NumLayersInIdList[ OlsIdxToLsIdx[ olsIdx ] ] is equal to 2, output\_layer\_flag[ olsIdx ][ j ] derived according to any active VPS shall be equal to 1 for j in the range of 0 to 1, inclusive, for subBitstream.

— All active VPSs shall have alt\_output\_layer\_flag[ olsIdx ] equal to 0 only.

— When ViewOrderIdx[ i ] derived according to any active VPS is equal to 1 for the layer with nuh\_layer\_id equal to i in subBitstream, inter\_view\_mv\_vert\_constraint\_flag shall be equal to 1 in the sps\_multilayer\_extension( ) syntax structure in each active SPS for that layer.

— When ViewOrderIdx[ i ] derived according to any active VPS is greater than to 0 for the layer with nuh\_layer\_id equal to i in subBitstream, num\_ref\_loc\_offsets shall be equal to 0 in each active PPS for that layer.

— When ViewOrderIdx[ i ] derived according to any active VPS is greater than 0 for the layer with nuh\_layer\_id equal to i in subBitstream, the values of pic\_width\_in\_luma\_samples and pic\_height\_in\_luma\_samples in each active SPS for that layer shall be equal to the values of pic\_width\_in\_luma\_samples and pic\_height\_in\_luma\_samples, respectively, in each active SPS for all reference layers of that layer.

— For a layer with nuh\_layer\_id iNuhLId equal to any value included in layerIdListTarget that was used to derive subBitstream, the value of NumRefLayers[ iNuhLId ], which specifies the total number of direct and indirect reference layers and is derived as specified in F.7.4.3.1, shall be less than or equal to 4.

— All active SPSs for layers in subBitstream shall have sps\_range\_extension\_flag and sps\_scc\_extension\_flag equal to 0 only.

— All active PPSs for layers in subBitstream shall have pps\_range\_extension\_flag and pps\_scc\_extension\_flag equal to 0 only.

— When an active PPS for any layer in subBitstream has tiles\_enabled\_flag equal to 1, it shall have entropy\_coding\_sync\_enabled\_flag equal to 0.

— When an active PPS for any layer in subBitstream has tiles\_enabled\_flag equal to 1, ColumnWidthInLumaSamples[ i ] shall be greater than or equal to 256 for all values of i in the range of 0 to num\_tile\_columns\_minus1, inclusive, and RowHeightInLumaSamples[ j ] shall be greater than or equal to 64 for all values of j in the range of 0 to num\_tile\_rows\_minus1, inclusive.

— The number of times read\_bits( 1 ) is called in 9.3.4.3.3 and 9.3.4.3.4 when parsing coding\_tree\_unit( ) data for any CTU shall be less than or equal to 5 \* RawCtuBits / 3.

— For any active VPS, ViewOrderIdx[ i ] shall be greater than ViewOrderIdx[ j ] for any values of i and j among layerIdListTarget that was used to derive subBitstream such that AuxId[ i ] is equal to AuxId[ j ] and i is greater than j.

When the layer conforms to the Multiview Main profile, the sub-bitstream subBitstream shall obey the following constraints:

— All active SPSs for layers in subBitstream shall have bit\_depth\_luma\_minus8 equal to 0 only.

— All active SPSs for layers in subBitstream shall have bit\_depth\_chroma\_minus8 equal to 0 only.

— All active PPSs for layers in subBitstream shall have colour\_mapping\_enabled\_flag equal to 0 only.

— The tier and level constraints specified for the Multiview Main profile in G.11.2 shall be fulfilled.

When the layer conforms to the Multiview Main 10 profile, the sub-bitstream subBitstream shall obey the following constraints:

— All active SPSs for layers in subBitstream shall have bit\_depth\_luma\_minus8 in the range of 0 to 2, inclusive.

— All active SPSs for layers in subBitstream shall have bit\_depth\_chroma\_minus8 in the range of 0 to 2, inclusive.

— The tier and level constraints specified for the Multiview Main 10 profile in G.11.2 shall be fulfilled.

In the remainder of this subclause and G.11.2.1, all syntax elements in the profile\_tier\_level( ) syntax structure refer to those in the profile\_tier\_level( ) syntax structure associated with the layer.

