Digital Imaging and Communications in Medicine (DICOM)

Supplement 245: RDSR Informative Annex

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Developed Pursuant to Work Items

- 2004-04-C Radiation Dose SR
- 2015-12-D Cone Beam CT-RDSR

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Document History

Document Version	Date	Content
Draft 01	June 10, 2021	Initial outline
Draft 02	Sept 17, 2021	Updated at WG-28 / WG-02 joint meeting
Draft 03	March 03, 2022	Updated sections 3.2, 3.2.1, 4.2, and 4.4
Draft 04	March 09, 2022	Updated 3.2.4, 3.2.1, general typo corrections
Draft 05	June 06, 2022	Updated 3.2.2 and 3.2.6
Draft 06	Sept 14-16, 2022	Updated at WG-28 / WG-02 joint meeting
Draft 07	Mar 06-08, 2023	Updated at WG-28 / WG-02 joint meeting
Draft 08	May 17-19, 2023	Updated at WG-28 / WG-02 joint meeting
Draft 09	July 19, 2023	Updated at WG-28 / WG-02 joint call
Draft 10	Oct 20, 2023	Updated at WG-28 / WG-02 joint meeting
Draft 11	Dec 18, 2023	Updated at WG-28 / WG-02 joint call
Draft 12	Jan 11, 2024	Updated at WG-06 First Reading. First Reading stopped on line 262

Scope and Field of Application

This Supplement provides explanatory information on the creation and usage of RDSR (traditional and enhanced) within Angiography, Mammography, Radiography, CT, Dentistry modalities etc. This supplement excludes Radiopharmaceutical and Patient Radiation Dose SR.

Given the modality-specific content definition of the RDSR, and the many different types of system configurations existing in the field, it becomes challenging for the manufacturers to have a clear understanding of the precise requirements for each type of device.

The purpose of this supplement can be summarized as follows:

- Give more information beyond the definitions in PS 3.16: describe real-world scenarios of typical equipment configurations, provide examples and encoding guidelines;
- Indicate restrictions on the applicable scenarios (defined terms recommended, values ranges, recommended presence of Content Items);
- Promote usage of optional Content Items under particular scenarios;
- Assess the applicability for some conditional Content Items under particular scenarios;

The scope of the proposed Supplement includes:

- An overview of the landscape of different modalities and types of equipment configuration, from simple legacy CR to modern integrated Angio equipment.
- Guidance on how to use the different TIDs and Content Items depending on the modality, equipment types and configurations. For example, in Projection Radiography the amount of information required in the RDSR will depend on the data integration technology: Two equipment categories can be defined:
    a. **Integrated System**: A projection radiography system where the X-Ray Detector, X-Ray Source and gantry/positioning components are integrated and the managing system is able to access details of each component (requires TID 10007);
    b. **Cassette-based System**: A projection radiography system where the X-Ray Detector, X-Ray Source and gantry/positioning components are not integrated. E.g., cassette-based CR and DR systems (requires TID 10006).

  Moreover, each of these two categories may have data available of one or more of the following components: X-Ray Detector, X-Ray source, and Gantry/Positioning.
- Similarities and equivalences of same information in both traditional RDSR and enhanced RDSR. Encoding examples of using the traditional RDSR and the enhanced RDSR (introduced in Supplement 214), and mapping between these two RDSRs.

The work of this Supplement was undertaken in liaison with the America Association of Physicists in Medicine (AAPM) and European Federation of Medical Physicists (EFOMP).

YELLOW highlight in this document are editor notes (to be removed once resolved)

Open / Closed Points

Item	Question	Answer	Status
1	How to explain the differences between Traditional RDSR and Enhanced RDSR on tricky things (e.g. filters)? In each section of this supplement? Or all in one single section?	In each section	Closed
2	How to merge existing P3.17 sections AA and UUUU with new supplement content?		Open
3	Do we need to add a section to explain how to uniquely identify the device that has created the RDSR? This question comes often from users, due to poor implementations not using Serial Number. Implementors are looking for guidance on how to encode the Equipment Module… Action: Add some context and details on what are the problems and what we try to accomplish (e.g. refer to email sent to ACR)	The group thinks yes. Refer to discussion WG-28/02 in Boston May 2023.	Open
4	Do we need to add a section to explain how to use the Dose Calibration information in RDSR? This question comes often from users, JIRA is working on a CP to improve the calibration container.	Refer to discussion WG-28/02 in Boston May 2023. JIRA is planning to create a CP.	Open
5			
6			

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Tasks

Item	Task
1	Sections ZZZZZ.3.2.6 are To Be Reviewed By WG-22
2	Table ZZZZZ.4.1-1, first row: Accumulated Dose Data, Calibration : Check if something was added or removed in 10041 vs. Traditional RDSR: Add here any difference between TID 10012 (CT) + 10002 + 10004 + 10005 + 10006 + 10007 and TID 10041
3	Table ZZZZZ.4.4.1-1 Reference Point Definitions: Mammography reference point definition: (113865, DCM, “4.2cm above Breast Support Surface”) From CP2287 is in CPACK 124. Make sure this Code Meaning does not change before FT. To be reviewed by WG-15. Dentistry (IO, PX): WG-22 to determine what would be the typical Reference Point Definition
4	ZZZZZ.4.4.3 Isocenter Reference System in Enhanced XA:

	Decide if we should create a CP for Part 16 TID 10002 Rows 18-20 to make these previous statements more explicit about Patient Fiducials?
5	Complete sections ZZZZZ.4.8 and ZZZZZ.4.9 (CR modality)
6	ZZZZZ.5.1.2. Example of Traditional RDSR for CT Complete text highlighted in yellow
7	ZZZZZ.5.1.3. Example of Traditional RDSR for DX ZZZZZ.5.1.4. Example of Traditional RDSR for MG Create examples
8	Work on highlights following WG-06 First Reading on Jan 11, 2024

Changes to NEMA Standards Publication DICOM 2023e

Digital Imaging and Communications in Medicine (DICOM)

Part 17: Explanatory Information

Item #01: Add new Annex to Part 17 (or replace Annex UUUU)

ZZZZZ Radiation Dose Structured Reporting (Informative)

ZZZZZ.1 [DONE] PURPOSE OF THIS ANNEX

Multiple systems contributing to patient care during a visit may expose the patient to irradiation during diagnostic and/or interventional procedures. Each of those systems may record the dose in a Radiation Dose Structured Reporting information object. Radiation information reporting systems may take advantage of this information and create additional reports or summaries for a visit, parts of a procedure performed, or accumulation for the patient in total, since information is completely available as structured content.

This Annex describes the use of the Radiation Dose SR Objects by different system types, highlighting the encoding similarities and differences across modalities, as well as the differences between traditional RDSR (defined with Root TIDs 10001 and 10011) and the Enhanced RDSR (defined with Root TID 10040).

[Say that capitalized words in this annex are only used for DICOM terms and definitions]

ZZZZZ.2 [DONE] DEFINITIONS

Need to reword this section. These definitions are only in the scope of this annex. We do not intend to create new definitions in DICOM standard. Rephrase with something like:

Traditional RDSR in this annex refers to a Radiation Dose Structured Report created with Root TIDs 10001 or 10011

Enhanced RDSR in this annex refers to a Radiation Dose Structured Report created with Root TID 10040

~~**Traditional RDSR**~~

~~A Radiation Dose Structured Report created with Root TIDs 10001 or 10011~~

~~**Enhanced RDSR**~~

~~A Radiation Dose Structured Report created with Root TID 10040~~

ZZZZZ.3 RADIATION DOSE OVERVIEW

ZZZZZ.3.1 [DONE] User Needs

Over the last few years, there is increased attention to the radiation dose delivered during diagnostic and interventional exams. As a consequence, systems that collect radiation dose indices from diagnostic or image guided interventional studies using ionizing radiation have been developed and implemented. Most of the information collected is obtained from the RDSR provided by the Modality and can be used for a wide range of applications, many of which are modality specific.

As a primary use, the information included in the RDSR can be used to evaluate protocol appropriateness. Modality-specific dosimetric indicators can be sent to local/regional/national dose registries. In this case, this information can be used to compare different practices and benchmark the dose levels of one's institution against diagnostic reference levels.

Dosimetric indicators, together with other information recorded about the exam (i.e., the name of operator who performed the exam), can also be used to monitor the utilization of the equipment. [add: and to catch any deviation from regulations or best practices…]

The information contained in the RDSR can be used not only to track but also to optimize the levels of radiation and the acquisition protocols. The analysis of the information included allows users to evaluate if the expected optimization was achieved. RDSRs also allow users to account for the variability in patient size and imaging system models, capabilities, and manufacturers during analysis.

Another use of the RDSR is providing the clinical medical physicist with the information necessary for individual patient and/or fetal dose estimates. Depending on the modality, the output of the equipment, together with patient information, could be used to perform organ dose and/or skin dose map estimations.

The RDSR may also be used to perform analysis of rejection and repetition of images *[note: RDSR does contain already reject and repeat flags – discuss whether we should drop this paragraph – see IHE Reject/Repeat profile]*. The RDSR is especially useful in this application because it will contain information of exposures that would otherwise be discarded during rejection of the unwanted image. Use of the RDSR allows for analysis of acquisition duplication independent of the archiving or deletion of the actual images.

The availability and quality of the RDSR produced by the image acquisition systems are critical to the success of the use cases mentioned above.

ZZZZZ.3.2 [DONE] Real-world Scenarios of Radiation Dose Reporting

[*break down this introduction more concept by concept*]

The radiation dose information and the related technical parameters contained in the RDSR are collected through different workflows depending on the clinical specialty, on the type of procedure reported, and on the type of equipment. Such workflows may involve one or several systems and components, which may be completely or not-at-all integrated *[discuss how to introduce the concept of integrated vs. non-integrated here, highlight the challenges of non-integrated]*, interacting at one or several moments in time, and requiring complete, some, or no manual input. For instance, an ~~Acquisition Modality~~ (system?) generating the RDSR might not necessarily generate the irradiation itself, the ~~Acquisition Modality~~ (RDSR creator? "anciliary system") will do it on behalf of an irradiating system based on irradiation details obtained by manual input and/or some proprietary method.

The type of procedure will determine the radiation dose ~~quantities~~ metrics (e.g. dose, technical parameters etc…) that are relevant to be reported. For instance, the average glandular dose is relevant to Mammography procedures, the cumulative air kerma at the reference point is relevant to Angiography and interventional procedures, and the exposure index is relevant to digital radiography to provide feedback regarding the estimated exposure on the detector.

In addition, for a given type of procedure, the technology of the equipment will also determine the available information that can be collected about the irradiation generation and the related device parameters such as X-Ray detector, X-Ray source, and mechanical configuration.

As a consequence, the amount of information reported in the RDSR will reflect the way the information is generated and collected. RDSR interoperability requires that implementers and interpreters of RDSR have the same understanding on how the different DICOM Templates and Content Items should be populated based on the real-world scenarios of irradiation generation and system data collection for the different types of procedures.

The following subsections provide an overview of these real-world scenarios in X-Ray Angiography, Radiography/Fluoroscopy, Radiography, Mammography, Computer Tomography, and Dentistry. While the procedures described hereafter follow a similar high level workflow in terms of irradiation generation, data collection, and radiation dose reporting, the exact workflow steps for each scenario may vary, resulting in different ways to report the data.

A common concept of all these procedures is the Irradiation Event, which is defined as "*the loading of X-Ray equipment caused by a single continuous actuation of the equipment's irradiation switch, from the start of the loading time of the first pulse until the loading time trailing edge of the final pulse*." Each Irradiation Event is identified by a UID, but it may not necessarily result in a stored DICOM image. On the other hand, a single Irradiation Event may result in the creation of multiple DICOM images from the same acquired raw data.

[Make sure that capitalized words are only used for DICOM terms and definitions]

ZZZZZ.3.2.1 [DONE] X-Ray Angiography

The term *X-Ray Angiography (XA)* used in DICOM denotes a wide range of procedures typically performed in the catheterization lab (cath lab). Historically, the term referred to diagnostic and interventional angiography procedures, i.e. imaging of the blood vessels and organs of the body (arteries, veins, and heart chambers) by injecting a radio-opaque contrast agent into the blood. These procedures require unique imaging techniques such as high cine frame rates and high spatial resolution, combined with a good dynamic range for optimal image quality.

XA equipment is also used for *electrophysiology (EP)* procedures in the cath lab (so-called EP lab), where catheters and wire electrodes are passed through blood vessels to assess and treat the heart's electrical activity. The growing use of fluoroscopically-guided procedures in the cath lab for minimally invasive surgical interventions led to the definition of the new term *Interventional*, which includes Interventional Radiology (IR) and Cardiology (IC) procedures that do not always use angiography techniques but require the same type of XA equipment to visualize instruments inside the body. They are performed in the so-called interventional lab or in hybrid operating rooms. Finally, imaging-guided surgical procedures may use similar XA imaging techniques on smaller mobile equipment.

A general XA procedure workflow is as follows:

1) The Study starts,
    a. Procedure information is provided (including operator, patient position relative to the table, etc.), including patient and exam information from the DICOM Modality Worklist.
2) XA images are generated during one procedure step (what is the exact meaning here? The Procedure Step defined in DICOM Real World Model?...)
    a. A Irradiation Event results in an XA 2D projection image created on the equipment and is displayed in real time as it is created.
        i. An XA 2D projection image can be multi-frame (cine) or single-frame (single shot).
        ii. When the two X-Ray sources of a biplane system are activated simultaneously between X-Ray ON and OFF, it results in two Irradiation Events, one for Plane A and one for Plane B.
        iii. XA has ~~An XA 2D projection image can be generated from one of the~~ two main irradiation modes: Fluoroscopy (e.g. low dose) and Acquisition (e.g. high dose or cine run). Fluoroscopy is typically used to place the instruments (catheters, guidewires, needles…) and may or may not be stored, while Acquisitions are usually stored.
        iv. The XA 2D projection images resulting directly from the irradiation (both Fluoroscopy and Acquisitions) are referred as original images in the scope of XA (do not use DICOM terms "primary" or "secondary").
    b. [Rework:], as opposed to derived images which are created after processing of original images (e.g., subtraction image resulting from two acquisitions). [Note: original images inherintly involve dose, derived images do not]
    c. 3D cone-beam reconstructions may be created from XA 2D projections and stored as X-Ray 3D instances. Since they are not directly created from a primary radiation but they are created from 2D X-Ray images, the 3D X-Ray instances may include a reference to the Irradiation Event UIDs of the 2D images.
    d. All XA images stored during one procedure step may be exported as DICOM XA images within one or several DICOM Series.
    e. [Add: there will be more irradiation events in this step]
3) Several procedure steps can be performed during the Study.
4) The Study ends.
5) One or several RDSR are created during and/or following the Study. The scope of accumulation of the RDSR indicates the period of irradiation reported in that RDSR instance, e.g. the Study, the Series, the Performed Procedure Step etc.

The equipment used in all these procedures typically includes the X-Ray Source and X-Ray Detector mounted on a C-Arm, and the technical data related to the Source and Detector is collected automatically. The mechanical data related to the gantry is known (e.g. positioner angles), while the data related to the table may be known if the table is integrated with the gantry but may be unknown on mobile C-Arms.

See also PS3.17 Annex FFF. Enhanced XA/XRF Encoding Examples (Informative) and PS3.17 Annex TTT. X-Ray 3D Angiographic Image Encoding Examples (Informative) for more information about X-Ray Angiography.

ZZZZZ.3.2.2 [DONE] Radiofluoroscopy

Fundamentally, fluoroscopy is real-time x-ray imaging where multiple images are acquired in rapid succession at various frame rates. As such, fluoroscopy systems have high spatial and temporal resolution combined with wide dynamic range for good image quality. Fluoroscopy is used to guide the placement of medical devices and to visualize dynamic physiological processes.

The term *Radiofluoroscopy* (*rad/fluoro,* or simply *RF,* for short) describes an exam room where a wide variety of both radiography and fluoroscopy studies can be performed. These include radiography of almost any anatomy or organ system as well as fluoroscopy of the gastrointestinal system, genitourinary system, hepatic and biliary system, spinal canal, joints, lungs, and others. Often, fluoroscopy involves real time imaging of the flow of radio-opaque contrast material (e.g., barium or iodine) through these organ systems.

The equipment always includes a fixed rad/fluoro system, typically capable of acquiring fluoroscopic, acquisition/cine, and radiographic images (and sometimes even tomosynthesis images). This system can be in 1 of 2 possible configurations:

- x-ray source below patient table and image receptor above table
- x-ray source above patient table and image receptor below table

In both configurations, the x-ray source and image receptor are connected to each other via a gantry. For most exams, the table is horizontal with the patient lying on the table. The table can often angulate even to the point where it is completely vertical for some studies (e.g., swallow studies).

An additional ceiling mounted x-ray source may be present in the exam room. This x-ray source may be used for:

- radiographic imaging with a DR or CR image receptor that is free floating or mounted on the side of the patient table
- radiographic imaging in conjunction with a table bucky or wall bucky that can accept either a DR or CR image receptor. The table bucky and/or wall bucky may or may not be present.

A general rad/fluoro procedure workflow is as follows:

1) The Study starts
    a. Procedure information, etc. is input by the operator and/or collected from the DICOM Modality Worklist
2) Images are generated during one procedure step
    a. The irradiation generation of one x-ray source during the time between x-ray ON and OFF is considered one Irradiation Event.
    b. One Irradiation Event can result in a single frame 2D projection image or multi-frame 2D projection images (a “loop” acquired at some frame rate) that is/are typically displayed in real time on the system.
    c. The rad/fluoro system can acquire lower dose fluoroscopy images that may or may not be stored locally (user selectable option) as well as higher dose RF acquisition/cine images that are always stored locally. The RF images can be single frame or multi-frame.
    d. The rad/fluoro system can acquire DX/CR 2D radiographic images. The ceiling mounted x-ray source (and associated image receptor) can acquire DX/CR 2D radiographic images. These images may be stored locally, or, as may be the case for CR detector, on an associated system. The DX/CR images are single frame.
    e. The image(s) stored locally during one procedure step may be exported as a DICOM series.
3) Several/many procedure steps can be performed during the Study.
4) The Study ends.

