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

Table of Contents

Document History

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Draft 03	March 03, 2022	Updated sections 3.2, 3.2.1, 4.2, and 4.4
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Draft 16	August 14, 2024	Updated for the WG-06 August meeting
Draft 17	August 21, 2024	Updated at WG-06 First Reading. First Reading stopped on ZZZZZ.4.1, and did not read from ZZZZZ.3.2.2 to ZZZZZ.3.2.6 included
Draft 18	November 01, 2024	Updated at WG-28 / WG-02 joint meeting
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Draft 20	January 10, 2025	Updated after December 2024 WG-28 / WG-02 joint meeting, for the WG-06 meeting in January 2025.
Draft 21	January 13, 2025	Updated after WG-06 review on Jan 13 2025
Draft 22	March 25, 2025	Updated at WG-28 / WG-02 joint call
Draft 23	March 26, 2025	Updated after WG-06 review on Mar 26 2025

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:
    - **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);
    - **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 this new supplement? (e.g. create a new Annex, merge with existing annex AA and copy Annex UUUU to AA, etc..)		Open

Tasks

Work to be done before Public Comments

Item	Task	Who
1	Update section 3.2.6 (Dentistry) to be aligned with the updates of section 3.2.1 (XA Angiography) (WG-06 agrees with the updated 3.2.1).	NB
7	ZZZZZ.5.2 Add examples of Enhanced RDSR for XA	FS
12	ZZZZZ.4.14 Finish the new section 4.14 to describe the use cases of Dose Calibration container (aligned with the new CP from JIRA)	JIRA
13	Editorial: In all the document: do not assume Enhanced RDSR is replacing Traditional RDSR, do not use temporal comparison, but just mention factual differences. Indeed, both Traditional and Enhanced RDSR implementations will cohexist for backward interoperability reasons.	FS
14	In section 4.13 include the case where an equipment encodes both Traditional and Enhanced RDSR for the same procedure/study (for interoperability and/or regulatory requirements). Explain that creators and consumers need to make sure there's no doublecounting of dose information (proper usage of Irradiation Event UIDs).	All
15	Editorial: For each section of chapter 4 (encoding guidelines), state clearly at the beginning what is the user need and what problem this section is trying to solve.	All
16	Editorial: Don't mention CP numbers in Part17, rather take the rationales	FS

Changes to NEMA Standards Publication DICOM 2024d

Digital Imaging and Communications in Medicine (DICOM)

Part 17: Explanatory Information

Item #01: Add new Annex to Part 17 (or replace Annex AAA and 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 or parts of a procedure performed, 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).

The purpose of the Radiation Dose SR Objects described in this Annex is to record the radiation output of the equipment. This Annex includes Projection X-Ray RDSR, CT RDSR and Enhanced RDSR, and it excludes Radiopharmaceutical Dose SR and Patient Radiation Dose SR.

Radiation for treatment is out of the scope of these RDSRs. Such radiation is encoded in the family of RT (Radiotherapy) objects.

The use of the Patient RDSR Objects is described in the DICOM PS3.17 Annex GGGG Patient Radiation Dose Structured Report Document (Informative).

ZZZZZ.2 [DONE] DEFINITIONS AND CONVENTIONS IN THIS ANNEX

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

This annex uses capitalized words to identify DICOM-defined terminology when the term is used in the defined sense. There are other uses of these terms that are not capitalized, in which case the term is being used in the general sense and not necessarily confined to any restrictions imposed by the DICOM definition.

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 (e.g., the name of operator who performed the exam), can also be used to monitor the utilization of the equipment, as well as deviations from intended protocols, best practices, and applicable regulations.

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 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

The nature of information reported in the RDSR will depend on the type of procedures performed, the different system designs of the equipment generating radiation, and the modality workflow.

a) Type of procedure

The radiation dose metrics and technical parameters that are relevant to be reported depend on the type of procedure. 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,
- the exposure index is relevant to digital radiography to provide feedback regarding the estimated exposure on the detector.

b) System Design

The technology of the equipment (x-ray detector, x-ray source, and positioner subsystems) will determine the available information that can be collected about those subsystems and their configuration parameters.

For instance, the RDSR produced by the detector subsystem would not be able to contain data related to the generation of the radiation if the generator is not digitally integrated with the detector.

Further, a system creating the RDSR might not necessarily generate the irradiation itself, but rather an ancillary system may do it based on the irradiation details obtained by manual input and/or some proprietary method.

c) Modality Workflow

The radiation dose information is recorded at different points in the acquisition workflow depending on the modality. For instance, in angiography studies, an RDSR with the scope of accumulation "Procedure Step To This Point" will contain partial information of the procedure up to the time when the RDSR is created, while a later RDSR with scope of accumulation "Study" will contain the complete information of the study.

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, computed 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.

A key motivation for having DICOM Dose Objects is that an Irradiation Event 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.

Both the Traditional and Enhanced RDSR include information summarizing dosimetric values across the scope of accumulation. The inclusion of such data is for convenience for users of RDSRs so that relevant data is readily available for viewing or interpretation, particularly by users. The underlying data used to generate the summary values relevant to a particular system are available in the Irradiation Events within the RDSR, allowing any user or interpreting system to derive summary values for themselves. A potential benefit of not relying on the summary values is the ability to use additional details of each event, e.g., X-Ray beam characteristics or geometry, as part of such calculations.

ZZZZZ.3.2.1 [DONE] X-Ray Angiography

The term *X-Ray Angiography (XA)* as 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 **procedure starts**,
    a. Patient and procedure information is provided to the equipment by the DICOM Modality Worklist or manually entered by the operator.
    b. Equipment settings like protocols, patient position relative to the table, etc. are then provided to the equipment by the operator.
2) During the procedure, **X-Ray exposures** are performed.
    a. XA has two main X-Ray exposure 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…).
    b. For each X-Ray exposure, dose and other related information is collected and recorded in an Irradiation Event (for BOTH Fluoroscopy and Acquisitions).
    c. When the two X-Ray sources of a biplane system are activated simultaneously during the X-Ray exposure, it results in two Irradiation Events, one for Plane A and one for Plane B.
    d. Optionally, one or more RDSRs are created during the procedure if there is an external dose consumer system that needs to process and display the information as the procedure goes. These RDSRs contain information of the Irradiation Events that were recorded at that time in the procedure.
        - Each RDSR Instance defines its Scope of Accumulation which indicates the period of irradiation reported in that RDSR Instance (E.g. Procedure Step To This Point, or Irradiation Event). Each RDSR Instance includes information of all the Irradiation Events within its scope of accumulation, as well as Accumulated Dose Data within that same scope.
3) During the procedure, **images** are generated.
    a. X-Ray exposures always result in images that are displayed on the equipment and have corresponding Irradiation Events.

- Images resulting from Fluoroscopy exposures may or may not be stored, while images resulting from Acquisition exposures are by definition stored.
- XA 2D projection images can be multi-frame or single frame.
- X-Ray exposures of two X-Ray sources of a biplane system activated simultaneously result into two XA 2D projection images, one for Plane A and one for Plane B.

b. XA 2D projection images may be processed to create new images (e.g., subtracted images), also stored as XA 2D images. No new X-Ray exposures were involved. The new images may include a reference to the Irradiation Event UIDs of the XA 2D images they were created from.
c. 3D cone-beam reconstructions may be created from XA 2D projections and stored as X-Ray 3D images. No new X-Ray exposures were involved. The new 3D cone-beam reconstructions may include a reference to the Irradiation Event UIDs of the XA 2D images they were created from.
d. DICOM XA images are stored in one or more DICOM Series grouping related images in a Series.
e. The Irradiation Event details are always kept regardless of whether the XA 2D images are stored or deleted during the procedure.

4) The procedure ends.
5) Following the procedure, one or more RDSR Instances are created from the data collected during the procedure.
   a. These RDSRs contain information for long-term storage and distribution to dose information management systems and cross-institutional systems such as dose registries, in order to perform relevant dose QA analysis, produce related reports, and support medical regulations.
   b. Each RDSR Instance defines its scope of accumulation which indicates the period of irradiation reported in that RDSR Instance (the Study, the Series, the Performed Procedure Step). Each RDSR Instance includes information of all the Irradiation Events within its scope of accumulation, as well as Accumulated Dose Data within that same scope.
   c. For almost all procedures, there will be an RDSR with the scope that covers all of the Irradiation Events during that procedure.
   d. These RDSRs are stored in a new DICOM Series different from the one where the XA images are stored.
6) Optionally, additional images are created (e.g. processed XA 2D images, 3D cone-beam reconstructions). No new X-Ray exposures were involved. The new images may include a reference to the Irradiation Event UIDs of the XA 2D images they were created from. These images produced after the creation of the RDSR are not referenced in the RDSR.
7) Subsequently there will be dose analysis based on the information of the Irradiation Events contained in the created RDSRs. Irradiation Events and images are often one to one, but there may be Irradiation Events with no images (e.g. images that come for Fluoroscopy, or deleted Acquisition images), and there may be also one Irradiation Event that ultimately results in multiple images (e.g. original and processed images, 3D reconstructions, etc.). For this reason, dose analysis is driven by the Irradiation Events, not by images. See section ZZZZZ.4.13 for the importance to use the Irradiation Event UIDs in the RDSRs.

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. These concepts are developed more in detail in section ZZZZZ.4.8.

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 and procedure start**,
    a. Patient and procedure information is provided to the equipment by the DICOM Modality Worklist or manually entered by the operator.
    b. Equipment settings like protocols, patient position relative to the table, etc. are then provided to the equipment by the operator.
2) During the procedure, **X-Ray exposures** are performed.
    a. The irradiation generation of one x-ray source during the time between x-ray ON and OFF is considered one Irradiation Event.
    b. The rad/fluoro system can acquire lower dose fluoroscopy exposures as well as higher dose RF exposures.
3) During the procedure, **images** are generated.
    a. 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.
    b. 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.
    c. 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.
    d. The image(s) stored locally during one procedure step may be exported as a DICOM series.
4) The procedure ends
5) Several/many procedure steps can be performed during the study.
6) The study ends.
7) Following the study, one or more RDSR Instances are created from the data collected during the procedure .
    a. 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.
8) Subsequently there will be dose analysis based on the information of the Irradiation Events contained in the created RDSRs. Irradiation Events and images are often one to one, but there may be Irradiation Events with no images (e.g. deleted images). For this reason, dose analysis is driven by the Irradiation Events, not by images. See section ZZZZZ.4.13 for the importance to use the Irradiation Event UIDs in the RDSRs.

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) During the procedure, **X-Ray exposures** are performed.
    a. One or several radiography exposures of the patient are performed as separate Irradiation Events.
    b. The patient and/or radiography system are repositioned for each view
4) During the procedure, **images** are generated.
    a. The radiography image from each exposure is typically stored as a separate DICOM Series.
    b. 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.
5) The study ends.
6) Following the study, one or more RDSR Instances are created from the data collected during the study.
    a. The scope of accumulation of the RDSR indicates the period of irradiation reported in that RDSR instance, e.g., the Study, the Series, etc.
7) Subsequently there will be dose analysis based on the information of the Irradiation Events contained in the created RDSRs. Irradiation Events and images are often one to one, but there may be Irradiation Events with no images (e.g. deleted images). For this reason, dose analysis is driven by the Irradiation Events, not by images. See section ZZZZZ.4.13 for the importance to use the Irradiation Event UIDs in the RDSRs.

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 that uses 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 **procedure starts**,
    a. Patient and procedure information is provided to the equipment by the DICOM Modality Worklist or manually entered by the operator.
    b. 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.

c. Equipment settings like protocols, patient position, laterality, etc. are provided to the equipment by the operator.

2) During the procedure, **X-Ray exposures** are performed.
   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).
   e. For each X-Ray exposure, dose and other related information is collected and recorded in an Irradiation Event.
3) During the procedure, **images** are generated.
   a. 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.
   b. 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.
4) The procedure ends.
5) Following the procedure, one or more RDSR Instances are created from the data collected during the procedure.
   a. These RDSRs contain information for long-term storage and distribution to dose information management systems and cross-institutional systems such as dose registries, in order to perform relevant dose QA analysis, produce related reports, and support medical regulations.
   b. Each RDSR Instance defines its scope of accumulation which indicates the period of irradiation reported in that RDSR Instance (the Study, the Series, the Performed Procedure Step). Each RDSR Instance includes information of all the Irradiation Events within its scope of accumulation, as well as Accumulated Dose Data within that same scope.
   c. For almost all procedures, there will be an RDSR with the scope that covers all of the Irradiation Events during that procedure.
   d. These RDSRs are stored in a new DICOM Series different from the one where the MG images are stored.
6) Subsequently there will be dose analysis based on the information of the Irradiation Events contained in the created RDSRs. Irradiation Events and images are often one to one, but there may be Irradiation Events with no images (e.g. rejected images or aborted acquisitions), and there may be also one Irradiation Event that ultimately results in multiple images (e.g. tomosynthesis, contrast-enhanced, etc.). For this reason, dose analysis is driven by the Irradiation Events, not by images. See section ZZZZZ.4.13 for the importance to use the Irradiation Event UIDs in the RDSRs.