Conformance of a layer in an output operation point associated with an OLS in a bitstream to the Multiview Main profile is indicated as follows:

— If OpTid of the output operation point is equal to vps\_max\_sub\_layer\_minus1, the conformance is indicated by having both of the following conditions satisfied:

— general\_profile\_idc being equal to 6 or general\_profile\_compatibility\_flag[ 6 ] being equal to 1,

— general\_max\_12bit\_constraint\_flag being equal to 1, general\_max\_10bit\_constraint\_flag being equal to 1, general\_max\_8bit\_constraint\_flag being equal to 1, general\_max\_422chroma\_constraint\_flag being equal to 1, general\_max\_420chroma\_constraint\_flag being equal to 1, general\_max\_monochrome\_constraint\_flag being equal to 0, general\_intra\_constraint\_flag being equal to 0, general\_one\_picture\_only\_constraint\_flag being equal to 0, and general\_lower\_bit\_rate\_constraint\_flag being equal to 1

— Otherwise (OpTid of the output operation point is less than vps\_max\_sub\_layer\_minus1), the conformance is indicated by having both of the following conditions satisfied:

— sub\_layer\_profile\_idc[ OpTid ] being equal to 6 or sub\_layer\_profile\_compatibility\_flag[ OpTid ][ 6 ] being equal to 1

— sub\_layer\_max\_12bit\_constraint\_flag[ OpTid ] being equal to 1, sub\_layer\_max\_10bit\_constraint\_flag[ OpTid ] being equal to 1, sub\_layer\_max\_8bit\_constraint\_flag[ OpTid ] being equal to 1, sub\_layer\_max\_422chroma\_constraint\_flag[ OpTid ] being equal to 1, sub\_layer\_max\_420chroma\_constraint\_flag[ OpTid ] being equal to 1, sub\_layer\_max\_monochrome\_constraint\_flag[ OpTid ] being equal to 0, sub\_layer\_intra\_constraint\_flag[ OpTid ] being equal to 0, sub\_layer\_one\_picture\_only\_constraint\_flag[ OpTid ] being equal to 0, and sub\_layer\_lower\_bit\_rate\_constraint\_flag[ OpTid ] being equal to 1

Conformance of a layer in an output operation point associated with an OLS in a bitstream to the Multiview Main 10 profile is indicated as follows:

— If OpTid of the output operation point is equal to vps\_max\_sub\_layer\_minus1, the conformance is indicated by having both of the following conditions satisfied:

— general\_profile\_idc being equal to 6 or general\_profile\_compatibility\_flag[ 6 ] being equal to 1,

— general\_max\_12bit\_constraint\_flag being equal to 1, general\_max\_10bit\_constraint\_flag being equal to 1, general\_max\_8bit\_constraint\_flag being equal to 0, general\_max\_422chroma\_constraint\_flag being equal to 1, general\_max\_420chroma\_constraint\_flag being equal to 1, general\_max\_monochrome\_constraint\_flag being equal to 0, general\_intra\_constraint\_flag being equal to 0, general\_one\_picture\_only\_constraint\_flag being equal to 0, and general\_lower\_bit\_rate\_constraint\_flag being equal to 1.

— Otherwise (OpTid of the output operation point is less than vps\_max\_sub\_layer\_minus1), the conformance is indicated by having both of the following conditions satisfied:

— sub\_layer\_profile\_idc[ OpTid ] being equal to 6 or sub\_layer\_profile\_compatibility\_flag[ OpTid ][ 6 ] being equal to 1

— sub\_layer\_max\_12bit\_constraint\_flag[ OpTid ] being equal to 1, sub\_layer\_max\_10bit\_constraint\_flag[ OpTid ] being equal to 1, sub\_layer\_max\_8bit\_constraint\_flag[ OpTid ] being equal to 0, sub\_layer\_max\_422chroma\_constraint\_flag[ OpTid ] being equal to 1, sub\_layer\_max\_420chroma\_constraint\_flag[ OpTid ] being equal to 1, sub\_layer\_max\_monochrome\_constraint\_flag[ OpTid ] being equal to 0, sub\_layer\_intra\_constraint\_flag[ OpTid ] being equal to 0, sub\_layer\_one\_picture\_only\_constraint\_flag[ OpTid ] being equal to 0, and sub\_layer\_lower\_bit\_rate\_constraint\_flag[ OpTid ] being equal to 1.

*New subclause G.11.1.2*

*Add a new subclause G.11.1.2 as follows:*

G.11.1.2 Multiview format range extensions profiles

The following profiles, collectively referred to as the multiview format range extensions profiles, are specified in this subclause:

— the Multiview Monochrome, Multiview Monochrome 10, and Multiview Monochrome 12 profiles.