5) One or several RDSR are created during and/or after the Study. The scope of accumulation of the RDSR indicates the period of irradiation reported in that RDSR instance, e.g., the Study, the Series, the Performed Procedure Step, etc.

The equipment used in all these procedures, including x-ray Sources and Image Receptors (if they are known), and the technical data related to the Sources and Images Receptors is collected automatically. In the case where the system may not know about the Image Receptor (e.g., CR), such information may not be stored in the RDSR, and may be part of a separate RDSR from the associated system.. The mechanical data related to the rad/fluoro gantry is generally known (e.g., positioner angles/column angles), and may also be included in the RDSR.

ZZZZZ.3.2.3 [DONE] Radiography

Radiography describes a wide range of imaging procedures using an X-Ray source and detector. It is the oldest form of X-Ray-based medical imaging, dating back to the earliest images in the age of Roentgen. In general, radiography procedures acquire one to several projection views of patient anatomy, which are typically reviewed without further reconstruction or post-processing. Radiography systems are available in variety of configurations, including fixed or mobile systems, systems with or without integrated detector systems, systems with or without tables, systems with or without wall stands, along with others. While a given system may have a typical imaging focus (e.g., chest X-Ray rooms), radiography systems can be used to image virtually all anatomic regions. Some radiography systems may include additional functionality (e.g., tomosynthesis, dual energy), which require additional hardware and software.

Radiography systems can be broadly characterized in several ways: fixed or mobile, and integrated or non-integrated detector. The configuration will impact both the workflow for system usage, as well as the content available for the creation of an RDSR.

Regardless of the configuration and detector type, the general workflow for radiography is similar:

1) The Study starts
    a. Procedure information, etc. is input by the operator and/or collected from the DICOM Modality Worklist. Depending on the type of detector integration, the information may be put on the generator control side, or on the detector side.
2) The patient is positioned for the initial view for the study.
3) One or several radiography acquisitions of the patient are performed as separate Irradiation Events:
    a. The patient and/or radiography system are repositioned for each view
4) The radiography image from each acquisition is typically stored as a separate DICOM Series.
5) Several Series can be performed during the Study. The number of images as part of a Study may vary based on exam type. For example, a two-view chest Study typically includes a PA and lateral view of the chest.
6) The Study ends.
7) One or several RDSR are created during and/or after the Study. The scope of accumulation of the RDSR indicates the period of irradiation reported in that RDSR instance, e.g., the Study, the Series, etc.

The system generating the RDSR (e.g., X-Ray tube/generator or detector) varies depending on the configuration of the system and level of integration. Generally, fully integrated systems with X-Ray tube, generator, and detector all in communication with one another should be expected to produce the most complete RDSRs with technique information, exposure information, and potentially system geometry information. Non-integrated systems (e.g., independent CR plate/reader and X-Ray tube/generator) generally have no communication between one another, resulting in an RDSR that does not have the same level of information.

ZZZZZ.3.2.4 [DONE] Mammography

Mammography describes an imaging procedure of the breast or portion of the breast. Mammography systems use specialty radiographic equipment, specifically designed to image breasts. This includes compression devices, special X-Ray tube target and filter combinations, and high-resolution detectors. Modern mammography systems also often include digital breast tomosynthesis (DBT) capabilities, which produce tomosynthetic reconstructions of the breast from a limited-angle tomosynthesis acquisition. Other acquisition modes may be available (e.g., contrast enhanced mammography), but the general methodology for image acquisition is similar.

A general mammography procedure workflow is as follows:

1) The Study starts
    a. Procedure information, etc. is input by the operator and/or collected from the DICOM Modality Worklist

2) The patient's breast is positioned in the mammography system (e.g., on the breast support or magnification stand) for the initial laterality and view.
3) One or several acquisitions of each breast are performed as separate Irradiation Events
    a. Each breast may be imaged one or several times. Subsequent views of the same breast may be performed after repositioning (e.g., mediolateral view following cranial-caudal view).
    b. Each breast is imaged separately, again with repositioning between exposures. A Study may include only a single breast.
    c. Each view may include several acquisitions. For example, both traditional 2D and DBT views may be performed at the same view.
    d. Images may be single frame (e.g., from 2D acquisition) or multi-frame (e.g., from DBT acquisition).
4) The mammography image from each acquisition is typically stored as a separate DICOM Series. While a traditional 2D acquisition generally creates one single-frame DICOM Series, other acquisition types may result in the creation of multiple DICOM series. For example, a DBT acquisition may generate a multi-frame DICOM Series with the projection images, one or more DICOM Series with multi-frame tomosynthesis reconstructions at varying thicknesses and overlaps, and a DICOM Series of a synthesized 2D view generated from the DBT acquisition.
5) Several Series can be performed during the Study. The number of images as part of a Study may vary based on exam type. For example, a screening mammography exam may include two views (mediolateral-oblique and cranial-caudal) of each breast, for a total of four images in four DICOM Series. If the screening exam uses DBT, the Study may include a combination of 2D and DBT images of these same views. A diagnostic mammography exam may only include views of one breast, with the total number varying based on the specifics of the diagnostic exam.
6) The Study ends.
7) One or several RDSR are created during and/or after the Study. The scope of accumulation of the RDSR indicates the period of irradiation reported in that RDSR instance, e.g., the Study, the Series, etc.

The equipment used in all these procedures typically includes the X-Ray Source and X-Ray Detector mounted on a gantry, and the technical data related to the Source and Detector is collected automatically. The mechanical data related to the gantry is generally known (e.g., positioner angles).

ZZZZZ.3.2.5 [DONE] Computed Tomography

Computed tomography (CT) describes a wide range of possible imaging procedures performed in a variety of clinical settings. Most CT imaging occurs in a radiology setting using a fixed gantry with a rotating source and detector to acquire data which are reconstructed to form cross-sectional images of a patient or object. These systems typically use a table that automatically positions the patient based on a localizer scan. The table may also move during image acquisition to acquire in a helical (or "spiral") mode. Examples of other areas which may use CT include interventional/surgical suites, radiation oncology departments, and dental offices. Systems which use a wide cone angle, often called cone-beam CT or CBCT systems, may use acquisition methods similar to XA systems mentioned in ZZZZZ.3.2.1, in addition to CT acquisitions. In such instances, the traditional RDSR may not be able to fully encompass meaningful radiation dose reporting from both modalities.

A general CT procedure workflow is as follows:

1) The Study starts
    a. Procedure information, etc. is input by the operator and/or collected from the DICOM Modality Worklist
2) One or more localizer acquisitions are performed, each as a separate Irradiation Event.
    a. Additional localization acquisitions may be performed during the Study if the patient positioning is changed, e.g., move from prone to supine, or if additional localization information is required.
3) One or several CT acquisitions are performed as separate Irradiation Events
    a. CT acquisitions are typically controlled from a remote location outside the CT scanner room. A CT operator actuates the beginning of the first CT acquisition, which may have delays or other timing associated with patient instructions, contrast agent injections, cardiac monitors, etc. The CT acquisition does not typically require continuous actuation of a switch or pedal, unlike other modalities.
    b. Subsequent acquisitions with new Irradiation Event UIDs may take place automatically following the scan parameters set up by the CT operator. This is often required due to the precise timing requirements associated with multiple CT scans, especially when trying to capture dynamic information (e.g., cardiac motion, respiratory motion, contrast agent enhancement, etc.).

Subsequent scans may also take place via manual actuation of the irradiation switch by the CT operator. In such a case, the scans are still associated with new Irradiation Event UIDs. A CT Study may contain a combination of automatic and manually started CT acquisitions, depending on the specific protocol.

c. All CT acquisitions may include periods where a CT scanner may switch the irradiation “off” to allow for gating or other delays as part of a scan protocol. In such instances, the acquisition is still contained within a single Irradiation Event.

d. Some CT scanners may include multiple X-Ray sources that are simultaneously irradiating during an acquisition. An acquisition with multiple sources still produces a single Irradiation Event UID, regardless of the number of sources.

4) CT reconstruction is performed:

a. The data collected during an acquisition may be reconstructed into zero, one, or several CT DICOM Series. The same acquisition data may be reconstructed into several DICOM Series using different reconstruction filters, slice thicknesses, fields-of-view, axial ranges, cardiac gating, etc. Data from certain acquisitions, e.g., bolus-tracking series, might not be reconstructed or saved. Several acquisitions may be combined to create a single DICOM Series, e.g., dual energy images. Any CT images created from one or more acquisitions should include the Irradiation Event UID(s) that was/were used for reconstruction. If multiple reconstructions come from the same acquisition, all would include the same Irradiation Event UID.

b. Additional reconstructions, e.g., multiplanar reformats or maximum intensity projections (MIPs), may be generated from the DICOM Series generated in the previous step. If the Irradiation Event UID is present in the additional reconstructions, it should be copied from the original image.

5) Several Series may be performed during the Study. In addition, a single Irradiation Event may be used to generate CT images as part of multiple DICOM Studies, e.g., chest CT Study separated from abdominal CT Study. In such a case, the Irradiation Event UID will be the same for both Studies.

6) The CT Study (or Studies) ends.

7) One or several RDSR are created during and/or after the Study. The scope of accumulation of the RDSR indicates the period of irradiation reported in that RDSR instance, e.g., the Study, the Series, etc.

The equipment used in all these procedures typically includes the X-Ray Source(s) and X-Ray Detector(s) mounted on a CT gantry or C-arm, and the technical data related to the Source(s) and Detector(s) is collected automatically. The mechanical data related to the gantry is known (e.g., positioner angles), while the data related to the table may be known if the table is integrated with the gantry but may be unknown on some specialty systems without integrated tables.

ZZZZZ.3.2.6 Dentistry

ZZZZZ.3.2.6.1 [DONE, To Be Reviewed By WG-22] Dental Computed Tomography (CT) Including Cone-Beam Computed Tomography (CBCT)

Dental computed tomography (CT), including cone-beam computed tomography (CBCT), describes a wide range of possible imaging procedures performed in a variety of clinical settings. Most CT imaging occurs in a dental office or imaging center using a gantry with a rotating source and detector to acquire data that are reconstructed to form cross-sectional images of a patient or object. These systems may position the patient in a standing or an upright seated position or may use a table that automatically positions the patient based on a localization acquisition. The table may also move during image acquisition to acquire in a helical (or "spiral") mode. Systems that use a wide cone angle, often called cone-beam CT/ CBCT system or dental volumetric CT, may use acquisition methods similar to XA systems mentioned in ZZZZZ.3.2.1, in addition to CT acquisitions. In such instances, the traditional RDSR may not be able to fully encompass meaningful radiation dose reporting from both modalities.

Commented [NB1]: Seek clarification from WG22. I'm personally unfamiliar with the small cone angle systems. Is that what's meant by dental CT (as opposed to dental CBCT)?

A general dental CT or CBCT procedure workflow is as follows:

1) The Study starts

a. Procedure information, etc. is input by the operator and/or collected from the DICOM Modality Worklist

2) One or more scout acquisitions may be performed

a. Additional scout acquisitions may be performed during the Study if the patient positioning is changed.

3) One or several CT or CBCT acquisitions are performed as separate Irradiation Events

a. Dental CT and CBCT acquisitions are typically controlled from a remote location outside the scanner room. An operator actuates the beginning of the first acquisition, which may have delays or other

Commented [NB2]: Are scouts typically performed for dental settings? Again, the systems I'm familiar with don't use scouts (maybe just lasers and cameras). Seek input from WG22.

timing associated with patient instructions, etc. The acquisition typically requires continuous actuation of a switch or pedal.

Commented [NB3]: Verify w WG22

b. All CT acquisitions may include periods where a CT or CBCT scanner may switch the irradiation "off" to allow for gantry motion or other delays as part of a scan protocol. In such instances, the acquisition is still contained within a single Irradiation Event.
c. The actuation of the irradiation switch between Irradiation events may be performed under the sole control of the CT or CBCT operator (e.g., to perform scans of the TM joints which may or may not be stitched to create a single DICOM volume). Note The stitching or bringing together of separate CBCT volumes into a single cohesive volume can be performed as an automated process (which is the case the majority of the time) or as an operator manually controlled process by matching together similar areas on 2 or more CBCT volumes. In the latter case, the acquisition of CBCT volumes can be separate volumes acquired at different places in time or at the same time but requiring different patient scout exams.

4) CT or CBCT reconstruction is performed:
   a. The data collected during an acquisition may be reconstructed into zero, one, or several DICOM Series. The same acquisition data may be reconstructed into several DICOM Series using different reconstruction filters, slice thicknesses, fields-of-view, axial ranges, etc. Any images created from one or more acquisitions should include the Irradiation Event UID(s) that was/were used for reconstruction. If multiple reconstructions come from the same acquisition, all would include the same Irradiation Event UID.
5) Additional reconstructions, e.g., multiplanar reformats, maximum intensity projections (MIPs), or curved reformats, etc. may be generated from the DICOM Series generated in the previous step. If the Irradiation Event UID is present in the additional reconstructions, it should be copied from the original image.
6) Several Series can be performed during the Study.
7) The Study ends.
8) One or several RDSR are created during and/or right after the Study. The scope of accumulation of the RDSR indicates the period of irradiation reported in that RDSR instance, e.g., the Study, the Series, etc.

The equipment used in all these procedures typically includes the X-Ray Source and X-Ray Detector mounted on a CT gantry or C-arm, and the technical data related to the Source and Detector is collected automatically. The mechanical data related to the gantry is known (e.g., positioner angles), while the data related to the table may be known if the table is integrated with the gantry.

ZZZZZ.3.2.6.2 [DONE, To Be Reviewed By WG-22] Cephalometry

Cephalometry describes imaging of the head for orthodontic treatment and is typically performed in specialist orthodontic clinics. Imaging typically occurs using a panoramic X-Ray system fitted with a fixed or movable arm with to acquire data within an integrated detector or a removable cassette. For integrated-detector systems, the detector may be a linear scanning type or a direct-exposure area detector. These systems position the patient in an upright standing or seated position.

A general cephalometry procedure workflow is as follows:

1) The Study starts
   a. Procedure information, etc. is input by the operator and/or collected from the DICOM Modality Worklist
2) One or several cephalometric acquisitions are performed as separate Irradiation Events. Each acquisition is typically stored as a separate Series.
3) The Study ends.
4) One or several RDSR are created during and/or right after the Study. The scope of accumulation of the RDSR indicates the period of irradiation reported in that RDSR instance, e.g., the Study, the Series, etc.

The technical data related to the X-Ray Source and Detector is collected automatically in the case of integrated-detector systems and included in the RDSR. In the case of non-integrated systems, X-Ray Source information will not be present in the RDSR unless additional software or user input is used to provide the information

ZZZZZ.3.2.6.3 [DONE, To Be Reviewed By WG-22] Intra-Oral Radiography

Intra-oral radiography describes imaging of the teeth and related structures with the X-Ray Detector placed within the patient's mouth and is performed in a variety of clinical settings. Imaging occurs using an X-Ray source typically fitted to a movable arm (but may also include a handheld portable X-Ray source) and an X-Ray Detector to acquire data. The patient is typically imaged in a seated position.

A general intra-oral radiography procedure workflow is as follows :

1) The Study starts
    a. Procedure information, etc. is input by the operator and/or collected from the DICOM Modality Worklist
2) One or several intra-oral acquisitions are performed as separate Irradiation Events. Each acquisition is typically stored as a separate Series.
3) The Study ends.
4) One or several RDSR are created during and/or right after the Study. The scope of accumulation of the RDSR indicates the period of irradiation reported in that RDSR instance, e.g., the Study, the Series, etc.

The equipment used in all these procedures typically includes the X-Ray Source and X-Ray Detector. Typical intra-oral radiography systems lack integration between the X-Ray Source and Detector. In this case, the X-Ray Source information will not be present in the RDSR unless additional software or user input is used to provide the information. On intra-oral radiography systems with an integrated X-Ray Source and Detector, X-Ray Source information is collected automatically and included in the RDSR.

ZZZZZ.3.2.6.4 [DONE, To Be Reviewed By WG-22] Panoramic Dental Radiography

Panoramic dental radiography, describes imaging of the head for dental treatment and is typically performed in a variety of clinical settings using specialized equipment. Imaging occurs using a panoramic X-Ray system with a X-Ray source and X-Ray Detector to acquire data. In the case of an integrated system, both the X-Ray Source and X-Ray Detector rotate around the patient's head. For non-integrated detector systems, only the X-Ray Source rotates. These systems position the patient in an upright standing or seated position.

A general panoramic dental radiography procedure workflow is as follows:

1) The Study starts
    a. Procedure information, etc. is input by the operator and/or collected from the DICOM Modality Worklist
2) One or several panoramic acquisitions are performed as separate Irradiation Events. Each acquisition is typically stored as a separate Series.
3) The Study ends.
4) One or several RDSR are created during and/or right after the Study. The scope of accumulation of the RDSR indicates the period of irradiation reported in that RDSR instance, e.g., the Study, the Series, etc.

The technical data related to the Source and Detector is collected automatically in the case of integrated-detector systems and included in the RDSR. In the case of non-integrated systems, X-Ray Source information will not be present in the RDSR unless additional software or user input is used to provide the information.

ZZZZZ.4 RADIATION DOSE SR ENCODING GUIDELINES

ZZZZZ.4.1 [DONE] Encoding dose in traditional and enhanced RDSR

There are many similarities and equivalent information in in both the Traditional RDSR and Enhanced RDSR. This section will discuss details of the encodings of the templates.

Information from the Traditional RDSR that may be required by various regulatory, accreditation, and government agencies is included in both the Enhanced and Traditional SR, but in different TIDs. All users of RDSRs (creators and consumers) should be aware that TID numbers and names are not included in the encoding of RDSRs and are simply an editorial convenience for navigating the DICOM standard. In general, both the Traditional and Enhanced RDSR should be able to supply the required content for such agencies.

One key difference between the Traditional and Enhanced RDSR is that the Enhanced RDSR decouples the dependence of reporting information based solely on the beginning and end of an Irradiation Event. For example, values that change infrequently within an RDSR (e.g., Focal Spot Size) may be encoded with a single value over a time period spanning multiple Irradiation Events. Alternatively, certain values that change within an Irradiation Event (e.g., Tube Current, X-Ray Source Position during CBCT) may be encoded at finer intervals than the Irradiation Event to allow for greater precision when performing dose calculation. Since the time period of each Irradiation Event is also encoded in the Enhanced RDSR, any set of information (e.g., Tube Current, X-Ray Source Position) can be mapped to the corresponding irradiation event.