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 that are reconstructed to form cross-sectional images of a patient or object. 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 procedure starts.
    a. Patient and procedure information is provided to the equipment by the DICOM Modality Worklist or manually entered by the operator.
    b. Equipment settings like protocols, patient position relative to the table, etc. are then provided to the equipment by the operator.
2) During the procedure, CT acquisitions are performed.
    a. CT has two broad types of acquisition modes: one where the X-Ray source is stationary and the patient moves in a linear direction (e.g., during a localizer acquisition) and another where the X-Ray tube is rotating relative to the patient. In the case of the rotating X-Ray source, the patient may move in a linear direction either during (e.g., helical/spiral acquisition), between (e.g., axial acquisition), or not at all (e.g., stationary acquisition) with relation to the X-Ray exposures during an acquisition.
    b. 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.
    c. For each CT acquisition, the dose and other related information is collected and recorded in an Irradiation Event.
        i. 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. 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 acquisitions, especially when trying to capture dynamic information (e.g., cardiac motion, respiratory motion, contrast agent enhancement, etc.).

       Subsequent acquisitions may also take place via manual actuation of the irradiation switch by the CT operator. In such a case, the acquisitions are 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.
    e. 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.
3) After each acquisition, CT reconstruction is performed, and images are generated.
    a. For acquisitions when the X-Ray tube is rotating, the data collected during an acquisition may be reconstructed into one or more CT images. The same acquisition data may be reconstructed into CT images using different reconstruction filters, slice thicknesses, fields-of-view, axial ranges, cardiac gating, etc. Data from certain acquisitions, e.g., bolus-tracking series, may not be saved. Several acquisitions may be combined to create a single CT image set, 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 CT images generated in the previous step. If the Irradiation Event UID is present in the additional reconstructions, it should be copied from the original image.
4) The procedure ends.
5) Following the procedure, an RDSR is created from the data collected during the procedure.
    a. The RDSR contains information for long-term storage and distribution to dose information management systems and cross-institutional systems such as dose registries, in order to perform relevant dose QA analysis, produce related reports, and support medical regulations.
    b. The RDSR Instance defines its scope of accumulation which indicates the period of irradiation reported in that RDSR Instance (the Study, the Series, the Performed Procedure Step). Each RDSR Instance includes information of all the Irradiation Events within its scope of accumulation, as well as Accumulated Dose Data within that same scope.
    c. For almost all procedures, there will be an RDSR with the scope that covers all of the Irradiation Events during that procedure.
    d. The RDSRs are stored in a new DICOM Series different from the one where the CT images are stored.
6) Subsequently there will be dose analysis based on the information of the Irradiation Events contained in the created RDSRs. Irradiation Events and images are often one to one, but there may be Irradiation Events with

no stored images (e.g., aborted acquisitions), and there may be also one Irradiation Event that results in multiple images (e.g., multiple reconstruction filters, etc.). For this reason, dose analysis is driven by the Irradiation Events, not by images. See section ZZZZZ.4.13 for the importance to use the Irradiation Event UIDs in the RDSRs.

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. These concepts are developed more in detail in section ZZZZZ.4.8.

ZZZZZ.3.2.6 Dentistry [NB]

Note: merge all subsections, like the other modalities

ZZZZZ.3.2.6.1 [WIP] Dental Cone-Beam CT (CBCT)

Computed tomography (CT), including cone-beam computed tomography (CBCT) in dentistry, 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 in machines which scan patients in supine 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.

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 timing associated with patient instructions, etc. The acquisition typically requires continuous actuation of a switch or pedal.
    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 [WIP] 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 [WIP] 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 [WIP] 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 RDSR and Enhanced RDSR

Traditional RDSR and Enhanced RDSR encode largely equivalent information in different ways and have a number of similarities. This section will discuss details of these encodings and advantages of using one or the other.

Traditional RDSR encodes the information based on the concept of each Irradiation Event, which is defined 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 (see PS3.16 Chapter D). In projection X-Ray settings (e.g., XA rooms, radiography equipment, mammography equipment), an irradiation event is often analogous with a pedal press or button press. On scanners like CT systems, the irradiation event may not necessarily have a one-to-one correlation with a button press depending on the protocol and acquisition settings. Any on-off switching of the irradiation during the event (e.g., pulsing, pausing for cardiac motion) is not treated as separate events. In the Traditional RDSR framework, the Irradiation Event is the smallest information entity recorded.

Enhanced RDSR decouples the Traditional RDSR dependence of reporting information based solely on the beginning and end of an Irradiation Event. For example, values that change infrequently within the scope of the 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 vs. Traditional RDSR. The same encoding methodology is applicable to all modalities and procedures in Enhanced RDSR.

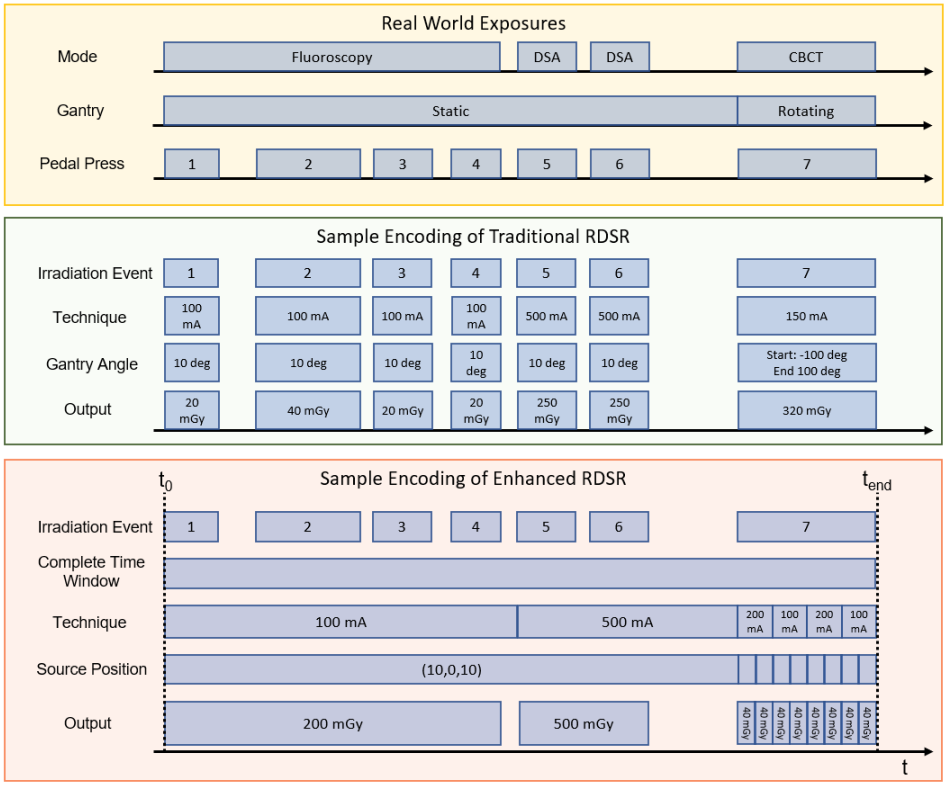

Figure ZZZZZ.4.1-1 Example of XA Procedure Encoding Concepts of Traditional and Enhanced RDSR

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

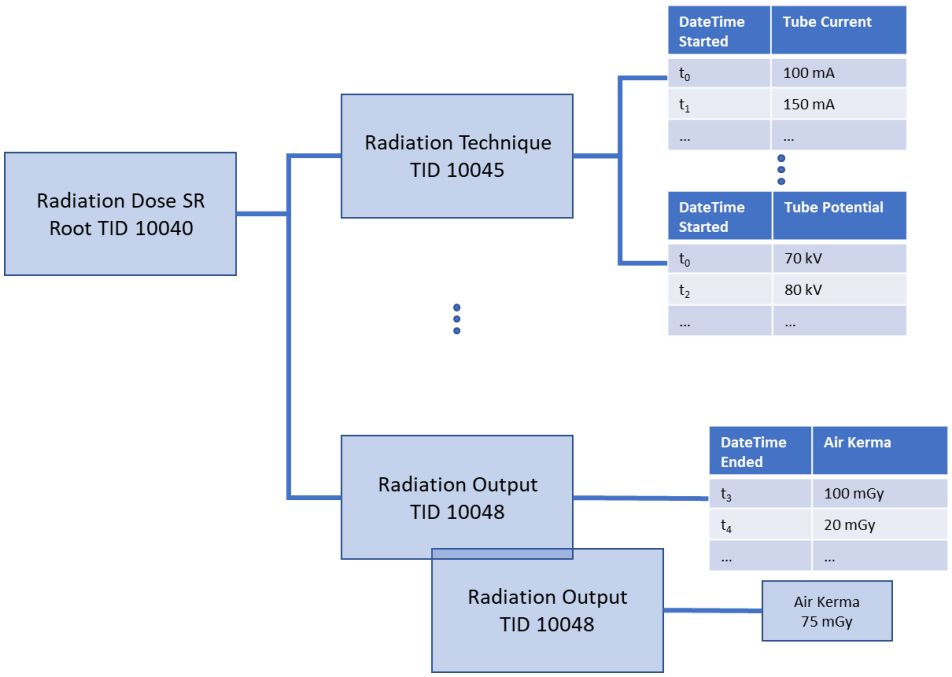

Figure ZZZZZ.4.1-2 Structure of Encoding of Content Items in TIDs and in TABLE Value Types

TODO: represent in the diagram above that TID 10048 (Radiation Output CONTAINER) can be present multiple times (VM=1-N), each time it contains the Air Kerma EITHER in a TABLE OR in a Single Value (but not both).

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 Table ZZZZZ.4.1-1 provides a general comparison between the Traditional and Enhanced RDSRs and explains where various information is contained within each RDSR type.

TODO: explain the intent of this table. Is it for physicists? For SW consumers?

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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	TID differs by modality. • Common: TIDs **10002, 10007** • CT: TID **10012** • XA, RF: TID **10004** • MG: TID **10005** • CR, DR, DX: TID **10006**	TID **10041** for all modalities. Say that a few items were omited vs. Traditional RDSR… and point to other sections of this ANNEX (<provide references, add a sub-section about changes in CT data>) (provide a comprehensive list, not detailed items) • EV (113764, DCM, “Acquisition Plane”) • EV (128750, DCM, "Equipment Landmark") and properties/contents • EV (128754, DCM, "Patient Location Fiducial") and properties/contents • EV (113813, DCM, "CT Dose Length Product Total"), replaced by EV (130745, DCM, "CT Dose Length Product Sub-Total") instead, ~~following CP1196~~ • EV (113814, DCM, "CT Effective Dose Total") and its associated properties, contents, and concept modifiers.
Observer Context	TID 1002	TID 1002
Person Participant	TID 1020	TID 1020
Device Participant	TID 1021	TID 1021
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 TODO: bullet list for each modality	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 details)**	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. TODO: remove redundancy between this row and previous one
Geometry **(Positioner, Table, Patient Orientation, Collimator, Attenuators in the beam)** **(See ZZZZZ.4.4 for further examples)**	Distances, angles, areas, typically patient-based. Mention the TIDs here	Equipment or Room Coordinate-based description of positions and shapes. Mention the TIDs here

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ZZZZZ.4.1.1 [DONE] Regulatory aspects

Information that may be required by various regulatory, accreditation, and government agencies is included in both Traditional RDSR and Enhanced RDSR but in different TIDs. Therefore, creators of RDSRs should provide the Content Items required by such agencies, regardless the TID.

Note that encoding the TID numbers is optional, they might not be included in the encoding of RDSRs (except the root template). See PS3.3 Table C.18.8-1 and Section C.18.8.1.2 Content Template Sequence

Even if the information is in both RDSRs, bla bla bla (try to explain that agencies may need to revisit their requirements if they are asking for specific TIDs and not only Content Items). TODO: rework this paragraph.

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

TODO: clarify what is the user need and what problem this section is trying to solve.

For some analysis, identifying the specific type of equipment and/or clinical procedure is useful to bla bla bla

This section provides guidance for RDSR encoding of bla bla bla.

~~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") is User Optional and may be absent in many RDSRs.

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 (e.g. Diagnostic, Therapeutic, Quality Control, Screening, etc.), which is not necessarily related to the type of procedure and the type of equipment used.

Note: Mention that overtime the codes change for the same or similar Concept Names (e.g. moving from DCM to SCT or SRT), and this affects the consumer…

TODO: We could add a discussion about procedure codes for registries… (see also PS3.3 C.17.2 SR Document General Module) Referenced Request Sequence (0040,A370), Performed Procedure Code Sequence (0040,A372).

The following table provides some examples of meaninful 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 Examples of Values for Procedure Reported and Acquisition Device Type

Modality (0008,0060) of the DICOM Images 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 (0008,0060) of the DICOM Images 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”) (1290849002, SCT, “Dental radiography”)
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.4.2b [DONE] Encoding of the Identity of the Equipment

From the user perspective, it’s beneficial to be able to know and record the identity of the device that generates an RDSR, with certain levels of uniqueness, e.g. the individual device, or the model of the device, or the manufacturer, etc.

