|    | Page 1 Waveform Presentation State   |
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| 8  | Digital Imaging and Communications in Medicine (DICOM)                             |
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| 10 | Supplement 236: Waveform Presentation State  |
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| 21 | Prepared by: Working Group 32 Neurophysiology Waveforms                            |
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## **Document History**

| 2022/06/06 | Version 0  | Initial version, fragmentary   |  |  |
|------------|------------|--|--|--|
| 2022/07/19 | Version 1  | First draft for wg-32  |  |  |
| 2022/09/20 | Version 5  | Draft for wg-06 / First Read   |  |  |
| 2022/10/14 | Version 6  | Changes after First Read   |  |  |
| 2022/11/11 | Version 7  | Added Cardio Use Case  |  |  |
| 2022/11/18 | Version 8  | After Discussion with WG-06  |  |  |
| 2023/01/18 | Version 9  | Prepared for WG-06 (2023-01-18)  |  |  |
| 2023/01/20 | Version 10 | Changes during and after WG-06 discussion Jan.2023   |  |  |
| 2023/03/17 | Version 11 | Prepared for WG-06 (2023-03-20)  |  |  |
| 2023/03/24 | Version 12 | Changes during WG-06 discussion (2023-03-20)   |  |  |
| 2023/03/24 | Version 13 | Prepared for WG-32 (2023-03-28)  |  |  |
| 2023/05/17 | Version 14 | Prepared for WG-32 (2023-05-17)  |  |  |
|            |            | <ul> <li>removed Annotation SR, moved to a separate<br/>document</li> </ul>  |  |  |
| 2023/06/15 | Version 15 | Prepared for WG-32 (2023-06-15)  |  |  |
|            |            | <ul> <li>removed separate (Non-Patient-related) Montage<br/>object, only explicitly defined montages are required</li> </ul> |  |  |
| 2023/08/23 | Version 16 | Changes after meeting with WG-06 (June 2023)   |  |  |
|            |            | <ul> <li>removed Structured Display IOD and renamed the<br/>document</li> </ul>  |  |  |
|            |            | Structured Annotation Module   |  |  |
|            |            | Montage Activation Module  |  |  |
| 2023/08/29 | Version 17 | Prepared for WG-06 (2023-08-30):   |  |  |
|            |            | Presentation State Identification  |  |  |
|            |            | Additional open issues   |  |  |
|            |            | PS3.4 and PS3.6 changes  |  |  |
| 2023/08/29 | Version 18 | Edits discussed in Meeting with WG-06 (2023-08-30)   |  |  |
|            |            | <ul> <li>Closed some open issues</li> <li>Move Multiplex Group issues to a separate CP</li> </ul>                            |  |  |
|            |            | o wove wattpiex Group issues to a separate Gr  |  |  |
| 2024/01/05 | Version 19 | Document cleaned up  |  |  |
|            |            | Re-written Open Issue #2   |  |  |
| 2024/01/12 | Version 20 | Changes during and after review with WG-06.  |  |  |
|            |            | No authors for individual annotations in the PR – see<br>closed issue #6   |  |  |
|            |            | No graphics in the Graphic Annotation Module, just text. Also changed the name of the module.                                |  |  |
|            |            | Removed ICC Profile Module and added an open issue for it (open issue #6).   |  |  |
|            |            | <ul> <li>Removed amendment of PS3.4 and placed an open<br/>issue for it (open issue #7)</li> </ul>                           |  |  |
|            |            | <ul> <li>Cleaned up the comments and preserved the</li> </ul>  |  |  |

|                                    |            | discussions in additional closed issues.  |  |
|------------------------------------|------------|---|--|
| 2024/03/22 Version 22 Changes duri |            | Changes during and after Review with WG-06  |  |
|                                    |            | reworked Instance References (in the PR Relationship<br>Module)   |  |
|                                    |            | New IOD for Acquisition PR  |  |
|                                    |            | changed Module Table overview   |  |
|                                    |            | Changes in the Waveform Presentation State<br>Relationship Module (also contain the reference to the<br>Waveform Annotations SR) and in the Structured<br>Waveform Annotations Module |  |
| 2024/04/10                         | Version 23 | Prepared for WG-32  |  |
| 2024/05/11                         | Version 24 | Prepared for WG-06 2024-05  |  |
| 2024/05/29                         | Version 25 | Prepared for WG-06 2024-05  |  |
| 2024/05/30                         | Version 26 | Prepared for WG-06 2024-05  |  |
| 2024/05/30                         | Version 27 | Public Comment  |  |
| 2024/08/16                         | Version 28 | public comments, prepared for WG-06 2024-08   |  |
| 2024/08/22                         | Version 29 | Review with WG-06, added new section for changes in PS3.3 F.x   |  |
| 2024/08/23                         | Version 30 | Review with WG-06; prepared for Letter Ballot   |  |
| 2024/10/31                         | Version 31 | LB comments   |  |
| <u>2024/1<mark>01</mark>/05</u>    | Version 32 | Diskcussion with WG-06, LB comments from HOLOGIC<br>Draft final text  |  |

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#### **Open Issues**

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#### **Closed Issues**

| 1. | Q: Should annotations also be included in the presentation state object or should annotations be saved separately - e.g. in a separate SR document.<br>If both is applicable: a clear distinction criterion is required: which annotations shall go to the display object, which go to the SR document.  |
|----|--|
|    | A: Annotations expressing clinical information (observations, measurements,) should go to a separate object, a DICOM SR document.  |
| 2. | Q: What sort of time information is required for display relevant information (when a filter was applied, when the montage was changed)? Relative to the recording (ms or samples)? A: relative to the recording   |
| 3. | Q: All IODs in PS3.3 A.33 Softcopy Presentation State Information Object Definitions relate to images, intention is the corrected display of pixel values. PS3.4 N describes how these objects apply to images.<br>If the new Waveform Presentation State IOD is added to A.33, PS3.4 N needs to distinguish between different sorts of Softcopy Presentation State objects. Would it be better to add the new IODs in a separate chapter in PS3.3 (e.g. A.xx Waveform Presentation State Object Definitions)? |
|    | A: Waveform Presentation State IOD has to go to a separate chapter in PS3.3. Description   |

|     | of Storage of these PRs has to go to a separate section in PS3.4.  |
|-----|--|
| 4.  | Q: Procedure Log is a SR intended to store time stamped events during a procedure (e.g. catheterization lab). Would the Procedure Log IOD fit the requirements as well as the Presentation State IOD? In imaging Presentation State objects are (usually) created after image creation, the neurophysiology the recording use case requires the PR to be created during the recording. |
|     | A: Use a separate object to store the annotations, but an SR.  |
| 5.  | Sup222 Microscopy Bulk Simple Annotations Storage introduced the definition of<br>Annotations as separate IEs in MORW and E-R model. Shall the new IODs make use of this<br>IE or choose another wording (not using Annotation) in order to keep the distinction?  |
|     | A: The existing definition is very general and does not contradict its use for waveforms. In the new IODs introducing the Annotations for waveforms, the definition could be narrowed.   |
| 6.  | Q: Presentation State Identification contains date/time, when the PR was created, and coded content descriptor and content creator (optional). Is this sufficient to meet legal and billing requirements or should the authorship be stored for every annotation individually?   |
|     | A: Annotations which require authorship have to be stored in the Annotation SR, unless the authorship of the entire PR is sufficient. There is no authorship for individual annotations in the PR.   |
| 7.  | Q: How should color and shading be encoded in the Presentation State and in the Structured Display Object?   |
|     | A: CIELab values   |
| 8.  | Q: Is there a general requirement to have a temporal assignment of display settings (filters and montages): When where which settings in place?<br>Or is this information just relevant in conjunctions with annotations: which settings were in place when the observations were made.  |
|     | A: The start time for a montage (offset in seconds to the start of the recording) can be stored.   |
| 9.  | Q: A montage can combine any type of channels from different object types, not just EEG channels from Routine Scalp EEGs.  |
|     | channels belong to.  |
|     | A: The reference to the original waveforms contains both, SOP Instance UID and SOP Class UID.  |
| 10. | Q: A concrete Presentation State object contains references to concrete SOP Instances - to concrete objects.   |
|     | It must be guaranteed that this reference works for recordings having been split to multiple files due to limitations on file size or recording gaps.  |
|     | A: Multiple objects can be referenced; multiplex groups can span multiple objects.   |
| 11. | Q: Should the Presentation State contain timing information?<br>In a sense: for which time range should this display settings be used. How should viewers<br>then behave? Do they switch the display (the filters, montages) when scrolling through the<br>recording?  |
|     | A: The Waveform Presentation State may contain timing information when (relatively to the recording) a montage was onset. It is up to the display implementers how to use this information.  |

| 12. | Does the MORW and the E-R model require an extension by introducing a new IE "Waveform Presentation"?   |
|-----|---|
|     | A: Yes. Reason is, the current Presentation State IE is image oriented.   |
| 13. | Q: Some Modules in the Presentations state allow for (optionally) denoting who added the information (the annotation, the segment of interest). This supplement proposes to use the Attribute Operator's Name and to restrict this to persons. Should also be devices/algorithms possible?  |
|     | A: There is no authorship for individual annotations in the PR – see closed issue #6. On the level of the PR itself, a personal authorship can be expressed via the Content Creator Macro in the Presentations State Identification Module or – if the PR is created by a device - via the General Equipment Module.                |
| 14. | Q: Shall Waveform Presentations States have a separate, new Modality Code?  |
|     | If no, the existing Presentation Series Module can be reused. In this case the description there has to be adapted (the Note talks about images).   |
|     | A: No. The new IOD would differ only with respect to this new Modality Code. The existing Module can be reused.   |
| 15. | Q: The Presentation State Relationship Module as currently defined can only be used for images (or CDA). It would require comprehensive changes if it should be used for waveforms as well (e.g. for images, it can refer to a list of frames. For waveforms, it has to refer to a list of channels).                               |
|     | There were also discussions about cases, where a presentation state would reference both, image objects and waveform objects (e.g. in angiography or in echocardiography). This is reflected in another open issue.   |
|     | A: Under the assumption that Presentation States refer either to images or to waveforms the decision is to use a separate Module instead of changing the existing.  |
| 16. | Q: Shall Annotations in the PR use the existing Attribute "Observation DateTime" to reflect the point in time when the annotation was added?  |
|     | A: No. A new Attribute shall be defined. Observation DateTime is only used in SR context.   |
| 17. | Q: What are the conditions to record the display montages during waveform acquisition (recording use case)? What information should be stored and which time precision is required?   |
|     | A: There is always a montage defined. The first has to start at the beginning (beginning of the recording). The start times of the different montages shall be in timely order. Time precision "second" is sufficient.  |
| 18. | Q: This presentation state object introduces the possibility to assign display properties to waveform annotations coming from separate SR documents. Currently this is constraint to only allow Waveform Annotation SR as a source. Should we expand the scope that such annotations come from SR objects with various SOP Classes? |
|     | A: No. Annotations from different types of waveforms such as ECG go to the same Waveform Annotation SR object. Annotation Groups are also found in other contexts like Microscopy and there is no intention to expand this presentation state to these objects.   |
| 19. | Q: Is it sufficient to just create a single Presentation State to store the display settings (montages) for a neurophysiology study during recording? Are there any other situations which also could trigger to store montage settings and so result in more than one  |
|     |   |