The following figure shows a simplified example of a short XA procedure meant to demonstrate the basic encoding concepts of the Enhanced RDSR timing. The same encoding methodology is applicable to all modalities and procedures.

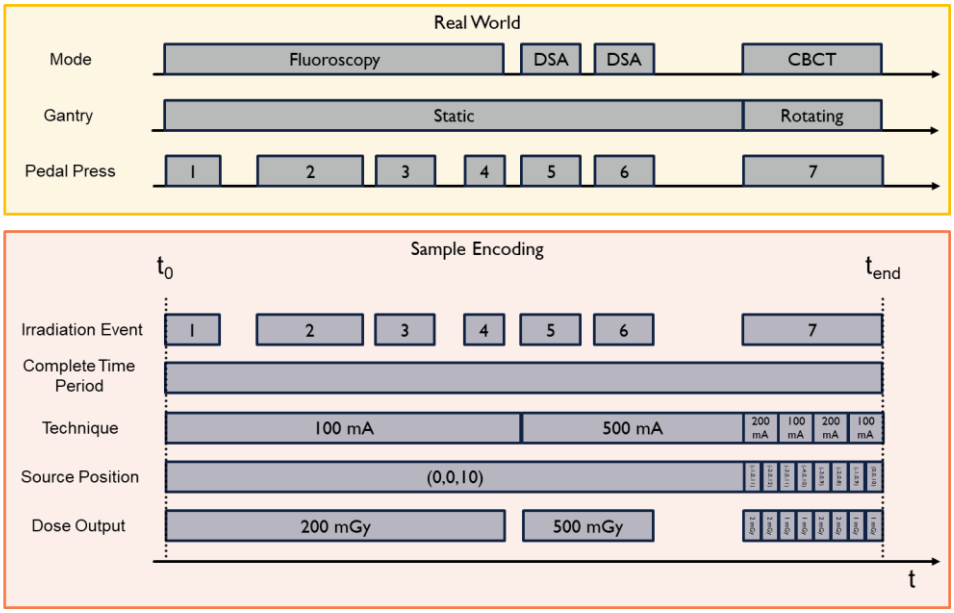

Figure ZZZZZ.4.1-1 Example of XA Procedure Encoding Concepts of the Enhanced RDSR Timing

In this figure, the yellow "Real World" box shows the imaging modes, gantry position, and "pedal presses" (i.e., X-Ray switch on/off) of an XA system. This reflects part of what the operator of the system may experience in the room and on the controls. In it, there are four presses of the X-Ray switch in regular fluoroscopy mode, two presses in DSA

mode, and one press in CBCT mode. The gantry is stationary for the fluoroscopy and DSA modes and rotates for the CBCT mode.

The orange “Sample Encoding” box shows a simplified example encoding of an Enhanced RDSR. In it, each pedal press from the real word example is shown as a separate Irradiation Event. Encoding the RDSR content by Irradiation Events is how Traditional RDSRs are created. For the Enhanced RDSR, the content is decoupled from the Irradiation Event, allowing content to either span multiple Irradiation Events or to be defined multiple times within a single Irradiation Event. In this example, all content is related by stating the DateTime at the beginning and end of a given item. The complete time period over the entire RDSR is shown on the second line and is defined by the beginning of the first Irradiation Event and the end of the final Irradiation Event.

The third line shows the Technique (tube current, in this example), and encodes the machine setting during different time periods. Here, all the fluoroscopy events (Irradiation Events 1-4) use the same tube current setting, requiring only a single encoding. Similarly, the DSA events use the same setting, requiring a second encoding. With this, the encoding of the tube current has been reduced from at least six times in the Traditional RDSR to two. Within the CBCT mode (Irradiation Event 7), the tube current is modulating and is encoded as many times as needed for dosimetric purposes (four in this example). For the Traditional RDSR, several values (e.g., tube current, tube potential, pulse width) may be encoded either once for the entire Irradiation Event or on a per-pulse basis. There is no mechanism in the Traditional RDSR for an arbitrary number of encodings.

Similar to the Technique, the Source Position can be encoded a single time for the first six Irradiation Events since it is not moving, and then encoded multiple times for Irradiation Event 7 to reflect the fact that it is rotating around the patient. The frequency of encoding for moving sources is implementation dependent.

Lastly, the Dose Output is encoded in this example to provide the dose during the fluoroscopy Irradiation Events, the dose during the DSA events, and the dose at different source positions during the CBCT event. All encodings can be related to one another via their associated DateTime values. Using this methodology, for each Dose Output encoding, the positioning, technique information, and other relevant values can be determined at any given time during the Scope of Accumulation. The Enhanced RDSR requires that the Dose Output is updated at least as often as the Source Position or Output Measurement Point Position are updated.

One important note is that the Dose Output is defined as the accumulated dose over the defined time period of the encoding. In this example, the first Dose Output encoding indicates 200 mGy of air kerma was accumulated between the beginning of the first Irradiation Event and the end of the fourth Irradiation Event. Because of how this sample encoding is performed, the Dose Output is not specifically known for each of the first four Irradiation Events.

Multiple instances of the TIDs may be encoded at different intervals from the Irradiation Events at whatever frequency is required to provide sufficient temporal resolution of the TID and its associated content items. Information in the Enhanced RDSR is grouped in different TIDs along with related information, which often change at similar frequencies. Within certain TIDs, some content items may be encoded at greater frequencies using a Value Type TABLE, which allows the encoding of multiple values in one content item along with associated DateTime values.

The following figure demonstrates the structure of encoding content items within the TIDs, as well as the use of the TABLE Value Type to encode a content item with multiple values. For a complete example of RDSR encodings see the examples located in ZZZZZ.5

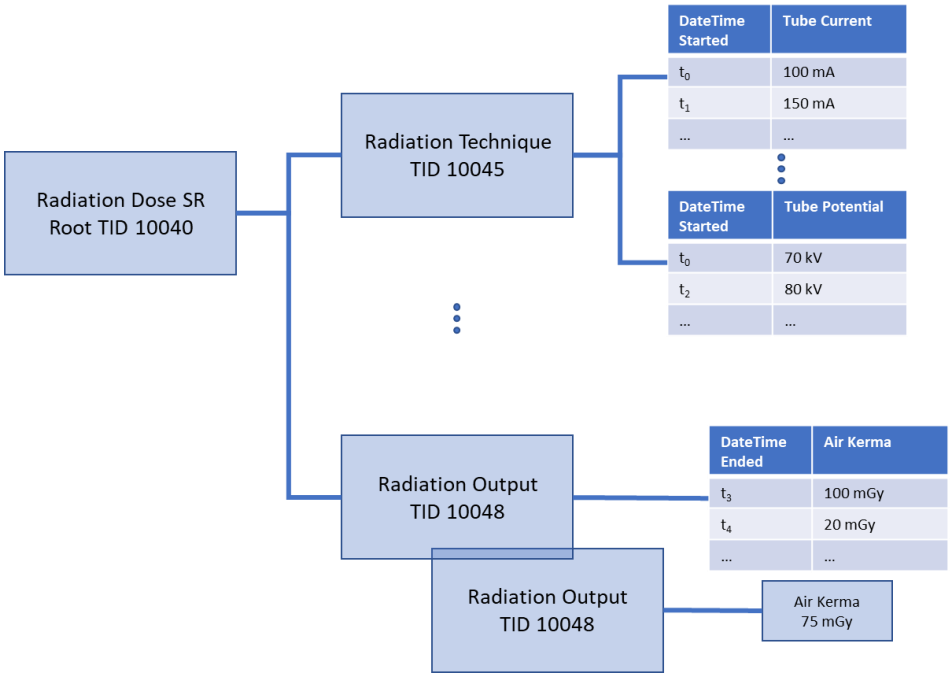

Figure ZZZZZ.4.1-2 Structure of Encoding of Content Items in TIDs and in TABLE Value Types

For TABLEs with DateTime Started as the first column, the DateTime Started of the first row matches the DateTime Started of the TID in which the content item resides. Subsequent times within each TABLE do not necessarily match each other. This is demonstrated by the tube potential and tube current TABLES: each has starting time of t_0, but the next value for tube current is t_1, while it is t_2 for tube potential. The time t_1 may be equal to t_2 but is not required to be. The final DateTime Started listed in the TABLE is not after the DateTime Ended of the TID. In this example, the TID for Radiation Technique is used only a single time, with all additional temporal information provided using the TABLE Value Type.

For TABLEs with DateTime Ended as the first column, the DateTime Ended of the first row is not before the DateTime Started of the TID in which the content item resides. For the Radiation Output TID in this example, it is used twice. In the first case, the Air Kerma at the Output Measurement Point is provided in a TABLE, where in the second case it is provided as a single value. As described earlier, in the case of using the TABLE VT for Air Kerma at the Output Measurement Point, the value provided is the Air Kerma accumulated over the period of time between the DateTime Ended listed in the table. For the first value, it is the Air Kerma accumulated between the DateTime Started listed in Row 2 of the Radiation Output TID and the DateTime Ended in the first row of the TABLE.

The following table provides a general comparison between the Traditional and Enhanced RDSRs and explains where various information is contained within each RDSR type.

Table ZZZZZ.4.1-1 Comparison Between Traditional and Enhanced RDSR

Concepts	Traditional RDSR Root TIDs 10001, 10011	Enhanced RDSR Root TID 10040
Accumulated Dose Data, Calibration	Dose output for all modalities in different TIDs: 10012, 10002, 10004, 10005, 10006, and 10007	Same data for each modality is put together in TID 10041 except: [Nick]: check if something was added or removed in 10041 vs. Traditional RDSR: Add here any difference between TID 10012 (CT) + 10002 + 10004 + 10005 + 10006 + 10007 and TID 10041 • DLP Total: it is replaced by DLP Sub-Total which is a phantom-specific addition to DLP
Observer Context, **Person Participant,** **Device Participant,** **Language of Content Items** **(See ZZZZZ.4.3 for further examples)**	TIDs 1002, 1020, 1021 TID 1204 (language)	Same TIDs as in Traditional RDSR
Irradiation Events and Radiation Technical data **(Techniques, radiation duration…)**	The technical data is described either once for the Irradiation Event (as average or a single measurement point) or for every pulse in the Event. See TIDs 10013, 10014, 10015, 10003, 10003A, 10003B, 10003C	TID 10042 provides summary data for each irradiation event. Technical data is described in TIDs included in TID 10043 based on the time periods defined at the beginning of each TID. This doesn't necessarily align with the Irradiation Event time periods, as it can be described at X-Ray pulse level, or across many Irradiation Events.
Timing **(See Figures ZZZZZ.4.1-1, ZZZZZ.4.1-2.** **See Figure ZZZZZ.4.5-1 for further examples)**	Irradiation Event (start time, duration)	Individual time period at the beginning of each TID included in TID 10043 or for each row of a TABLE Value Type. Overall DateTime Started and Ended is listed in TID 10043, providing the complete time period for all events within the Scope of Accumulation.
Geometry **(Positioner, Table, Patient Orientation, Collimator, Attenuators in the beam)** **(See ZZZZZ.4.4 for further examples)**	Distances, angles, areas, typically patient-based	Equipment or Room Coordinate-based description of positions and shapes

ZZZZZ.4.2 [DONE] Encoding of Modality, Equipment, and Procedure Information

The content of RDSR is primarily intended to provide radiation dose information, not to differentiate the exact type of equipment or clinical procedure performed. However, the RDSR includes content items that can be used to identify or infer the type of equipment and procedure, E.g. Device participant, Observer context, Image UID in the irradiation events which contain equipment module, etc.

ZZZZZ.4.2.1 [DONE] Traditional RDSR

The content item EV (121058, DCM, "Procedure reported") may contain the code (113704, DCM, "Projection X-Ray") which is defined in DICOM as "*Imaging using a point X-Ray source with a diverging beam projected onto a 2 dimensional detector*". The definition of this code is quite general and it would be applicable to many clinical procedures. In the RDSR it is expected that this code is used in X-Ray Angiography, Radio Fluoroscopy, Radiography,

and Dentistry procedures. When the RDSR is from a Mammography procedure, the code (71651007, SCT, "Mammography") is used.

The content item EV (122142, DCM, "Acquisition Device Type"), whose possible values are defined in the **CID 10032 "Projection X-Ray Acquisition Device Types**", can be used when the EV (121058, DCM, "Procedure reported") equals (113704, DCM, "Projection X-Ray"). This indicates the type of equipment used, but not the type of procedure performed. Indeed, the codes in **CID 10032** include equipment types used to do many types of procedures; angiography, electrophysiology, fluoroscopy, radiography, single frame acquisition etc. In turn, the same equipment may be used to do different procedures and acquisition types. Therefore the Acquisition Device Type should not be used to infer the clinical procedures performed. Note that the EV (122142, DCM, "Acquisition Device Type"), was introduced some years after the definition of the RDSR, it's User Optional and may be absent in many RDSRs in the field from existing and legacy systems.

EV (121058, DCM, "Procedure reported") and EV (122142, DCM, "Acquisition Device Type") are used as conditions in the template TID 10002 "Accumulated X-Ray Dose" to specify the appropriate accumulated radiation dose quantities that are reported for each type of procedure and device type.

Also note that the EV (363703001, SCT, "Has Intent") with DCID 3629 "Procedure Intent" indicates the clinical intent of the procedure, which is not necessarily related to the type of procedure and the type of equipment used.

The following table provides the recommended values of these two content items EV (121058, DCM, "Procedure reported") and EV (122142, DCM, "Acquisition Device Type") for the state-of-the-art Traditional RDSR.

Table ZZZZZ.4.2.1-1 Recommended Values for Procedure Reported and Acquisition Device Type

Modality of the DICOM Instances created by the equipment	**Root TID**	(121058, DCM, "Procedure reported")	(122142, DCM, "Acquisition Device Type") See *DCID 10032 "Projection X-Ray Acquisition Device Types"*
X-Ray Angiography (XA)	**10001**	(113704, DCM, "Projection X-Ray")	(113957, DCM, "Fluoroscopy-Guided Projection Radiography System")
Fluoroscopy (RF)	**10001**	(113704, DCM, "Projection X-Ray")	(113957, DCM, "Fluoroscopy-Guided Projection Radiography System")
Radiography (DX, CR-DR)	**10001**	(113704, DCM, "Projection X-Ray")	(113958, DCM, "Integrated Projection Radiography System") Or (113959, DCM, "Cassette-based Projection Radiography System")
Mammography (MG)	**10001**	(71651007, SCT, "Mammography")	N/A
Dentistry (IO, PX)	**10001**	(113704, DCM, "Projection X-Ray")	(113958, DCM, "Integrated Projection Radiography System") Or (113959, DCM, "Cassette-based Projection Radiography System")
Computer Tomography (CT)	**10011**	(77477000, SCT,"Computed Tomography X-Ray")	N/A

ZZZZZ.4.2.2 [DONE] Enhanced RDSR

TID 10040 requires the content item EV (121058, DCM, "Procedure reported") to be present, but there's no condition on other Content Items based on the value of the Procedure Reported.

CP-2217 "**X-Ray Radiation Dose Procedures Reported**" introduced a new BCID 10005 that specifies a limited set of general procedures for the purpose of sorting/processing RDSRs based on radiation dose reporting characteristics associated with the different procedures. This list is extensible and should follow a recognized standard for coded terminologies. Note that there are other CIDs used in DICOM PS3.16 for "Procedure Reported" on other SR Templates, which include more detailed clinical procedures. However the modality creating the RDSR may not be able to provide such granularity at the time of the RDSR creation.

Also note that (122142, DCM, "Acquisition Device Type") is not included anymore in Enhanced RDSR, because the BCID 10005 used in (121058, DCM, "Procedure reported") (TID 10040) contains the equivalent granularity.

The following table provides the recommended values of the content item **EV (121058, DCM, "Procedure reported")** for the state-of-the-art Enhanced RDSR.

Table ZZZZZ.4.2.2-1 Recommended Values for Procedure Reported in Enhanced RDSR

Modality attribute (0008,0060) of the DICOM Instances created by the equipment	**Root TID**	(121058, DCM, "Procedure reported") *See BCID 10005 "X-Ray Radiation Dose Procedure Reported"*
X-Ray Angiography (XA)	**10040**	(169014003, SCT, "Fluoroscopy and radiography") or (717193008, SCT, "Cone beam computed tomography")
Fluoroscopy (RF)	**10040**	(44491008, SCT, "Fluoroscopy")
Radiography (DX, CR)	**10040**	(168537006, SCT, "Plain radiography")
Mammography (MG)	**10040**	(71651007, SCT, "Mammography")
Dentistry (IO, PX)	**10040**	(717193008, SCT, "Cone beam computed tomography")
Computer Tomography (CT)	**10040**	(77477000, SCT, "Computed tomography")
Bone Densitometry (X-Ray) (BMD)	**10040**	(241686001, SCT, "Dual energy X-ray absorptiometry")

Note: In practice, equipment may produce DICOM images with different values of the modality attribute (0008,0060) than the previous table but still same procedure reported. For instance, a dentistry equipment may produce instances with DX or CR modality and procedure reported as (22891007, SCT, "Radiography of teeth (procedure)").

ZZZZZ.4.3 [DONE] Encoding of Observers (Physicians, Operator)

The Modules defined at the Series level on the X-Ray Radiation Dose SR IOD (DICOM PS3.3 Table A.35.8-1) are different from the Modules present on the Image IODs. In particular, the General Series Module is not defined on the SR IOD.

Therefore, the **Performing Physician's Name** (0008,1050) and the **Operator's Name** (0008,1070), which are defined in the General Series Module, are not present at Series level on the SR.

Note that the Referring and Reading Physician Name attributes are defined in the General Study Module, thus common to both Image and SR objects.

As the name Structured Report already indicates, there are concepts for including person names into the structured content of the SR. The X-Ray Radiation Dose SR provides the following mechanisms to include physician/operator names:

In the RDSR Root Template TID 10001:

- use the TID 1002 "**Observer Context**" to generally encode the person observer names. Many persons/roles can be included in this template, e.g. Performing Physician, Operator, Referring Physician etc.
- use the TID 1020 "**Person Participant**" to explicitly denominate the person who performed the justification of an X-Ray procedure under the role "Irradiation Authorizing".