For a layer in an output operation point associated with an OLS in a bitstream, the layer being conforming to the Multiview Monochrome, Multiview Monochrome 10, or Multiview Monochrome 12 profiles, the following applies:

— Let olsIdx be the OLS index of the OLS, the sub-bitstream subBitstream and the base layer sub-bitstream baseBitstream are derived as specified in F.11.3.

When vps\_base\_layer\_internal\_flag is equal to 1, the base layer sub-bitstream baseBitstream shall obey the following constraints:

— When the layer conforms to the Multiview Monochrome, the base layer sub-bitstream baseBitstream shall be indicated to conform to the Monochrome profile.

— When the layer conforms to the Multiview Monochrome 10, the base layer sub-bitstream baseBitstream shall be indicated to conform to the Monochrome profile or the Monochrome 10 profile.

— When the layer conforms to the Multiview Monochrome 12, the base layer sub-bitstream baseBitstream shall be indicated to conform to the Monochrome profile, the Monochrome 10 profile, or a format range extensions profile.

The sub-bitstream subBitstream shall obey the following constraints:

— All active VPSs shall have vps\_num\_rep\_formats\_minus1 in the range of 0 to 15, inclusive.

— All active SPSs for layers in subBitstream shall have chroma\_format\_idc equal to 1 only.

— All active SPSs for the layers in subBitstream shall have separate\_colour\_plane\_flag, cabac\_bypass\_alignment\_enabled\_flag, when present, equal to 0 only.

— CtbLog2SizeY derived from all active SPSs for layers in subBitstream shall be in the range of 4 to 6, inclusive.

— ScalabilityId[ j ][ smIdx ] derived according to any active VPS shall be equal to 0 for any smIdx value not equal to 1 or 3 and for any value of j such that layer\_id\_in\_nuh[ j ] is among layerIdListTarget that was used to derive subBitstream.

— The constraints specified in Table H.3, in which entries marked with “–“ indicate that the table entry does not impose a profile-specific constraint on the corresponding syntax element, shall apply for all active SPSs and PPSs for layers in subBitstream.

NOTE For some syntax elements with table entries marked with “–“, a constraint may be imposed indirectly – e.g. by semantics constraints that are imposed elsewhere in this document when other specified constraints are fulfilled.

— All active SPSs for layers in subBitstream shall have the same value of chroma\_format\_idc.

— All active SPSs for layers in subBitstream shall have sps\_scc\_extension\_flag equal to 0 only.

— All active PPSs for layers in subBitstream shall have pps\_scc\_extension\_flag equal to 0 only.

— When an active PPS for any layer in subBitstream has tiles\_enabled\_flag equal to 1, it shall have entropy\_coding\_sync\_enabled\_flag equal to 0.

— When an active PPS for any layer in subBitstream has tiles\_enabled\_flag equal to 1, ColumnWidthInLumaSamples[ i ] shall be greater than or equal to 256 for all values of i in the range of 0 to num\_tile\_columns\_minus1, inclusive, and RowHeightInLumaSamples[ j ] shall be greater than or equal to 64 for all values of j in the range of 0 to num\_tile\_rows\_minus1, inclusive.

— The number of times read\_bits( 1 ) is called in 9.3.4.3.3 and 9.3.4.3.4 when parsing coding\_tree\_unit( ) data for any CTU shall be less than or equal to 5 \* RawCtuBits / 3.

— For any active VPS, DependencyId[ i ] shall be greater than DependencyId[ j ] for any values of i and j among layerIdListTarget that was used to derive subBitstream such that AuxId[ i ] is equal to AuxId[ j ] and i is greater than j.

— The tier and level constraints specified for the Multiview Monochrome, Multiview Monochrome 10, and Multiview Monochrome 12 profiles in G.11.2, as applicable, shall be fulfilled.