For instance, medical physicists doing quality control, dose/protocol management and dose optimization of X-Ray equipment in an institution need to identify the individual device that is creating the RDSR.

Also, a National Registry receiving RDSRs need to know what is the origin of the radiation for the purpose of sorting/classifying the RDSRs.

This is achieved by including the information about the irradiating device in the General Equipment and Enhanced General Equipment Modules of the RDSR, that specify the Manufacturer, Model, Software Version and Serial Number, etc. They are intended to be a primary identification of the system that produces the data (e.g., device providing the content of the SOP Instance) and not the identification of the component that encodes the SOP Instance (e.g., a commonly used DICOM encoding toolkit).

In addition, the structured content of the RDSR should be used to include more details in the Observer Context TID 1002, when Observer Type equals (121007, DCM, “Device”). Refer to TID 1004 “Device Observer Identifying Attributes”. These values should be consistent with the ones in the General Equipment and Enhanced General Equipment Modules.

This allows to document four levels of “uniqueness”, the most detailed being the UDI, and also the Serial Number which should be unique for each individual device for a given manufacturer and model.

Note that the General Equipment and Enhanced General Equipment Modules are mandatory for both Traditional RDSR and Enhanced RDSR. Note also that while Observer Context TID 1002 is mandatory in the RDSR, it might contain only a Person observer and not the Device, so device information is not mandatory in the structured content.

The following table provides some guidance on the values, from less to more uniqueness.

Table ZZZZZ.4.2.3-1 Guidance for values in the Equipment Modules and in TID 1004

Attribute Name / Content Item Concept Name	Implementation Guidance
Manufacturer	This is mandatory in the Enhanced General Equipment Module. From the user perspective, this value should be consistent with the name of the company that sold the device. However, it’s important to notice that for a given manufacturer, this value may not be changed over time as often as the manufacturer changes legal entity names.
Model Name	This is mandatory in the Enhanced General Equipment Module. This should be a name that represents a type of equipment known by the end user, typically the commercial name.
Device Name	Optional. In TID 1004 it defaults to the Station Name of the General Equipment Module.
Station Name	Optional. User defined name, ideally unique in the local network.
Station AE Title	Optional. This is the AE Title of the equipment generating the RDSR.

Software version	This is mandatory in the Enhanced General Equipment Module. Typically this is the version of the system, the product, or the component creating the DICOM instances. Additionally, it may contain several values to describe multiple system components.
Serial Number	This is mandatory in the Enhanced General Equipment Module. This is the serial number of the whole system, it does not include parts/components of the system. It's intended to be unique to the individual device across the same manufacturer and model.
Device UID	Mandatory if the Observer Type equals (121007, DCM, "Device"). It's unique across all other DICOM UIDs and it describes only one individual device.
Device UDI	Optional. It's unique to each individual device, as defined by a corresponding Issuing Agency. Refer to PS3.3 section 10.29.1.

ZZZZZ.4.3 [DONE] Encoding of Physicians and Operators (observers)

TODO: rework opening paragraph.

Mention when is in the header metadata and when is in the structured content (SR content tree). Talk about header first, then about SR tree…

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

<Because they are not there, look at the content items>

Indeed, 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 at the Series level present on the Image IODs. In particular, the General Series Module is not defined on the SR IOD.

Note that the Referring Physician and Reading Physician Name attributes are defined in the General Study Module, thus they are present in the header metadata of the SR objects and they are common to both Images and Structured Reports.

Person names are encoded 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".

<TODO: (ordering, performing, administering) could explain typical persons & roles for each modality. E.g. in a typical XA procedure, three Dr. would be the same (performing interventionalist = authorizing and administering), in XR and MG the authorizing is not the performing/technologist). Is there a scenario in XA where they may be different? Also: for example in XA, if authorizing is not present should we assume that it's the same as the administering?.

In XA, the ordering should be invisible? In XR, MG is different.

<We don't care about the role in the organization (it may change depending on hospital, region, country…). The important thing is the **role in the procedure**>

Open issue (to be discussed with physicians and dose analysis persons): Is the Radiologist that is protocoling the procedure (in CT…) also the one that "authorizes the irradiation"?. Should we record both ordering and protocoling physicians?

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) 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 (remove this bullet? It's going too far in the design assumptions).

<TODO: For query use cases, it could be interesting to encode physicians in the header metadata: to be discussed if query use case should be described in this section. Question not only for creators, but mainly for users. We would not promote this unless we identify a strong Query use case. SR tree is enough for the users.> 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**. These sequences can be used to describe the names of the persons involved in the creation of the technical data of the RDSR.

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.

TODO: provide one table example for a typical XA interventional scenario, another table example for CT/DX/Mammo diagnostic procedures (somebody orders, someone protocols the exam, other performs the scan,…)

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 (VM = 1-N)			
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

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.n1.1	Person Role in Procedure	(113850, DCM, "**Irradiation Authorizing**")	TID 1020
1.p1	Irradiation Event X-Ray Data	*<CONTAINER>*	TID 10003
Example of TID 1020 "Person Participant" within the TID 10003 (VM = 1-N)			
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

Systems that provide a value of the Air Kerma at the Reference Point are required to define the Reference Point based on codes from CID 10025 "Radiation Dose Reference Points".

Table ZZZZZ.4.4.1-1 provides recommended Reference Points for different mechanical configurations of different modalities.

Table ZZZZZ.4.4.1-1 Reference Point Definitions

Modality	Reference Point Definition	Mechanical Configuration
X-Ray Angiography (XA)	(113860, DCM, "15cm from Isocenter toward Source")	Recommended for Interventional System with C-arm and Isocenter.
	(113862, DCM, "1cm above Tabletop")	Recommended 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")	Recommended for C-arm type Fluoroscopes without integrated table.
	(113864, DCM, "15cm from Table Centerline")	Recommended for lateral type of fluoroscopes.
	(113862, DCM, "1cm above Tabletop")	Recommended for Fluoroscopy System with X-Ray source assembly fixed below table.
	(113863, DCM, "30cm above Tabletop")	Recommended for Fluoroscopy System with X-Ray source assembly fixed above table.
Radiography (DX, CR)	(113941, DCM, "In Detector Plane")	Recommended for Radiography System with mobile cassettes or mobile digital detectors.
	(113965, DCM, "100cm from X-Ray Source")	Recommended for mobile X-Ray sources without knowledge of the detector location.

Modality	Reference Point Definition	Mechanical Configuration
Mammography (MG)	(113865, DCM, "4.2cm above Breast Support Surface")	(Either) recommended for conventional systems, applicable for all types of acquisitions including tomosynthesis. *Question: "At surface of the patient" for Mammo is a point but for Tomo, unless you define a single point in time, it is not a point but a curved line made of multiple points during acquisition.* *Ask WG-15 how they use it.*
	(113964, DCM, "At Surface of Patient")	
Dentistry (IO, PX)	(113941, DCM, "In Detector Plane")	Recommended for xxxx.
Computer Tomography (CT)	Reference Point is not defined.	Conventional CT geometry.
	Reference Point is not defined.	Dental Cone Beam CT.

ZZZZZ.4.4.2 [DONE] Equipment Geometry in Traditional RDSR

In order to translate 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, angulations, 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
>	(13745, DCM, "Patient Table Relationship")	(102540008, SCT, "**headfirst**")	TID 10003

	Code Meaning of Concept Name	Code or Example Value	TID
>	(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" (VM = 1-N)			
>	(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 Traditional RDSR

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 images 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.

964 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
966 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.

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

970 <TODO: make an example with real numbers, with numbers maybe not expected to show the extend of this geometry>

972 **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" VM = 1-N			
>	(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

	Code Meaning of Concept Name	Code or Example Value	TID
>	(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 (and the Dose Reference Point) to the patient laying on the table.

Equipment Landmark

<TODO: add definition (is an spatial reference to establish the location of the patient support in the Table Reference System, and the purpose. Use the word "point". State what coordinate system is. Then go to the mechanics.>

TID 10002 uses (128751, DCM, "Center of Table Head") as the Equipment Landmark.

The Equipment Landmark is defined in the Table Coordinate System by its coordinates X and Z, encoded as (128752, DCM, "Equipment Landmark X Position") and (128753, DCM, "Equipment Landmark Z Position").

The Equipment Landmark Y Position is not recorded, its value is zero by definition since (128751, DCM, "Center of Table Head") is defined as being in the plane of the table.

Patient Fiducials

<TODO: add definition (is a "spatial reference" to establish the location of the patient in the Table Reference System, and the purpose. State what coordinate system is. Then go to the mechanics.>

They are typically a traverse plane through an anatomical reference point on the patient.

This is expressed in the RDSR TID 10002 by encoding the anatomical feature in (128772, DCM, "Reference Basis") and the nature of the plane in (128773, DCM, "Reference Geometry").

For a given Scope of Accumulation, multiple patient fiducials may be recorded, e.g. plane through the the top of the head, and plane through the bottom of the feet.

- 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")

Equipment to Patient Relationship

In order to approximately translate the dose at the reference point (expressed in the equipment coordinate system) to the dose in the patient anatomy, it is necessary to establish the relationship between the patient and the equipment.

This is accomplished by recording the distance in the table plane from the Equipment Landmark to each Patient Fiducial in TID 10002 (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, an additional RDSR Instance should be created. <TODO: discussion about two RDSRs with

different Irradiation Event UIDs in the same Study. DO it in section 4.13> >>> if the patient moves during the procedure, and the distance from the Equipment Landmark to each of the Patient Location Fiducials changes and is populated in the RDSR. an additional RDSR Instance 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.

The following figure shows the relationship between these concepts.

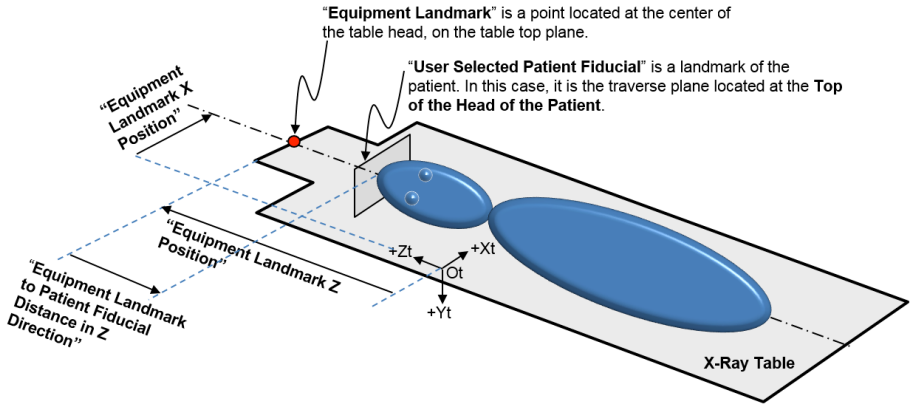


Figure ZZZZZ.4.4.3-1 Relationship Between Equipment Landmark and Patient Fiducial

The Table ZZZZZ.4.4.3-1 shows an example of encoding patient position and patient location for a patient of 175 cm height 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.

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

	Code Meaning of Concept Name	Code or Example Value	TID
>>	(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
>>	(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 facilitates (improves? Or makes it possible? Or more accurate?) further dosimetry analysis. TODO: elaborate about the improvement).

SUB SECTION 1: Coordinate Reference systems

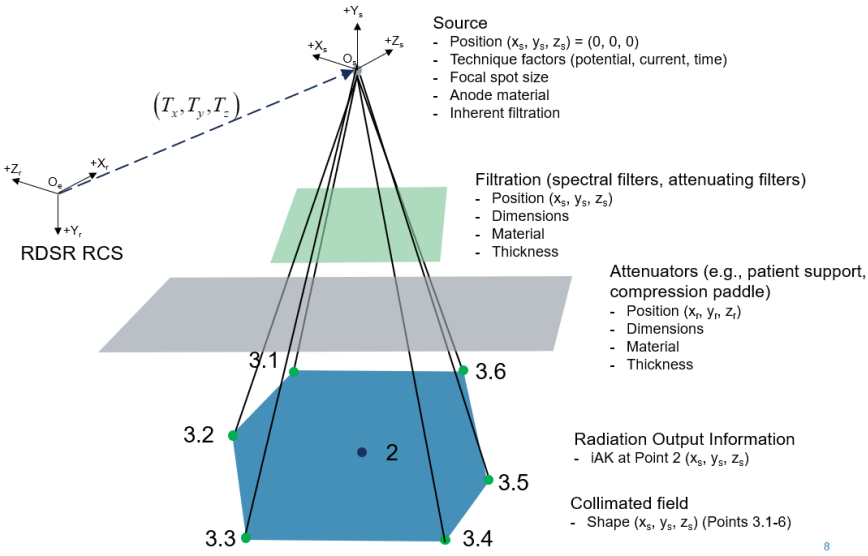
<start by defining of RDSR Coordinate System TID 10043> (stuff that does not move with the source)

- Mention what is in this RCS and what is encoded in this RCS. e.g. attenuators like patient support

<definitions of Soure Coordinate System TID 10050> (stuff that moves with the source)

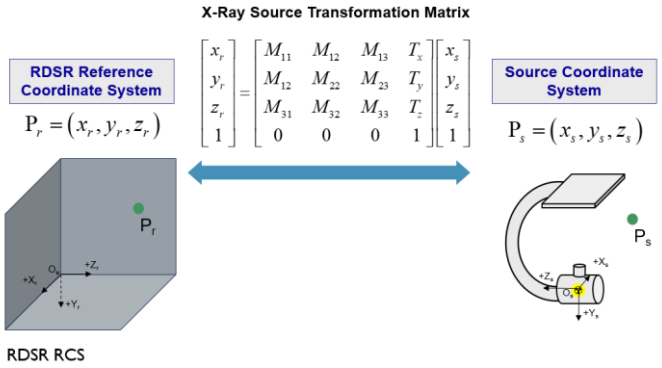
- Equipment components and reference points related to the X-Ray Beam, including the X-Ray Source, Collimator, X-Ray Filters, Reference Point for Air Kerma etc. are described in the so-called Soure Coordinate System

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.