|     | Presentation State in one Study?  |
|-----|---|
|     | A: Having more than one PR would not influence the content of the PR IOD. It is up to the display application how to present this fact to the user and how to select the PR to present.   |
| 20. | Q: Is it sufficient to just create a single Presentation State to store the display settings<br>(montages) for a neurophysiology study during recording? Is there any other situation which<br>also could trigger to store montage settings and so result in more than one Presentation<br>State in one Study?<br>A: Having more than one PR would not influence the content of the PR IOD. It is up to the                 |
|     | display application how to present this fact to the user and how to select the PR to present.   |
| 21. | Q: Shall it be possible to refer to both – images and waveforms - from one PR, e.g. in Angiography or fMRI? Usually the objects are synchronized, but the existing PR objects only allow for referencing images and the new ones defined in this supplement only allows for referencing waveforms.  |
|     | A: No comments, open issue is closed and the supplement remains as currently done.  |
| 22. | Q: Besides the storage of montages used in a neurophysiology recording, the proposed PR allows for both: containing simple text annotations and providing display information for annotations stored in a separate Waveform Annotation SR. Are there any scenarios which require annotations in the PR or shall all annotations go to SRs (there might be different ones depending on the situation when they are created)? |
|     | A: No comments, open issue is closed and the supplement remains as currently done.  |
| 23. | Q: This supplement restricts the Presentation State to only refer to SR documents in the same study. There might be use cases were the annotation SR resides in a different study. Should this be possible in the PR considering, that this results in issues in deciding about which metadata (Study A, Study B) to display?   |
|     | A: No use cases were provided showing the necessity to allow referencing across multiple studies. A note was added to section C.xx.hh describing the fact, that the PR and the SR documents and the waveforms all belong to one study.  |
| 24. | Q: Is it necessary to include the ICC Profile Module if all color values are defined as CIELab values in PCS?   |
|     | A: No. All Attributes with color information are defined to contain PCS values.   |
| 25. | Q: This supplement allows assigning simple text annotations to dedicated waveforms – besides having complex annotations in referenced Waveform Annotation SR documents. Presentation states for images support in addition presentation properties like graphical annotations. Are there any use cases which would require such additional properties in the Waveform Presentation State and, if yes, which one?            |
|     | A: No comments, open issue is closed and the supplement remains as currently done.  |
| 26. | Q: Within the presentation state object only the temporal coordinates of the annotation and color properties are defined. All other properties are left to the implementation of the viewing software. Would it be necessary to specify further display properties in the presentation state and, if yes, which one?  |
|     | A: No comments, open issue is closed and the supplement remains as currently done.  |
| 27. | Q: Part 4 of the DICOM Standard provides a comprehensive chapter which describes the behavior of applications when they create and assign Presentation States to images (e.g. by a description of the pixel value rendering pipeline).  |

|     | The Waveform Presentation State is not intended to fully render the display of waveforms.<br>Therefor no Service Class specific behavior is described in this supplement. Are there any<br>specific requirements for displays to be normatively defined for applications assigning<br>Waveform Presentation States to waveforms and, if yes, which one?   |
|-----|---|
|     | A: No comments, open issue is closed and the supplement remains as currently done.  |
| 28. | Q: Waveform montages introduced in the supplement are fully defined within the Waveform<br>Presentation State object, that uses them. Montages could also be defined and managed<br>externally. Would it be necessary to also standardize such predefined montages and allow<br>to refer to them in the Waveform Presentation State?<br>If yes, this requires separate mechanisms to address and access such montage objects. |
|     | A: No comments were received, so this issue is closed for this supplement. It may be addressed later in a separate supplement document, if necessary.   |
| 29. | Q: Is there any relevant information missing that should be added to Part 17?   |
|     | A: No comment was received on this, so changes for Part 17 remain unchanged.  |
| 30. | Q: Are there any properties in the PR that need to be digitally signed?   |
|     | A: Add the new Modules added in this supplement (C.xx.hh, C.xx.aa, C.xx.bb, C.xx.cc, C.xx.dd, C.xx.ee) to PS 3.15 Section C.2 (end of list of Attributes to be included in the digital signature).  |
| 31. | Q: In PC the question was raised that as if Annotation is defined in PS3.3 Section 3.8, annotation should be Annotation (first letter be capitalized)?  |
|     | A: No. Only capitalize, if exactly the defined Annotation from PS3.3 is meant. The definition in PS 3.3 Section 3.8 relates to the IE added for Microscopy Bulk Simple Annotations. The annotations in context of this supplements should not interfere with the specific usage there.  |
| 32. | Q: When annotations are added to waveforms the user often sees the recording using a specific montage. Supplement 239 Waveform Annotations and this supplement define Annotations as always referring to the recording channels in the related waveforms but it allows to store a recommended montage to show the annotation.   |
|     | Would it be useful if some annotations could choose to refer to the montage channel(s) instead of the recording channel(s)? For the Annotations stored in a separate SR object the definition of this relationship might be complicated.  |
|     | A: No comments, open issue is closed and the supplement remains as currently done. The Waveform Presentation State just provides a view on the data, the clinical data are in the SR document and in the waveform. There should be no dependency from clinical data to viewing information.   |
|     | If viewing information like the montage would be added to the SR document and later it turns out to be wrong, this would invalidate the SR document, which should be avoided. DICOM does not provide a mechanism to invalidate clinical objects and replace them by other.  |
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[HOLOGIC] Figure A.1-1 does not match PS3.3-2024d but adding Waveform Presentation State below Treatment Record is clear. [OK: current drawing will be amended accordingly]

[HOLOGIC] A.1.2.3 Series IE: Are any updates needed regarding series grouping expectations for Waveform Presentation States compared to the existing Presentation States wording? [FIXED.]

[HOLOGIC] Table A.1-x: Module name consistency, "Structured Waveform Annotations" => "Structured Waveform Annotation", "Simple Waveform Annotations" => "Simple Waveform Annotation", and "Display Waveform Segments" => "Display Waveform Segment", <singular is used throughout the document>. [FIXED.]

[HOLOGIC] A.xx.2.1: Wording suggestion: "display settings like filters" => "display settings such as filters" <change "like" to "such as">. [FIXED.]

[HOLOGIC] A.xx.2.1, Note: Why is "Presentation State" used (twice) rather than "Waveform Presentation State" or "Waveform Acquisition Presentation State"? [FIXED.]

[HOLOGIC] C.xx.hh, first statement: Grammar, "describes" should be "describe", subject is "Attributes". [FIXED.]

[HOLOGIC] Table C.xx.hh-1: The (0008,1115) structure seems conflicting with respect to the use of (0020,000E) Series Instance UID. Given differing values for (0008,0060) Modality, it is doubtful that Waveform Annotation SR instances would be in the same Series as Waveform instances.

- With the current structure it seems like a (0008,1115) Item would contain either (0008,114A) or (0008,113A), not both, since they would be in different Series, but the Type and Attribute Descriptions do not convey that. [FIXED. Both References are exclusive.]

[HOLOGIC] Table C.xx.hh-1, (0008,114A) Attribute Description: The referenced instances are in the same Study (0020,000D) as the Presentation State, but which (0020,000E) Series Instance UID occurrence is meant - within the Sequence item (I would expect, once the (0008,1115) structure is clarified), or the top level (for the Presentation State)? Please clarify as "in the enclosing Item". [FIXED.]

[HOLOGIC] Table C.xx.hh-1, (0008,113A) Attribute Description: The referenced instances are in the same Study (0020,000D) as the Presentation State, but which (0020,000E) Series Instance UID occurrence is meant - within the Sequence item (I would expect, once the (0008,1115) structure is clarified), or the top level (for the Presentation State)? Please clarify as "in the enclosing Item". [FIXED.] [DONE: Check how this affects F.5 – see below.]

[HOLOGIC] Table C.xx.hh-1, (0040,A0B0) Attribute Description: Grammar, "Required it" => "Required if" <change "it" to "if">. [FIXED.]

[HOLOGIC] Table C.xx.-aa, (ggga,eeec) Attribute Description: (ggge,eeea) Attribute Name reference is inconsistent, change "Montages" to "Montage". [FIXED.]

[HOLOGIC] Table C.xx.-bb, (0008,113A) Attribute Description: Why is the (0008,1115) constraint conveyed differently than for (ggga,eee1) in Table C.xx.-aa? For consistency the statement could be moved to the subsequent "Include Table 10-11" row and the phrasing updated to be more like Table CC.xx.-aa. [FIXED. Changed as proposed.]

[HOLOGIC] Table C.xx.-bb, (0008,113A) Attribute Description: Condition statement consistency, "listed in" => "contained in", "inside" => "in", and remove "in the top-level data set".[FIXED. Changed as proposed.]

[HOLOGIC] Table C.xx.-bb, (ggga,eeec) Attribute Description: (ggge,eeea) Attribute Name reference is inconsistent, change "Montages" to "Montage". [FIXED.]

[HOLOGIC] Table C.xx-cc, (0008,113A) Attribute Description: Why is the (0008,1115) constraint conveyed differently than for (ggga,eee1) in Table C.xx.-aa? For consistency the statement could be moved to the subsequent "Include Table 10-11" row and the phrasing updated to be more like Table CC.xx.-aa. [FIXED. Changed as proposed.]

[HOLOGIC] Table C.xx-cc, (0008,113A) Attribute Description: Condition statement consistency, "listed in" => "contained in", "inside" => "in", and remove "in the top-level data set". [FIXED. Changed as proposed.]