Table G.3 — Allowed values for syntax elements in the multiview format range extensions profiles

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Profile for which constraint is specified** | **chroma\_format\_idc** | **bit\_depth\_luma\_minus8 and bit\_depth\_chroma\_minus8** | **transform\_skip\_rotation\_enabled\_flag, transform\_skip\_context\_enabled\_flag, implicit\_rdpcm\_enabled\_flag, explicit\_rdpcm\_enabled\_flag, intra\_smoothing\_disabled\_flag, persistent\_rice\_adaptation\_enabled\_flag, and log2\_max\_transform\_skip\_block\_size\_minus2** | **extended\_precision\_processing\_flag** | **chroma\_qp\_offset\_list\_enabled\_flag** |
| Multiview Monochrome | 0 | 0 | 0 | 0 | 0 |
| Multiview Monochrome 10 | 0 | 0..2 | 0 | 0 | 0 |
| Multiview Monochrome 12 | 0 | 0..4 | 0 | 0 | 0 |

In the remainder of this subclause and H.11.2.1, all syntax elements in the profile\_tier\_level( ) syntax structure refer to those in the profile\_tier\_level( ) syntax structure associated with the layer.

Conformance of a layer in an output operation point associated with an OLS in a bitstream for the multiview format range exensions profiles is indicated as follows:

— If OpTid of the output operation point is equal to vps\_max\_sub\_layer\_minus1, the conformance is indicated by general\_profile\_idc being equal to 10 or general\_profile\_compatibility\_flag[ 10 ] being equal to 1, with the additional indications specified in Table H.4 for the general constraint flags.

— Otherwise (OpTid of the output operation point is less than vps\_max\_sub\_layer\_minus1), the conformance is indicated by sub\_layer\_profile\_idc[ OpTid ] being equal to 10 or sub\_layer\_profile\_compatibility\_flag[ OpTid ][ 10 ] being equal to 1, with the additional indications specified in Table H.4 for the flags associated with the index OpTid.

All other combinations of general\_max\_14bit\_constraint\_flag, general\_max\_12bit\_constraint\_flag, general\_max\_10bit\_constraint\_flag, general\_max\_8bit\_constraint\_flag, general\_max\_422chroma\_constraint\_flag, general\_max\_420chroma\_constraint\_flag, general\_max\_monochrome\_constraint\_flag, general\_intra\_constraint\_flag, general\_one\_picture\_only\_constraint\_flag, and general\_lower\_bit\_rate\_constraint\_flag with general\_profile\_idc equal to 10 or general\_profile\_compatibility\_flag[ 10 ] equal to 1 are reserved for future use by ITU-T | ISO/IEC. All other combinations of sub\_layer\_max\_14bit\_constraint\_flag[ OpTid ], sub\_layer\_max\_12bit\_constraint\_flag[ OpTid ], sub\_layer\_max\_10bit\_constraint\_flag[ OpTid ], sub\_layer\_max\_8bit\_constraint\_flag[ OpTid ], sub\_layer\_max\_422chroma\_constraint\_flag[ OpTid ], sub\_layer\_max\_420chroma\_constraint\_flag[ OpTid ], sub\_layer\_max\_monochrome\_constraint\_flag[ OpTid ], sub\_layer\_intra\_constraint\_flag[ OpTid ], sub\_layer\_one\_picture\_only\_constraint\_flag[ OpTid ], and sub\_layer\_lower\_bit\_rate\_constraint\_flag[ OpTid ] with sub\_layer\_profile\_idc[ OpTid ] equal to 10 or sub\_layer\_profile\_compatibility\_flag[ OpTid ][ 10 ] equal to 1 are reserved for future use by ITU-T | ISO/IEC. Such combinations shall not be present in bitstreams conforming to this document. However, decoders conforming to the multiview format range extensions profiles shall allow other combinations as specified below in this clause to occur in the bitstream.

Table G.4 — Bitstream indications for conformance to multiview range extensions profiles

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Profile for which the bitstream indicates conformance** | **general\_max\_14bit\_constraint\_flag or sub\_layer\_max\_14bit\_constraint\_‌flag[ OpTid ]** | **general\_max\_12bit\_constraint\_flag or sub\_layer\_max\_12bit\_constraint\_‌flag[ OpTid ]** | **general\_max\_10bit\_constraint\_flag or sub\_layer\_max\_10bit\_constraint\_‌flag[ OpTid ]** | **general\_max\_8bit\_constraint\_flag or sub\_layer\_max\_8bit\_constraint\_‌flag[ OpTid ]** | **general\_max\_422chroma\_constraint\_flag or sub\_layer\_max\_422chroma\_constraint\_‌flag[ OpTid ]** | **general\_max\_420chroma\_constraint\_flag or sub\_layer\_max\_420chroma\_constraint\_‌flag[ OpTid ]** | **general\_max\_monochrome\_constraint\_flag or sub\_layer\_max\_monochrome\_constraint\_‌flag[ OpTid ]** | **general\_intra\_constraint\_flag or sub\_layer\_intra\_constraint\_‌flag[ OpTid ]** | **general\_one\_picture\_only\_constraint\_flag or sub\_layer\_one\_picture\_only\_constraint\_‌flag[ OpTid ]** | **general\_lower\_bit\_rate\_constraint\_flag or sub\_layer\_lower\_bit\_rate\_constraint\_‌flag[ OpTid ]** |
| Multiview Monochrome | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 |
| Multiview Monochrome 10 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| Multiview  Monochrome 12 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |

*Subclause G.11.2.1*

*Make the following changes:*

G.11.2.1 General tier and level limits

For purposes of comparison of tier capabilities, the tier with general\_tier\_flag or sub\_layer\_tier\_flag[ i ] equal to 0 is considered to be a lower tier than the tier with general\_tier\_flag or sub\_layer\_tier\_flag[ i ] equal to 1.

For purposes of comparison of level capabilities, a particular level of a specific tier is considered to be a lower level than some other level of the same tier when the value of the general\_level\_idc or sub\_layer\_level\_idc[ i ] of the particular level is less than that of the other level.

The following is specified for expressing the constraints in this subclause and H.11.2.2:

— For the Multiview Main profile, the value of each of the variables CpbVclFactor, CpbNalFactor, FormatCapabilityFactor, and MinCrScaleFactor is the same as that specified in Table A.10 for the Main profile. For the Multiview Main 10 profile, the value of each of these variables is the same as that specified in Table A.10 for the Main 10 profile.

— For the Multiview Monochrome profile, the value of each of the variables CpbVclFactor, CpbNalFactor, FormatCapabilityFactor, and MinCrScaleFactor is the same as that specified in Table A.10 for the Monochrome profile.

— For the Multiview Monochrome 10 profile, the value of each of the variables CpbVclFactor, CpbNalFactor, FormatCapabilityFactor, and MinCrScaleFactor is the same as that specified in Table A.10 for the Monochrome 10 profile.

— For the Multiview Monochrome 12 profile, the value of each of the variables CpbVclFactor, CpbNalFactor, FormatCapabilityFactor, and MinCrScaleFactor is the same as that specified in Table A.10 for the Monochrome 12 profile.

— Let access unit n be the n-th access unit in decoding order, with the first access unit being access unit 0 (i.e. the 0-th access unit).

— Let the variable fR be set as follows:

— If the bitstream or sub-layer representation is indicated to conform to the Main tier or is indicated to conform to a level that is lower than level 7.0, fR is set equal to 1 ÷ 300.

— Otherwise, fR is set equal to 1 ÷ 960.

— Let the variable olsIdx be the index of the OLS.

— For each layer with nuh\_layer\_id equal to currLayerId, let the variable layerSizeInSamplesY be derived as follows:

layerSizeInSamplesY = pic\_width\_vps\_in\_luma\_samples \* pic\_height\_vps\_in\_luma\_samples (G-2)

where pic\_width\_vps\_in\_luma\_samples and pic\_height\_vps\_in\_luma\_samples are found in the vps\_rep\_format\_idx[ LayerIdxInVps[ currLayerId ] ]-th rep\_format( ) syntax structure in the VPS.

When the specified level is not level 8.5, each layer with nuh\_layer\_id equal to currLayerId conforming to a profile at a specified tier and level shall obey the following constraints for each bitstream conformance test as specified in F.13, where “access unit” is used to denote the picture unit in the layer and the CPB is understood to be the BPB:

a) The value of layerSizeInSamplesY shall be less than or equal to MaxLumaPs, where MaxLumaPs is specified in Table A.8 for the tier and level of the layer.

b) The value of pic\_width\_vps\_in\_luma\_samples of the vps\_rep\_format\_idx[ LayerIdxInVps[ currLayerId ] ]-th rep\_format( ) syntax structure in the VPS shall be less than or equal to Sqrt( MaxLumaPs \* 8 ).

c) The value of pic\_height\_vps\_in\_luma\_samples of the vps\_rep\_format\_idx[ LayerIdxInVps[ currLayerId ] ]-th rep\_format( ) syntax structure in the VPS shall be less than or equal to Sqrt( MaxLumaPs \* 8 ).