1044 **Figure ZZZZZ.4.4.4-1 System Components in the RDSR and Source Coordinate Systems**

1046 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
1048 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
1050 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.



1052 **Figure ZZZZZ.4.4.4-2 X-Ray Source Transformation Matrix**

SUB SECTION 2: Encoding of a Rotating Source

In TID10050: 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.

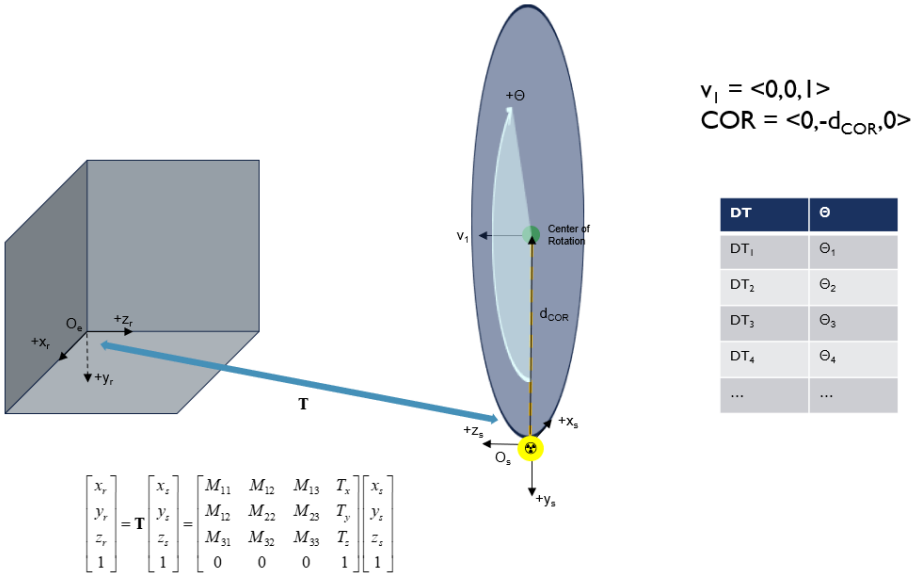


Figure ZZZZZ.4.4.4-3 Simplification for Sources Rotating in a Plane

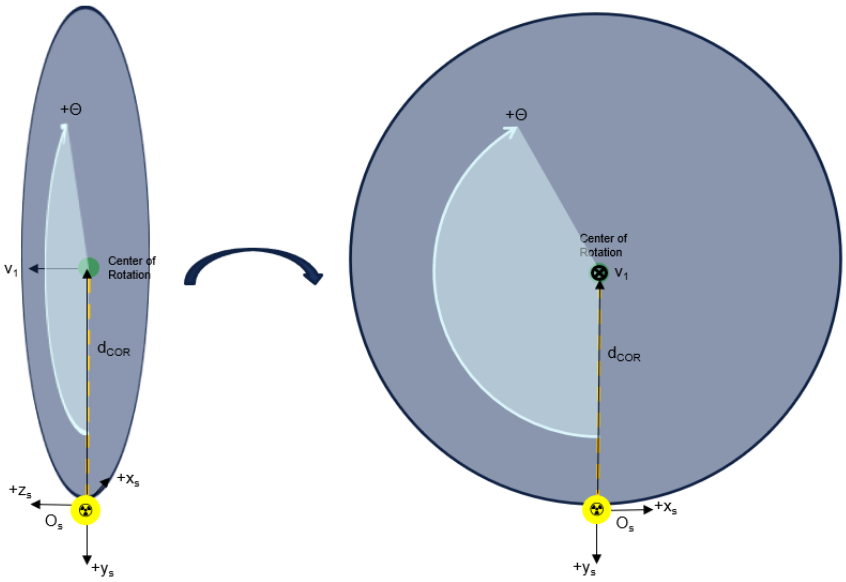


Figure ZZZZZ.4.4.4-4 Definition of a Source Rotating in a Plane

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

[Note: add introduction to clearly state what is the purpose of this section, or what problem we're trying to solve with these guidelines]

The Total Fluoro Time and Total Acquisition Time in RDSR are defined by their codes as the sum of the Irradiation Duration of the Irradiation Events. The Irradiation Duration is defined by its DICOM code [NB: use the coded triplet structure when referencing codes and their definitions?] 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. This removes the ambiguity of the term “pedal time”.[NB: include the diagram in the standard with the loading/trailing time? Or clickable reference (maintain only one instance)?]

1084

The Table ZZZZZ.4.5-1 provides equivalences of some concepts between the image header of one XA image (single
1086 or multi-frame) and its corresponding Irradiation Event in the RDSR.

[NB: "Correspondances" rather than equivalences? Potentially switch columns 2 and 3, using RDSR as baseline. If
1088 including Enhanced – state when concepts are changed vs. just rearranged from an encoding-standpoint?]

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

Concept [NB: only include "definition" language if necessary – otherwise, just rely on RDSR]	**XA Image Header**	**Traditional RDSR [NB: Also Enhanced?]**
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) [NB: in frame averaging or recursive filtering, would the number of frames represent the "raw" count or averaged count?]	(113768, DCM, "Number of Pulses")
Acquisition or Irradiation Duration Not necessarily equal between 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. [NB: less well-defined. Explain implications? Examples?]	(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 emission (i.e. tube current flowing) of a single pulse	Average Pulse Width (0018,1154) or Frame Acquisition Duration (0018,9220) [NB: elaborate on differences between these two values – why one or the other?]	(113793, DCM, "Pulse Width")
Exposure Time Time of X-Ray emission (i.e. tube current flowing) for the image [frame or image?] or irradiation event	Exposure Time (0018,9328) It is equivalent to the SUM $_{1\text{-}N}$ { 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.

Concept [NB: only include "definition" language if necessary – otherwise, just rely on RDSR]	XA Image Header	Traditional RDSR [NB: Also Enhanced?]
Total Fluoro Time Accumulation of clock time of the period of fluoroscopy	The SUM of Acquisition Duration (0018,9073) of all the images for which the Radiation Setting (0018,1155) equals "**SC**", i.e., low dose (fluoroscopy).	(113730, DCM, "Total Fluoro Time") Total clock time of Fluoroscopy, defined as the SUM of (113742, DCM, "Irradiation Duration") of all Irradiation Events [where concept type is Fluoro…].
Total Acquisition Time Accumulation of clock time of the period of acquisition	The SUM of Acquisition Duration (0018,9073) of all the images for which the Radiation Setting (0018,1155) equals "**GR**", i.e., high dose (acquisition, digital spot or cine).	(113855, DCM, "Total Acquisition Time") Total clock time of Acquisitions, defined as the SUM of (113742, DCM, "Irradiation Duration") of all Irradiation Events [where concept type contains Acquisition…]..

Notes [NB: include notes in appropriate locations w/in table, or just in cell?]:

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

2- [NB: consider as part of comment to include/exclude Enhanced] 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 (e.g., one DICOM X-Ray Angiographic Image [NB: generalize to other modalities? Same timing rules, etc.])

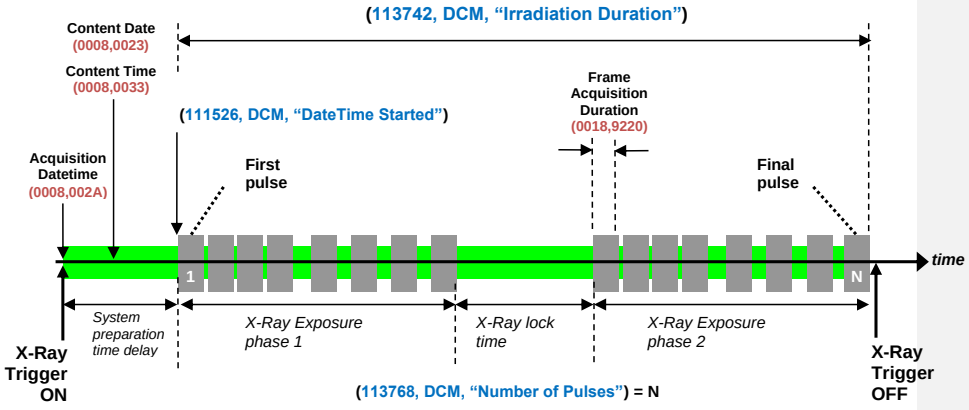


Figure ZZZZZ.4.5-1. Representation of One DICOM Irradiation Event (e.g., one DICOM X-Ray Angiographic Image) [NB: shorten title of figure. Add description text to paragraphs around figure]

ZZZZZ.4.6 [DONE] Encoding of Applied Filters [NB: Filters? Attenuators? Review content of TIDs and terminology. Include clarification between the two in the text (already partially there). What about Grids (currently included)? Multiple descriptors for one grid?]

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 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”. . If no filtration was used during an Irradiation Event, the value “No Filter” is used. 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 [NB: make symmetrical with earlier section (intro, traditional, enhanced)]

Filters in Enhanced RDSR are described in TID 10046, which references 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 TID 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 in TID 10047 and are not defined as being in the Source Coordinate System. Therefore, for each attenuator, a separate TID 10052 Attenuator Position is 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] Encoding of 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 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 [NB: Generalize this section for an example of the TABLE VT?]

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 Integrated vs. Non-Integrated equipment Radiography Equipment

ZZZZZ.4.8.1 [DONE] Traditional RDSR

The X-Ray Dose Structured Report is organized to support radiographic imaging equipment with various levels of integration in providing dose information via Structured Report. The level of integration encoded in (122142, DCM, "Acquisition Device Type") specifies the information required in the subtemplates. If the level of integration is not encoded, all details must be provided. The level of integration uses the terms Integrated Projection Radiography System and Cassette-based Projection Radiography System, though the latter can be considered to include all systems that are not integrated and not just those that use cassette-based detectors.

The two major concepts for tailoring are [NB: consider reworking as a table? Each type of system and the required TIDs (including when no system type is present)]

- Acquisition Device Type with the values drawn from CID 10032 "Projection X-Ray Acquisition Device Types" is used to tailor the availability of Accumulated X-Ray Dose data. If the concept is absent, 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 cassette-based and other non-integrated system types.
- 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 system where integration with the generator may not be possible, data related to the creation of the radiation cannot be provided. In this case, the X-Ray Source Data Available flag can be set to "NO." Non-integrated systems may also not able to derive Exposure Index values. This can be indicated by setting the X-Ray Detector Data Available flag to "NO."

A system with a compatible detector may set the above mentioned flags X-Ray Source Data Available and X-Ray Mechanical Data Available to "NO," while setting X-Ray Detector Data Available to "YES" if the system can provide the Exposure Index values.

In 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 radiography varies in integration from fully

integrated (i.e., generator, detector, x-ray tube positioner, and patient support communicate with one another) to completely non-integrated (i.e., no communication between generator, detector, x-ray tube positioner, or patient support).

In the case where the system is fully integrated, it may provide all technical information relevant to a radiographic procedure. If the system is not fully integrated, the component or system generating the RDSR may only provide the technical information that the component is aware of (e.g., a detector generating an RDSR may only provide detector-related information, while if a DAP/KAP meter is the component generating the RDSR, the content of the RDSR will only include DAP/KAP related information.

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.4.8.1-1 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"

ZZZZZ.4.9 CR Availability of DAP (Dose Area Product) [NB: restructure in a similar manner as the previous section. Explain it's only Traditional RDSR.]

As already explained in the previous section about integrated vs. non-integrated equipment, equipment implementers may 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, 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" is exempt from providing the detailed concepts of TID 10004 "Accumulated Fluoroscopy and Acquisition projection X-Ray Dose". But 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. 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). In addition, the Dose Area Product Total may be included to allow for DAP/KAP meters to create an RDSR for system which have such a meter installed but lack complete integration to include the value elsewhere.

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

[NB: If you want to know about dose: RDSR; if you want to know about images: Images. There is related information, but those are the places to go.]

[NB: Include discussion of encoding Irradiation Event UID in image metadata?]