[HOLOGIC] Table C.xx-cc, (0040,A0B0) Attribute Description: Consistency, change "Instances" to

"Instance" <each Item references one SOP Instance>. [FIXED.] [HOLOGIC] Table C.xx-cc, (003A,0231) & (003A,0244) Attribute Description: The conditions do not follow the convention of "Required if" & "May be present otherwise". [FIXED. Following the proposals - see below.1 - For example for (003A,0231): "Required if Channel Recommended Display CIELab Value (003A,0244) is not present. May be present otherwise." - For example for (003A,0244): "Required if Waveform Display Background CIELab Value (003A,0231) is not present. May be present otherwise." [HOLOGIC] Table C.xx-dd, (ggga,eeec) Attribute Description: (ggge,eeea) Attribute Name reference is inconsistent, change "Montages" to "Montage". [FIXED.] [HOLOGIC] Table C.xx-b is referenced as "Table C.xx.-b" where the macro is invoked. Should be consistent. [FIXED.Also renamed to C.xx-f to be consistent.] [HOLOGIC] Table C.xx-b, (gggf,0208) Attribute Name: Recommend change to "Montage Channel Source Code Sequence" <convention to identify Code Sequence attributes>.[NOT CHANGED; Attribute name follows Waveform Module's Attribute Channel Source Sequence (003A,0208) – should be changed consistently -see later comments.]. [HOLOGIC] Table C.xx-b, (003A,020A): The subsequent Include Table 10-11 row is missing the leading '>'.[FIXED.] [HOLOGIC] Table C.xx-b, (0040,A0B0) Attribute Description: Consistency, change "Instances" to "Instance" <each Item references one SOP Instance>. [FIXED.] [HOLOGIC] Table C.xx-b, (003A,0208) Attribute Name: Should have been named "Channel Source Code Sequence" <convention to identify Code Sequence attributes>. Consider changing it throughout PS3.3 & PS3.6. [REJECTED here, since this is an existing Attribute, will be changed via a CP [HOLOGIC] Table C.xx-b, (003A,0208) Attribute Description: Type is 1C, where is the requirement condition? [FIXED.] [HOLOGIC] Table C.xx-b, (003A,020A) within (gggf,0209): Type is 1C, where is the requirement condition? [FIXED.] [HOLOGIC] Table CC.x-b, (0040,A0B0) within (gggf,0209): Change '>' to '>>' if this is supposed to be within (003A,020A). [FIXED.] [HOLOGIC] Table C.xx-b, (003A,0211) Attribute Name: Should have been named "Channel Sensitivity Units Code Sequence" <convention to identify Code Sequence attributes>. Consider changing it throughout PS3.3 & PS3.6. [REJECTED here, since this is an existing Attribute, will be changed via a CP] [HOLOGIC] Table C.xx-b, (003A,0212) Attribute Description: Aren't the units specified in (003A,0211), not (003A,0210)? [FIXED, also added a correction forcorrected for C.10-9 Waveform Module to change it consistently?via CP.] [HOLOGIC] Table C.xx-b, (003A,0318) Attribute Description: How many Items are permitted in the sequence? [FIXED.] [HOLOGIC] Table C.xx-b, (003A,0319) Attribute Description: How many Items are permitted in the sequence? [FIXED.] [HOLOGIC] Table C.xx-b, (003A,0321) Attribute Description: How many Items are permitted in the sequence? [UNCHANGEDFIXED, optional attribute, also no-defined item count in C.10-9 Waveform Module via CP.] [HOLOGIC] Table F.3-3, (0004,1430) Attribute Description needs the new value added to the

Enumerated Values list. However, "WAVEFORM PRESENTATION" is 21 characters but the maximum for VR=CS is 16 characters. Value needs to be shortened. [FIXED. Added WAVEFORM PRESENTATION] [HOLOGIC] Table F.4-1, SERIES row needs the new (shortened) value added to the list. [FIXED. Added WAVEFORM PRESENTATION] [HOLOGIC] Table F.5-X: (0008,1115) content rows need to be updated after the Table C.xx.hh-1 comments are addressed. [HOLOGIC] PS3.6: (gggf,020A) Attribute Name does not match Table C.xx-b. Which is correct, "Channel" or "Calculatory"? [FIXED. Channel Weight is correct.] [HOLOGIC] PS3.6, (gggf,020B) does not exist anywhere else in the document. Remove. [FIXED.] [HOLOGIC] PS3.17 XXX title: Should the title be "Waveform Presentation State (Informative)"? [Yes. FIXED.] [HOLOGIC] PS3.17 XXX: Should this section distinguish between Waveform Presentation State and Waveform Acquisition Presentation State, to assist with understanding the context for each type of use? [Yes. FIXED.] [HOLOGIC] PS3.17, line 356 (PDF): Should "Waveform Presentation State Object" be uppercase given the definition in line 346? [Yes, FIXED.] [HOLOGIC] PS3.17, line 362 (PDF): Why is a generic term "presentation state object" used here? [FIXED. Use Waveform Acquisition Presentation State object.] [HOLOGIC] PS3.17, line 363 (PDF): Where are the physician added annotations stored, in a new Waveform Presentation State Object or elsewhere? [FIXED. Added additional explanatory information.] [HOLOGIC] PS3.17, line 365 (PDF): What is the usage of a Waveform Presentation State Object or Waveform Acquisition Presentation State Object in this scenario? [FIXED. Added additional explanatory information.] [HOLOGIC] PS3.17, line 372 (PDF): What is the usage of a Waveform Presentation State Object or Waveform Acquisition Presentation State Object in this scenario? [FIXED. Added additional explanatory

73

information.]

Page 12

74

#### Scope and Field of Application

75 This supplement introduces Service Classes for storage and exchange of presentation information for

76 DICOM waveform objects by adding Waveform Presentation State IODs. The Waveform Presentation

77 State object stores the display montages, i.e. calculative combinations of recorded channels, display filter

78 settings, and other display properties as well as arbitrary Annotations.

79 This supplement

adds a new Waveform Presentation State IE
adds new SOP Classes to store Waveform P

adds new SOP Classes to store Waveform Presentation States and the related Modules

amends the Basic Directory IOD by adding Waveform Presentation as a new Directory Type
 83

84 In clinical neurophysiology it is important to be able to recreate the presentation of the recorded data as it 85 was displayed during the recording or during review and reporting. This is important for example when 86 activity is noted by the operator during recording and that view needs to be recreated post-hoc for review 87 by a specialist.

In cardiology, technicians annotate previously recorded waveforms (e.g. from home monitoring Holter
 ECG) and highlight areas of interest. This information is essential input for the cardiologist who reviews
 the ECG and finally provides the report.

91 Waveform objects support limited display information, which has to be provided within the recorded 92 waveforms. These Attributes only cover color and scaling of waveform channels.

A Waveform Presentation State object provides simple textual annotations, segments of interest,
 montages including filters, colors, gain, and display scale for a given recording (patient related).

In neurophysiology a montage defines a list of channels for visualization of the data which is created by a
 list of original channel sources and the method for their mathematical (linear) recombination.

97 Waveform annotations are textual or coded markers assigned to a specific timepoint or time range, 98 related to all channels or a selected set of channels. Annotations could be observations as well as 99 measurements.

### Changes to NEMA Standards Publications PS3.3 Digital Imaging and Communications in Medicine (DICOM) Part 3: Information Object Definitions

104

101 102 103

105 Add a new Overview Table to PS3.3 Section A.1.4.:

106 107

#### Table A.1-x. Composite Information Object Modules Overview – Waveform Presentation States

| IODs  | Waveform Presentation<br>State | Waveform Acquisition<br>Presentation State |  |
|---|--------------------------------|--|--|
| Modules                                     |                                |  |  |
| Patient                                     | M                              | M  |  |
| Clinical Trial Subject                      | U                              | U  |  |
| General Study                               | Μ                              | М  |  |
| Patient Study                               | U                              | U  |  |
| Clinical Trial Study                        | U                              | U  |  |
| General Series                              | Μ                              | М  |  |
| Clinical Trial Series                       | U                              | U  |  |
| Presentation Series                         | Μ                              | Μ  |  |
| Synchronization                             | С                              | С  |  |
| General Equipment                           | M                              | М  |  |
| Enhanced General<br>Equipment               | М                              | М  |  |
| Presentation State<br>Identification        | Μ                              | М  |  |
| Waveform Presentation<br>State Relationship | Μ                              | М  |  |
| Structured Waveform<br>Annotation           | U                              | U  |  |
| Simple Waveform<br>Annotation               | U                              | U  |  |
| Displayed Waveform<br>Segment               | U                              | U  |  |
| Montage Activation                          | U                              | М  |  |
| Waveform Presentation<br>Montage            | С                              | М  |  |
| SOP Common                                  | Μ                              | М  |  |

108

109

110

Amend PS3.3 Figure 7-1.a DICOM Model of the Real World by adding Waveform Presentation State IE





| 119 A.1.2 | 3 Series IE |
|-----------|-------------|
|-----------|-------------|

IE

Patient

Module

**Clinical Trial Subject** 

Patient

120 Presentation States shall be grouped into one or more Series without Images or Waveforms (i.e., in a different 121 Series from the Series containing the Images or Waveforms to which they refer). 122 123 ... 124 Notes: 125 1. The Series containing Grayscale, Color and Pseudo-Color Softcopy Presentation States and the Series 126 containing the Images to which they refer are both contained within the same Study, except for Blended 127 Presentation States, which may refer to images from different Studies. 128 2. The Series containing the Waveform Presentation State and the Series containing the Waveforms to 129 which they refer are both contained within the same Study. 130 131 Waveforms shall be grouped into Series without Images. A Frame of Reference IE may apply to both 132 Waveform Series and Image Series. 133 SR Documents shall be grouped into Series without Images. .... 134 A.1.2.nnn Waveform Presentation State IE 135 The Waveform Presentation State IE defines how referenced waveforms will be presented. 136 137 The Waveform Presentation State IE comprises simple text annotations, segments of interest, and montages including filters, colors, gain, and vertical sizes of waveform channels if this information is to be 138 applied to the referenced waveform(s). It might also contain display information for structured annotations 139 related to the referenced waveform(s). 140 141 Add the following new content to PS3.3 Section A.xx 142 143 A.xx Waveform Presentation State Information Object Definitions A.xx.1 Waveform Presentation State IOD 144 145 A.xx.1.1 Waveform Presentation State IOD Description The Waveform Presentation State Information Object Definition (IOD) specifies information that may be 146 147 used to present (display) waveforms that are referenced from within the IOD. 148 Note 149 The Waveform Presentation State object allows to store simple textual annotations, as well as to provide display 150 information for annotations stored in a separate SR document. The policies related to the criteria for 151 where specific annotations should be stored - in the Waveform Presentation State object or in the SR 152 document - are outside the scope of the Standard. 153 A.xx.1.2 Waveform Presentation State IOD Entity-Relationship Model 154 This IOD uses the E-R Model in Section A.1-2, with only the Waveform Presentation State IE below the Series IE. 155 156 A.xx.1.3 Waveform Presentation State IOD Module Table Table A.xx.1-1 specifies the Modules of the Waveform Presentation State IOD. 157 158 Table A.xx.1-1. Waveform Presentation State IOD Modules

Reference

C.7.1.1

C.7.1.3

Usage

Μ

U

Commented [S1]: The PR may also refer to Waveform Annotations SR - add a third note or include this here in Note 2?

| Study                          | General Study                                  | C.7.2.1 | М  |
|--------------------------------|--|---------|--|
|                                | Patient Study                                  | C.7.2.2 | U  |
|                                | Clinical Trial Study                           | C.7.2.3 | U  |
| Series                         | General Series                                 | C.7.3.1 | М  |
|                                | Clinical Trial Series                          | C.7.3.2 | U  |
|                                | Presentation Series                            | C.11.9  | М  |
| Frame of Reference             | Synchronization                                | C.7.4.2 | C – Required if time synchronization was applied.        |
| Equipment                      | General Equipment                              | C.7.5.1 | М  |
|                                | Enhanced General<br>Equipment                  | C.7.5.2 | М  |
| Waveform<br>Presentation State | Presentation State<br>Identification           | C.11.10 | М  |
|                                | Waveform<br>Presentation State<br>Relationship | C.xx.hh | М  |
|                                | Structured Waveform<br>Annotation              | C.xx.aa | U  |
|                                | Simple Waveform<br>Annotation                  | C.xx.bb | U  |
|                                | Displayed Waveform<br>Segment                  | C.xx.cc | U  |
|                                | Montage Activation                             | C.xx.dd | U  |
|                                | Waveform<br>Presentation Montage               | C.xx.ee | C – Required if Montage<br>Activation Module is present. |
|                                | SOP Common                                     | C.12.1  | М  |

159

#### 160 Note: 161 All At

All Attributes containing color information are defined to contain PCS values, so the ICC Profile Module is not used.