In the Irradiation Event X-Ray Data template TID 10003:

- use the TID 1020 "**Person Participant**" to explicitly denominate the person who performed the image acquisitions and applied X-Ray under the role "Irradiation Administering" (typically the Performing Physician).

When encoding the content of the above-mentioned concepts, please observe the following guidance concerning the "Irradiation Authorizing":

a) The physician authorizing the application of radiation (i.e. the person that "justifies" that the irradiation is appropriate for that patient) is not necessarily the same physician that applies (i.e "administers") the radiation during performance of the procedure.

b) The name of the physician taking the role "Irradiation Authorizing" is not part of the information contained in the DICOM worklist.

c) Because of the previous statements, extra means should be provided on the equipment to be able to input the name of the person who was authorizing the irradiation. It could be appropriate to use the name of the performing physician to pre-populate such an input.

Note: The tag **Person Name (0040,A123)** defined in the Table C.17-3b "Identified Person or Device Macro Attributes", which is included in the **Author Observer Sequence (0040,A078)** and in the **Participant Sequence (0040,A07A)** of the **SR Document General Module**, is not intended to describe the names of the persons involved in the creation of the technical data of the RDSR. These sequences are intended to describe the authors that created the clinical content of the SR, applicable typically to the clinical reports (e.g. cardiac measurements etc…).

The following table provides a coding example showing the situation where *<name of the authorizer doctor>* has done the justification of the procedure performed by *<name of the performing physician>* . The system is operated by *<name of the operator>* assisting in the procedure.

Table ZZZZZ.4.3-1 RDSR Observer Encoding Example

Node	Code Meaning of Concept Name	Code or Example Value	TID
1	X-Ray Radiation Dose Report	*<CONTAINER>*	TID 10001
Example of TID 1002 "Observer Context" within the RDSR Root Template TID 10001			
1.m1	Observer Type	(121006, DCM, "**Person**")	TID 1002
1.m2	Person Observer Name	*<name of the performing physician>*	TID 1003
1.m3	Person Observer's Role in the Organization	(J-004E8, SRT, "**Physician**")	TID 1003
1.m4	Person Observer's Role in the Procedure	(121094, DCM, "**Performing**")	TID 1003
1.m5	Observer Type	(121006, DCM, "**Person**")	TID 1002
1.m6	Person Observer Name	*<name of the operator>*	TID 1003
1.m7	Person Observer's Role in the Organization	(J-00187, SRT, "**Radiologic Technologist**")	TID 1003
1.m8	Person Observer's Role in the Procedure	(121099, DCM, "**Assisting**")	TID 1003
Example of TID 1020 "Person Participant" within the RDSR Root Template TID 10001			
1.n1	Person Name	*<name of the authorizer doctor>*	TID 1020
1.n1.1	Person Role in Procedure	(113850, DCM, "**Irradiation Authorizing**")	TID 1020

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.p1	Irradiation Event X-Ray Data	*<CONTAINER>*	TID 10003
Example of TID 1020 "Person Participant" within the TID 10003			
1.p1.o1	Person Name	*<name of the performing physician>*	TID 1020
1.p1.o1.1	Person Role in Procedure	(113850, DCM, "**Irradiation Administering**")	TID 1020

ZZZZZ.4.4 [DONE] Encoding of Distances and Geometry

To be properly interpreted, an Air Kerma value should be provided along with the point to which it has been measured or calculated (so-called Reference Point, or RP). Most of the systems define the Reference Point (RP) related to the equipment (e.g. Isocenter, Table, Detector…), which is defined by an assumed radiation entrance location for a typical patient.

ZZZZZ.4.4.1 [DONE] Reference Point Definition

For systems without complete geometrical information, e.g. X-Ray sources without information about the detector, the Reference Point may be defined as a fixed distance from the X-Ray source.

For the different uses of RDSR, the following coded terms of Reference Point Definition are provided for systems that provide a value of the Air Kerma at the Reference Point, E.g. EV (113738, DCM, "Dose (RP)") or EV (111636, DCM, "Entrance Exposure at RP"). The table below provides recommended values to be used for different modalities:

Table ZZZZZ.4.4.1-1 Reference Point Definitions

Modality attribute (0008,0060) of the DICOM Instances created by the equipment	**Distances of the (113780, DCM, "Reference Point Definition")** *See CID 10025 "Radiation Dose Reference Points"*	**Comments**
X-Ray Angiography (XA)	(113860, DCM, "15cm from Isocenter toward Source")	Typically used for Interventional System with C-arm and Isocenter.
	(113862, DCM, "1cm above Tabletop")	Typically used for Interventional System without Isocenter and with X-Ray source assembly fixed below table.
Radio Fluoroscopy (RF)	(113861, DCM, "30cm in Front of Image Input Surface")	Typically used for C-arm type Fluoroscopes without integrated table.
	(113864, DCM, "15cm from Table Centerline")	Typically used for lateral type of fluoroscopes.
	(113862, DCM, "1cm above Tabletop")	Typically used for Fluoroscopy System with X-Ray source assembly fixed below table.
	(113863, DCM, "30cm above Tabletop")	Typically used for Fluoroscopy System with X-Ray source assembly fixed above table.
Radiography (DX, CR)	(113941, DCM, "In Detector Plane")	Typically used as alternative for Radiography System with mobile cassettes or mobile digital detectors.
	(113965, DCM, "100cm from X-Ray Source")	Typically used for mobile X-Ray sources without knowledge of the detector location.

Modality attribute (0008,0060) of the DICOM Instances created by the equipment	**Distances of the (113780, DCM, "Reference Point Definition")** *See CID 10025 "Radiation Dose Reference Points"*	**Comments**
Mammography (MG)	(113865, DCM, "4.2cm above Breast Support Surface") [Nick] CP2287 is in CPACK 124. Make sure this Code Meaning does not change before FT.	Both definitions are typically used. Note: To Be Reviewed with WG-15
	(113964, DCM, "At Surface of Patient")	
Dentistry (IO, PX)	Note: To Be Determined with WG-22	
Computer Tomography (CT)	N/A	Reference Point is not defined for CT Systems.

ZZZZZ.4.4.2 [DONE] Equipment Geometry in Traditional RDSR

In order to transpose the value of Air Kerma at Reference Point to the Air Kerma at any other point on the patient (i.e. for organ dose calculations), additional geometric information is needed about the components of the imaging equipment as well as the patient location with respect to those components.

Depending on the modality and the type of equipment, the Reference Points are defined in defferent ways (e.g. based on Isocenter, detector, table, X-Ray source, breast support,…) so the required geometric information will vary from one RDSR to another. In all cases it is necessary to know the orientation of the center of the X-Ray beam, the collimated area, as well as the distances between the equipment components related to the Reference Point.

The RDSR allows to encode positions, andgulations and distances of the equipment components as follows:

- Distance Source to Reference Point
- Distance Source to Detector
- Distance Source to Table Plane
- Positioner or Column Angles
- Table Position and Angles
- Collimated Area

DICOM allows an equipment to arbitrarily choose the origin of the coordinate system used, but recommends to use it consistently over the scope of accumulation of the RDSR. This allows comparing values and deriving conclusions on the relative positions between all performed irradiation events.

Note that the origin of the Table coordinates should be consistent with the image header attribute Table height (0018,1130). The positioner/column angles are used to calculate the incidence of the X-Ray beam with respect to a patient.

System geometry distances are defined in the **CID 10008 Dose Related Distance Measurements**.

The following table shows an example of encoding equipment geometry at the Irradiation Event level in Traditional RDSR for a patient position Head-First Supine (e.g. positioner angles, distances, collimated area, and patient position).

Table ZZZZZ.4.4.2-1 Example of Encoding Equipment Geometry at the Irradiation Event Level

	Code Meaning of Concept Name	Code or Example Value	TID
	(113706, DCM, "Irradiation Event X-Ray Data")	*<CONTAINER>*	TID 10003

	Code Meaning of Concept Name	Code or Example Value	TID
>	(13745, DCM, "Patient Table Relationship")	(102540008, SCT, "**headfirst**")	TID 10003
>	(113743, DCM, "Patient Orientation")	(102538003, SCT, "**recumbent**")	TID 10003
>>	(113744, DCM, "Patient Orientation Modifier")	(40199007, SCT, "**supine**")	TID 10003
>	(113790, DCM, "Collimated Field Area")	***<any value>*** "m2"	TID 10003B
>	(113788, DCM, "Collimated Field Height")	***<any value>*** "mm"	TID 10003B
>	(113789, DCM, "Collimated Field Width")	***<any value>*** "mm"	TID 10003B
>	(112011, DCM, "Positioner Primary Angle")	***<any value>*** "deg"	TID 10003C
>	(112012, DCM, "Positioner Secondary Angle")	***<any value>*** "deg"	TID 10003C
>	(113739, DCM, "Positioner Primary End Angle")	***<any value>*** "deg"	TID 10003C
>	(113740, DCM, "Positioner Secondary End Angle")	***<any value>*** "deg"	TID 10003C
>	(113754, DCM, "Table Head Tilt Angle")	***<any value>*** "deg"	TID 10003C
>	(113755, DCM, "Table Horizontal Rotation Angle")	***<any value>*** "deg"	TID 10003C
>	(113756, DCM, "Table Cradle Tilt Angle")	***<any value>*** "deg"	TID 10003C
Next rows are defined in the DCID 10008 "Dose Related Distance Measurement"			
>	(113751, DCM, Table Longitudinal Position)	***<any value>*** "mm"	TID 10003C
>	(113752, DCM, Table Lateral Position)	***<any value>*** "mm"	TID 10003C
>	(113753, DCM, Table Height Position)	***<any value>*** "mm"	TID 10003C
>	(113750, DCM, Distance Source to Detector)	***<any value>*** "mm"	TID 10003C
>	(113737, DCM, Distance Source to Reference Point)	***<any value>*** "mm"	TID 10003C

Note: **TID 10007 Accumulated Total Projection Radiography Dose** includes the possibility to encode the Distance Source to Reference Point. This is only applicable if this distance does not change through the whole RDSR (i.e. it is the same distance for all Irradiation Events).

ZZZZZ.4.4.3 [DONE] Isocenter Reference System in Enhanced XA

As stated previously, a complete geometric description of the equipment components within the same coordinates system is required for a complete understanding of dose distribution and potential patient impact.

In particular, when the Reference Point is defined with respect to the Isocenter, the position of the table supporting the patient should also be defined with respect to that same Isocenter. However, in Traditional XA modality the table position is defined with respect to an arbitrary coordinate system which is not necessarily related to the Isocenter. This does not allow to relate the Reference Point to the surface of the patient laying on the table.

To overcome this limitation of Traditional XA, the Enhanced XA SOP Class introduced the X-Ray Isocenter Coordinate System to define a coordinate system that relates the Positioner and Table Coordinate Systems to the Isocenter (see PS 3.3 Section C.8.19.6.13 and PS 3.17 Annex Z. Refer to PS 3.17 Section FFF.2.1.3 for additional examples). There are Content Items in **TID 10003C** to allow encoding the X-Ray Isocenter Coordinate System in the RDSR.

The following table shows the encoding of the Isocenter Reference System in Traditional RDSR for equipment that implements the Isocenter Reference System model:

Table ZZZZZ.4.4.3-1 Example of Encoding Isocenter Reference System in Traditional RDSR

	Code Meaning of Concept Name	Code or Example Value	TID
	(113706, DCM, "Irradiation Event X-Ray Data")	*<CONTAINER>*	TID 10003
>	(128757, DCM, "Positioner Isocenter Primary Angle")	***<any value>*** "deg"	TID 10003C
>	(128758, DCM, "Positioner Isocenter Secondary Angle")	***<any value>*** "deg"	TID 10003C
>	(128759, DCM, "Positioner Isocenter Detector Rotation Angle")	***<any value>*** "deg"	TID 10003C
>	(128760, DCM, "Positioner Isocenter Primary End Angle")	***<any value>*** "deg"	TID 10003C
>	(128761, DCM, "Positioner Isocenter Secondary End Angle")	***<any value>*** "deg"	TID 10003C
>	(128762, DCM, "Positioner Isocenter Detector Rotation End Angle")	***<any value>*** "deg"	TID 10003C
>	(113754, DCM, "Table Head Tilt Angle")	***<any value>*** "deg"	TID 10003C
>	(113755, DCM, "Table Horizontal Rotation Angle")	***<any value>*** "deg"	TID 10003C
>	(113756, DCM, "Table Cradle Tilt Angle")	***<any value>*** "deg"	TID 10003C
>	(128763, DCM, "Table Head Tilt End Angle")	***<any value>*** "deg"	TID 10003C
>	(128764, DCM, "Table Horizontal Rotation End Angle")	***<any value>*** "deg"	TID 10003C
>	(128765, DCM, "Table Cradle Tilt End Angle")	***<any value>*** "deg"	TID 10003C
Next rows are defined in the DCID 10008 "Dose Related Distance Measurement"			
>	(128766, DCM, Table X Position to Isocenter)	***<any value>*** "mm"	TID 10003C
>	(128767, DCM, Table Y Position to Isocenter)	***<any value>*** "mm"	TID 10003C
>	(128768, DCM, Table Z Position to Isocenter)	***<any value>*** "mm"	TID 10003C
>	(128769, DCM, Table X End Position to Isocenter)	***<any value>*** "mm"	TID 10003C
>	(128770, DCM, Table Y End Position to Isocenter)	***<any value>*** "mm"	TID 10003C
>	(128771, DCM, Table Z End Position to Isocenter)	***<any value>*** "mm"	TID 10003C

Additionally, there are Content Items in **TID 10002** to relate the patient position to the X-Ray Table, which in turn allows to relate the Isocenter Reference Point to the patient laying on the table:

Equipment Landmark: Defines the landmark as the point located at the center of the X-Ray Table head on the table top plane. In the RSDR it is defined by EV (128750, DCM, "Equipment Landmark") which equals to EV (128751, DCM, "Center of Table Head"). In the RSDR, the location of the Equipment Landmark in the Table Coordinate System is defined by its coordinates X and Z, encoded as EV (128752, DCM, "Equipment Landmark X Position") and EV (128753, DCM, "Equipment Landmark Z Position"). Note that The Equipment Landmark Y Position is not recorded since it is, by definition, in the plane of the table as is the origin of the Table Coordinate System so the value would always be zero.

Patient Fiducial: it is typically a traverse plane located on the patient (e.g. the top of the head or the bottom of the feet), that allows to locate the patient with respect to the Equipment Landmark. In the RSDR this is defined by the CONTAINER EV (128754, DCM, "Patient Location Fiducial") which includes two nested Content Items:

1) Patient Location Fiducial: A plane on the patient. The values suggested in the Content Item Description are:
   - Top of the head :
     - EV (128772, DCM, "Reference Basis") = (88986008, SCT, "Vertex of Head")
     - EV (128773, DCM, "Reference Geometry") = (128120, DCM, "Plane through Superior Extent")
   - Bottom of the feet :
     - EV (128772, DCM, "Reference Basis") = (56459004, SCT, "Foot")
     - EV (128773, DCM, "Reference Geometry") = (128121, DCM, "Plane through Inferior Extent")

   Multiple Patient Location Fiducials could be included in this CONTAINER to describe the patient body size more precisely.

2) The distance from the Equipment Landmark to each of the Patient Location Fiducials, defined in the RDSR by EV (128756, DCM, "Equipment Landmark to Patient Fiducial Z Distance"). This distance is likely recorded by the operator who can measure it from the table top to the patient before starting the procedure. Note that the patient is assumed to be centered in the X axis of the X-Ray table (i.e. in the patient left-right axis).

For the creators of RDSR it's important to notice that the distance between the Equipment Landmark and each Patient Fiducial does not change within the RDSR across all Irradiation Events. In other words, if the distance should change during the scope of the RDSR (e.g. the patient changes position during the XA procedure step), and this CONTAINER is included in the RDSR, a new RDSR should be created.

Also important to notice is that the same Patient Location Fiducial should not be repeated multiple times in the CONTAINER with different distances, and that the distances of all the Patient Location Fiducials should be consistently defined for a real patient shape.

Should we create a CP for Part 16 TID 10002 Rows 18-20 to make these previous statements more explicit?

The following figure shows the relationship between these concepts.

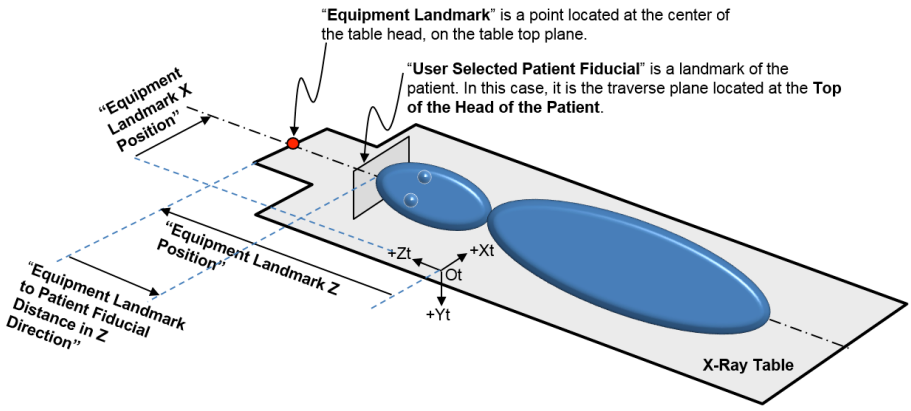

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Figure ZZZZZ.4.4.3-1 Relationship Between Equipment Landmark and Patient Fiducial

846 The following table shows an example of encoding patient position and patient location for a patient laying on the table in Head First Supine orientation, with the top of the head at 15 cm from the table head in the direction of the table foot.