[NB: Include entity diagram. Relationship between irradiation events, images, recons, etc. Talk about n=0 images, 1 image, multiple images, etc.]

The RDSR contains all the irradiation events that occurred during the scope of accumulation regardless of whether the irradiation resulted in any 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 it 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 example, both 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

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).

[NB: Review Enhanced RDSR 10042 concepts and conditions. Also potential CP to include free acquisition for projection x-ray]

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 RDSR 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 [DONE] Importance of the Irradiation Event UID

[NB: Consider merging 4.10, 4.12, and 4.13]

RDSR vs. stored images

Dose analysis is based on the information of the Irradiation Events contained in the RDSRs created during and after a procedure. Irradiation Events and images are often one to one, but there may be Irradiation Events with no images, for example:

- Electrophysiology with only Fluoroscopy not stored
- Exams where images have been deleted before sending to PACS (rejected)

Also, there may be cases of one single Irradiation Event that ultimately results in multiple images (e.g. original and processed images, 3D reconstructions, etc.), all these images have the same Irradiation Event UID.

For this reason, dose analysis should be driven by the Irradiation Events, not by images.

Several RDSR Instances for the same procedure or the same study

In some cases, there may be multiple RDSRs containing the same Irradiation Event UIDs. For example:

- Several RDSR Instances within the same Procedure Step:
  - The equipment creates multiple RDSR Instances during the Procedure Step, with Scope of Accumulation = **Procedure Step to this point**, for an external device to display dose in real time
  - Then, at the end of the procedure step, the equipment creates one final RDSR Instance with the Scope of Accumulation = **Procedure Step**, containing the Irradiation Events of the whole Procedure Step.

- Several RDSR Instances for different Procedure Steps in one single Study Instance UID:
  - When the first Procedure Step is finished, the equipment creates a first RDSR Instance containing the Irradiation Events of the first procedure step (Scope of Accumulation = **Procedure Step)**,
  - Then, the equipment does a second Procedure Step (e.g. continue the study for the same patient) and creates a second RDSR Instance for the whole study (Scope of Accumulation = **Study**) containing the Irradiation Events of both procedure steps.

- Several RDSR Instances in one single Study Instance UID:
  - When the Study is finished, the equipment creates one RDSR Instance containing the Irradiation Events of that study (Scope of Accumulation = **Study**).
  - Then the Study is reopened [NB: add a few examples (e.g., additional mammo views, patient complications after XA, CT anatomic coverage issues)], and more Irradiation Events are created on that Study. At the end of the Study, the equipment creates an additional RDSR Instance for the whole study (Scope of Accumulation = **Study**) containing the Irradiation Events since the beginning of the Study.

Each RDSR Instance includes information of all the Irradiation Events within its scope of accumulation, as well as Accumulated Dose Data within that same scope.

Dose analysis should be based on Irradiation Event UIDs to avoid overestimating the dose by counting multiple times the same Irradiation Events from different RDSR Instances.

Refer to the IHE REM Profile for additional details of the user scenario of Radiation Dose SR and Irradiation Events:

https://wiki.ihe.net/index.php/Radiation_Exposure_Monitoring

ZZZZZ.4.14 [JIRA - WIP] Encoding of Dose Calibration

In some cases, dose output by X-Ray irradiation equipment is not a measured value for each irradiation but rather an estimated value by manufacturer. It may be slightly different than the actual dose value since there are several unknowns in the irradiating condition, such as scatter, attenuators, etc.

Dose calibration may be performed by the users to allow reducing this difference and to ensure a more accurate dose evaluation.

Encoding of dose calibration in RDSR is defined in TID 10002 (Projection X-Ray RDSR) and 10041 (Enhanced X-Ray RDSR). It is a factor to be multiplied by the estimated output from X-Ray equipment. The calibration factor is separated from the dose output value, and it is typically provided by medical physicists. It must not be applied to the measured values before storing them in the report. This means that usage of the dose calibration is not for performance guarantee by manufacturer, such as validation, adjustment feature and so on.

The interpreter of the RDSR optionally applies dose calibration to dose output when performing dose management, so relations between each dose calibration and dose output values are not strictly defined on RDSR instance. Because the relation can be complex and not clear in some cases, dose calibration provider RDSR is recommended to inform its intended use to the interpreter of RDSR by some means. The way to encode it in RDSR is not defined. Row of (113720, DCM, "Calibration Protocol") is for calibration method and encoding to here is non-obvious solution.

Note: In this draft, new rows by JIRA's CP are not considered yet.

Rationale from CP: The calibration container in the Projection X-Ray RDSR and Enhanced X-Ray RDSR contains information related to the calibration factors stored on the irradiating device or device generating the RDSR. These calibrations are typically determined by a user or owner of the system, such as a medical physicist. They are intended only to be stored and sent with the RDSR, not to be applied by the RDSR-generating system to the values stored within the RDSR. The current DICOM framework for this container allows for multiple calibration containers within an RDSR but does not provide sufficient guidance on how they may be applied by users or interpreters of the RDSR.

This CP proposes two additional content items within the calibration container. The first is a coded value describing the radiation dose index for which the calibration factor is intended. The second is a text value describing the acquisition protocol for which the calibration factor is intended. For both values, the intent of the additions is to provide the user/interpreter of the RDSR with sufficient information on when to apply a given calibration factor. Ultimately, the decision on whether to apply a calibration factor will be made by the user of the RDSR after consideration of the content of the calibration container and the other dose information and technical details of the RDSR. There may be instances when calibration containers are sent with the RDSR even if they are not applicable to the irradiation events that are contained within that RDSR.

If a calibration factor is applicable to multiple dose indices or acquisition protocols, the calibration container may be repeated 1-n times, with each repeat changing the coded dose index and/or acquisition protocol.

(Example of usage, encoding, complexed cases and so on would be shown below. Not done yet.)

ZZZZZ.4.15 Place holder for new cases

1. A lot of data is in the RDSR. But, for proper interpretation and usage, how do you dissect the RDSR for individual 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).

4. How to handle the case where there are multiple reference point definitions within one RDSR. Traditional vs. Enhanced differences. In Enhanced, one may treat the sources as distinct from one another, allowing encoding of each within the same RDSR. Need to review how to handle in Traditional case (see CP with multiple RDSR – proposed solution was to just create separate RDSR for each RP).

5. TABLE VT (vs. NUM, CODE, etc.). Reuse 4.7.2 as an example encoding.

ZZZZZ.5 RADIATION DOSE SR EXAMPLES

This section contains examples of the use of Radiation Dose Structured Reports for XA, CT, Cone Beam CT (CBCT), DX, and MG.

[State some ground rules of the way we write the examples: e.g. units are always the text and not the codes, etc…]

[Make sure that the example real-world scenarios for each modality are the same in Traditional RDSR and Enhanced RDSR, to allow comparison of the different encoding]

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 lasting 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 [NB: review intent of "dose image" – Specify Dose map or include definition] has been created at the end of the procedure step
- One grid, fixed and focused (two descriptors)

Table ZZZZZ.5.1.1-1. XA Traditional RDSR

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			
1.4	Observer Type	(121007, DCM, "Device")	TID 1002
1.5	Device Observer UID	**2.999.1**	TID 1004
1.6	Device Observer Name	*MyStationName*	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

Node	Code Meaning of Concept Name	Code or Example Value	TID
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
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

Node	Code Meaning of Concept Name	Code or Example Value	TID
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
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

Node	Code Meaning of Concept Name	Code or Example Value	TID
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	*68.0454 mm [NB: Verify]*	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 [NB: verify that units are correctly encoded based on TID definitions]			
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
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

Node	Code Meaning of Concept Name	Code or Example Value	TID
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
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

Node	Code Meaning of Concept Name	Code or Example Value	TID
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 [NB: Include this same formatting for other TID calls]**	**<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
1.30.8	Dose Area Product	*0.00003100 Gy.m2*	TID 10003
1.30.9	Patient Equivalent Thickness	*103.40 mm [NB: Verify – consider adding note to preamble (AEC parameter, not physical meas't). Changing between irradiation events (fluoro/acq)?]*	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

Node	Code Meaning of Concept Name	Code or Example Value	TID
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
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 m2*	TID 10003B
1.30.27	Collimated Field Height	*129 mm*	TID 10003B
1.30.28	Collimated Field Width	*83 mm*	TID 10003B

Node	Code Meaning of Concept Name	Code or Example Value	TID
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
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

Node	Code Meaning of Concept Name	Code or Example Value	TID
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 [NB: Is this best practice? Why include redundant information?]	*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 [NB: Add Person ID and Person ID Issuer – Check w Ed and Steve]			
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

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

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.

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 10011
Start Observer Context			
Observer #1: Irradiating Device			
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	*CT1_HOSPITAL_A*	Section TID 1004

Node	Code Meaning of Concept Name	Code or Example Value	TID
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
Observer #2: Operator			
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
End Observer Context			
1.15	Start of X-Ray Irradiation	*20230725120000.000*	Section TID 10011
1.16	End of X-Ray Irradiation	*20230725120300.000*	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
Start first Irradiation Event			
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	*20230725120000.000*	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	*5.0 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
End first Irradiation Event			
Start second Irradiation Event			
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	*20230725120258.000*	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

Node	Code Meaning of Concept Name	Code or Example Value	TID
Start Scanning Length TID 10014			
1.20.6.2	Scanning Length	*220 mm*	Section TID 10014
1.20.6.3	Length of Reconstructable Volume	*200 mm*	Section TID 10014
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
End Scanning Length			
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

Node	Code Meaning of Concept Name	Code or Example Value	TID
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
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
Start CT Dose Check Details TID 10015			
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
End CT Dose Check Details *End Second Irradiation Event*			
1.21	Source of Dose Information	(113856, DCM, "Automated Data Collection")	Section TID 10011

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

The following is an example RDSR for a routine radiograph study. In this example, a X-Ray system performs a lateral and AP view of the lumbar spine. [Add note: As this is an integrated system, most of the conditions of TIDs are satisfied…]

[Proposal: add another example for the non-integrated system, with much less information (CR)]

Table ZZZZZ.5.1.3-1. DX Traditional RDSR

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	(261004008, SCT, "Diagnostic Intent")	TID 10001
1.3	Acquisition Device Type	(113958, DCM, "Integrated Projection Radiography System")	TID 10001
Start Observer Context			
Observer #1: Irradiating device			
1.4	Observer Type	(121007, DCM, "Device")	TID 1002
1.5	Device Observer UID	**2.999.1**	TID 1004
1.6	Device Observer Name	*MyStationName*	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: Referring Physician			
1.11	Observer Type	(121006, DCM, "Person")	TID 1002
1.12	Person Observer Name	*Referring^^^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	(C1709880, UMLS, "Referring")	TID 1003
Observer #3: Operator			
1.15	Observer Type	(121006, DCM, "Person")	TID 1002
1.16	Person Observer Name	*Operator^^^Mr*	TID 1003
1.17	Person Observer's Role in the Organization	(159016003, SCT, "Radiographer")	TID 1003

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.18	Person Observer's Role in this Procedure	(121094, DCM, "Performing")	TID 1003
<End Observer Context>			
1.19	Scope of Accumulation	(113014, DCM, "Study")	TID 10001
1.19.1	Study Instance UID	**2.999.2**	TID 10001
1.20	X-Ray Detector Data Available	(373066001, SCT, "Yes")	TID 10001
1.21	X-Ray Source Data Available	(373066001, SCT, "Yes")	TID 10001
1.22	X-Ray Mechanical Data Available	(373066001, SCT, "Yes")	TID 10001
1.23	**Accumulated X-Ray Dose**	**<CONTAINER>**	**TID 10002**
1.23.1	Acquisition Plane	(113622, DCM, "Single Plane")	TID 10002
<Start Accumulated X-Ray Dose>			
1.23.2	**Accumulated Total Projection Radiography Dose**	**<CONTAINER>**	**TID 10007**
1.23.2.1	Dose Area Product Total	*0.000178600000 Gy.m2*	TID 10007
1.23.2.2	Dose (RP) Total	*0.00211933 Gy*	TID 10007
1.23.2.3	Distance Source to Reference Point	*1150 mm*	TID 10007
1.23.2.4	Total Number of Radiographic Frames	*2 no units*	TID 10007
1.23.2.5	Reference Point Definition	(113941, DCM, "In Detector Plane")	TID 10007
<End Accumulated X-Ray Dose>			
1.24	**Irradiation Event X-Ray Data**	**<CONTAINER>**	**TID 10003**
1.24.1	Acquisition Plane	(113622, DCM, "Single Plane")	TID 10003
1.24.2	Irradiation Event UID	**2.999.3**	TID 10003
1.24.3	DateTime Started	*20241016213726.000*	TID 10003
1.24.4	Irradiation Event Type	(113611, DCM, "Stationary Acquisition")	TID 10003
1.24.5	Acquisition Protocol	*Wallstand L-Spine Lateral*	TID 10003
1.24.6	Image View	(399198007, SCT, "right lateral")	TID 10003