162 163

#### 164 A.xx.2 Waveform Acquisition Presentation State IOD

#### 165 A.xx.2.1 Waveform Acquisition Presentation State IOD Description

166 The Waveform Acquisition Presentation State Information Object Definition (IOD) provides information 167 about the display settings such as filters and montages used during acquisition of the waveform. This 168 allows presentation of the "recording view" later during review of the waveform.

169 Note:

- The Waveform Acquisition Presentation State object allows to store simple textual annotations, as well as to
   provide display information for annotations stored in a separate SR document. The policies related to
   the criteria for where specific annotations should be stored in the Waveform Acquisition Presentation
   State object or in the SR document are outside the scope of the Standard.
- 174

#### 175 A.xx.2.2 Waveform Acquisition Presentation State IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1-2, with only the Waveform Presentation State IE below theSeries IE.

#### 178 A.xx.2.3 Waveform Acquisition Presentation State IOD Module Table

179 Table A.xx.2-1 specifies the Modules of the Waveform Acquisition Presentation State IOD.

| Table A.xx.2-1. Waveform Acquisition Presentation State IOD Modules |  |           |   |  |
|---|--|-----------|---|--|
| IE  | Module   | Reference | Usage   |  |
| Patient   | Patient  | C.7.1.1   | M   |  |
|   | Clinical Trial Subject                         | C.7.1.3   | U   |  |
| Study   | General Study                                  | C.7.2.1   | Μ   |  |
|   | Patient Study                                  | C.7.2.2   | U   |  |
|   | Clinical Trial Study                           | C.7.2.3   | U   |  |
| Series  | General Series                                 | C.7.3.1   | M   |  |
|   | Clinical Trial Series                          | C.7.3.2   | U   |  |
|   | Presentation Series                            | C.11.9    | M   |  |
| Frame of Reference  | Synchronization                                | C.7.4.2   | C – Required if time synchronization was applied. |  |
| Equipment   | General Equipment                              | C.7.5.1   | M   |  |
|   | Enhanced General<br>Equipment                  | C.7.5.2   | Μ   |  |
| Waveform<br>Presentation State                                      | Presentation State<br>Identification           | C.11.10   | Μ   |  |
|   | Waveform<br>Presentation State<br>Relationship | C.xx.hh   | М   |  |
|   | Structured Waveform<br>Annotation              | C.xx.aa   | U   |  |
|   | Simple Waveform<br>Annotation                  | C.xx.bb   | U   |  |
|   | Displayed Waveform<br>Segment                  | C.xx.cc   | U   |  |
|   | Montage Activation                             | C.xx.dd   | Μ   |  |
|   | Waveform<br>Presentation Montage               | C.xx.ee   | Μ   |  |
|   | SOP Common                                     | C.12.1    | М   |  |

181

| 182<br>183<br>184<br>185                                  | Note:<br>All Attributes in this IOD containing color information are defined to contain PCS values, so the ICC Profile<br>Module is not used.   |
|---|---|
| 186<br>187  | Adapt Section PS3.3 Section C.10.10.1 by adding an additional note to indicate, that this Attribute is also used in context of Waveform Presentation States.  |
| 188<br>  189<br>  190<br>  191<br>  192<br>  193<br>  194 | <ul> <li>Notes 1:<br/>1.: As an example, an annotation that applies to the entire first multiplex group and channels 2 and 3 of the third multiplex group would have Referenced Channels value 0001 0000 0003 0002 0003 0003.</li> <li>Note 2:.<br/>This Attribute is also used in context of Waveform Presentation States to express the relationship of a presentation property to selected waveform channels.</li> </ul> |
| 195<br>196  | Adapt Section PS3.3 Section C.11.9 by changing the note to reflect, that a PR could not only apply to images.   |

180

Page 19 197 Note 198 This implies that presentation states will be in different Series from the images instances to which they apply, 199 which will have different values for Modality. 200 Add the following new content to PS3.3 Section C.xx 201 **C.xx Waveform Presentation State Modules** C.xx.hh Waveform Presentation State Relationship Module describe the waveforms to which a Waveform Presentation State applies. Note: This module only allows for referencing waveforms and SR documents from a single study. The Presentation State itself will belong to the same study. Creating annotations that reference waveforms and SR documents in a different study can be done by creating another Waveform Presentation State in that other study. 213 Table C.xx.hh-1. Waveform Presentation State Relationship Module

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#### 203

204 Table C.xx.hh-1 specifies the Attributes of the Waveform Presentation State Relationship Module, which 205

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| Attribute Name                | Tag         | Туре | Attribute Description  |
|-------------------------------|-------------|------|--|
| Referenced Series Sequence    | (0008,1115) | 1    | Sequence of Items where each Item includes the Attributes of one Series to which the Waveform Presentation State applies.  |
|                               |             |      | One or more Items shall be included in this Sequence.  |
| >Series Instance UID          | (0020,000E) | 1    | Unique identifier of a Series that is part of the<br>Study defined by the Study Instance UID<br>(0020,000D) in the enclosing data set.<br>Note<br>The Study Instance UID (0020,000D) value will be<br>that of the Wayoform Proceetation State  |
| >Referenced Instance Sequence | (0008,114A) | 1C   | The set of SR documents containing waveform<br>Annotations to which the Presentation State<br>applies.<br>These SR documents shall be of the Study<br>defined by Study Instance UID (0020,000D) and<br>the Series defined by Series Instance UID<br>(0020,000E) in the enclosing Item.<br>The referenced Instances shall be of SOP Class<br>1.2.840.10008.5.1.4.1.1.88.77 Waveform<br>Annotation SR Storage.<br>One or more Items shall be included in this<br>Sequence.<br>Required if Structured Waveform Annotation<br>Sequence (ggga,eee1) is present. |

#### Waveform Presentation State

| Attribute Name  | Tag           | Туре | Attribute Description  |
|---|---------------|------|--|
| >> Include Table 10-11 "SOP Instance Reference Macro<br>Attributes" |               |      |  |
| >Referenced Waveform Sequence                                       | (0008,113A)   | 1C   | The set of waveforms to which the Presentation<br>State applies. These shall be of the Study<br>defined by Study Instance UID (0020,000D) and<br>the Series defined by Series Instance UID<br>(0020,000E) in the enclosing Item.<br>One or more Items shall be included in this<br>Sequence.<br>The referenced SOP Class shall be the same for<br>all SOP Instances in a single Item of this<br>Referenced Series Sequence (0008,1115) but<br>may be different for different Items.<br>Notes:<br>1. For example, some Series might represent<br>EEG and some Series might represent<br>ECG.<br>2. The Waveform Presentation State applies to<br>waveforms that are referenced in<br>annotations in Structured Waveform<br>Annotation Sequence (ggga,eee1), thus<br>those waveforms also need to be<br>included here. |
|   |               |      | Required if Referenced Instance Sequence (0008,114A) is not present.   |
| >>Include Table 10-11 "SOP Instance Reference Macro Attributes"     |               |      |  |
| >>Referenced Waveform Channels                                      | : (0040,A0B0) | 1C   | Identifies the waveform multiplex group (M) and<br>channel (C) within the referenced waveform SOP<br>Instance using pairs of values (M,C).<br>See Section C.10.10.1.1.<br>Required if the Referenced Waveform SOP<br>Instance contains multiple channels and the<br>reference does not apply to all channels of all<br>multiplex groups.   |

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#### 216 C.xx.aa Structured Waveform Annotation Module

217 218 This Module defines how a display device applies waveform annotations that are stored in a separate SR document to a waveform.

#### 219

#### Table C.xx-aa. Structured Waveform Annotation Module Attributes

| Attribute Name                             | Tag         | Туре | Attribute Description   |
|--|-------------|------|---|
| Structured Waveform Annotation<br>Sequence | (ggga,eee1) | 1    | Selects and provides display information for<br>waveform annotations and measurements<br>contained in the referenced SR document.<br>One or more Items shall be included in this<br>Sequence. |

Page 20

#### Waveform Presentation State

| Attribute Name   | Tag         | Туре | Attribute Description  |
|--|-------------|------|--|
| >Include Table 10-11 "SOP Instance Reference Macro Attributes" |             |      | This references an SR document which contains the annotations.   |
|  |             |      | The Instance referenced here shall be contained<br>in the Referenced Instance Sequence<br>(0008,114A) in the Referenced Series Sequence<br>(0008,1115).  |
| >Waveform Annotation Display<br>Selection Sequence             | (ggga,eee2) | 3    | Selects subsets of annotations in the referenced SR document for display.  |
|  |             |      | If no subset is selected (i.e. this Attribute is missing or the Sequence is empty) all annotations in the referenced SR document shall be displayed.   |
|  |             |      | One or more Items may be included are permitted in this Sequence.  |
| >>Annotation Group Number                                      | (0040,A180) | 1    | References an annotation group number<br>(130872, DCM, "Waveform Annotation Group<br>Number") defined within the referenced SR<br>document to which the display information<br>applies.  |
| >>Referenced Montage Index                                     | (ggga,eeec) | 3    | The recommended viewing montage identified by the Montage Index (ggge,eeee) in the Waveform Montage Sequence (ggge,eeea).  |
| >>Text Color CIELab Value                                      | (0070,0241) | 3    | A default color triplet value used to specify the<br>text color in which it is recommended that the<br>text be rendered on a color display. The units are<br>specified in PCS-Values, and the value is<br>encoded as CIELab. See Section C.10.7.1.1. |