848 **Table ZZZZZ.4.4.3-1 Example of Encoding Patient Position, Equipment Landmark, and Patient Fiducial**

	Code Meaning of Concept Name	Code or Example Value	TID
	(113702, DCM, "Accumulated X-Ray Dose Data")	*<CONTAINER>*	TID 10002
>	(128750, DCM, "Equipment Landmark")	(128751, DCM, "**Center of Table Head**")	TID 10002
>>	(128752, DCM, "Equipment Landmark X Position")	***<any value>*** "mm"	TID 10002
>>	(128753, DCM, "Equipment Landmark Z Position")	***<any value>*** "mm"	TID 10002
>	(128754, DCM, "Patient Location Fiducial")	*<CONTAINER>*	TID 10002
>>	(128772, DCM, "Reference Basis")	(88986008, SCT, "**Vertex of Head**")	TID 400
>>	(128773, DCM, "Reference Geometry")	(128120, DCM, "**Plane through Superior Extent**")	TID 400
>>	(128756, DCM, "Equipment Landmark to Patient Fiducial Z Distance")	***-150*** "mm"	TID 10002
>	(128754, DCM, "Patient Location Fiducial")	*<CONTAINER>*	TID 10002
>>	(128772, DCM, "Reference Basis")	(56459004, SCT, "**Foot**")	TID 400
>>	(128773, DCM, "Reference Geometry")	(128121, DCM, "**Plane through Inferior Extent**")	TID 400

	Code Meaning of Concept Name	Code or Example Value	TID
>>	(128756, DCM, "Equipment Landmark to Patient Fiducial Z Distance")	***-1900*** "mm"	TID 10002
	(113706, DCM, "Irradiation Event X-Ray Data")	*<CONTAINER>*	TID 10003
>	(13745, DCM, "Patient Table Relationship")	(102540008, SCT, "**headfirst**")	TID 10003
>	(113743, DCM, "Patient Orientation")	(102538003, SCT, "**recumbent**")	TID 10003
>>	(113744, DCM, "Patient Orientation Modifier")	(40199007, SCT, "**supine**")	TID 10003

ZZZZZ.4.4.4 [DONE] Geometry in Enhanced RSDR

In the Enhanced RDSR, a complete geometric description of all equipment components is required for an accurate understanding of dose distribution and potential patient impact. Describing all components within one single RDSR Reference Coordinate System improves downstream users and systems to perform further dosimetry analysis.

Equipment components and reference points related to the X-Ray Beam, including the X-Ray Source, Collimator, X-Ray Filters, Reference Point for Air Kerma etc. are described in the so-called Soure Coordinate System.

The Figure below provides a view of such components described in the Soure Coordinate System, as well as attenuators described directly in the RDSR Reference Coordinate System.

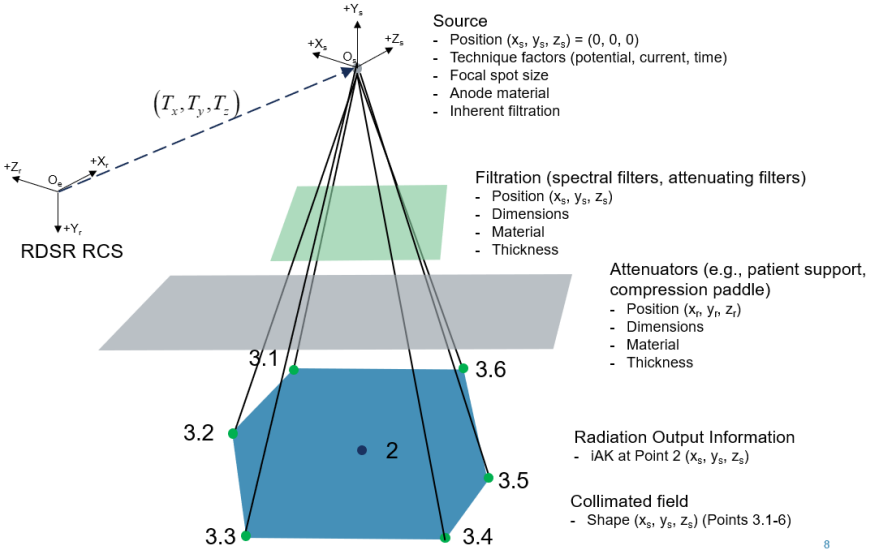


Figure ZZZZZ.4.4.4-1 System Components in the RDSR and Source Coordinate Systems

The Enhanced RDSR includes a transformation matrix to relate the Source Coordinate System (which may be moving) to the RDSR Reference Coordinate System. Therefore, when the X-Ray Beam is moving w.r.t the RDSR Reference Coordinate System, the components of the Source Coordinate System may be fixed within this coordinate system, and the X-Ray Source Transformation Matrix describes the movement (position/orientation) of the X-Ray Source components in the RDSR Reference Coordinate System. The figure below shows the relationship between the RDSR Reference Coordinate System and the Source Coordinate System through the X-Ray Source transformation Matrix.

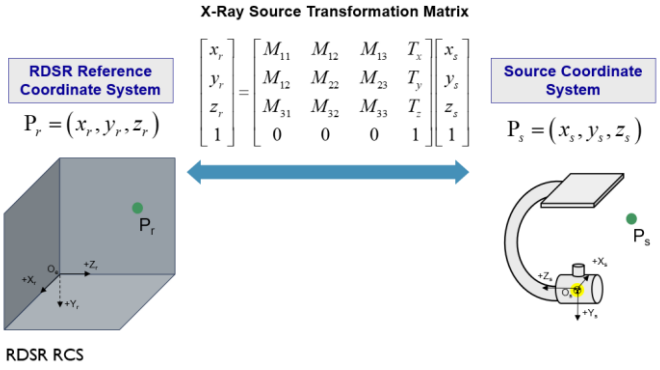
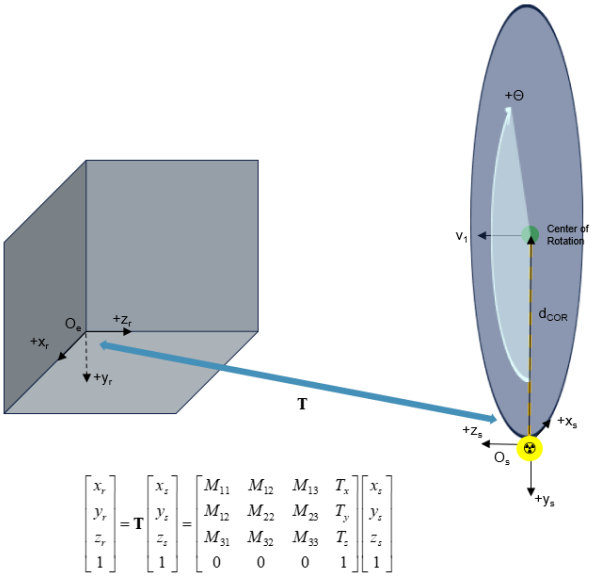


Figure ZZZZZ.4.4.4-2 X-Ray Source Transformation Matrix

Additionally, the rotating source descriptions can be simplified for many image acquisitions. Indeed, for sources rotating in a plane, a description of initial positioning within the Source Coordinate System, rotation radius, and rotation axis is sufficient to determine future positions and transformation matrices. This simplified encoding scheme reduces the burden for implementation and relies on the end user for calculation if desired. The following two figures illustrate the cases of sources rotating in a plane.



$$\begin{bmatrix} x_r \\ y_r \\ z_r \\ 1 \end{bmatrix} = \mathbf{T} \begin{bmatrix} x_s \\ y_s \\ z_s \\ 1 \end{bmatrix} = \begin{bmatrix} M_{11} & M_{12} & M_{13} & T_x \\ M_{12} & M_{22} & M_{23} & T_y \\ M_{31} & M_{32} & M_{33} & T_z \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_s \\ y_s \\ z_s \\ 1 \end{bmatrix}$$

$v_1 = \langle 0,0,1 \rangle$

$COR = \langle 0,-d_{COR},0 \rangle$

DT	Θ
DT_1	Θ_1
DT_2	Θ_2
DT_3	Θ_3
DT_4	Θ_4
…	…

878 **Figure ZZZZZ.4.4.4-3 Simplification for Sources Rotating in a Plane**

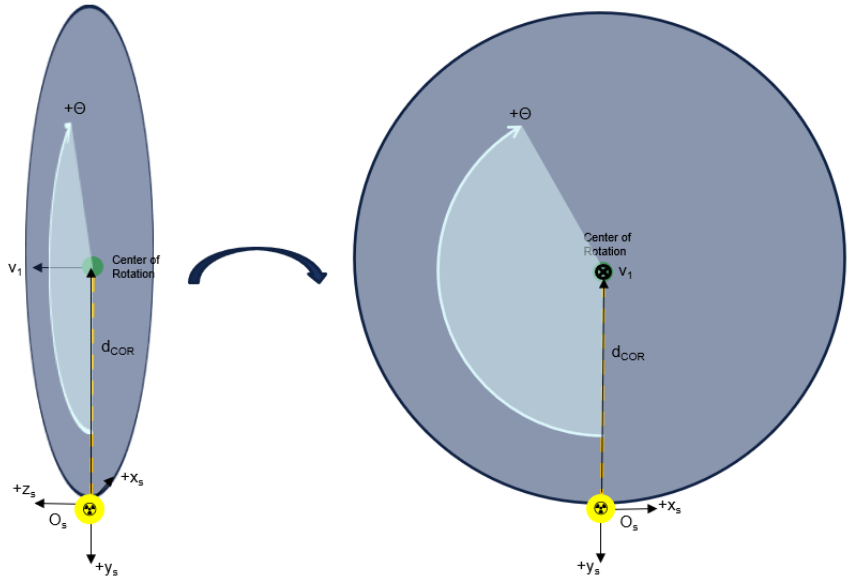


Figure ZZZZZ.4.4.4-4 Definition of a Source Rotating in a Plane

ZZZZZ.4.5 [DONE] Encoding of Irradiation Durations vs. Exposure Times

CP1173 clarified the definition of Total Fluoro Time and Total Acquisition Time in RDSR as the sum of the Irradiation Duration of the Irradiation Events.

Also, CP1254 clarified the definition of the Irradiation Duration as the clock time from the start of the loading time of the first pulse until the loading time trailing edge of the final pulse in the same irradiation event, which removes the ambiguity of the term “pedal time”.

Going further, the following table provides equivalences of some concepts between the image header and the RDSR. For one single Irradiation Event, which corresponds to one XA image (single or multi-frame).

Table ZZZZZ.4.5-1 Equivalences of Concepts Between Image Header and RDSR

Concept	XA Image Header	Traditional RDSR
Acquisition Datetime	Acquisition Datetime (0008,002A) Is the time the acquisition of data that resulted in sources started. It can be equal to the Frame Acquisition DateTime (0018,9074) of frame #1, or equal to Content Date (0008,0023) and Content Time (0008,0033). Note that the actual time of "pedal press" is not a correct definition, it can be before the Acquisition Datetime.	(111526, DCM, "Date Time Started") of the Irradiation Event in TID 10003 Irradiation Event X-Ray Data. The DateTime that the application of X-Rays started for this irradiation event. This corresponds to the start of the first irradiation in the Irradiation Event, which defines the starting point for the calculation of (113742, DCM, "Irradiation Duration »).
Number of Pulses	Number of Frames (0028,0008)	(113768, DCM, "Number of Pulses")
Acquisition or Irradiation Duration Clock time of the period of acquisition. May not be equal in image header and RDSR	Acquisition Duration (0018,9073) Duration of the single continuous gathering of data over a period of time that resulted in this instance, in seconds.	(113742, DCM, "Irradiation Duration") Clock time from the start of loading time of the first pulse until the loading time trailing edge of the final pulse in the same irradiation event.
Pulse Width Time of X-Ray emmission (i.e. tube current flowing) of a single pulse	Average Pulse Width (0018,1154) or Frame Acquisition Duration (0018,9220)	(113793, DCM, "Pulse Width")
Exposure Time Time of X-Ray emmission (i.e. tube current flowing) for the image or irradiation event	Exposure Time (0018,9328) It is equivalent to the SUM 1-N { Frame Acquisition Duration (0018,9220) } N = number of frames of the XA image	(113824, DCM, "Exposure Time") Cumulative time the patient has received X-Ray exposure during the irradiation event. Could be equivalent to the multiplication of (113793, DCM, "Pulse Width") * (113768, DCM, "Number of Pulses") Note: 113735 Exposure Time (ms) was retired in DICOM.
Total Fluoro Time Accumulation of clock time of the period of fluoroscopy	Equivalent to the SUM of Acquisition Duration (0018,9073) of all the low dose (fluoroscopy) images, for which the Radiation Setting (0018,1155) equals "**SC**".	(113730, DCM, "Total Fluoro Time") Total clock time of Fluoroscopy accumulated over the defined scope of accumulation (i.e. the sum of the Irradiation Duration values for accumulated fluoroscopy irradiation events) It is equivalent to the SUM of (113742, DCM, "Irradiation Duration") of all FLUOROSCOPY Irradiation Events.
Total Acquisition Time Accumulation of clock time of the period of acquisition	Equivalent to the SUM of Acquisition Duration (0018,9073) of all the high dose (acquisition, digital spot or cine) images, for which the Radiation Setting (0018,1155) equals "**GR**".	(113855, DCM, "Total Acquisition Time") Total clock time of acquisitions accumulated over the defined scope of accumulation (i.e. the sum of the Irradiation Duration values for accumulated acquisition irradiation events). It is equivalent to the SUM of (113742, DCM, "Irradiation Duration") of all ACQUISITION Irradiation Events.

Notes:

1- When an image acquisition has applied pre-pulses before the first actual frame stored in the multi-frame image, some equivalences between image header and RDSR are not correct because the pre-pulses are not stored as image frames but they are counted in the RDSR as actual radiation.

2- Enhanced RDSR has changed the way to encode times. For instance, (113742, DCM, "Irradiation Duration ») in Traditional RDSR is replaced by the difference between (111527, DCM, "DateTime Ended") and (111526, DCM, "DateTime Started") in Enhanced RDSR (see TID 10042).

The figure below shows a representation of one DICOM Irradiation Event (i.e. one DICOM X-Ray Angiographic Image)

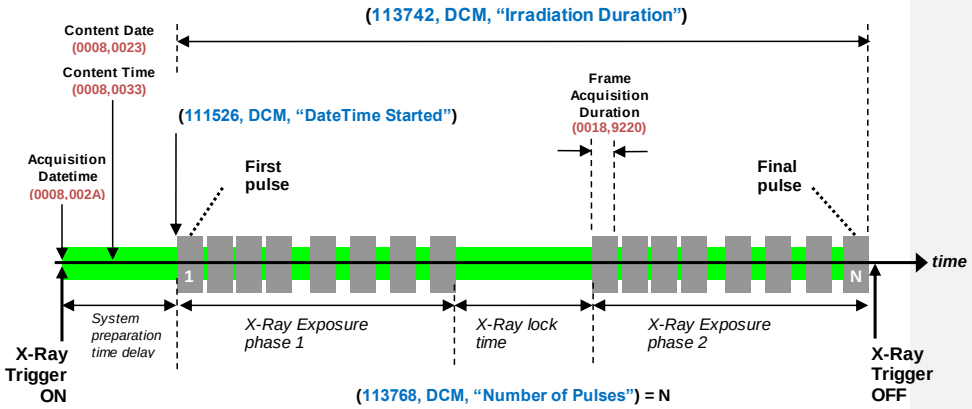


Figure ZZZZZ.4.5-1. Representation of One DICOM Irradiation Event (i.e. one DICOM X-Ray Angiographic Image)

ZZZZZ.4.6 [DONE] Encoding of Applied Filters

The quality of ionizing radiation is influenced by filters applied in the full range of the field of view (spectral filters) or partially applied (modulating filters). The latter should not be mixed up with beam limiting devices (lead collimator blades). Not directly related to filters, but covering the full range of the field of view is the grid, if used.

The TID 10003B irradiation Event X-Ray Source Data conveys an X-Ray Filters container that can be repeatedly included for each filter applied during an irradiation event. The focus is on spectral filters (e.g. copper, aluminum etc.). The container has concepts to specify the X-Ray Filter Type, X-Ray Filter Material, X-Ray Filter Thickness Minimum and X-Ray Filter Thickness Maximum. The filter types and filter material are drawn from CID 10007 and CID 10006. The typical filtration with a copper filter is declared by the filter type of "Flat filter". Of course the very important value "No filter" is available to indicate the often mandated removal of the filter during pediatric procedures. In the typical case that the filter has a homogeneous thickness, the same value is encoded in the minimum and maximum thickness concepts.

Modulating filters are listed in the filter types, but the concepts in the X-Ray Filters containers cannot fully describe the profile and geometry of such modulating filters rather than indicating that one of these filters was used.

In the same TID 10003B, the concept X-Ray Grid can be used to denote if a grid was used by indicating the related grid type (see PS3.16 CID 10017 X-Ray Grid). A value of "No grid" is available to indicate it was removed or not support by a type of equipment.

ZZZZZ.4.6.1 [DONE] Applied Filters in Enhanced RSDR

Filters in Enhanced RDSR are described based on TID 10046, which includes the reference to the X-Ray Source to which they are applied. As the filters are in the X-Ray source reference coordinate system, no

separate transformation matrix needs to be specified. Filters are described with the common DTID 10055 "Attenuator Characteristics" shared with the template to describe Attenuators. This covers the technical description of the filters (e.g. Material, Type and Thickness).

If the filter position is additionally known and not located in the X-Ray source coordinate system, a 3D - Model of the filter can be referenced in the TID 10051 "Beam Position" Template including the Transformation Matrix for the referenced 3D filter model into the Source Coordinate System of the referenced X-Ray Source.

If the filter position is not known and no model of the filter can be supplied, the filter is assumed to cover the complete Field of View of the X-Ray beam.

Attenuators are described based on the TID 10047 and are per se not defined as being in the Source coordinate system. Therefore, for each attenuator, a separate TID 10052 Attenuator Position is to be filled with the 3D-Model of the Attenuator and the related Transformation Matrix to transform the Attenuator coordinates to the RDSR reference coordinate system.

ZZZZZ.4.7 [DONE] Pulse Rate and Number of Pulses in Fluoroscopy and Angiography

ZZZZZ.4.7.1 [DONE] Traditional RDSR

In the Traditional RDSR, the pulse rate and number of pulses are documented in **TID 10003 Irradiation Event X-Ray Data** and in **TID 10003B Irradiation Event X-Ray Source Data**. The requirements depend on the type of Irradiation Event (i.e. Fluoroscopy or Acquisition) as well as the fluoro mode (i.e. pulsed or continuous).