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.24.6a	Patient Orientation	(C86043, NCIt, "erect")	TID 10003
1.24.6a.1	Patient Orientation Modifier	(10904000, SCT, "standing")	TID 10003
1.24.7	Target Region	(122496007, SCT, "Lumbar spine")	TID 10003
1.24.8	Dose Area Product	*0.0001156000 Gy.m2*	TID 10003
1.24.9	**Irradiation Event X-Ray Detector Data**	**<CONTAINER>**	**TID 10003A**
1.24.9.1	Exposure Index	*227.00 no units*	TID 10003A
1.24.9.2	Target Exposure Index	*250.00 no units*	TID 10003A
1.24.9.3	Deviation Index	*-0.41914 no units*	TID 10003A
1.24.9.4	Acquired Image	**2.999.4**	TID 10003A
1.24.10	**Irradiation Event X-Ray Source Data**	**<CONTAINER>**	**TID 10003B**
1.24.10.1	Dose (RP)	*0.00123015 Gy*	TID 10003B
1.24.10.2	Reference Point Definition	(113941, DCM, "In Detector Plane")	TID 10003B
1.24.10.3	Number of Pulses	*1 no units*	TID 10003B
1.24.10.4	KVP	*89.800000 kV*	TID 10003B
1.24.10.5	X-Ray Tube Current	*724.00 mA*	TID 10003B
1.24.10.6	Exposure Time	*32.00 ms*	TID 10003B
1.24.10.7	Exposure	*23160.00 uA.s*	TID 10003B
1.24.10.8	Focal Spot Size	*1.6 mm*	TID 10003B
1.24.10.9	**X-Ray Filters**	**<CONTAINER>**	**TID 10003B**
1.24.10.9.1	X-Ray Filter Type	(111609, DCM, "No filter")	TID 10003B
1.24.10.10	Collimated Field Area	*0.0886542 m2*	TID 10003B
1.24.10.11	Collimated Field Height	*425.2 mm*	TID 10003B
1.24.10.12	Collimated Field Width	*208.5 mm*	TID 10003B
1.24.10.13	X-Ray Grid	(111642, DCM, "Focused grid")	TID 10003B

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.24.11	**Irradiation Event X-Ray Mechanical Data**	**<CONTAINER>**	**TID 10003C**
1.24.11.1	Distance Source to Detector	*1150.00 mm*	TID 10003C
1.25	**Irradiation Event X-Ray Data**	**<CONTAINER>**	**TID 10003**
1.25.1	Acquisition Plane	(113622, DCM, "Single Plane")	TID 10003
1.25.2	Irradiation Event UID	**2.999.5**	TID 10003
1.25.3	DateTime Started	*20241016214647.000*	TID 10003
1.25.4	Irradiation Event Type	(113611, DCM, "Stationary Acquisition")	TID 10003
1.25.5	Acquisition Protocol	*Wallstand L-Spine AP*	TID 10003
1.25.6	Image View	(399348003, SCT, "antero-posterior")	TID 10003
1.25.6a	Patient Orientation	(C86043, NCIt, "erect")	TID 10003
1.25.6a.1	Patient Orientation Modifier	(10904000, SCT, "standing")	TID 10003
1.25.7	Target Region	(122496007, SCT, "Lumbar spine")	TID 10003
1.25.8	Dose Area Product	*0.000063000 Gy.m2*	TID 10003
1.25.9	**Irradiation Event X-Ray Detector Data**	**<CONTAINER>**	**TID 10003A**
1.25.9.1	Exposure Index	*243.00 no units*	TID 10003A
1.25.9.2	Target Exposure Index	*250.00 no units*	TID 10003A
1.25.9.3	Deviation Index	*-0.123 no units*	TID 10003A
1.25.9.4	Acquired Image	**2.999.6**	TID 10003A
1.25.10	**Irradiation Event X-Ray Source Data**	**<CONTAINER>**	**TID 10003B**
1.25.10.1	Dose (RP)	*0.00088918 Gy*	TID 10003B
1.25.10.2	Reference Point Definition	(113941, DCM, "In Detector Plane")	TID 10003B
1.25.10.3	Number of Pulses	*1 no units*	TID 10003B
1.25.10.4	KVP	*80.90 kV*	TID 10003B
1.25.10.5	X-Ray Tube Current	*780.00 mA*	TID 10003B

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.25.10.6	Exposure Time	*26.00 ms*	TID 10003B
1.25.10.7	Exposure	*20360 uA.s*	TID 10003B
1.25.10.8	Focal Spot Size	*1.6 mm*	TID 10003B
1.25.10.9	**X-Ray Filters**	**<CONTAINER>**	**TID 10003B**
1.25.10.9.1	X-Ray Filter Type	(111609, DCM, "No filter")	TID 10003B
1.25.10.10	Collimated Field Area	*0.067497 m2*	TID 10003B
1.25.10.11	Collimated Field Height	*372.500 mm*	TID 10003B
1.25.10.12	Collimated Field Width	*181.200 mm*	TID 10003B
1.25.10.13	X-Ray Grid	(111642, DCM, "Focused grid")	TID 10003B
1.25.11	**Irradiation Event X-Ray Mechanical Data**	**<CONTAINER>**	**TID 10003C**
1.25.11.1	Distance Source to Detector	*1150.00 mm*	TID 10003C
<End Irradiation Event X-Ray Data>			
1.26	Source of Dose Information	(113856, DCM, "Automated Data Collection")	TID 10001

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

The following is an example RDSR for a routine mammography imaging procedure. In this example, a typical four-view screening exam is performed with a CC and MLO view for both the left and right breast.

Table ZZZZZ.5.1.4-1. MG Traditional RDSR

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	(71651007, SCT, "Mammography")	TID 10001
1.2.1	Has Intent	(360156006, SCT, "Screening Intent")	TID 10001
<Start Observer Context>			
Observer #1: Irradiating device			
1.3	Observer Type	(121007, DCM, "Device")	TID 1002

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.4	Device Observer UID	**2.999.1**	TID 1004
1.5	Device Observer Name	*MyStationName*	TID 1004
1.6	Device Observer Manufacturer	*Manufacturer X*	TID 1004
1.7	Device Observer Model Name	*Model Y*	TID 1004
1.8	Device Observer Serial Number	*SerialNumber123*	TID 1004
1.9	Device Role in Procedure	(113859, DCM, “Irradiating Device”)	TID 1004
Observer #2: Operator			
1.10	Observer Type	(121006, DCM, "Person”)	TID 1002
1.11	Person Observer Name	*Operator^^^Ms*	TID 1003
1.12	Person Observer's Role in the Organization	(159016003, SCT, “Radiologic Technologist”)	TID 1003
1.13	Person Observer's Role in this Procedure	(121094, DCM, “Performing”)	TID 1003
<End Observer Context>			
1.14	Scope of Accumulation	(113014, DCM, “Study”)	TID 10001
1.15	Study Instance UID	**2.999.2**	TID 10001
1.16	X-Ray Detector Data Available	(373066001, SCT, “Yes”)	TID 10001
1.17	X-Ray Source Data Available	(373066001, SCT, “Yes”)	TID 10001
1.18	X-Ray Mechanical Data Available	(373066001, SCT, “Yes”)	TID 10001
1.19	**Accumulated X-Ray Dose Data**	**<CONTAINER>**	**TID 10002**
1.19.1	Acquisition Plane	(113622, DCM, "Single Plane")	TID 10002
1.19.2	Accumulated Average Glandular Dose	*2.50 mGy*	TID 10005
1.19.2.1	Laterality	(80248007, SCT, "Left Breast")	TID 10005
1.19.3	Accumulated Average Glandular Dose	*2.80 mGy*	TID 10005
1.19.3.1	Laterality	(73056007, SCT, "Right Breast")	TID 10005
1.20	**Irradiation Event X-Ray Data**	**<CONTAINER>**	TID 10001
1.20.1	Acquisition Plane	(113622, DCM, "Single Plane")	TID 10003

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.20.2	Irradiation Event UID	**2.999.3**	TID 10003
1.20.3	DateTime Started	*20240418123000.000*	TID 10003
1.20.4	Irradiation Event Type	(113611, DCM, "Stationary Acquisition")	TID 10003
1.20.5	Image View	(SCT, 399162004, "cranio-caudal")	TID 10003
1.20.6	Target Region	(76752008, SCT, "Breast")	TID 10003
1.20.6.1	Laterality	(7771000, SCT, "Left")	TID 10003
1.20.7	Half Value Layer	*0.50 mm*	TID 10003
1.20.8	Patient Equivalent Thickness	*44.0 mm*	TID 10003
1.20.9	Entrance Exposure at RP	*4.10 mGy*	TID 10003
1.20.10	Reference Point Definition	(113865, DCM, "4.2cm above Breast Support Surface")	TID 10003
Irradiation Event X-Ray Detector Data TID 10003A			
1.20.11	Acquired Image	**SOP Class UID: 1.2.840.10008.5.1.4.1.1.1.2** **SOP Instance UID: 2.999.6**	TID 10003A
Irradiation Event X-Ray Source Data TID 10003B			
1.20.12	Average Glandular Dose	*1.20 mGy*	TID 10003B
1.20.13	KVP	*28.00 kV*	TID 10003B
1.20.14	X-Ray Tube Current	*160.00 mA*	TID 10003B
1.20.15	Exposure Time	*625.00 ms*	TID 10003B
1.20.16	Exposure	*100000 uA.s*	TID 10003B
1.20.17	Focal Spot Size	*0.3 mm*	TID 10003B
1.20.18	Anode Target Material	(26194003, SCT, "Tungsten")	TID 10003B
1.20.19	**X-Ray Filters**	**<CONTAINER>**	TID 10003B
1.20.19.1	X-Ray Filter Type	(113653, DCM, "Flat filter")	TID 10003B
1.20.19.2	X-Ray Filter Material	(59801003, SCT, "Rhodium")	TID 10003B
1.20.19.3	X-Ray Filter Thickness Minimum	*0.050 mm*	TID 10003B

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.20.19.4	X-Ray Filter Thickness Maximum	*0.050 mm*	TID 10003B
1.20.20	Collimated Field Area	*0.0696 m2*	TID 10003B
1.20.21	Collimated Field Height	*240 mm*	TID 10003B
1.20.22	Collimated Field Width	*290 mm*	TID 10003B
1.20.23	X-Ray Grid	(111642, DCM, "Focused grid")	TID 10003B
1.20.24	X-Ray Grid	(111642, DCM, "Reciprocating grid")	TID 10003B
Irradiation Event X-Ray Mechanical Data TID 10003C			
1.20.25	Positioner Primary Angle	*0.00 deg*	TID 10003C
1.20.26	Compression Thickness	*44.00 mm*	TID 10003C
1.20.27	Compression Force	*70 Newton*	TID 10003C
<Start CID 10008 Dose Related Distance Measurement>			
1.20.28	Distance Source to Reference Point	*633.00 mm*	TID 10003C
1.20.29	Distance Source to Detector	*700.00 mm*	TID 10003C
<End CID 10008 Dose Related Distance Measurement>			
1.21	**Irradiation Event X-Ray Data**	**<CONTAINER>**	TID 10001
Repeat Irradiation Event X-Ray Data TID 10003 for LMLO Acquisition			
1.22	**Irradiation Event X-Ray Data**	**<CONTAINER>**	TID 10001
Repeat Irradiation Event X-Ray Data TID 10003 for RCC Acquisition			
1.23	**Irradiation Event X-Ray Data**	**<CONTAINER>**	TID 10001
Repeat Irradiation Event X-Ray Data TID 10003 for RMLO Acquisition			
1.24	Source of Dose Information	(113856, DCM, "Automated Data Collection")	TID 10001

ZZZZZ.5.2 Examples of Enhanced RDSR

ZZZZZ.5.2.1 [WIP] Example of Enhanced RDSR for XA

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

- Patient position is Head First Supine
- 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

Table ZZZZZ.5.2.1-1. XA Enhanced RDSR

Node	Code Meaning of Concept Name	Code or Example Value	TID
1	**X-Ray Radiation Dose Report**	**<CONTAINER>**	**Section TID 10040**
1.1	Language of Content Item and Descendants	(en, IETF4646, "English")	Section TID 1204
1.2	Procedure reported	(113704, DCM, "Projection X-Ray")	Section TID 10040
1.2.1	Has Intent	(1279505009, SCT, "Combined Diagnostic and Therapeutic Intent")	Section TID 10040
<Start Observer Context> *Observer #1: Irradiating device*			
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	*MyStationName*	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
Observer #2: Performing Physician			
1.9	Observer Type	(121006, DCM, "Person")	Section TID 1002
1.10	Person Observer Name	*Performing^^^Dr*	Section TID 1003
1.11	Person Observer's Role in the Organization	(309343006, SCT, "Physician")	Section TID 1003
1.12	Person Observer's Role in this Procedure	(121094, DCM, "Performing")	Section TID 1003
Observer #3: Referring Physician			