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#### 221 C.xx.bb. Simple Waveform Annotation Module

This Module defines Attributes of textual annotations that shall be made available by a display device to be applied to a waveform. The text is defined in position relative to the waveform time information. 222

223

224 A simple waveform Annotation shall be related to a waveform.

#### Table C.xx-bb. Simple Waveform Annotation Module Attributes

| Attribute Name                | Tag                                   | Туре | Attribute Description  | ]  |
|-------------------------------|---------------------------------------|------|--|--|
| Waveform Annotation Sequence  | <del>(gggb,eee1)(0</del><br>040,B020) | 1    | Selects and provides simple texts <b>Com</b><br>annotations for a group of wavefor exist<br>or channels within these wavefort Text<br>One or more Items shall be included<br>in this Sequence. | mented [S2]: This attribute already exists – reuse<br>ing one or define a new one (Waveform Simple /<br>ual Annotation Sequence gggb,eee1) |
| >Annotation DateTime          | (gggb,eee2)                           | 3    | The date and time the annotation was added.  |  |
| >Referenced Waveform Sequence | (0008,113A)                           | 1C   | The waveform to which this annotation applies.   |  |

| Attribute Name                                     | Tag              | Туре   | Attribute Description  |
|--|------------------|--|--|
|  |                  |  | One or more Items shall be included in this Sequence.  |
|  |                  |  | Required if the annotation in this Item<br>does not apply to all the waveforms<br>and channels contained in<br>Referenced Waveform Sequence<br>(0008,113A) in the Referenced Series<br>Sequence (0008,1115).   |
| >>Include Table 10-11 "SOP Instance Reference Ma   | acro Attributes" |  | This references waveforms to which the annotation applies.   |
|  |                  |  | The Instances referenced here shall<br>be contained in the Referenced<br>Waveform Sequence (0008,113A) in<br>the Referenced Series Sequence<br>(0008,1115).  |
| >>Referenced Waveform Channels                     | (0040,A0B0)      | 1  | Identifies the waveform multiplex<br>group (M) and channels (C) within the<br>referenced SOP Instance using pairs<br>of values (M,C).See Section<br>C.10.10.1.1.   |
| >Include Table C.xx-a "Temporal Range Macro Attrib |                  | Enumerated Values for Temporal<br>Range Type (0040,A130):<br>POINT<br>MULTIPOINT |  |
| >Referenced Montage Index                          | (ggga,eeec)      | 3  | The recommended viewing montage<br>identified by the Montage Index<br>(ggge,eeee) in the Waveform<br>Montage Sequence (ggge,eeea).   |
| >Text Object Sequence                              | (0070,0003)      | 1  | Describes a text annotation.<br>A single Item shall be included in this<br>Sequence.   |
| >>Unformatted Text Value                           | (0070,0006)      | 1  | The text to be displayed.  |
| >>Text Color CIELab Value                          | (0070,0241)      | 3  | A default color triplet value used to<br>specify the text color in which it is<br>recommended that the text be<br>rendered on a color display. The units<br>are specified in PCS-Values, and the<br>value is encoded as CIELab. See<br>Section C.10.7.1.1. |

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#### 227 C.xx.cc Displayed Waveform Segment Module

This Module defines Attributes required to define waveform segments and the properties how to display them. A waveform segment is a temporal portion of a waveform ("segment of interest").

Page 23

#### Table C.xx-cc. Displayed Waveform Segment Module Attributes

| Attribute Name                                    | Tag  | Туре | Attribute Description   |
|---|--|------|---|
| Displayed Waveform Segment Sequence               | (gggc,eee1)  | 1    | Selects and provides display<br>parameters for segments from a<br>group of waveforms or channels<br>within these waveforms.<br>One or more Items shall be included<br>in this Sequence.   |
| >Segment Definition DateTime                      | (gggc,eee2)  | 3    | The date and time the segment was defined.  |
| >Referenced Waveform Sequence                     | (0008,113A)  | 1C   | The waveforms to which the segment<br>display parameters in this Item apply.<br>One or more Items shall be included<br>in this Sequence.<br>Required if the segment display<br>parameters in this Item do not apply to<br>all the waveforms and channels<br>contained in Referenced Waveform<br>Sequence (0008,113A) in the<br>Referenced Series Sequence |
| >>Include Table 10-11 "SOP Instance Reference M   | This references waveforms to which<br>the segment display parameters in<br>this Item apply.<br>The Instances referenced here shall<br>be contained in the Referenced<br>Waveform Sequence (0008,113A) in<br>the Referenced Series Sequence<br>(0008,1115). |      |   |
| >>Referenced Waveform Channels                    | (0040,A0B0)  | 1    | Identifies the waveform multiplex<br>group (M) and channels (C) within the<br>referenced SOP Instance using pairs<br>of values (M,C).<br>See Section C.10.10.1.1.   |
| >Include Table C.xx-a "Temporal Range Macro Attri | Enumerated Values for Temporal<br>Range Type (0040,A130):<br>SEGMENT<br>MULTISEGMENT<br>BEGIN<br>END   |      |   |
| >Waveform Display Background CIELab Value         | (003A,0231)  | 1C   | A color triplet value recommended for<br>rendering the waveform display<br>background on a color display. The<br>units are specified in PCS-Values,<br>and the value is encoded as CIELab.<br>See Section C.10.7.1.1.<br>Required if Channel Recommended  |

| Attribute Name                            | Tag         | Туре | Attribute Description  |
|---|-------------|------|--|
|   |             |      | Display CIELab Value (003A,0244) is<br>not present. May be present<br>otherwise.   |
| >Channel Recommended Display CIELab Value | (003A,0244) | 1C   | A color triplet value recommended for<br>rendering the channel on a color<br>display. The units are specified in<br>PCS-Values, and the value is<br>encoded as CIELab. See Section<br>C.10.7.1.1.<br>Required if Waveform Display<br>Background CIELab Value<br>(003A,0231) is not present. May be<br>present otherwise. |

231

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#### 232 C.xx.dd Montage Activation Module

233 This Module defines Attributes recording the timepoints of montage activation.

234

#### Table C.xx-dd. Montage Activation Module Attributes

| Attribute Name                  | Tag         | Туре | Attribute Description   |
|---------------------------------|-------------|------|---|
| Montage Activation Sequence     | (gggd,eeea) | 1    | Provides information about when a montage was activated.  |
|                                 |             |      | One or more Items shall be included in this Sequence.   |
|                                 |             |      | The Items shall be ordered by ascending<br>Montage Activation Time Offset (gggd,eeeb)<br>value.                   |
| >Referenced Montage Index       | (ggga,eeec) | 1    | The Montage Index (ggge,eeee) of the montage<br>in the Waveform Montage Sequence<br>(ggge,eeea).                  |
| >Montage Activation Time Offset | (gggd,eeeb) | 1    | Time offset in seconds relative to the beginning<br>of the recording.<br>The offset of the first Item shall be 0. |

235

#### 236 C.xx.ee Waveform Presentation Montage Module

237 This Module contains Attributes describing presentation montages of waveform channels.

238

#### Table C.xx-ee Waveform Presentation Montage Module Attributes

| Attribute Name            | Tag         | Туре | Description  |
|---------------------------|-------------|------|--|
| Waveform Montage Sequence | (ggge,eeea) | 1    | Description of the waveform montage(s) in the Waveform Presentation State. |
|                           |             |      | One or more Items shall be included in this Sequence.                      |
| >Montage Name             | (ggge,eeec) | 3    | The name of the montage.   |
| >Montage Index            | (ggge,eeee) | 1    | The index of the montage within this Sequence.                             |

|  |                    |         | The value shall start at 1 and increase monotonically by 1.  |
|--|--------------------|---------|--|
|  |                    |         | This index will be used elsewhere to refer to this specific montage Sequence Item.   |
| >Montage Channel Sequence                      | (ggge,eeed)        | 1       | The channel(s) that comprise this montage.<br>One or more Items shall be included in this<br>Sequence.   |
|  |                    |         | significant.   |
| >>Include Table C.xx-f "Montage                | Channel Macro Attr | ibutes" |  |
| >Waveform Data Display Scale                   | (003A,0230)        | 3       | The recommended time-based waveform data display scale in units of mm/s (see Section C.10.9.1.8).  |
|  |                    |         | Note: This does not prevent applications to<br>change this during display. The value<br>might be used as an initial default<br>setting.  |
| >Waveform Display Background<br>CIELab Value   | (003A,0231)        | 3       | A color triplet value recommended for<br>rendering the waveform display background on<br>a color display. The units are specified in   |
|  |                    |         | PCS-Values, and the value is encoded as<br>CIELab. See Section C.10.7.1.1.   |
| >Waveform Presentation Group<br>Sequence       | (003A,0240)        | 3       | Sequence of Items, each Item describing a<br>Presentation Group of one or more waveform<br>channels to be displayed together.  |
|  |                    |         | Note<br>A Presentation Group is conventionally denoted<br>a "display page", and a waveform object may be<br>rendered using several Presentation Groups<br>under user display control.          |
|  |                    |         | One or more Items are shall be included in this Sequence.  |
| >>Presentation Group Number                    | (003A,0241)        | 1       | A number that identifies the Presentation Group.   |
| >>Channel Display Sequence                     | (003A,0242)        | 1       | Sequence of Items, each Item describing a<br>channel to be displayed in the Presentation<br>Group.<br>One or more Items shall be included in this<br>Sequence                                  |
| >>>Referenced Montage<br>Channel Number        | (ggge,eeeb)        | 1       | Number of the montage channel to be displayed in the Presentation Group.   |
|  |                    |         | This is the ordinal number of the Item in the Montage Channel Sequence (ggge,eeed).  |
| >>>Channel Offset                              | (003A,0218)        | 3       | The offset in seconds from the beginning of the montage channel waveform data to the first sample to be used for presentation. Value may be negative.  |
| >>>Channel Recommended<br>Display CIELab Value | (003A,0244)        | 1       | A color triplet value recommended for<br>rendering the channel on a color display. The<br>units are specified in PCS-Values, and the<br>value is encoded as CIELab. See Section<br>C.10.7.1.1. |

| >>>Channel Position                    | (003A,0245) | 1  | Position of the channel within the Presentation<br>Group display area<br>(see Section C.10.9.1.9).  |
|--|-------------|----|---|
| >>>Display Shading Flag                | (003A,0246) | 3  | Specifies display area shading between the<br>displayed waveform channel and another line.<br>The nature of the shading (e.g., solid,<br>or cross-hatching) is implementation<br>dependent.<br>Enumerated Values:<br>NONE no shading<br>BASELINE shading between the waveform<br>and the channel display baseline |
|  |             |    | (sample value 0 equivalent location)<br><b>ABSOLUTE</b> shading between the waveform<br>and the channel real world actual<br>value 0 (i.e., taking into account the<br>Channel Baseline (003A,0213) value)  |
|  |             |    | DIFFERENCE shading between the waveform<br>and a second waveform in the<br>Presentation Group at the same<br>channel position that also has Display<br>Shading Flag (003A,0246) value<br>DIFFERENCE.  |
| >>>Fractional Channel Display<br>Scale | (003A,0247) | 1C | Fraction of the Presentation Group vertical<br>display dimension assigned to the unit quantity<br>(least significant bit) of the channel samples<br>(see Section C.10.9.1.10).<br>Required if Absolute Channel Display Scale<br>(003A,0248) is not present, may be present<br>otherwise.                          |
| >>>Absolute Channel Display<br>Scale   | (003A,0248) | 1C | Nominal vertical display height in mm assigned<br>to the unit quantity (least significant bit) of the<br>channel samples (see Section C.10.9.1.10).<br>Required if Fractional Channel Display Scale<br>(003A,0247) is not present, may be present<br>otherwise  |