d) The value of max\_vps\_dec\_pic\_buffering\_minus1[ olsIdx ][ LayerIdxInVps[ currLayerId ] ][ HighestTid ] shall be less than or equal to MaxDpbSize as derived by Formula (A‑2), with PicSizeInSamplesY being replaced with layerSizeInSamplesY, for the tier and level of the layer.

e) For level 5 and higher levels, the value of CtbSizeY for the layer shall be equal to 32 or 64.

f) The value of NumPicTotalCurr for each picture in the layer shall be less than or equal to 8.

g) When decoding each coded picture in the layer, the value of num\_tile\_columns\_minus1 shall be less than MaxTileCols and num\_tile\_rows\_minus1 shall be less than MaxTileRows, where MaxTileCols and MaxTileRows are specified in Table A.8 for the tier and level of the layer.

h) For the VCL HRD parameters of the layer, CpbSize[ i ] shall be less than or equal to CpbVclFactor \* MaxCPB for at least one of the delivery schedules identified by bsp\_sched\_idx[ olsIdx ][ 0 ][ HighestTid ][ combIdx ][ LayerIdxInVps[ currLayerId ] ] for combIdx ranging from 0 to num\_bsp\_schedules\_minus1[ olsIdx ][ 0 ][ HighestTid ], inclusive, where CpbSize[ i ] is specified in F.13.1 and MaxCPB is specified in Table A.8 for the tier and level of the layer in units of CpbVclFactor bits.

i) For the NAL HRD parameters of the layer, CpbSize[ i ] shall be less than or equal to CpbNalFactor \* MaxCPB for at least one of the delivery schedules identified by bsp\_sched\_idx[ olsIdx ][ 0 ][ HighestTid ][ combIdx ][ LayerIdxInVps[ currLayerId ] ] for combIdx ranging from 0 to num\_bsp\_schedules\_minus1[ olsIdx ][ 0 ][ HighestTid ], inclusive, where CpbSize[ i ] is specified in F.13.1 and MaxCPB is specified in Table A.8 for the tier and level of the layer in units of CpbNalFactor bits.

j) For each coded picture, the value of BinCountsInNalUnits shall be less than or equal to ( 32 ÷ 3 ) \* NumBytesInVclNalUnits + ( RawMinCuBits \* PicSizeInMinCbsY ) ÷ 32.

Table A.8 specifies the limits for each level of each tier for levels other than level 8.5.

NOTE Since there are no limits specified by Table A.8 for level 8.5, it is not possible in general for a practical decoder to be assured of being able to decode all bitstreams that conform to this level. The purpose of the definition of level 8.5 is to provide a suitable label for bitstreams that can exceed the limits of all other specified levels. When the bitstream is indicated to conform to level 8.5, a decoder is expected to examine the characteristics of the bitstream during its operation in order to determine whether it is capable of decoding the bitstream.

A tier and level to which a layer in an output operation point associated with an OLS in a bitstream conforms are indicated by the syntax elements general\_tier\_flag and general\_level\_idc if OpTid of the output layer set is equal to vps\_max\_sub\_layer\_minus1, and by the syntax elements sub\_layer\_tier\_flag[ OpTid ] and sub\_layer\_level\_idc[ OpTid ] otherwise, as follows:

— If the specified level is not level 8.5, general\_tier\_flag or sub\_layer\_tier\_flag[ OpTid ] equal to 0 indicates conformance to the Main tier, and general\_tier\_flag or sub\_layer\_tier\_flag[ OpTid ] equal to 1 indicates conformance to the High tier, according to the tier constraints specified in Table A.8, and general\_tier\_flag and sub\_layer\_tier\_flag[ OpTid ] shall be equal to 0 for levels below level 4 (corresponding to the entries in Table A.8 marked with "-"). Otherwise (the specified level is level 8.5), it is a requirement of bitstream conformance that general\_tier\_flag and sub\_layer\_tier\_flag[ OpTid ] shall be equal to 1 and the value 0 for general\_tier\_flag and sub\_layer\_tier\_flag[ OpTid ] is reserved for future use by ITU-T | ISO/IEC, and decoders shall ignore the value of general\_tier\_flag and sub\_layer\_tier\_flag[ OpTid ].

— general\_level\_idc and sub\_layer\_level\_idc[ OpTid ] shall be set equal to a value of 30 times the level number specified in Table A.8.