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.13	Observer Type	(121006, DCM, "Person")	Section TID 1002
1.14	Person Observer Name	*Referring^^^Dr*	Section TID 1003
1.15	Person Observer's Role in the Organization	(309343006, SCT, "Physician")	Section TID 1003
1.16	Person Observer's Role in this Procedure	(C1709880, UMLS, "Referring")	Section TID 1003
Observer #4: Operator			
1.17	Observer Type	(121006, DCM, "Person")	Section TID 1002
1.18	Person Observer Name	*Operator^^^Mr*	Section TID 1003
1.19	Person Observer's Role in the Organization	(159016003, SCT, "Radiologic Technologist")	Section TID 1003
1.20	Person Observer's Role in this Procedure	(121099, DCM, "Assisting")	Section TID 1003
<End Observer Context>			
1.21	Scope of Accumulation	(113016, DCM, "Performed Procedure Step")	Section TID 10040
1.22	**Accumulated Dose Data**	**<CONTAINER>**	**Section TID 10041**
1.22.1	Identification of the X-Ray Source	*1*	Section TID 10041
1.22.2	Dose Area Product Total	*0.00003410 Gy.m2*	Section TID 10041
1.22.3	Fluoro Dose Area Product Total	*0.00000310 Gy.m2*	Section TID 10041
1.22.4	Acquisition Dose Area Product Total	*0.00003100 Gy.m2*	Section TID 10041
1.22.5	Total Fluoro Time	*10 s*	Section TID 10041
1.22.6	Total Acquisition Time	*30 s*	Section TID 10041
1.22.7	Detector Type	(113948, DCM, "Direct Detector")	Section TID 10041
1.22.8	Total Number of Radiographic Frames	*600 no units*	Section TID 10041
1.22.9	**Reference Point Dosimetry**	**<CONTAINER>**	**Section TID 10041**
1.22.9.1	Reference Point Definition	(113860, DCM, "15cm from Isocenter toward Source")	Section TID 10041
1.22.9.2	Dose (RP) Total	*0.00089400 Gy*	Section TID 10041
1.22.9.3	Fluoro Dose (RP) Total	*0.00007700 Gy*	Section TID 10041
1.22.9.4	Acquisition Dose (RP) Total	*0.00081700 Gy*	Section TID 10041
1.22.9.5	Distance Source to Reference Point	*570.00 mm*	Section TID 10041

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.23	**Irradiation Event Summary Data**	**<CONTAINER>**	**Section TID 10042**
<Start summary information of Irradiation Event #1 (fluoroscopy acquisition)>			
1.23.1	Irradiation Event UID	**2.999.2.3.4**	Section TID 10042
1.23.2	DateTime Started	*20250325123000.000*	Section TID 10042
1.23.3	DateTime Ended	*20250325123010.000*	Section TID 10042
1.23.4	Identification of the X-Ray Source	*1*	Section TID 10042
1.23.5	Irradiation Event Label	*1*	Section TID 10042
1.23.5.1	Label Type	(113608, DCM, "Acquisition Number")	Section TID 10042
1.23.6	Irradiation Event Type	(44491008, SCT, "Fluoroscopy")	Section TID 10042
1.23.7	Dose (RP)	*0.00007700 Gy*	Section TID 10042
1.23.8	Number of Pulses	*150 no units*	Section TID 10042
1.23.9	Exposure Time	*20 ms*	Section TID 10042
1.23.10	Comment	*Fluoro Loop*	Section TID 10042
Start Person Participant within TID 10042			
1.23.11	Person Name	*Performing^^^Dr*	Section TID 1020
1.23.11.1	Person Role in Procedure	(113851, DCM, "Irradiation Administering")	Section TID 1020
End Person Participant			
1.24	**Irradiation Event Summary Data**	**<CONTAINER>**	**Section TID 10042**
<Start summary information of Irradiation Event #2 (Cone Beam CT acquisition)>			
1.24.1	Irradiation Event UID	**2.999.2.3.5**	Section TID 10042
1.24.2	DateTime Started	*20250325123200.000*	Section TID 10042
1.24.3	DateTime Ended	*20250325123230.000*	Section TID 10042
1.24.4	Identification of the X-Ray Source	*1*	Section TID 10042
1.24.5	Irradiation Event Label	*2*	Section TID 10042
1.24.5.1	Label Type	(113608, DCM, "Acquisition Number")	Section TID 10042
1.24.6	Irradiation Event Type	(113613, DCM, "Rotational Acquisition")	Section TID 10042
1.24.7	Acquired Image	**SOP Class UID: 1.2.840.10008.5.1.4.1.1.12.1.1** **SOP Instance UID: 2.999.5**	Section TID 10042
1.24.8	Dose (RP)	*0.00081700 Gy*	Section TID 10042

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.24.9	Number of Pulses	*600 no units*	Section TID 10042
1.24.10	Exposure Time	*3000 ms*	Section TID 10042
1.24.11	Comment	*CBCT*	Section TID 10042
Start Person Participant within TID 10042			
1.24.12	Person Name	*Performing^^^Dr*	Section TID 1020
1.24.12.1	Person Role in Procedure	(113851, DCM, "Irradiation Administering")	Section TID 1020
End Person Participant			
1.25	**Irradiation Details**	**<CONTAINER>**	**Section TID 10043**
The rest of this example is Work in Progress…			

ZZZZZ.5.2.2 [DONE] Example of Enhanced RDSR for Cone Beam CT (CBCT)

[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.5.2.2-1. Cone Beam CT (CBCT) Enhanced RDSR

Node	Code Meaning of Concept Name	Code or Example Value	TID
1	**X-Ray Radiation Dose Report**	**<CONTAINER>**	**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

Node	Code Meaning of Concept Name	Code or Example Value	TID
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**	**<CONTAINER>**	**Section TID 10041**
1.9.1	Identification of the X-Ray Source	1	Section TID 10041
1.9.2	**Reference Point Dosimetry**	**<CONTAINER>**	**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**	**<CONTAINER>**	**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**	**<CONTAINER>**	**Section TID 10043**
1.11.1	DateTime Started	*20200101120000*	Section TID 10043
1.11.2	DateTime Ended	*20200101120030*	Section TID 10043
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**	**<CONTAINER>**	**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

Node	Code Meaning of Concept Name	Code or Example Value	TID
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**	**<CONTAINER>**	**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**	**<CONTAINER>**	**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*; *20200101120020* / *100.0*; *20200101120025* / *150.0*	Section TID 10045
1.11.8	**Filtration**	**<CONTAINER>**	**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**	**<CONTAINER>**	**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

Node	Code Meaning of Concept Name	Code or Example Value	TID
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**	**<CONTAINER>**	**Section TID 10047**
1.11.9.1	DateTime Started	*20200101120000*	TID eRSDRT07
1.11.9.2	DateTime Ended	*20200101120030*	TID eRSDRT07
1.11.9.3	**Attenuator Characteristics**	**<CONTAINER>**	**Section TID 10055**
1.11.9.3.1	Identification of the Attenuator	2	Section TID 10055
1.11.9.3.2	Attenuator Category	(128459, DCM, "Table")	Section TID 10055
1.11.9.3.3	Filter Material	(256501007, SCT, "Carbon Fiber")	Section TID 10055
1.11.9.3.4	Filter Type	(113650, DCM, "Strip Filter")	Section TID 10055
1.11.9.3.5	X-Ray Filter Thickness	*30 mm*	Section TID 10055
1.11.10	**Radiation Output**	**<CONTAINER>**	**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
1.11.10.4	Air Kerma at Output Measurement Point	**DateTime Ended** / **Air Kerma at Output Measurement Point (mGy)**: *20200101120005* / *10.0*; *20200101120010* / *15.0*; *20200101120015* / *20.0*; *20200101120020* / *15.0*; *20200101120025* / *10.0*; *20200101120030* / *15.0*	Section TID 10048
1.11.11	**Radiation Field Area**	**<CONTAINER>**	**Section TID 10049**
1.11.11.1	DateTime Started	*20200101120000*	Section TID 10049

<table>
<tr><th>Node</th><th>Code Meaning of Concept Name</th><th>Code or Example Value</th><th>TID</th></tr>
<tr><td>1.11.11.2</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 points</td><td>Section TID 10049</td></tr>
<tr><td>1.11.12</td><td>X-Ray Source Reference Coordinate System</td><td><CONTAINER></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>
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<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><table>
<tr><th>DateTime Started</th><th>Rotation Angle (deg)</th></tr>
<tr><td>20200101120005</td><td>40.0</td></tr>
<tr><td>20200101120010</td><td>80.0</td></tr>
<tr><td>20200101120015</td><td>120.0</td></tr>
<tr><td>20200101120020</td><td>160.0</td></tr>
<tr><td>20200101120025</td><td>200.0</td></tr>
<tr><td>20200101120030</td><td>240.0</td></tr>
</table></td><td>Section TID 10050</td></tr>
<tr><td>1.11.13</td><td>Beam Position</td><td><CONTAINER></td><td>Section TID 10051</td></tr>
<tr><td>1.11.13.1</td><td>DateTime Started</td><td>20200101120000</td><td>Section TID 10051</td></tr>
<tr><td>1.11.13.2</td><td>DateTime Ended</td><td>20200101120030</td><td>Section TID 10051</td></tr>
<tr><td>1.11.13.3</td><td>Identification of the X-Ray Source</td><td>1</td><td>Section TID 10051</td></tr>
<tr><td>1.11.13.4</td><td>Output Measurement Point Position</td><td>SCOORD3D POINT</td><td>Section TID 10051</td></tr>
</table>

Node	Code Meaning of Concept Name	Code or Example Value	TID
		[note: should we add numbers in the example?(x,y,z)]	
1.11.13.5	Reference Point Position	SCOORD3D POINT [note: should we add numbers in the example?(x,y,z)]	Section TID 10051
1.11.13.6	**X-Ray Beam Attenuator Model**	**<CONTAINER>**	**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**	**<CONTAINER>**	**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**	**<CONTAINER>**	Section TID 10052
1.11.14.3.1	Identification of the Attenuator	*2*	Section TID 10052
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**	**<CONTAINER>**	**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

Node	Code Meaning of Concept Name	Code or Example Value	TID
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

ZZZZZ.5.2.3 [DONE] Example of Enhanced RDSR for MG

The following is an example RDSR for a routine mammography imaging procedure. In this example, a typical four-view screening exam is performed with a CC and MLO view for both the left and right breast, and a digital breast tomosynthesis acquisition.

Table ZZZZZ.5.2.3-1. MG Enhanced RDSR

Node	Code Meaning of Concept Name	Code or Example Value	TID
1	**X-Ray Radiation Dose Report**	**<CONTAINER>**	**Section TID 10040**
1.1	Language of Content Item and Descendants	(en, IETF4646, "English")	Section TID 1204
1.2	Procedure reported	(71651007, SCT, "Mammography")	Section TID 10040
1.2.1	Has Intent	(360156006, SCT, "Screening 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 Name	*Station Name W*	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	Scope of Accumulation	(113014, DCM, "Study")	Section TID 10040
1.10	**Accumulated Dose Data**	**<CONTAINER>**	**Section TID 10041**
1.10.1	Identification of the X-Ray Source	*1*	Section TID 10041
1.10.2	Accumulated Average Glandular Dose	*5.00 mGy*	Section TID 10041
1.10.2.1	Laterality	(7771000, SCT, “Left”)	Section TID 10041

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.10.3	Accumulated Average Glandular Dose	*5.60 mGy*	Section TID 10041
1.10.3.1	Laterality	(24028007, SCT, "Right")	Section TID 10041
1.10.4	**Reference Point Dosimetry**	**<CONTAINER>**	**Section TID 10041**
1.10.4.1	Reference Point Definition	(113865, DCM, "4.2cm above Breast Support Surface")	Section TID 10041
1.11	**Irradiation Event Summary Data**	**<CONTAINER>**	**Section TID 10042**
1.11.1	Irradiation Event UID	**2.999.2.3.4**	Section TID 10042
1.11.2	DateTime Started	*20240418123000.000*	Section TID 10042
1.11.3	DateTime Ended	*20240418123003.000*	Section TID 10042
1.11.4	Identification of the X-Ray Source	*1*	Section TID 10042
1.11.5	Irradiation Event Type	(113611, DCM, "Stationary Acquisition")	Section TID 10042
1.11.6	Image View	(SCT, 399162004, "cranio-caudal")	Section TID 10042
1.11.8	Average Glandular Dose	*1.20 mGy*	Section TID 10042
1.11.9	Is Rejected Acquisition	*No*	Section TID 10042
1.11.10	Exposure Time	*625.00 ms*	Section TID 10042
1.12	**Irradiation Event Summary Data**	**<CONTAINER>**	**Section TID 10042**
Repeat Irradiation Event Summary Data TID 10042 for LCC Tomosynthesis *From Date Time 20240418123100.000 to 20240418123103.000*			
1.13	**Irradiation Event Summary Data**	**<CONTAINER>**	**Section TID 10042**
Repeat Irradiation Event Summary Data TID 10042 for LMLO *From Date Time 20240418123200.000 to 20240418123203.000*			
1.14	**Irradiation Event Summary Data**	**<CONTAINER>**	**Section TID 10042**
Repeat Irradiation Event Summary Data TID 10042 for LMLO Tomosynthesis *From Date Time 20240418123300.000 to 20240418123303.000*			
1.15	**Irradiation Event Summary Data**	**<CONTAINER>**	**Section TID 10042**
Repeat Irradiation Event Summary Data TID 10042 for RCC *From Date Time 20240418123400.000 to 20240418123403.000*			
1.16	**Irradiation Event Summary Data**	**<CONTAINER>**	**Section TID 10042**
Repeat Irradiation Event Summary Data TID 10042 for RCC Tomosynthesis *From Date Time 20240418123500.000 to 20240418123503.000*			
1.17	**Irradiation Event Summary Data**	**<CONTAINER>**	**Section TID 10042**

Commented [LK1]: Should we give a more detailed example for a tomo?