239

#### 240

#### 241 C.xx.ff Montage Channel Macro

242 This Macro consists of Attributes describing a single channel of a waveform montage.

#### 243

#### Table C.xx-f. Montage Channel Macro Attributes

| Attribute Name                          | Тад         | Туре | Description  |                      |  |
|---|-------------|------|--|----------------------|--|
| Montage Channel Number                  | (gggf,0202) | 1    | The number of the montage channel.   |                      |  |
| Montage Channel Label                   | (gggf,0203) | 3    | Text label of the channel, which may be us for display purposes.   | used                 |  |
| Montage Channel Source Code<br>Sequence | (gggf,0208) | 1    | A coded descriptor of the waveform channel in source. This identifies a single channel in recorded waveform in terms of the lead frow which it is collected. | inel<br>i the<br>rom |  |

|   |                     |  | Only a single Item shall be included in this Sequence.  |
|---|---------------------|--|---|
| >Include Table 8.8-1 "Code Seque                | nce Macro Attribut  | DCID 3001 "ECG Leads"<br>DCID 3004 "Arterial Pulse Waveform"<br>DCID 3005 "Respiration Waveform"<br>DCID 3030 "EEG Leads"<br>DCID 3031 "Lead Location Near or in Muscle"<br>DCID 3032 "Lead Location Near Peripheral<br>Nerve"<br>DCID 3033 "EOG Lead"<br>DCID 3033 "EOG Lead"<br>DCID 3034 "Body Position Waveform" |   |
| Source Waveform Sequence                        | (003A,020A)         | 1  | A Sequence that provides reference to a<br>waveform from which this channel was<br>derived.<br>One or more Items shall be included in this<br>Sequence.<br>If there are multiple Items in this Sequence,<br>they shall share the same multiplex group<br>identified by Multiplex Group UID (003A,0310). |
| >Include Table 10-11 "SOP Instan<br>Attributes" | ce Reference Macr   | Ö  |   |
| >Referenced Waveform<br>Channels                | (0040,A0B0)         | 1  | Identifies the waveform multiplex group (M)<br>and channel (C) within the referenced SOP<br>Instance using a pair of values (M,C).<br>See Section C.10.10.1.1.  |
| Channel Derivation Description                  | (003A,020C)         | 3  | Additional description of the channel derivation.   |
| Contributing Channel Sources<br>Sequence        | (gggf,0209)         | 2  | A Sequence of Items each representing the<br>source of a channel contributing to this<br>montage.<br>Zero or more Items shall be included in this<br>Sequence.  |
| >Channel Weight                                 | (gggf,020A)         | 1  | The relative weight this channel contributes to<br>the montage channel.<br>The weights of all Items in this Sequence shall<br>sum up to 1.  |
| >Channel Source Sequence                        | (003A,0208)         | 1  | A coded descriptor of the contributing<br>waveform channel source.<br>Only a single Item shall be included in this<br>Sequence.   |
| >>Include Table 8.8-1 "Code Sequ                | ience Macro Attribu | DCID 3001 "ECG Leads"<br>DCID 3004 "Arterial Pulse Waveform"<br>DCID 3005 "Respiration Waveform"<br>DCID 3030 "EEG Leads"  |   |

|  |                     |          | DCID 3031 "Lead Location Near or in Muscle"<br>DCID 3032 "Lead Location Near Peripheral<br>Nerve"<br>DCID 3033 "EOG Lead"<br>DCID 3034 "Body Position Waveform"   |
|--|---------------------|----------|---|
| >Source Waveform Sequence                        | (003A,020A)         | 1        | Reference to waveforms from which this channel was derived.   |
|  |                     |          | One or more items shall be included in this Sequence.   |
|  |                     |          | If there are multiple Items in this Sequence,<br>they shall share the same multiplex group<br>identified by Multiplex Group LIID (003A 0310)  |
| >>Include Table 10-11 "SOP Ins<br>Attributes     | tance Reference M   | acro     |   |
| >>Referenced Waveform<br>Channels                | (0040,A0B0)         | 1        | Identifies the waveform multiplex group (M)<br>and channel (C) within the referenced SOP<br>Instance using a pair of values (M,C). See<br>Section C.10.10.1.1.  |
| Channel Sensitivity                              | (003A.0210)         | 1C       | Aniya single channel shall be referenced     here.     Nominal numeric value of unit quantity of  |
|  |                     |          | sample. See Section C.10.9.1.4.2.<br>Required if samples represent defined (not<br>arbitrary) units.  |
| Channel Sensitivity Units<br>Sequence            | (003A,0211)         | 1C       | A coded descriptor of the units of measure for<br>the Channel Sensitivity (003A,0210). See<br>Section C.10.9.1.4.2.<br>Only a single Item shall be included in this<br>Sequence.<br>Required if Channel Sensitivity (003A,0210) is<br>present |
| >Include Table 8.8-1 "Code Sequ                  | uence Macro Attrib  | utes"    | DCID 82 "Measurement Unit"  |
| Channel Sensitivity Correction<br>Factor         | (003A,0212)         | 1C       | Multiplier to be applied to encoded sample<br>values to match units specified in Channel<br>Sensitivity Units Sequence (003A,0211) (e.g.<br>based on calibration data). See Section   |
|  |                     |          | C.10.9.1.4.2.<br>Required if Channel Sensitivity (003A,0210) is<br>present.   |
| Filter Low Frequency<br>Characteristics Sequence | (003A,0318)         | 1C       | The properties of low frequency (high-pass)<br>filters applied to the waveform montage<br>channel.<br>Required if a high-pass filter is used.<br>One or more Items shall be included in this<br>Sequence                                      |
| >Include Table C.10.12-1 "Wave                   | form Filter Charact | eristics | Commented [SW4]: Change waveform module, too  |
| Macro Attributes"                                |                     |          |   |

#### Waveform Presentation State

| Filter High Frequency<br>Characteristics Sequence  | (003A,0219)           | 1C       | The properties of high frequency (low-pass)<br>filters applied to the waveform montage<br>channel.<br>Required if a low-pass filter is used.<br>One or more Items shall be included in this |
|--|-----------------------|----------|---|
|  |                       |          | Sequence. Commented [S6]: Done in CP.   |
| >Include Table C.10.12-1 "Way<br>Macro Attributes" | /eform Filter Charact | eristics |   |
| Notch Filter Characteristics<br>Sequence           | (003A,0321)           | 3        | The properties of notch filters applied to the waveform montage channel.  |
|  |                       |          | Sequence. Commented [S7]: Done in CP.   |
| >Include Table C.10.12-1 "Way<br>Macro Attributes" | /eform Filter Charact | eristics |   |

244

#### 245 C.xx.gg Temporal Range Macro

246

# Ed. Note: This Macro could also replace this set of Attributes in the Waveform Annotation Module C.10.10

247 This macro contains Attributes that define one or more points in time or time ranges in waveforms or

dedicated channels of those waveforms. The waveforms and channels are selected in the enclosing dataset.

| Table C.xx-a. Temporal Range Macro Attributes |             |      |   |             |  |
|---|-------------|------|---|-------------|--|
| Attribute Name                                | Tag         | Туре | Description   |             |  |
| Temporal Range Type                           | (0040,A130) | 1    | See Section C.xx.gg.g for Enumerated Va   | lues.       |  |
| Referenced Sample Positions                   | (0040,A132) | 1C   | List of samples within a multiplex group<br>specifying one or more temporal points.<br>Position of first sample is 1.<br>See Section C.xx.gg.h.<br>Required if Referenced Time Offsets<br>(0040,A138) and Referenced DateTime<br>(0040,A13A) are not present. |             |  |
| Referenced Time Offsets                       | (0040,A138) | 1C   | List of time offsets by number of seconds a<br>start defining one or more temporal points<br>Required if Referenced Sample Positions<br>(0040,A132) and Referenced DateTime<br>(0040,A13A) are not present.   | after       |  |
| Referenced DateTime                           | (0040,A13A) | 1C   | List of one or more temporal points by abs<br>datetime.<br>Required if Referenced Sample Position<br>(0040,A132) and Referenced Time Offsets<br>(0040,A138) are not present.  | solute<br>s |  |

| 252  | C.xx.gg.g Temporal Range Type  |
|--|--|
| 253<br>254   | Ed. Note: This is a rewording of existing C.10.10.1.2. In the current Standard this section only belongs to the Waveform Annotation Module   |
| 255<br>256<br>257<br>258<br>259<br>260<br>261<br>262 | The Temporal Range Type (0040,A130) Attribute defines the type of temporal extent of the annotated region of interest <u>a selected region of waveform data</u> . A temporal point (or instant of time) may be defined by a waveform sample offset (for a single waveform multiplex group only), time offset, or absolute time.<br>The value or the values shall be present either as Referenced Sample Positions (0040, A132), or as Referenced Time Offsets (0040,A138), or as Referenced DateTimes (0040,A13A).<br>Enumerated Values: |
| 263  | <b>POINT</b> a single temporal point <u>: a single value shall be present</u> .  |
| 264  | MULTIPOINT multiple temporal points; multiple values shall be present.   |
| 265  | <b>SEGMENT</b> a range between two <u>different</u> temporal points; two values shall be present.  |
| 266<br>267   | MULTISEGMENT multiple segments, each denoted by two temporal points. An even number of values<br>shall be present, each pair representing one segment.   |
| 268<br>269   | BEGIN range beginning at one temporal point, and extending beyond the end of the acquired data; a<br>single value shall be present.  |
| 270<br>271<br>272                                    | <b>END</b> a range beginning before the start of the acquired data, and extending to (and including) the identified temporal point <u>: a single value shall be present</u> .  |
| 273  |  |
| 274  | C.xx.gg.h Referenced Sample Position   |
| 275<br>276   | Ed. Note: This is a rewording of existing C.10.10.1.3. In the current Standard this section only belongs to the Waveform Annotation Module   |
| 277<br>278<br>279<br>280                             | Referenced Sample Positions (0040,A132) may be used only if Referenced Waveform Channels (0040,A0B0) <u>in the enclosing dataset</u> refers to channels within a single multiplex group. The sample position is by channel, and applies to all channels specified in Referenced Channels (0040,A0B0) <u>in the enclosing dataset.</u>  |
| 281  |  |
| 282  | Amend Figure F.4.1. Basic Directory IOD Information Model by adding a Waveform Presentation DR   |



| Offset of the First<br>Directory Record of the<br>Root Directory Entity<br> | (0004,1200) | 1 | Offset of the first byte  |
|---|-------------|---|---|
| >Directory Record Type  | (0004,1430) | 1 | Defines as specialized type of Directory<br>Record by reference to its position in the<br>Media Storage Directory Information Model<br>(see Section F.4).<br>Enumerated Values:<br>PATIENT<br>STUDY<br><br>WF PRESENTATION<br>PRIVATE |
| >   |             |   |   |
| >Include Record Selection Keys  |             |   | A number of DICOM Data Elements that<br>contain specific Keys defined for each type<br>of Directory Record (0004,1430) defined in<br>Section F.5.   |