The table below shows an example of a **pulsed Fluoroscopy** Irradiation Event of 4 seconds at 7.5 pulses per second: It is mandatory in RDSR to document the pulse rate and the number of pulses.

Table ZZZZZ.4.7.1-1 Example of a Pulsed Fluoroscopy Irradiation Event

Code Meaning of Concept Name	Code or Example Value	TID
EV (113721, DCM, "Irradiation Event Type")	(44491008, SCT, "**Fluoroscopy**")	TID 10003
EV (113732, DCM, "Fluoro Mode")	(113631, DCM, "**Pulsed**")	TID 10003B
EV (113791, DCM, "Pulse Rate")	***7.5*** "pulse/s"	TID 10003B
EV (113768, DCM, "Number of Pulses")	***30***	TID 10003B

The table below shows an example of a **continuous Fluoroscopy** Irradiation Event. It is not allowed in RDSR to document the pulse rate nor the number of pulses.

Table ZZZZZ.4.7.1-2 Example of a Continuous Fluoroscopy Irradiation Event

Code Meaning of Concept Name	Code or Example Value	TID
EV (113721, DCM, "Irradiation Event Type")	(44491008, SCT, "**Fluoroscopy**")	TID 10003
EV (113732, DCM, "Fluoro Mode")	(113630, DCM, "**Continuous**")	TID 10003B

The table below shows an example of a stationary **Acquisition** Irradiation Event of 5 seconds at 30 pulses per second: It is mandatory in RDSR to document the the number of pulses, and it is not allowed to document the fluoro mode nor the pulse rate.

Table ZZZZZ.4.7.1-3 Example of an Acquisition Irradiation Event

Code Meaning of Concept Name	Code or Example Value	TID
EV (113721, DCM, "Irradiation Event Type")	(11361, DCM, "**Stationary Acquisition**")	TID 10003
EV (113768, DCM, "Number of Pulses")	***150***	TID 10003B

It is not possible to document in the Traditional RDSR several pulse rates in one Fluoroscopy Irradiation Event. In case of variable pulse rate during the Irradiation Event, it is recommend to document an average pulse rate.

Note that the pulse rate value is not documented on the Acquisition Irradiation Events. Indeed, the average pulse rate and be calculated from the number of pulses (113768, DCM, "Number of Pulses") and the acquisition duration (113742, DCM, "Irradiation Duration").

ZZZZZ.4.7.2 [DONE] Enhanced RDSR

In the Enhanced RDSR, the pulse rate is documented in **TID 10045 Radiation Technique**, and several values of pulse rate can be encoded within a single Irradiation Event, regardless the type of Irradiation Event (i.e. Fluoroscopy or Acquisition) as well as the fluoro mode (i.e. pulsed or continuous).

There are two possible ways to encode several values of pulse rate:

1. Encode the item EV (113791, DCM, "Pulse Rate") of Value Type TABLE with as many rows as different values of pulse rate within the time period over which the CONTAINER EV (130511, DCM, "Radiation Technique") is applicable. Each row will contain the pulse rate applied during the time period of that particular row. The number of pulses can be calculated from the pulse rate of the row (in pulses per second) and the duration of the time period of the row (in seconds).
2. Encode the item EV (113791, DCM, "Pulse Rate") of Value Type NUM with one value of pulse rate within the time period over which the CONTAINER EV (130511, DCM, "Radiation Technique") is applicable. Then repeat the CONTAINER EV (130511, DCM, "Radiation Technique") over time with different values of pulse rate. Each CONTAINER will contain the pulse rate applied during the time period of that CONTAINER. The number of pulses can be calculated from the pulse rate of the CONTAINER (in pulses per second) and the duration of the time period of the CONTAINER (in seconds).

Note that in both ways of encoding, the time period defined for a single value of pulse rate can be shorter than the duration of an Irradiation Event, or it can span across multiple Irradiation Events.

ZZZZZ.4.8 [Work In Progress] CR Integrated vs. Non-Integrated equipment

With the approval of CP 1077, the X-Ray Dose Structured Report was refactored to support CR-DR equipment in providing dose information via Structured Report. The possibility of tailoring the contents based on explicit condition concepts was introduced. The changes were made and the requirement that the existing reports are still valid and their structure can still be derived from the PS3.16 Template definitions.

The two major concepts for tailoring are

- Acquisition Device Type with the values drawn from DCID 10032 "Projection X-Ray Acquisition Device Types" is used to tailor the availability of Accumulated X-Ray Dose data. If the concept is absent, because this is a Dose SR following the pre CP1077 encoding, the report has to be supplied in full-scope as no tailoring is possible. If present, the value of "Fluoroscopy-Guided Projection Radiography System" provided the same meaning and the full gamut of concept values can be expected. The values of "Integrated Projection Radiography System" or "Cassette-based Projection Radiography System" indicate that the flags explained in the next bullet point are very likely to be used to tailor the level of data supported. The TID 10002 "Accumulated X-Ray Dose" is generally available for all types of Systems, the TID 10004 "Accumulated Fluoroscopy and Acquisition projection X-Ray Dose" is only mandatory for system creating the default Dose SR format or identify as suitable for fluoroscopy-guided procedures, the TID 10007 "Accumulated Total

Projection Radiography Dose" for fluoroscopy-guided and integrated equipment, the TID 10006 "Accumulated Cassette-based Projection Radiography Dose" for that type of equipment.

- the X-Ray Detector Data Available, X-Ray Source Data Available and X-Ray Mechanical Data Available flags to indicate what data can be expected in the Irradiation Event Data of the Dose SR. The X-Ray Detector Data Available flag controls the provision of the TID 10003A Irradiation Event X-Ray Detector Data sub-template concepts in the irradiation event data. The X-Ray Source Data Available flag controls the same for the TID 10003B Irradiation Event X-Ray Source Data sub-template and the X-Ray Mechanical Data Available flag controls the availability of the 10003C Irradiation Event X-Ray Mechanical Data sub-template.

With this mechanism an Integrated Projection Radiography System can tailor the level of integration. If the patient support is not integrated, the X-Ray Mechanical Data Available flag can be set to "NO". No table position data or angulations based on the patient coordinate system can be technically derived and are therefore except from the Dose SR by setting the dedicated flag to "NO".

For a CR System also the integration with the generator may not be possible and therefore data related to the creation of the radiation cannot be provided. The X-Ray Source Data Available flag can be set to "NO" to indicate this. Furthermore it could be the fact that the CR-System is not able to derive Exposure Index values. This can be indicated by setting the X-Ray Detector Data Available flag to "NO".

A system replacing the CR cassette by a compatible digital detector unit connected to a computer, may set the above mentioned flags for Integration of X-Ray Source and Mechanical Integration to "NO", but is able to provide Exposure Index values and sets the dedicated X-Ray Detector Data Available flag to "YES".

<following paragraph to be adapted to CR-DR>

In the **TID 10003 "Irradiation Event X-Ray Data"**, the amount of information per Irradiation Event required in the RDSR will depend on the data integration technology. The equipment used in XA procedures includes a C-Arm with the X-Ray Source and X-Ray Detector integrated, therefore most of the technical information is collected and available for reporting. However, in non-integrated CR-DR the Detector or Source components may generate the RDSR without knowing the data from the other components.

The following three items in the template **TID 10001 "Projection X-Ray Radiation Dose"** are flags to indicate whether the data is available for reporting, which are used as conditions in the template **TID 10003 "Irradiation Event X-Ray Data"** to include or not the appropriate sub-templates of technical information as follows:

Table ZZZZZ.4.8-1 Conditions to Provide Irradiation Event X-Ray Data in Traditional RDSR

TID 10001	In TID 10003
EV (113945, DCM, "X-Ray Detector Data Available")	IFF "Yes" in TID10001 then include: TID 10003A "Irradiation Event X-Ray Detector Data"
EV (113943, DCM, "X-Ray Source Data Available")	IFF "Yes" in TID10001 then include: TID 10003B "Irradiation Event X-Ray Source Data"
EV (113944, DCM, "X-Ray Mechanical Data Available")	IFF "Yes" in TID10001 then include: TID 10003C "Irradiation Event X-Ray Mechanical Data"

Note: need to talk about Enhanced RDSR

ZZZZZ.4.9 [Work In Progress] CR Availability of DAP (Dose Area Product)

As already explained in the previous section about integrated vs. non-integrated equipment, it is now possible for equipment implementers to tailor the availability of certain Dose SR concepts. This includes the availability of one of the central dose parameters – the Dose Area Product (alternatively named as Area Dose Product in PS3.3). The recommendations can be structured as follows:

- Equipment not using the tailoring and not providing the Acquisition Device Type is providing the pre-CP 1077 version of the Dose SR and therefore all dose values are mandatory.

- Equipment identifying as “Fluoroscopy-Guided Projection Radiography System” has to provide all dose values.
- Equipment identifying as “Integrated Projection Radiography System” definitely is exempt from providing the detailed concepts of TID 10004 “Accumulated Fluoroscopy and Acquisition projection X-Ray Dose”. But the dose values defined in TID 10007 “Accumulated Total Projection Radiography Dose” are to be provided. This includes the concept values for Dose Area product Total, Dose (RP) Total and the coded or textual definition of the Reference Point have to be supplied. This is independent of the values provided in the X-Ray Detector Data Available, X-Ray Source Data Available and X-Ray Mechanical Data Available flags.
- Equipment identifying as “Cassette-based Projection Radiography System” is exempt from providing individual Dose values. The Total Number of Radiographic Frames and the Detector Type are mandatory if the X-Ray Detector Data Available flag is set to “YES” or is absent (for compatibility with the pre-CP 1077 Dose SR versions).

Note: when we talk about Enhanced RDSR, include Air Kerma definition…

Note: Incorporate CP2318

ZZZZZ.4.10 [DONE] Relationship between Irradiation events and image storage

The RDSR contains all the irradiation events that occurred during the scope of accumulation regardless whether the irradiation resulted into one or more stored images. Additionally, for those Irradiation Events that resulted into DICOM stored image(s), the RDSR provides means to refer to the UID(s) of such image(s).

However, it might happen that the DICOM Image Objects were created but then rejected and also possibly deleted before being stored for long term archiving. In order to document such situation, the RDSR provides means to label each Irradiation Event indicating if it was rejected, and if if was the result of a repeated irradiation.

If an acquisition is a rejected because it was unsatisfactory, this may be recorded along with a coded reason. This is intended to help with subsequent analysis by providing a priori information about why the study might be flagged as an outlier with higher dose exposure values than usual for the type of study.

If an acquisition is a repeat because an earlier acquisition was unsatisfactory, this may be recorded along with a coded reason and the earlier acquisition's irradiation event UID. This is intended to help with subsequent analysis by providing a priori information about why the study might be flagged as an outlier with higher dose exposure values than usual for the type of study.

Note that several Irradiation Event UIDs may be rejected consecutively, i.e. the repeated acquisition may be also rejected in turn.

In Traditional RDSR:

The Image UID corresponding to an Irradiation Event is encoded in **TID 10003A**, EV (113795, DCM, "Acquired Image"). The requirement Type is “MC” and the condition is IFF Image Object is created for this irradiation event.

The information whether the Irradiation Event was **rejected** is in **TID 10003** and **TID 10013**, EV (130503, DCM, "Is Rejected Acquisition"). If the value is “Yes” the reason for rejection is in EV (130504, DCM, "Reason for Rejecting Acquisition”).

The information whether the Irradiation Event was a **repeated** acquisition is in **TID 10003** and **TID 10013**, EV (128551, DCM, "Is Repeated Acquisition"). If the value is “Yes” the reason for repeating is in EV (128552, DCM, "Reason for Repeating Acquisition”), and the information about the previously rejected Irradiation Event UID resulting into this repeated event is in EV (113769, DCM, " Irradiation Event UID”).

In Enhanced RDSR:

The Image UID corresponding to an Irradiation Event is encoded in **TID 10042**, EV (113795, DCM, "Acquired Image"). The requirement Type “U” with no condition.

The information whether the Irradiation Event was **rejected** is in **TID 10042**, EV (130503, DCM, "Is Rejected Acquisition"). If the value is “Yes” the reason for rejection is in EV (130504, DCM, "Reason for Rejecting Acquisition”).

The information whether the Irradiation Event was a **repeated** acquisition is in **TID 10042**, EV (128551, DCM, "Is Repeated Acquisition"). If the value is “Yes” the reason for repeating is in EV (128552, DCM, "Reason for Repeating

Acquisition"), and the information about the previously rejected Irradiation Event UID resulting into this repeated event is in EV (113769, DCM, " Irradiation Event UID").

ZZZZZ.4.11 [DONE] Encoding of Irradiation Event Type

In the Traditional RDSR, in **TID 10003 "Irradiation Event X-Ray Data"** the mandatory item EV (113721, DCM, "Irradiation Event Type") allows to distinguish between several "X-Ray modes" (e.g. Fluoroscopy or Acquisition). However, one "X-Ray mode" is not exclusive to only one type of equipment and may not be used to infer the type of equipment used. For instance XA and R&F equipment may use the Fluoroscopy X-Ray mode.

The possible "X-Ray modes" are defined in the **CID 10002 "Irradiation Event Types"** and can be:

Table ZZZZZ.4.11-1 Applicability of Irradiation Event Type to Different Modalities

EV (113721, DCM, "Irradiation Event Type")	Comment
(44491008, SCT, "Fluoroscopy")	Applicable to X-Ray Angiography and Radio Fluoroscopy procedures.
(113611, DCM, "Stationary Acquisition")	Applicable basically to any X-Ray procedure (including Mammography, Angiography etc.)
(113612, DCM, "Stepping Acquisition")	Typically applicable to X-Ray Angiography, but also Mammo tomosynthesis (DBT)
(113613, DCM, "Rotational Acquisition")	Applicable to X-Ray Angiography, Dentistry, CT, Mammo Tomosynthesis (DBT)

In the Enhanced RDSR, in **TID 10042 "Irradiation Event Summary Data"** the mandatory item EV (113721, DCM, "Irradiation Event Type") can be used in CT equipment to document a Rotational Acquisition, and then use the optional item (113820, DCM, "CT Acquisition Type") in the same TID to specify the details of the CT rotation as defined in the **CID 10013 "CT Acquisition Type"** (e.g. spiral, sequenced, constant angle, free, cone beam).

ZZZZZ.4.12 [DONE] Append case: Multiple RDSRs in the same Procedure Step

After initial RDSR object creation, the equipment has administered more dose to the patient. The equipment creates a new RDSR with new Irradiation Dose UIDs.

IHE has recommendations to manage multiple RDSRs in the REM profile by duplicating the same Irradiation Event UIDs and populating the Predecessor Documents Sequence (0040,A360).

See: 4.62.4.1.1 https://www.ihe.net/uploadedFiles/Documents/Radiology/IHE_RAD_TF_Vol2.pdf#page=441

When creating a second RDSR object of the same Procedure Step with additional Irradiation Event UIDs, IHE recommends to duplicate the previous Irradiation Event UIDs. This can be detected by receiving systems since the same irradiation event UIDs will appear in both Dose objects.

An existing implementation of the creation of additional views within the same Procedure Step (append) is that the RDSR creator generates an additional DoseSR with the additional dose for the same procedure step. In such implementation the irradiation events will NOT be duplicated in the second RDSR object, and to get the full dose the consumer needs to take into account all the Dose SR objects of the same Procedure Step and check whether or not the Irradiation Events are duplicated across the different RDSRs.

ZZZZZ.4.13 Place holder for new cases

1. A lot of data is in the RDSR. But, for proper interpretation and usage, how do you disect the RDSR for indivudual separate uses (e.g. whether is radiation from Fluoroscopy, from …)? E.g. systems that didn't deliver Fluoroscopy dose (so value is zero in RDSR) but did deliver Acquisition dose.

2. Systems that have delivered dose BUT cannot calculate a value for the Dose at Reference Point but users/regulators are still requiring to create a DICOM RDSR. What is the recommendation of the RDSR encoding (e.g. say UNKNOWN?). Refer to Part 16 Section 6.1.7.1: This situation of UNKNOWN is NOT allowed in DICOM…

3. Acquisition techniques (kV, mA…): talk about definitions in part 3 (image headers) and part 16 (content items). Explain that they may not be the same definition (or the definitions are open or fuzzy), so the implementor can apply different calculation in images and RDSR. See Enhanced XA Informative Annex for examples (e.g. pre-pulse radiation that does not creates pixels).

ZZZZZ.5 RADIATION DOSE SR EXAMPLES [WORK IN PROGRESS]

This section contains examples of the use of Radiation Dose Structured Reports, excluding Radiopharmaceutical RDSRs and Patient RDSRs.