Node	Code Meaning of Concept Name	Code or Example Value	TID
Repeat Irradiation Event Summary Data TID 10042 for RMLO *From Date Time 2024041812**3600**.000 to 2024041812**3603**.000*			
1.18	**Irradiation Event Summary Data**	**<CONTAINER>**	**Section TID 10042**
Repeat Irradiation Event Summary Data TID 10042 for RMLO Tomosynthesis *From Date Time 2024041812**3700**.000 to 2024041812**3703**.000*			
1.19	**Irradiation Details**	**<CONTAINER>**	**Section TID 10043**
1.19.1	DateTime Started	*2024041812**3000**.000*	Section TID 10043
1.19.2	DateTime Ended	*2024041812**3703**.000*	Section TID 10043
1.19.3	Frame of Reference UID	**2.999.1.2.3**	Section TID 10043
1.19.4	RDSR Frame of Reference Origin	(130538, DCM, "Patient Support Origin")	Section TID 10043
1.19.5	RDSR Frame of Reference Description	*Patient support origin located at center of the front-most (chest) edge of the patient support. Y-axis is anti-gravity direction when the gantry is positioned at 0 degrees. Z-axis is from the chest edge to the anterior edge of the detector. X-axis is cross product of y and z axes (+y × +z).*	Section TID 10
1.19.6	**Radiation Source Characteristics**	**<CONTAINER>**	**Section TID 10044**
1.19.6.1	DateTime Started	*2024041812**3000**.000*	Section TID 10044
1.19.6.2	DateTime Ended	*2024041812**3703**.000*	Section TID 10044
1.19.6.3	Identification of the X-Ray Source	*1*	Section TID 10044
1.19.6.4	Focal Spot Size	*0.3 mm*	Section TID 10044
1.19.6.5	Anode Target Material	(26194003, SCT, "Tungsten")	Section TID 10044
1.19.6.6	**Attenuator Characteristics**	**<CONTAINER>**	**Section TID 10044**
1.19.6.6.1	Equivalent Attenuator Material	(12503006, SCT, "Aluminum")	Section TID 10044
1.19.6.6.2	Equivalent Attenuator Thickness	*0.03 mm*	Section TID 10044
1.19.7	**Radiation Technique**	**<CONTAINER>**	**Section TID 10045**
1.19.7.1	DateTime Started	*2024041812**3000**.000*	Section TID 10045
1.19.7.2	DateTime Ended	*2024041812**3703**.000*	Section TID 10045
1.19.7.3	Identification of the X-Ray Source	*1*	Section TID 10045
1.19.7.4	Half Value Layer	*0.514 mm*	Section TID 10045
1.19.7.5	KVP	*28.00 kV*	Section TID 10045
1.19.7.6	X-Ray Tube Current	*160.0 mA*	Section TID 10045

Commented [LK2]: Not sure if this makes sense

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.19.8	**Filtration**	**<CONTAINER>**	**Section TID 10046**
1.19.8.1	DateTime Started	*20240418123000.000*	Section TID 10046
1.19.8.2	DateTime Ended	*20240418123703.000*	Section TID 10046
1.19.8.3	Identification of the X-Ray Source	*1*	Section TID 10046
1.19.8.4	**Attenuator Characteristics**	**<CONTAINER>**	**Section TID 10055**
1.19.8.4.1	Identification of the Attenuator	*1*	Section TID 10055
1.19.8.4.2	Attenuator Category	(113771, DCM, "X-Ray Filters")	Section TID 10055
1.19.8.4.3	X-Ray Filter Material	(59801003, SCT, "Rhodium")	Section TID 10055
1.19.8.4.4	X-Ray Filter Type	(113653, DCM, "Flat filter")	Section TID 10055
1.19.8.4.5	X-Ray Filter Thickness	*0.050 mm*	Section TID 10055
1.19.9	**Attenuators**	**<CONTAINER>**	**Section TID 10047**
1.19.9.1	DateTime Started	*20240418123000.000*	Section TID 10047
1.19.9.2	DateTime Ended	*20240418123703.000*	Section TID 10047
1.19.9.3	**Attenuator Characteristics**	**<CONTAINER>**	**Section TID 10055**
1.19.9.3.1	Identification of the Attenuator	*2*	Section TID 10055
1.19.9.3.2	Attenuator Category	(129460009, STC, "Compression Paddle")	Section TID 10055
1.19.9.3.3	X-Ray Filter Material	(412154003, SCT, "Polycarbonate")	Section TID 10055
1.19.9.3.4	X-Ray Filter Thickness	*2.5 mm*	Section TID 10055
1.19.10	**Radiation Output**	**<CONTAINER>**	**Section TID 10048**
1.19.10.1	DateTime Started	*20240418123000.000*	Section TID 10048
1.19.10.2	DateTime Ended	*20240418123703.000*	Section TID 10048
1.19.10.3	Identification of the X-Ray Source	*1*	Section TID 10048
1.19.10.4	Air Kerma at Output Measurement Point	*4.1 mGy*	Section TID 10048
1.19.11	**Radiation Field Area**	**<CONTAINER>**	**Section TID 10049**
1.19.11.1	DateTime Started	*20240418123000.000*	Section TID 10049
1.19.11.2	DateTime Ended	*20240418123703.000*	Section TID 10049
1.19.11.3	Identification of the X-Ray Source	*1*	Section TID 10049
1.19.11.4	Radiation Field Outline	SCOORD3D POLYGON	Section TID 10049

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.19.12	**X-Ray Source Reference Coordinate System**	**<CONTAINER>**	**Section TID 10050**
1.19.12.1	DateTime Started	*20240418123000.000*	Section TID 10050
1.19.12.2	DateTime Ended	*20240418123703.000*	Section TID 10050
1.19.12.3	Identification of the X-Ray Source	*1*	Section TID 10050
1.19.12.4	Transformation Matrix	*1.0 0.0 0.0 0* / *0.0 1.0 0.0 675* / *0.0 0.0 1.0 0* / *0.0 0.0 0.0 1.0*	Section TID 10
1.19.13	**Beam Position**	**<CONTAINER>**	**Section TID 1**
1.19.13.1	DateTime Started	*20240418123000.000*	Section TID 10051
1.19.13.2	DateTime Ended	*20240418123703.000*	Section TID 10051
1.19.13.3	Identification of the X-Ray Source	*1*	Section TID 10051
1.19.13.4	Output Measurement Point Position	SCOORD3D POINT	Section TID 10051
1.19.13.5	Reference Point Position	SCOORD3D POINT	Section TID 10051
1.19.13.6	**X-Ray Beam Attenuator Model**	**<CONTAINER>**	**Section TID 10051**
1.19.13.6.1	Identification of the Attenuator	***1***	Section TID 10051
1.19.13.6.2	X-Ray Attenuator Model Data	**2.999.3.4.5**	Section TID 10051
1.19.13.6.3	Transformation Matrix	*1.0 0.0 0.0 0.0* / *0.0 1.0 0.0 -10* / *0.0 0.0 1.0 0.0* / *0.0 0.0 0.0 1.0*	Section TID 10051
1.19.14	**Attenuator Position**	**<CONTAINER>**	**Section TID 10052**
1.19.14.1	DateTime Started	*20240418123000.000*	Section TID 10052
1.19.14.2	DateTime Ended	*20240418123703.000*	Section TID 10052
1.19.14.3	**X-Ray Beam Attenuator Model**	**<CONTAINER>**	**Section TID 10052**
1.19.14.3.1	Identification of the Attenuator	***2***	Section TID 10052
1.19.14.3.2	X-Ray Attenuator Model Data	**2.999.3.4.5.6**	Section TID 10052

Commented [LK3]: I'm not sure what the source position would be in x, y, z. I know the distance from breast support to source for a Hologic system is 67.5 cm, but I'm not sure where it is in z.

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.19.14.3.3	Transformation Matrix	*1.0 0.0 0.0 0.0 0.0 1.0 0.0 44 0.0 0.0 1.0 0.0 0.0 0.0 0.0 1.0*	Section TID 10052
1.19.15	**Patient Attenuation Characteristics**	**<CONTAINER>**	**Section TID 10053**
1.19.15.1	DateTime Started	*20240418123000.000*	Section TID 10053
1.19.15.2	DateTime Ended	*20240418123703.000*	Section TID 10053
1.19.15.3	Identification of the X-Ray Source	*1*	Section TID 10053
1.19.15.4	Patient Equivalent Thickness	*44 mm*	Section TID 10[illegible]
1.19.16	**Procedure Characteristics**	**<CONTAINER>**	**Section TID 10**
1.19.16.1	DateTime Started	*20240418123000.000*	Section TID 10054
1.19.16.2	DateTime Ended	*20240418123003.000*	Section TID 10054
1.19.16.3	Identification of the X-Ray Source	*1*	Section TID 10054
1.19.16.4	Acquisition Protocol	*Conventional Acquisition*	Section TID 10054
1.19.16.5	Patient Table Relationship	(102540008, SCT, "headfirst")	Section TID 10054
1.19.16.6	Patient Orientation	(C86043, NCIt, "erect")	Section TID 10054
1.19.16.6.1	Patient Orientation Modifier	(10904000, SCT, "standing")	Section TID 10054
1.19.16.7	Target Region	(76752008, SCT, "Breast")	Section TID 10054
1.19.16.7.1	Laterality	(7771000, SCT, "Left")	Section TID 10054
1.19.16.8	X-Ray Grid	(111642, DCM, "Focused grid")	Section TID 10054
1.19.16.9	X-Ray Grid	(111642, DCM, "Reciprocating grid")	Section TID 10054
1.19.16.10	Distance Source to Detector	*700 mm*	Section TID 10054
1.19.17	**Procedure Characteristics**	**<CONTAINER>**	**Section TID 10054**
Repeat Procedure Characteristics TID 10054 for LCC Tomosynthesis *From Date Time 20240418123100.000 to 20240418123103.000* *Laterality = Left*			
1.19.18	**Procedure Characteristics**	**<CONTAINER>**	**Section TID 10**
Repeat Irradiation Details TID 10043 for LMLO *From Date Time 20240418123200.000 to 20240418123203.000*			

Commented [LK4]: I couldn't find anywhere else to fit the compression thickness. And I didn't find a spot for the compression force.

Commented [LK5]: Should we give a more detailed example for a tomo?

Commented [LK6]: It's unclear to me whether Irradiation Details should get repeated for each acquisition (as I have it now) or if the individual elements that change for the eight acquisitions are repeated where necessary due to changing kV, filter, etc.

Node	Code Meaning of Concept Name	Code or Example Value	TID
Laterality = Left			
1.19.19	**Procedure Characteristics**	**<CONTAINER>**	**Section TID 10054**
Repeat Irradiation Details TID 10043 for LMLO Tomosynthesis *From Date Time 20240418123300.000 to 20240418123303.000* *Laterality = Left*			
1.19.20	**Procedure Characteristics**	**<CONTAINER>**	**Section TID 10054**
Repeat Irradiation Details TID 10043 for RCC *From Date Time 20240418123400.000 to 20240418123403.000* *Laterality = Right*			
1.19.21	**Procedure Characteristics**	**<CONTAINER>**	**Section TID 10054**
Repeat Irradiation Details TID 10043 for RCC Tomosynthesis *From Date Time 20240418123500.000 to 20240418123503.000* *Laterality = Right*			
1.19.22	**Procedure Characteristics**	**<CONTAINER>**	**Section TID 10054**
Repeat Irradiation Details TID 10043 for RMLO *From Date Time 20240418123600.000 to 20240418123603.000* *Laterality = Right*			
1.19.23	**Procedure Characteristics**	**<CONTAINER>**	**Section TID 10054**
Repeat Irradiation Details TID 10043 for RMLO Tomosynthesis *From Date Time 20240418123700.000 to 20240418123703.000* *Laterality = Right*			
1.20	**Person Participant**	**<CONTAINER>**	**Section TID 10040**
1.20.1	Person Name	*Operator^^^X*	Section TID 1020
1.20.2	Person Role in Procedure	(121094, DCM, “Performing”)	Section TID 1020
1.20.3	Person Role in Organization	(159016003, SCT, “Radiologic Technologist”)	Section TID 1020
1.21	Source of Dose Information	(113856, DCM, "Automated Data Collection")	Section TID 10040