288

289 290

Add new Enumerated Value for the new Basic Directory Type to Table F.4-1 Relationship Between Directory Records

291

| Table F.4-1. Relationship Between Directory Records |         |   |                 |
|---|---------|---|-----------------|
| Directory Record Type                               | Section | Directory Record Types that may be included in t<br>lower-level directory Entity  |                 |
|   |         |   |                 |
| SERIES  | F.5.3   | IMAGE, RT DOSE, RT STRUCTURE SET, RT PLAN,<br>RT TREAT RECORD, PRESENTATION, WAVEFORM,<br>SR DOCUMENT, KEY OBJECT DOC, SPECTROSCOP<br>RAW DATA, REGISTRATION, FIDUCIAL, ENCAP DOC<br>VALUE MAP, STEREOMETRIC, PLAN, MEASUREMEN<br>SURFACE, TRACT, ASSESSMENT, RADIOTHERAPY,<br>ANNOTATION, <u>WF PRESENTATION</u> , PRIVATE | Υ,<br>',<br>JT, |
| IMAGE   | F.5.4   | PRIVATE   |                 |

| WF PRESENTATION | <u>F.5.x</u> | PRIVATE  |  |
|-----------------|--------------|--|--|
| PRIVATE         | F.6.1        | PRIVATE, (any of the above as privately defined) |  |

292

293 Add new Basic Directory Record PS3 Section F.5

#### 294 F.5.x Waveform Presentation State Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type (0004,1430) of Value "WF PRESENTATION". Table F.5-X lists the set of Keys with their associated Types for such a Directory Record Type. The description of these Keys may be found in the Modules 295 296

297

related to the Waveform Presentation State IE of Waveform Presentation State IODs. This Directory 298

Record shall be used to reference a Waveform Presentation State SOP Instance. This Type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as 299

300 301

defined in Table F.4-1

302 303

#### Table F.5-X. Waveform Presentation Keys

| Кеу                           | Tag                     | Туре          | Attribute Description   |
|-------------------------------|-------------------------|---------------|---|
| Specific Character Set        | (0008,0005)             | 1C            | Required if an extended or replacement character set is used in one of the Keys.  |
| Presentation Creation<br>Date | (0070,0082)             | 1             | Date on which the waveform presentation<br>was created.<br>Note<br>This date may be different from<br>the date that the DICOM SOP<br>Instance was created, since the<br>presentation information contained<br>may have been recorded earlier.   |
| Presentation Creation<br>Time | (0070, 0083)            | 1             | Time at which this waveform presentation<br>was created.<br>Note:<br>This time may be different from the time<br>that the DICOM SOP Instance<br>was created, since the<br>presentation information contained<br>may have been recorded earlier. |
| Include Table 10-12 "Conte    | nt Identification Macro | o Attributes" |   |
| Referenced Series<br>Sequence | (0008,1115)             | 1C            | Sequence of Items where each Item<br>includes the Attributes of one Series to<br>which the Waveform Presentation State<br>applies.  |

| 1                                | 1                    | 1                   |  |
|----------------------------------|----------------------|---------------------|--|
|                                  |                      |                     | One or more Items shall be included in this Sequence.  |
|                                  |                      |                     | Required if the IOD of the Waveform<br>Presentation State SOP Instance<br>referenced by this Directory Record<br>includes the Waveform Presentation State<br>Relationship Module.  |
| >Series Instance UID             | (0020,000E)          | 1                   | Unique identifier of a Series that is part of<br>the Study defined by the Study Instance<br>UID (0020,000D) in the enclosing data set.<br>Note<br>The Study Instance UID (0020,000D) value<br>will be that of the Waveform<br>Presentation State.  |
| >Referenced Instance<br>Sequence | (0008,114A)          | 1C                  | The set of SR documents containing<br>waveform Annotations to which the<br>Waveform Presentation State applies.<br>These shall be of the Study defined by<br>Study Instance UID (0020,000D) and the<br>Series defined by Series Instance UID<br>(0020,000E) in the enclosing Item.<br>The referenced Instances shall be of SOP<br>Class 1.2.840.10008.5.1.4.1.1.88.77<br>Waveform Annotation SR Storage.   |
|                                  |                      |                     | Sequence.<br>Required if Structured Waveform<br>Annotation Sequence (ggga,eee1) is<br>present.   |
| >> Include Table 10-11 "SC       | P Instance Reference | e Macro Attributes" |  |
| >Referenced Waveform<br>Sequence | (0008,113A)          | 1C                  | The set of waveforms to which the<br>Waveform Presentation State applies.<br>These shall be of the Study defined by<br>Study Instance UID (0020,000D) and the<br>Series defined by Series Instance UID<br>(0020,000E) in the enclosing Item.<br>One or more Items shall be included in this<br>Sequence.<br>The referenced SOP Class shall be the<br>same for all SOP Instances in a single Item<br>of this Referenced Series Sequence<br>(0008,1115) but may be different for<br>different Items.<br>Notes: |
|                                  |                      |                     | 1. For example, some Series might  |

|  |   | might represent ECG.<br>2. The Presentation State applies<br>waveforms that are refere<br>annotations in Structured<br>Waveform Annotation Se<br>(ggga,eee1), thus those<br>waveforms also need to I<br>included here.<br>Required if Referenced Instance S<br>(0008 114A) is not present | to<br>enced in<br>quence<br>be<br>equence |
|--|---|---|---|
| >>Include Table 10-11 "SOP Instance Reference                        |   |   |   |
| Any other Attribute of the Waveform<br>Presentation State IE Modules | 3 |   |   |

304

# 305Changes to NEMA Standards Publications PS 3.4306307308Digital Imaging and Communications in Medicine (DICOM)<br/>Part 4: Service Class Specifications

309 Add new SOP Class to PS3.4 Annex B tables

#### 310 B.5 Standard SOP classes

311 The SOP Classes in the Storage Service Class identify the Composite IODs to be stored. Table B.5-1 312 identifies Standard SOP Classes.

313

#### Table B.5-1. Standard SOP Classes

| SOP Class Name             | SOP Class UID  | IOD Specification (defined in PS3.3)           | Specialization |
|----------------------------|--|--|----------------|
|                            |  |  |                |
| <u>1.2.840.10008.1.XX1</u> | <u>Waveform</u><br>Presentation<br>State Storage         | Waveform Presentation State IOD                |                |
| <u>1.2.840.10008.1.XX2</u> | Waveform<br>Acquisition<br>Presentation<br>State Storage | Waveform Acquisition Presentation<br>State IOD |                |

314

| 315 | Changes to NEMA Standards Publications PS 3.6          |
|-----|--|
| 316 |  |
| 317 | Digital Imaging and Communications in Medicine (DICOM) |
| 318 | Part 6: Data Dictionary                                |
|     |  |

319 Add new Elements to PS3.6 6 Table 6-1. Registry of Data Elements

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320

#### Table 6-1. Registry of DICOM Data Elements

| Tag  | Name   | Keywords                                       | , VR          |            |  |  |  |
|--|--|--|---------------|------------|--|--|--|
|  |  |  |               |            |  |  |  |
| (ggga,eee1)  | Structured Waveform<br>Annotation Sequence           | StructuredWaveformAnnotationSeque nce          | SQ            | 1          |  |  |  |
| (ggga,eee2)  | Waveform Annotation<br>Display Selection<br>Sequence | WaveformAnnotationDisplaySelection<br>Sequence | SQ            | 1          |  |  |  |
| (ggga,eeec)  | Referenced Montage<br>Index                          | ReferencedMontageIndex                         | US            | 1          |  |  |  |
| <del>(gggb,eee1)</del>                                 | Waveform Annotation<br>Sequence                      | WaveformAnnotationSequence                     | <del>SQ</del> | 4          |  |  |  |
| (gggb,eee2)  | Annotation DateTime                                  | AnnotationDateTime                             | DT            | 1          |  |  |  |
| (gggc,eee1)  | Displayed Waveform<br>Segment Sequence               | DisplayedWaveformSegmentSequenc<br>e           | SQ            | 1          |  |  |  |
| (gggc,eee2)  | Segment Definition<br>DateTime                       | SegmentDefinitionDateTime                      | DT            | 1          |  |  |  |
| (gggd,eeea)  | Montage Activation<br>Sequence                       | MontageActivationSequence                      | SQ            | 1          |  |  |  |
| (gggd,eeeb) Montage Activation<br>Time Offset          |  | MontageActivationTimeOffset                    | DS            | 1          |  |  |  |
| (ggge,eeea) Waveform Montage<br>Sequence               |  | WaveformMontageSequence                        | SQ            | 1          |  |  |  |
| (ggge,eeeb)  | Referenced Montage<br>Channel Number                 | ReferencedMontageChannelNumber                 | IS            | 1          |  |  |  |
| (ggge,eeec)  | Montage Name   | MontageName                                    | LT            | 1          |  |  |  |
| <u>(ggge,eeed)(</u><br><del>ggge,eece)</del>           | Montage Channel<br>SequenceMontage<br>Index          | MontageChannelSequenceMontageIn<br>dex         | <u>SQ</u> US  | <u>1</u> 4 |  |  |  |
| (ggge,eeee)  | Montage Index  | MontageIndex                                   | <u>US</u>     | <u>1</u>   |  |  |  |
| <del>(ggge,eeed)</del>                                 | Montage Channel<br>Sequence                          | MontageChannelSequence                         | SQ            | 4          |  |  |  |
| (gggf,0202)  | Montage Channel<br>Number                            | MontageChannelNumber                           | IS            | 1          |  |  |  |
| (gggf,0203))   | Montage Channel<br>Label                             | MontageChannelLabel                            | SH            | 1          |  |  |  |
| (gggf,0208) Montage Channel<br>Source Code<br>Sequence |  | MontageChannelSourceCodeSequenc<br>e           | SQ            | 1          |  |  |  |
| (gggf,0209)  | Contributing Channel<br>Sources Sequence             | ContributingChannelSourcesSequenc e            | SQ            | 1          |  |  |  |
| (gggf,020A)  | Channel Weight                                       | ChannelWeight                                  | FL            | 1          |  |  |  |
|  |  |  |               |            |  |  |  |