ZZZZZ.5.1 Examples of Traditional RDSR

ZZZZZ.5.1.1 [DONE] Example of Traditional RDSR for XA

The following is an example RDSR for a routine XA procedure step combining diagnostic and interventional treatment. In this example, a single plane Interventional X-Ray acquisition system (Irradiating Device) performs an exam (one procedure step) with the following characteristics:

- Patient position is Head First Supine
- Patient top of the head is located at 25 cm from the table top to the table feet direction
- 1 fluoroscopy Irradiation Event during 10 seconds, with no XA image recorded
- 1 rotational acquisition (CBCT) Irradiation Event, at 10 degrees per second and 30 frames per second over an arc of 200 degrees. An XA image has been recorded.
- A dose image has been created at the end of the procedure step

Node	Code Meaning of Concept Name	Code or Example Value	TID
1	**X-Ray Radiation Dose Report**	**<CONTAINER>**	**TID 10001**
1.1	Language of Content Item and Descendants	(en, IETF4646, "English")	TID 1204
1.2	Procedure reported	(113704, DCM, "Projection X-Ray")	TID 10001
1.2.1	Has Intent	(1279505009, SCT, "Combined Diagnostic and Therapeutic Intent")	TID 10001
1.3	Acquisition Device Type	(113957, DCM, "Fluoroscopy-Guided Projection Radiography System")	TID 10001
Start Observer Context			
Observer #1: Irradiating device			

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.4	Observer Type	(121007, DCM, “Device”)	TID 1002
1.5	Device Observer UID	**2.999.1**	TID 1004
1.6	Device Observer Name	*MyAETitle*	TID 1004
1.7	Device Observer Manufacturer	*Manufacturer X*	TID 1004
1.8	Device Observer Model Name	*Model Y*	TID 1004
1.9	Device Observer Serial Number	*SerialNumber123*	TID 1004
1.10	Device Role in Procedure	(113859, DCM, “Irradiating Device”)	TID 1004
Observer #2: Performing Physician			
1.11	Observer Type	(121006, DCM, "Person”)	TID 1002
1.12	Person Observer Name	*Performing^^^Dr*	TID 1003
1.13	Person Observer’s Role in the Organization	(309343006, SCT, “Physician”)	TID 1003
1.14	Person Observer's Role in this Procedure	(121094, DCM, “Performing”)	TID 1003
Observer #3: Referring Physician			
1.15	Observer Type	(121006, DCM, "Person”)	TID 1002
1.16	Person Observer Name	*Referring^^^Dr*	TID 1003
1.17	Person Observer's Role in the Organization	(309343006, SCT, “Physician”)	TID 1003
1.18	Person Observer's Role in this Procedure	(C1709880, UMLS, “Referring”)	TID 1003
Observer #4: Operator			
1.19	Observer Type	(121006, DCM, "Person”)	TID 1002
1.20	Person Observer Name	*Operator^^^Mr*	TID 1003
1.21	Person Observer's Role in the Organization	(159016003, SCT, “Radiologic Technologist”)	TID 1003
1.22	Person Observer's Role in this Procedure	(121099, DCM, "Assisting”)	TID 1003
<End Observer Context>			
1.23	Scope of Accumulation	(113016, DCM, "Performed Procedure Step")	TID 10001
1.24	Performed Procedure Step SOP Instance UID	**2.999.2**	TID 10001

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.25	X-Ray Detector Data Available	(373066001, SCT, "Yes")	TID 10001
1.26	X-Ray Source Data Available	(373066001, SCT, "Yes")	TID 10001
1.27	X-Ray Mechanical Data Available	(373066001, SCT, "Yes")	TID 10001
1.28	**Accumulated X-Ray Dose Data**	**<CONTAINER>**	**TID 10002**
1.28.1	Acquisition Plane	(113622, DCM, "Single Plane")	TID 10002
1.28.2	Fluoro Dose Area Product Total	*0.00000310 Gy.m2*	TID 10004
1.28.3	Fluoro Dose (RP) Total	*0.00007700 Gy*	TID 10004
1.28.4	Total Fluoro Time	*10 s*	TID 10004
1.28.5	Acquisition Dose Area Product Total	*0.00003100 Gy.m2*	TID 10004
1.28.6	Acquisition Dose (RP) Total	*0.00081700 Gy*	TID 10004
1.28.7	Total Acquisition Time	*30 s*	TID 10004
1.28.8	Dose Area Product Total	*0.00003410 Gy.m2*	TID 10007
1.28.9	Dose (RP) Total	*0.00089400 Gy*	TID 10007
1.28.10	Distance Source to Reference Point	*570.00 mm*	TID 10007
1.28.11	Total Number of Radiographic Frames	*600 no units*	TID 10007
1.28.12	Reference Point Definition	(113860, DCM, "15cm from Isocenter toward Source")	TID 10007
1.28.13	Equipment Landmark	(128751, DCM, "Center of Table Head")	TID 10002
1.28.13.1	Equipment Landmark X Position	*50.00 mm*	TID 10002
1.28.13.2	Equipment Landmark Z Position	*400.00 mm*	TID 10002
1.28.14	**Patient Location Fiducial"**	**<CONTAINER>**	**TID 10002**
1.28.14.1	Reference Basis	(88986008, SCT, "Vertex of Head")	TID 400
1.28.14.2	Reference Geometry	(128120, DCM, "Plane through Superior Extent")	TID 400
1.28.14.3	Equipment Landmark to Patient Fiducial Z Distance	*-250.00 mm*	TID 10002
1.29	**Irradiation Event X-Ray Data**	**<CONTAINER>**	TID 10001
1.29.1	Acquisition Plane	(113622, DCM, "Single Plane")	TID 10003

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.29.2	Irradiation Event UID	**2.999.3**	TID 10003
1.29.3	DateTime Started	*20231020125921.000*	TID 10003
1.29.4	Irradiation Event Type	(44491008, SCT, "Fluoroscopy")	TID 10003
1.29.5	Acquisition Protocol	*Cardiac and Vascular FLUORO*	TID 10003
1.29.6	Patient Table Relationship	(102540008, SCT, "headfirst")	TID 10003
1.29.7	Patient Orientation	(102538003, SCT, "recumbent")	TID 10003
1.29.7.1	Patient Orientation Modifier	(40199007, SCT, "supine")	TID 10003
1.29.8	Target Region	(80891009, SCT, "Heart")	TID 10003
1.29.9	Dose Area Product	*0.00000310 Gy.m2*	TID 10003
1.29.10	Patient Equivalent Thickness	*6.80454 cm*	TID 10003
1.29.11	Comment	*Fluoro Loop*	TID 10003
Start Person Participant within TID 10003			
1.29.12	Person Name	*Performing^^^Dr*	TID 1020
1.29.12.1	Person Role in Procedure	(113851, DCM, "Irradiation Administering")	TID 1020
End Person Participant			
Irradiation Event X-Ray Source Data TID 10003B			
1.29.13	Dose (RP)	*0.00007700 Gy*	TID 10003B
1.29.14	Reference Point Definition	(113860, DCM, "15cm from Isocenter toward Source")	TID 10003B
1.29.15	Fluoro Mode	(113631, DCM, "Pulsed")	TID 10003B
1.29.16	Pulse Rate	*15 pulse/s*	TID 10003B
1.29.17	Number of Pulses	*150 no units*	TID 10003B
1.29.18	Pulse Width	*2.01 ms*	TID 10003B
1.29.19	Irradiation Duration	*10.000 s*	TID 10003B
1.29.20	KVP	*71 kV*	TID 10003B
1.29.21	X-Ray Tube Current	*12 mA*	TID 10003B

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.29.22	Average X-Ray Tube Current	*12 mA*	TID 10003B
1.29.23	Exposure Time	*20 ms*	TID 10003B
1.29.24	Exposure	*250 uA.s*	TID 10003B
1.29.25	Focal Spot Size	*0.6 mm*	TID 10003B
1.29.26	Anode Target Material	(26194003, SCT, "Tungsten")	TID 10003B
1.29.27	**X-Ray Filters**	**<CONTAINER>**	TID 10003B
1.29.27.1	X-Ray Filter Type	(113653, DCM, "Flat filter")	TID 10003B
1.29.27.2	X-Ray Filter Material	(66925006, SCT, "Copper")	TID 10003B
1.29.27.3	X-Ray Filter Thickness Minimum	*0.300000 mm*	TID 10003B
1.29.27.4	X-Ray Filter Thickness Maximum	*0.300000 mm*	TID 10003B
1.29.28	**X-Ray Filters**	**<CONTAINER>**	TID 10003B
1.29.28.5	X-Ray Filter Type	(113651, DCM, "Wedge filter")	TID 10003B
1.29.28.6	X-Ray Filter Material	(66925006, SCT, "Copper")	TID 10003B
1.29.28.7	X-Ray Filter Thickness Minimum	*1.000000 mm*	TID 10003B
1.29.28.8	X-Ray Filter Thickness Maximum	*2.000000 mm*	TID 10003B
1.29.29	Collimated Field Area	*0.010781 m^2*	TID 10003B
1.29.30	Collimated Field Height	*129 mm*	TID 10003B
1.29.31	Collimated Field Width	*83 mm*	TID 10003B
1.29.32	X-Ray Grid	(111641, DCM, "Fixed grid")	TID 10003B
1.29.33	X-Ray Grid	(111642, DCM, "Focused grid")	TID 10003B
Irradiation Event X-Ray Mechanical Data TID 10003C			
1.29.34	Positioner Primary Angle	*23.70 deg*	TID 10003C
1.29.35	Positioner Secondary Angle	*10.30 deg*	TID 10003C
1.29.36	Table Head Tilt Angle	*0.0 deg*	TID 10003C
1.29.37	Table Horizontal Rotation Angle	*0.0 deg*	TID 10003C

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.29.38	Table Cradle Tilt Angle	*0.0 deg*	TID 10003C
Start CID 10008 Dose Related Distance Measurement			
1.29.39	Distance Source to Isocenter	*720 mm*	TID 10003C
1.29.40	Distance Source to Reference Point	*570.00 mm*	TID 10003C
1.29.41	Distance Source to Detector	*1195 mm*	TID 10003C
1.29.42	Table Longitudinal Position	*727.90 mm*	TID 10003C
1.29.43	Table Lateral Position	*50.90 mm*	TID 10003C
1.29.44	Table Height Position	*87.5 mm*	TID 10003C
1.29.45	Table X Position to Isocenter	*727.90 mm*	TID 10003C
1.29.46	Table Y Position to Isocenter	*87.5 mm*	TID 10003C
1.29.47	Table Z Position to Isocenter	*50.90 mm*	TID 10003C
End CID 10008 Dose Related Distance Measurement			
1.29.48	Positioner Isocenter Primary Angle	*23.70 deg*	TID 10003C
1.29.49	Positioner Isocenter Secondary Angle	*10.30 deg*	TID 10003C
1.29.50	Positioner Isocenter Detector Rotation Angle	*0.0 deg*	TID 10003C
1.30	**Irradiation Event X-Ray Data**	**<CONTAINER>**	TID 10001
1.30.1	Acquisition Plane	(113622, DCM, "Single Plane")	TID 10003
1.30.2	Irradiation Event UID	**2.999.4**	TID 10003
1.30.3	DateTime Started	*20231020130412.000*	TID 10003
1.30.4	Irradiation Event Type	(113613, DCM, “Rotational Acquisition”)	TID 10003
1.30.4	Acquisition Protocol	*Cardiac and Vascular FLUORO*	TID 10003
1.30.5	Patient Table Relationship	(102540008, SCT, “headfirst”)	TID 10003
1.30.6	Patient Orientation	(102538003, SCT, “recumbent”)	TID 10003
1.30.6.1	Patient Orientation Modifier	(40199007, SCT, “supine”)	TID 10003
1.30.7	Target Region	(80891009, SCT, ”Heart”)	TID 10003

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.30.8	Dose Area Product	*0.00003100 Gy.m2*	TID 10003
1.30.9	Patient Equivalent Thickness	*10.340 cm*	TID 10003
1.30.10	Comment	*Rotational CBCT*	TID 10003
Start Person Participant within TID 10003			
1.30.11	Person Name	*Performing^^^Dr*	TID 1020
1.30.11.1	Person Role in Procedure	(113851, DCM, "Irradiation Administering")	TID 1020
End Person Participant			
Irradiation Event X-Ray Detector Data TID 10003A			
1.30.12	Acquired Image	**SOP Class UID: 1.2.840.10008.5.1.4.1.1.12.1.1** **SOP Instance UID: 2.999.5**	TID 10003A
Irradiation Event X-Ray Source Data TID 10003B			
1.30.13	Dose (RP)	*0.00081700 Gy*	TID 10003B
1.30.14	Reference Point Definition	(113860, DCM, "15cm from Isocenter toward Source")	TID 10003B
1.30.15	Number of Pulses	*600 no units*	TID 10003B
1.30.16	Pulse Width	*5.00 ms*	TID 10003B
1.30.17	Irradiation Duration	*20.000 s*	TID 10003B
1.30.18	KVP	*75 kV*	TID 10003B
1.30.19	X-Ray Tube Current	*20 mA*	TID 10003B
1.30.20	Average X-Ray Tube Current	*20 mA*	TID 10003B
1.30.21	Exposure Time	*3000 ms*	TID 10003B
1.30.22	Exposure	*940 uA.s*	TID 10003B
1.30.23	Focal Spot Size	*0.6 mm*	TID 10003B
1.30.24	Anode Target Material	(26194003, SCT, "Tungsten")	TID 10003B
1.30.25	**X-Ray Filters**	**<CONTAINER>**	TID 10003B
1.30.25.1	X-Ray Filter Type	(113653, DCM, "Flat filter")	TID 10003B
1.30.25.2	X-Ray Filter Material	(66925006, SCT, "Copper")	TID 10003B

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.30.25.3	X-Ray Filter Thickness Minimum	*0.300000 mm*	TID 10003B
1.30.25.4	X-Ray Filter Thickness Maximum	*0.300000 mm*	TID 10003B
1.30.26	Collimated Field Area	*0.010781 m^2*	TID 10003B
1.30.27	Collimated Field Height	*129 mm*	TID 10003B
1.30.28	Collimated Field Width	*83 mm*	TID 10003B
1.30.29	X-Ray Grid	(111641, DCM, "Fixed grid")	TID 10003B
1.30.30	X-Ray Grid	(111642, DCM, "Focused grid")	TID 10003B
Irradiation Event X-Ray Mechanical Data TID 10003C			
1.30.31	Positioner Primary Angle	*-100.00 deg*	TID 10003C
1.30.32	Positioner Secondary Angle	*0.0 deg*	TID 10003C
1.30.33	Positioner Primary End Angle	*100.00 deg*	TID 10003C
1.30.34	Positioner Secondary End Angle	*0.0 deg*	TID 10003C
1.30.35	Table Head Tilt Angle	*0.0 deg*	TID 10003C
1.30.36	Table Horizontal Rotation Angle	*0.0 deg*	TID 10003C
1.30.37	Table Cradle Tilt Angle	*0.0 deg*	TID 10003C
Start CID 10008 Dose Related Distance Measurement			
1.30.38	Distance Source to Isocenter	*720 mm*	TID 10003C
1.30.39	Distance Source to Reference Point	*570.00 mm*	TID 10003C
1.30.40	Distance Source to Detector	*1195 mm*	TID 10003C
1.30.41	Table Longitudinal Position	*727.90 mm*	TID 10003C
1.30.42	Table Lateral Position	*50.90 mm*	TID 10003C
1.30.43	Table Height Position	*87.5 mm*	TID 10003C
1.30.44	Table X Position to Isocenter	*727.90 mm*	TID 10003C
1.30.45	Table Y Position to Isocenter	*87.5 mm*	TID 10003C
1.30.46	Table Z Position to Isocenter	*50.90 mm*	TID 10003C

Node	Code Meaning of Concept Name	Code or Example Value	TID
End CID 10008 Dose Related Distance Measurement			
1.30.47	Positioner Isocenter Primary Angle	*-100.0 deg*	TID 10003C
1.30.48	Positioner Isocenter Secondary Angle	*0.0 deg*	TID 10003C
1.30.49	Positioner Isocenter Detector Rotation Angle	*0.0 deg*	TID 10003C
1.30.50	Positioner Isocenter Primary End Angle	*100.00 deg*	TID 10003C
1.30.51	Positioner Isocenter Secondary End Angle	*0.00 deg*	TID 10003C
1.30.52	Positioner Isocenter Detector Rotation End Angle	*0.0 deg*	TID 10003C
1.31	Comment	*Dose report of Performed Procedure Step*	TID 10001
1.32	Dose Image	**SOP Class UID: 1.2.840.10008.5.1.4.1.1.7** **SOP Instance UID: 2.999.6**	TID 10001
Start Person Participant within TID 10001			
1.33	Person Name	*Performing^^^Dr*	TID 1020
1.33.1	Person Role in Procedure	(113850, DCM, "Irradiation Authorizing")	TID 1020
End Person Participant			
1.34	Source of Dose Information	(113856, DCM, "Automated Data Collection")	TID 10001

1150

ZZZZZ.5.1.2 [DONE] Example of Traditional RDSR for CT

1152 The following is an example RDSR for a routine CT study. In this example, a CT scanner performs a CT localizer scan and a single CT acquisition.