*Subclause G.11.2.2*

*Make the following changes:*

**G.11.2.2 Profile-specific tier and level limits for the Multiview Main, Multiview Main 10, and multiview format range extensions profiles**

The following is specified for expressing the constraints in this subclause:

— The variable HbrFactor is set equal to 1.

— The variable BrVclFactor is set equal to CpbVclFactor \* HbrFactor.

— The variable BrNalFactor is set equal to CpbNalFactor \* HbrFactor.

— The variable MinCr is set equal to MinCrBase \* MinCrScaleFactor ÷ HbrFactor, where MinCrBase is specified in Table A.9.

When the specified level is not level 8.5, each layer conforming to the Multiview Main, Multiview Main 10 profiles, or the multiview format range extensions profiles at a specified tier and level shall obey the following constraints for each conformance test as specified in F.13, where "access unit" is used to denote the picture unit in the layer, and the CPB is understood to be the BPB:

a) The nominal removal time of access unit n (with n greater than 0) from the CPB, as specified in F.13.2.3, shall satisfy the constraint that AuNominalRemovalTime[ n ] − AuCpbRemovalTime[ n − 1 ] is greater than or equal to Max( layerSizeInSamplesY ÷ MaxLumaSr, fR ), where layerSizeInSamplesY is the value of layerSizeInSamplesY for access unit n − 1 and MaxLumaSr is the value specified in Table A.9 that applies to access unit n − 1 for the tier and level of the layer.

b) The difference between consecutive output times of pictures in different access units, as specified in F.13.3.3, shall satisfy the constraint that DpbOutputInterval[ n ] is greater than or equal to Max( layerSizeInSamplesY ÷ MaxLumaSr, fR ), where layerSizeInSamplesY is the value of layerSizeInSamplesY of access unit n and MaxLumaSr is the value specified in Table A.9 for access unit n for the tier and level of the layer, provided that access unit n is an access unit that has a picture that is output and is not the last of such access units.

c) The removal time of access unit 0 shall satisfy the constraint that the number of coded slice segments in access unit 0 is less than or equal to Min( Max( 1, MaxSliceSegmentsPerPicture \* MaxLumaSr / MaxLumaPs \* ( AuCpbRemovalTime[ 0 ] − AuNominalRemovalTime[ 0 ] ) + MaxSliceSegmentsPerPicture \* layerSizeInSamplesY / MaxLumaPs ), MaxSliceSegmentsPerPicture ), for the value of layerSizeInSamplesY of access unit 0, where MaxSliceSegmentsPerPicture, MaxLumaPs, and MaxLumaSr are the values specified in Table A.8 and Table A.9 for the tier and level of the layer.

d) The difference between consecutive CPB removal times of access units n and n − 1 (with n greater than 0) shall satisfy the constraint that the number of slice segments in access unit n is less than or equal to Min( ~~(~~Max( 1, MaxSliceSegmentsPerPicture \* MaxLumaSr / MaxLumaPs \* ( AuCpbRemovalTime[ n ] − AuCpbRemovalTime[ n − 1 ] ) ), MaxSliceSegmentsPerPicture ), where MaxSliceSegmentsPerPicture, MaxLumaPs, and MaxLumaSr are the values specified in Table A.8 and Table A.9 that apply to access unit n for the tier and level of the layer.

e) For the VCL HRD parameters for the layer, BitRate[ i ] shall be less than or equal to BrVclFactor \* MaxBR for at least one of the delivery schedules identified by bsp\_sched\_idx[ olsIdx ][ 0 ][ HighestTid ][ combIdx ][ LayerIdxInVps[ currLayerId ] ] for combIdx ranging from 0 to num\_bsp\_schedules\_minus1[ olsIdx ][ 0 ][ HighestTid ], inclusive, where BitRate[ i ] is specified in F.13.1 and MaxBR is specified in Table A.9 in units of BrVclFactor bits/s for the tier and level of the layer.

f) For the NAL HRD parameters for the layer, BitRate[ i ] shall be less than or equal to BrNalFactor \* MaxBR for at least one of the delivery schedules identified by bsp\_sched\_idx[ olsIdx ][ 0 ][ HighestTid ][ combIdx ][ LayerIdxInVps[ currLayerId ] ] for combIdx ranging from 0 to num\_bsp\_schedules\_minus1[ olsIdx ][ 0 ][ HighestTid ], inclusive, where BitRate[ i ] is specified in F.13.1 and MaxBR is specified in Table A.9 in units of BrNalFactor bits/s for the tier and level of the layer.