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 323
 Add new SOP Classes to PS3.6 Annex A Table A-1:

 324
 UID Value

 UID Value
 UID Name

 UID Keyword
 UID Type

| <u>1.2.840.10008.1.XX1</u> | Waveform Presentation<br>State Storage                | WaveformPresentation<br>StateStorage            | SOP Class | <u>PS3.4</u> |
|----------------------------|---|---|-----------|--------------|
| <u>1.2.840.10008.1.XX2</u> | Waveform Acquisition<br>Presentation State<br>Storage | WaveformAcquisitionPr<br>esentationStateStorage | SOP Class | <u>PS3.4</u> |
|                            |   |   |           |              |

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|                          | Page 38 Waveform Presentation State   |
|--------------------------|---|
| 330<br>331<br>332<br>333 | Changes to NEMA Standards Publications PS3.15<br>Digital Imaging and Communications in Medicine (DICOM)<br>Part 15: Security and System Management Profiles |
| 334                      | Add the new Modules from the new IODs to PS3.15 Section C.2 by continuation of the list   |
| 335                      |   |
|                          |   |
| 336<br>337               | As a minimum, an implementation shall include the following Attributes in generating the Creator RSA Digital Signature:                                     |
| 338                      | a. the SOP Class and Instance UIDs  |
| 339                      | b. the SOP Creation Date and Time, if present   |
| 340                      | c. the Study and Series Instance UIDs   |
| 341                      | d   |
| 342                      | ae. any Attributes of the Waveform Presentation State Relationship Module that are present  |
| 343                      | af. any Attributes of the Structured Waveform Annotation Module that are present  |
| 344                      | ag. any Attributes of the Simple Waveform Annotation Module that are present  |
| 345                      | ah. any Attributes of the Displayed Waveform Segment Module that are present  |
| 346                      | ai. any Attributes of the Montage Activation Module that are present  |
| 347                      | aj. any Attributes of the Waveform Presentation Montage Module that are present   |
| 348                      | Add new Data Elements to PS3.15 Annex E   |

#### Table E.1-1. Application Level Confidentiality Profile Attributes

| Attribute<br>Name                        | Tag                | Retd.<br>(from<br>PS3.6) | In Std.<br>Comp.<br>IOD<br>(from<br>PS3.3) | Basic<br>Prof. | Rtn.<br>Safe<br>Priv.<br>Opt. | Rtn.<br>UIDs<br>Opt. | Rtn.<br>Dev.<br>Id.<br>Opt. | Rtn.<br>Inst.<br>Id.<br>Opt. | Rtn.<br>Pat.<br>Chars.<br>Opt. | Rtn.<br>Long.<br>Full<br>Dates<br>Opt. | Rtn.<br>Long.<br>Modif.<br>Dates<br>Opt. | Clean<br>Desc.<br>Opt. | Clea<br>Stru<br>Coi<br>Op | an<br>Ict.<br>ht. | Clean<br>Graph.<br>Opt. |
|--|--------------------|--------------------------|--|----------------|-------------------------------|----------------------|-----------------------------|------------------------------|--------------------------------|--|--|------------------------|---------------------------|-------------------|-------------------------|
|  |                    |                          |  |                |                               |                      |                             |                              |                                |  |  |                        |                           |                   |                         |
| Annotation<br>DateTime                   | <u>(agab.eee2)</u> | N                        | Y  | <u>x/z</u>     |                               |                      |                             |                              |                                | ĸ                                      | <u>c</u>                                 |                        |                           |                   |                         |
| <u>Segment</u><br>Definition<br>DateTime | <u>(qqqc,eee2)</u> | N                        | Y  | <u>x/z</u>     |                               |                      |                             |                              |                                | <u>K</u>                               | <u>c</u>                                 |                        |                           |                   |                         |
|  |                    |                          |  |                |                               |                      |                             |                              |                                |  |  |                        |                           |                   |                         |

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# 352Changes to NEMA Standards Publications PS3.17353354355Digital Imaging and Communications in Medicine (DICOM)355Part 17: Explanatory Information

#### 356 XXX Waveform Presentation State (Informative)

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In clinical neurophysiology it is important to be able to recreate the presentation of the recorded data as it was displayed during the recording or during review and reporting. This allows subsequent reviewers to recreate the display when the recording was made and when an annotation was created, which allows for

361 review of subtle features that may not be obvious in other montages or reference states.

# In cardiology, technicians annotate previously recorded waveforms (e.g. from home monitoring Holter ECG) and highlight areas of interest. This information is essential input for the cardiologist who reviews the ECG and finally provides the report.

365 Waveform objects support limited display information, including only Attributes for color and scaling of 366 waveform channels. This leaves out much information about how waveforms were visualized by the 367 technician who recorded the study, including the mathematical derivation of channels needed for

368 visualization, the ordering of channels on the display screen, and filters used for channel visualization.

369 In neurophysiology a **montage** defines a list of channels for visualization of the waveform data which is

370 created from the originally recorded channel sources and it conveys the method for their mathematical

- 371 (linear) recombination. In principle, montages could be either predefined (for a common list of sources) 372 and referenced by a montage object identifier or defined for each specific recording, because the
- 372 and referenced by a montage object identifier of defined for373 recording could include a unique list of sources.

Waveform Annotations are textual or coded markers assigned to a specific timepoint or time range, related to all channels or a selected set of channels. Annotations could be observations of waveforms, patient stimuli, comments about the recording, as well as measurements.

A Waveform Presentation State Object stores annotations, visualization filters, and montages used for a given recording (patient related). A Waveform Presentation State object is stored together with the waveform study (e.g. a Routine Scalp EEG recording) and can be exchanged between systems.

The Waveform Presentation State Object differs from the Waveform Acquisition Presentation Stage Object because in the former, encoding of montages is optional and, in the latter, it is mandatory. In the Waveform Presentation State Object, the Montage Activation module is optional and the Waveform Presentation Montage module is conditional (mandatory only if the Montage Activation module is

385 present). The Montage Activation module encodes a sequence of times during the recording when a

montage was activated by the technician for viewing the waveforms. The Waveform PresentationMontage Module encodes a description of each montage.

387 388

#### 389 XXX.1 Waveform Presentation State usage

#### 390 Use case: Post-hoc Review

A physician acting as a post-hoc reviewer looks through a completed EEG recording and marks potential
 epileptiform features. The annotations added by the technician during the recording are displayed for
 anyone reviewing the recording and can be helpful to the interpreting physician to understanding how a

neurophysiology recording was made, such as annotations by the technician about when a patient is

395 moving their body. If the physician adds annotations a Waveform Annotation SR is created. In addition, if

triggered by the post-hoc study reviewer, a Waveform Presentation State object is created to store

397 recommended filter settings and montages.398

#### 399 Use case: Electronic Health Record

400 An epilepsy patient is treated in another organization and the neurologist wants to see the EEGs and 401 findings of previous epilepsy monitoring recordings (accessible via the patient's health record). Montages

402 and filter settings used during recording and review may be different between hospitals. So the reviewer 403 may decide to use either the Waveform Acquisition Presentation State object to see directly what the 404 outside EEG staff annotated and which filters and montages where used. Or she may wish to review the 405 data with montage settings as provided in a Waveform Presentation State created by the outside 406 neurologist.

#### 408 Use case: Automated Waveform Analysis

409 Algorithms may store observations and measurements as annotations in a Waveform Annotation SR

410 object. Additionally, it might be useful to store montages and filter settings used by the algorithm in a 411 Waveform Presentation State object for future reference.

#### 412 XXX.2 Waveform Acquisition Presentation State usage

413 Everything in the description of the Waveform Presentation State Object above also applies to the

414 Waveform Acquisition Presentation State Object, but the Waveform Acquisition Presentation Object

415 provides extended functions and use cases. With the Waveform Acquisition Presentation Statge Object,

416 encoding of visualization montage use over time during the recording is mandatory using the Montage 417 Activation module and the Waveform Presentation Montage module. The Montage Activation module

- 417 Activation module and the waveform resentation montage module. The montage Activation module
   418 encodes a sequence of times during the recording when a montage was activated by the technician (for
- viewing the weeforms) and the Waveform Presentation Montage Module encodes a description of each montage.
- 421

#### 422 Use case: Recording

423 When a technician performs an EEG recording, from time to time, the technician changes the

424 visualization filter settings and montage, in order to check the quality of the source signals and/or to better

visualize a potential abnormal signal pattern in the live neurophysiology recording. Based on this

information, during the live recording, the technician may adjust the physical parameters of the recording,

427 such as manually manipulating surface electrode contract with the skin to improve the signal quality. If

428 abnormalities occur or if external circumstances change that could be of importance for the evaluation of 429 the recording, the technician may add an annotation at a particular time point. The Annotations added by

429 the recording, the technician may add an annotation at a particular time point. The Annotations added by 430 the technician during the recording may either be stored in this Waveform Presentation State object or in

431 a separate Waveform Annotation SR object.

#### 432 433 Use case: Electronic Health Record

An epilepsy patient is treated in another organization and the reviewing physician wants to see the EEGs and findings of previous epilepsy monitoring recordings (accessible via the patient's health record). Montages and filter settings used during recording may be different between hospitals. Certain neurophysiology recordings have unique and/or unusual sources, such as intracranial EEG recordings, which require the creation of a custom set of montages for that recording. So, the physician reviewer may decide to use the Waveform Acquisition Presentation State object to see directly what filters and montages where used during the recording without having to recreate a custom montage.

#### 442 Use case: Quality Control

443 A neurophysiology technician makes a recording which is of suboptimal quality. A neurophysiology lab director (who is also a neurophysiology technician) reviews the recording with the technician who made 444 445 the recording several days later. The lab director discusses with the technician that the reason the poor 446 signal quality of certain sources was not noticed during the recording (leading to certain physical parameters not being adjusted during the recording, which would have rectified the problem) was that the 447 448 technician used suboptimal filter and/or montage settings. Such suboptimal filter and montage settings can include filter settings with notch filter on which can hide line noise (which can indicate poor 449 450 impedance) or a montage that does not include relevant sources. This allows the lab director to provide 451 education on how to improve the recording process in the future. 452

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