1154 **Table ZZZZZ.5.1.2-1. CT Traditional RDSR**

Node	Code Meaning of Concept Name	Code or Example Value	TID
1	**X-Ray Radiation Dose Report**	**<CONTAINER>**	**Section TID 10011**
1.1	Language of Content Item and Descendants	(en, IETF4646, "English")	Section TID 1204
1.2	Procedure reported	(77477000, SCT, "Computed Tomography X-Ray")	Section TID 10011
1.2.1	Has Intent	(261004008, SCT, "Diagnostic Intent")	Section TID 10040

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.3	Observer Type	(121007, DCM, "Device")	Section TID 1002
1.4	Device Observer UID	2.999.1.2.3.4	Section TID 1004
1.5	Device Observer Name	CT Scanner Z	Section TID 1004
1.6	Device Observer Manufacturer	Manufacturer X	Section TID 1004
1.7	Device Observer Model Name	Model Y	Section TID 1004
1.8	Device Observer Serial Number	123456789	Section TID 1004
1.9	Device Role in Procedure	(113859, DCM, "Irradiating Device")	Section TID 1004
1.10	Device Role in Procedure	(121097, DCM, "Recording")	Section TID 1004
1.11	Observer Type	(121007, DCM, "Person")	Section TID 1002
1.12	Person Observer Name	<Mann^Hugh>	Section TID 1003
1.13	Person Observer's Role in the Organization	(159016003,SCT,"Radiologic Technologist")	Section TID 1003
1.14	Person Observer's Role in this Procedure	(121094,DCM,"Performing")	Section TID 1003
1.15	Start of X-Ray Irradiation	20230725120000	Section TID 10011
1.16	End of X-Ray Irradiation	20230725120300	Section TID 10011
1.17	Scope of Accumulation	(113014, DCM, "Study")	Section TID 10011
1.17.1	Study Instance UID	2.999.2.3.4.5	Section TID 10011
1.18	**CT Accumulated Dose Data**	**<CONTAINER>**	**Section TID 10012**
1.18.1	Total Number of Irradiation Events	2 events	Section TID 10012
1.18.2	CT Dose Length Product Total	220 mGy.cm	Section TID 10012
1.19	**CT Acquisition**	**<CONTAINER>**	**Section TID 10013**
1.19.1	Acquisition Protocol	CT Abdomen W contrast IV	Section TID 10013
1.19.2	Target Region	(818981001, SCT, "Abdomen")	Section TID 10013
1.19.3	CT Acquisition Type	(113805, DCM, "Constant Angle Acquisition")	Section TID 10013
1.19.4	Irradiation Event UID	2.999.3.4.5.6	Section TID 10013
1.19.5	DateTime Started	20230725120000	Section TID 10013

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.19.6	**CT Acquisition Parameters**	**<CONTAINER>**	**Section TID 10013**
1.19.6.1	Exposure Time	3.00 s	Section TID 10013
1.19.6.2	Scanning Length	250 mm	Section TID 10014
1.19.6.3	Top Z Location of Scanning Length	0.00 mm	Section TID 10014
1.19.6.4	Bottom Z Location of Scanning Length	-250.00 mm	Section TID 10014
1.19.6.5	Frame of Reference UID	2.999.4.5.6.7	Section TID 10014
1.19.6.6	Nominal Single Collimation Width	0.625 mm	Section TID 10013
1.19.6.7	Nominal Total Collimation Width	4.0 mm	Section TID 10013
1.19.6.8	Number of X-Ray Sources	1 X-Ray sources	Section TID 10013
1.19.6.9	**CT X-Ray Source Parameters**	**<CONTAINER>**	**Section TID 10013**
1.19.6.9.1	Identification of the X-Ray Source	1	Section TID 10013
1.19.6.9.2	KVP	120.0 kV	Section TID 10013
1.19.6.9.3	Maximum X-Ray Tube Current	40 mA	Section TID 10013
1.19.6.9.4	X-Ray Tube Current	40 mA	Section TID 10013
1.19.7	Comment	Localizer	Section TID 10013
1.20	**CT Acquisition**	**<CONTAINER>**	**Section TID 10013**
1.20.1	Acquisition Protocol	CT Abdomen W contrast IV	Section TID 10013
1.20.2	Target Region	(818981001, SCT, "Abdomen")	Section TID 10013
1.20.3	CT Acquisition Type	(116152004, SCT, "Spiral Acquisition")	Section TID 10013
1.20.4	Irradiation Event UID	2.999.5.6.7.8	Section TID 10013
1.20.5	DateTime Started	20230725120258	Section TID 10013
1.20.6	**CT Acquisition Parameters**	**<CONTAINER>**	**Section TID 10013**
1.20.6.1	Exposure Time	2.00 s	Section TID 10013
1.20.6.2	Scanning Length	220 mm	Section TID 10014
1.20.6.3	Length of Reconstructable Volume	200 mm	Section TID 10014

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.20.6.4	Exposed Range	260 mm	Section TID 10014
1.20.6.5	Top Z Location of Reconstructable Volume	-25.00 mm	Section TID 10014
1.20.6.6	Bottom Z Location of Reconstructable Volume	-225.00 mm	Section TID 10014
1.20.6.7	Top Z Location of Scanning Length	-15.00 mm	Section TID 10014
1.20.6.8	Bottom Z Location of Scanning Length	-235.00 mm	Section TID 10014
1.20.6.9	Frame of Reference UID	2.999.6.7.8.9	Section TID 10014
1.20.6.10	Nominal Single Collimation Width	0.625 mm	Section TID 10013
1.20.6.11	Nominal Total Collimation Width	40.0 mm	Section TID 10013
1.20.6.12	Pitch Factor	1.375	Section TID 10013
1.20.6.13	Number of X-Ray Sources	1 X-Ray sources	Section TID 10013
1.20.6.14	**CT X-Ray Source Parameters**	**<CONTAINER>**	**Section TID 10013**
1.20.6.14.1	Identification of the X-Ray Source	1	Section TID 10013
1.20.6.14.2	KVP	120.0 kV	Section TID 10013
1.20.6.14.3	Maximum X-Ray Tube Current	500 mA	Section TID 10013
1.20.6.14.4	X-Ray Tube Current	394 mA	Section TID 10013
1.20.6.14.5	Exposure Time per Rotation	0.5 s	Section TID 10013
1.20.7	**CT Dose**	**<CONTAINER>**	**Section TID 10013**
1.20.7.1	Mean CTDIvol	10.00 mGy	Section TID 10013
1.20.7.2	CTDIw Phantom Type	(113691, DCM, "IEC Body Dosimetry Phantom")	Section TID 10013
1.20.7.3	CTDIfreeair Calculation Factor	0.25 mGy/mA.s	Section TID 10013
1.20.7.4	Mean CTDIfreeair	49.25 mGy	Section TID 10013
1.20.7.5	DLP	220.00 mGy.cm	Section TID 10013
1.20.7.6	Size Specific Dose Estimate	12.30 mGy	Section TID 10013
1.20.7.6.1	Measurement Method	(113988, DCM, "Estimated from Water Equivalent Diameter")	Section TID 10013

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.20.7.6.2	Water Equivalent Diameter	300 mm	Section TID 10013
1.20.7.6.2.1	Measurement Method	(113984, DCM, "Water Equivalent Diameter From Localizer")	Section TID 10013
1.20.7.4	**Dose Check Alert Details**	**<CONTAINER>**	**Section TID 10015**
1.20.7.4.1	DLP Alert Value Configured	(373067005, SCT, "No")	Section TID 10015
1.20.7.4.2	CTDIvol Alert Value Configured	(373066001, SCT, "Yes")	Section TID 10015
1.20.7.4.3	CTDIvol Alert Value	1000.0 mGy	Section TID 10015
1.20.7.5	**Dose Check Notification Details**	**<CONTAINER>**	**Section TID 10015**
1.20.7.5.1	DLP Notification Value Configured	(373067005, SCT, "No")	Section TID 10015
1.20.7.5.2	CTDIvol Notification Value Configured	(373066001, SCT, "Yes")	Section TID 10015
1.20.7.5.3	CTDIvol Notification Value	45.00 mGy	Section TID 10015
1.21	Source of Dose Information	(113856, DCM, "Automated Data Collection")	Section TID 10011

ZZZZZ.5.1.3 [EM] Example of Traditional RDSR for DX

[Provide an example of specific items for the DX modality traditional RDSR]

ZZZZZ.5.1.4 [AT] Example of Traditional RDSR for MG

[Provide an example of specific items for the Mammography modality traditional RDSR]

ZZZZZ.5.2 Examples of Enhanced RDSR

ZZZZZ.5.2.1 [DONE] Cone Beam CT (CBCT) Enhanced RDSR in TID 10040

[This section is copied from PS3.17 UUUU.1]

The following is a simple example of a CBCT acquisition. The device acquires data by rotating a source around a table. There are simple assumptions about the filtration and attenuators present. Many optional entries, particularly legacy dose values, are not included in the interest of making it as simple as possible.

This example could apply to C-arm CBCT acquisitions, dental CBCT, on board imagers in RT, and standard CT scanners.

Table ZZZZZ.5.2-1. Cone Beam CT (CBCT) Enhanced RDSR

Node	Code Meaning of Concept Name	Code or Example Value	TID
1	X-Ray Radiation Dose Report		Section TID 10040
1.1	Language of Content Item and Descendants	(en, IETF4646, "English")	Section TID 1204
1.2	Procedure reported	(702569007, SCT, "Cone Beam Acquisition")	Section TID 10040
1.2.1	Has Intent	(261004008, SCT, "Diagnostic Intent")	Section TID 10040
1.3	Observer Type	(121007, DCM, "Device")	Section TID 1002
1.4	Device Observer UID	2.999.1.2.3.4	Section TID 1004
1.5	Device Observer Manufacturer	Manufacturer X	Section TID 1004
1.6	Device Observer Model Name	Model Y	Section TID 1004
1.7	Device Observer Serial Number	123456789	Section TID 1004
1.8	Scope of Accumulation	(113014, DCM, "Study")	Section TID 10040
1.9	Accumulated Dose Data		Section TID 10041
1.9.1	Identification of the X-Ray Source	1	Section TID 10041
1.9.2	Reference Point Dosimetry		Section TID 10041
1.9.2.1	Reference Point Definition	(113860, DCM, "15cm from Isocenter toward Source")	Section TID 10041
1.9.2.2	Dose (RP) Total	85 mGy	Section TID 10041
1.10	Irradiation Event Summary Data		Section TID 10042
1.10.1	Irradiation Event UID	2.999.2.3.4	Section TID 10042
1.10.2	DateTime Started	20200101120000	Section TID 10042
1.10.3	DateTime Ended	20200101120030	Section TID 10042
1.10.4	Identification of the X-Ray Source	1	Section TID 10042
1.10.5	Irradiation Event Types	(113613, DCM, "Rotational Acquisition")	Section TID 10042
1.11	Irradiation Details		Section TID 10043
1.11.1	DateTime Started	20200101120000	Section TID 10043
1.11.2	DateTime Ended	20200101120030	Section TID 10043

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.11.3	Frame of Reference UID	2.999.1.2.3	Section TID 10043
1.11.4	RDSR Frame of Reference Origin	(130537, DCM, "Equipment Origin")	Section TID 10043
1.11.5	RDSR Frame of Reference Description	Equipment origin located on left-most, rear-most corner of gantry support when viewing equipment from the front. Y-axis is anti-gravity direction. Z-axis is along table travel direction into the gantry. X-axis is cross product of y and z axes (+y × +z).	Section TID 10043
1.11.6	Radiation Source Characteristics		Section TID 10044
1.11.6.1	DateTime Started	20200101120000	Section TID 10044
1.11.6.2	DateTime Ended	20200101120030	Section TID 10044
1.11.6.3	Identification of the X-Ray Source	1	Section TID 10044
1.11.6.4	Focal Spot Size	1.2 mm	Section TID 10044
1.11.6.5	Anode Target Material	(26194003, SCT, "Tungsten")	Section TID 10044
1.11.6.6	Attenuator Characteristics		Section TID 10044
1.11.6.6.1	Equivalent Attenuator Material	(12503006, SCT, "Aluminum")	Section TID 10044
1.11.6.6.2	Equivalent Attenuator Thickness	2.5 mm	Section TID 10044
1.11.6.6.2.1	Reported Value Type	(117362005, SCT, "Nominal")	Section TID 10044
1.11.7	Radiation Technique		Section TID 10045
1.11.7.1	DateTime Started	20200101120000	Section TID 10045
1.11.7.2	DateTime Ended	20200101120030	Section TID 10045
1.11.7.3	Identification of the X-Ray Source	1	Section TID 10045
1.11.7.4	KVP	100 kV	Section TID 10045
1.11.7.5	X-Ray Tube Current	**DateTime Started** / **X-Ray Tube Current (mA)** 20200101120000 / 100.0 20200101120005 / 150.0 20200101120010 / 200.0 20200101120015 / 150.0	Section TID 10045

Node	Code Meaning of Concept Name	Code or Example Value		TID
		20200101120020	100.0	
		20200101120025	150.0	
1.11.8	Filtration			Section TID 10046
1.11.8.1	DateTime Started	20200101120000		Section TID 10046
1.11.8.2	DateTime Ended	20200101120030		Section TID 10046
1.11.8.3	Identification of the X-Ray Source	1		Section TID 10046
1.11.8.4	Attenuator Characteristics			Section TID 10055
1.11.8.4.1	Identification of the Attenuator	1		Section TID 10055
1.11.8.4.2	Attenuator Category	(113771, DCM, "X-Ray Filters")		Section TID 10055
1.11.8.4.3	Filter Material	(66925006, SCT, "Copper")		Section TID 10055
1.11.8.4.4	Filter Type	(113653, DCM, "Flat Filter")		Section TID 10055
1.11.8.4.5	X-Ray Filter Thickness	0.3 mm		Section TID 10055
1.11.9	Attenuators			Section TID 10047
1.11.9.1	DateTime Started	20200101120000		TID eRSDRT07
1.11.9.2	DateTime Ended	20200101120030		TID eRSDRT07
1.11.9.4	Attenuator Characteristics			Section TID 10055
1.11.9.4.1	Identification of the Attenuator	2		Section TID 10055
1.11.9.4.2	Attenuator Category	(128459, DCM, "Table")		Section TID 10055
1.11.9.4.3	Filter Material	(256501007, SCT, "Carbon Fiber")		Section TID 10055
1.11.9.4.4	Filter Type	(113650, DCM, "Strip Filter")		Section TID 10055
1.11.9.4.5	X-Ray Filter Thickness	30 mm		Section TID 10055
1.11.10	Radiation Output			Section TID 10048
1.11.10.1	DateTime Started	20200101120000		Section TID 10048
1.11.10.2	DateTime Ended	20200101120030		Section TID 10048
1.11.10.3	Identification of the X-Ray Source	1		Section TID 10048

<table>
<tr><th>Node</th><th>Code Meaning of Concept Name</th><th>Code or Example Value</th><th>TID</th></tr>
<tr><td>1.11.10.4</td><td>Air Kerma at Output Measurement Point</td><td><table><tr><th>DateTime Ended</th><th>Air Kerma at Output Measurement Point (mGy)</th></tr><tr><td>20200101120005</td><td>10.0</td></tr><tr><td>20200101120010</td><td>15.0</td></tr><tr><td>20200101120015</td><td>20.0</td></tr><tr><td>20200101120020</td><td>15.0</td></tr><tr><td>20200101120025</td><td>10.0</td></tr><tr><td>20200101120030</td><td>15.0</td></tr></table></td><td>Section TID 10048</td></tr>
<tr><td>1.11.11</td><td>Radiation Field Area</td><td></td><td>Section TID 10049</td></tr>
<tr><td>1.11.11.1</td><td>DateTime Started</td><td>20200101120000</td><td>Section TID 10049</td></tr>
<tr><td>1.11.11.2</td><td>DateTime Ended</td><td>20200101120030</td><td>Section TID 10049</td></tr>
<tr><td>1.11.11.3</td><td>Identification of the X-Ray Source</td><td>1</td><td>Section TID 10049</td></tr>
<tr><td>1.11.11.4</td><td>Radiation Field Outline</td><td>SCOORD3D POLYGON</td><td>Section TID 10049</td></tr>
<tr><td>1.11.12</td><td>X-Ray Source Reference Coordinate System</td><td></td><td>Section TID 10050</td></tr>
<tr><td>1.11.12.1</td><td>DateTime Started</td><td>20200101120000</td><td>Section TID 10050</td></tr>
<tr><td>1.11.12.2</td><td>DateTime Ended</td><td>20200101120030</td><td>Section TID 10050</td></tr>
<tr><td>1.11.12.3</td><td>Identification of the X-Ray Source</td><td>1</td><td>Section TID 10050</td></tr>
<tr><td>1.11.12.4</td><td>Transformation Matrix</td><td><table><tr><td>1.0</td><td>0.0</td><td>0.0</td><td>-40.0</td></tr><tr><td>0.0</td><td>1.0</td><td>0.0</td><td>20.0</td></tr><tr><td>0.0</td><td>0.0</td><td>1.0</td><td>-50.0</td></tr><tr><td>0.0</td><td>0.0</td><td>0.0</td><td>1.0</td></tr></table></td><td>Section TID 10050</td></tr>
<tr><td>1.11.12.5</td><td>Center of Rotation</td><td>SCOORD3D POINT</td><td>Section TID 10050</td></tr>
<tr><td>1.11.12.6</td><td>Rotation Plane Normal Point</td><td>SCOORD3D POINT</td><td>Section TID 10050</td></tr>
<tr><td>1.11.12.7</td><td>Rotation Angle</td><td></td><td>Section TID 10050</td></tr>
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Node	Code Meaning of Concept Name	Code or Example Value	TID
		DateTime Started: 20200101120005 — Rotation Angle (deg): 40.0 DateTime Started: 20200101120010 — Rotation Angle (deg): 80.0 DateTime Started: 20200101120015 — Rotation Angle (deg): 120.0 DateTime Started: 20200101120020 — Rotation Angle (deg): 160.0 DateTime Started: 20200101120025 — Rotation Angle (deg): 200.0 DateTime Started: 20200101120030 — Rotation Angle (deg): 240.0	
1.11.13	Beam Position		Section TID 10051
1.11.13.1	DateTime Started	20200101120000	Section TID 10051
1.11.13.2	DateTime Ended	20200101120030	Section TID 10051
1.11.13.3	Identification of the X-Ray Source	1	Section TID 10051
1.11.13.4	Output Measurement Point Position	SCOORD3D POINT	Section TID 10051
1.11.13.5	Reference Point Position	SCOORD3D POINT	Section TID 10051
1.11.13.6	X-Ray Beam Attenuator Model		Section TID 10051
1.11.13.6.1	Identification of the Attenuator	1	Section TID 10051
1.11.13.6.2	X-Ray Attenuator Model Data	2.999.3.4.5	Section TID 10051
1.11.13.6.6	Transformation Matrix	1.0 0.0 0.0 0.0 0.0 1.0 0.0 5.0 0.0 0.0 1.0 0.0 0.0 0.0 0.0 1.0	Section TID 10051
1.11.14	Attenuator Position		Section TID 10052
1.11.14.1	DateTime Started	20200101120000	Section TID 10052
1.11.14.2	DateTime Ended	20200101120030	Section TID 10052
1.11.14.3	X-Ray Beam Attenuator Model		
1.11.14.3.1	Identification of the Attenuator	2	Section TID 10052

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.11.14.3.2	X-Ray Attenuator Model Data	2.999.4.5.6	Section TID 10052
1.11.14.3.3	Transformation Matrix	1.0 0.0 0.0 -40.0 0.0 1.0 0.0 60.0 0.0 0.0 1.0 -45.0 0.0 0.0 0.0 1.0	Section TID 10052
1.11.15	Procedure Characteristics		Section TID 10054
1.11.15.1	DateTime Started	20200101120000	Section TID 10054
1.11.15.2	DateTime Ended	20200101120030	Section TID 10054
1.11.15.3	Identification of the X-Ray Source	1	Section TID 10054
1.11.15.4	Acquisition Protocol	CBCT Acquisition	Section TID 10054
1.11.15.5	Patient Table Relationship	(102540008, SCT, "headfirst")	Section TID 10054
1.11.15.6	Patient Orientation	(102538003, SCT, "recumbent")	Section TID 10054
1.11.15.6.1	Patient Orientation Modifier	(40199007, SCT, "supine")	Section TID 10054
1.11.15.7	Distance Source to Detector	1200 mm	Section TID 10054
1.12	Source of Dose Information	(113856, DCM, "Automated Data Collection")	Section TID 10040