g) The sum of the NumBytesInNalUnit variables for access unit 0 shall be less than or equal to FormatCapabilityFactor \* ( Max( layerSizeInSamplesY, fR \* MaxLumaSr ) + MaxLumaSr \* ( AuCpbRemovalTime[ 0 ] − AuNominalRemovalTime[ 0 ] ) ) ÷ MinCr for the value of layerSizeInSamplesY of access unit 0, where MaxLumaSr is specified in Table A.9, and both MaxLumaSr and FormatCapabilityFactor are the values that apply to access unit 0 for the tier and level of the layer.

h) The sum of the NumBytesInNalUnit variables for access unit n (with n greater than 0) shall be less than or equal to FormatCapabilityFactor \* MaxLumaSr \* ( AuCpbRemovalTime[ n ] − AuCpbRemovalTime[ n − 1 ] ) ÷ MinCr, where MaxLumaSr is specified in Table A.9, and both MaxLumaSr and FormatCapabilityFactor are the values that apply to access unit n for the tier and level of the layer.

i) The removal time of access unit 0 shall satisfy the constraint that the number of tiles in coded pictures in access unit 0 is less than or equal to Min( Max( 1, MaxTileCols \* MaxTileRows \* 120 \* ( AuCpbRemovalTime[ 0 ] − AuNominalRemovalTime[ 0 ] ) + MaxTileCols \* MaxTileRows \* PicSizeInSamplesY / MaxLumaPs ), MaxTileCols \* MaxTileRows ), for the value of layerSizeInSamplesY of access unit 0, where MaxTileCols and MaxTileRows are the values specified in Table A.8 that apply to access unit 0 for the tier and level of the layer.

j) The difference between consecutive CPB removal times of access units n and n − 1 (with n greater than 0) shall satisfy the constraint that the number of tiles in coded pictures in access unit n is less than or equal to Min( Max( 1, MaxTileCols \* MaxTileRows \* 120 \* ( AuCpbRemovalTime[ n ] − AuCpbRemovalTime[ n − 1 ] ) ), MaxTileCols \* MaxTileRows ), where MaxTileCols and MaxTileRows are the values specified in Table A.8 that apply to access unit n for the tier and level of the layer.

*Subclause G.14.3.1*

*Make the following changes:*

The specifications in clause F.14.3.1 apply with the following modifications and additions:

The list VclAssociatedSeiList is set to consist of the payloadType values 2, 3, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 131, 132, 134 to 152, inclusive, 154 to 159, inclusive, 161, 165, 167, 168, 177, 178, 179, 200 to 202, inclusive, ~~and~~ 205, and 210 to 212, inclusive.

The list PicUnitRepConSeiList is set to consist of the payloadType values 0, 1, 2, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 129, 131, 132, 133, 135 to 152, inclusive, 154 to 168, inclusive, 176 to 180, inclusive, 200 to 202, inclusive, ~~and~~ 205, and 210 to 212, inclusive.

…

*Subclause H.11.2.2*

*Make the following change:*

Min( ~~(~~Max( 1, MaxSliceSegmentsPerPicture \* MaxLumaSr / MaxLumaPs \* ( AuCpbRemovalTime[ n ] − AuCpbRemovalTime[ n − 1 ] ) ), MaxSliceSegmentsPerPicture )

*Subclause I.14.3.1*

*Make the following changes:*

The specifications in clause G.14.3.1 apply with the following modifications and additions:

The list VclAssociatedSeiList is set to consist of the payloadType values 2, 3, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 131, 132, 134 to 152, inclusive, 154 to 159, inclusive, 161, 165, 167, 168, 177, 178, 179, 200 to 202, inclusive, ~~and~~ 205, and 210 to 212, inclusive.

The list PicUnitRepConSeiList is set to consist of the payloadType values 0, 1, 2, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 129, 131, 132, 133, 135 to 152, inclusive, 154 to 168, inclusive, 176 to 181, inclusive, 200 to 202, inclusive, ~~and~~ 205, and 210 to 212, inclusive.

…

*Bibliography*

*Add the following after entry [41] and renumber remaining entries:*

[42] SMPTE ST 2128, *Colorimetry of IPT-PQ-C2 Color Space for High Dynamic Range and Wide Color Gamut Images*