Digital Imaging and Communications in Medicine (DICOM)

Supplement 245: RDSR Informative Annex

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Table of Contents

Document History

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Open Issues

None

Closed Issues

Item	Issue	Decision
1	**Issue**: Should this supplement include encoding guidelines for systems that have delivered dose but cannot calculate a value for the Dose at Reference Point? **Context**: Users and/or regulators might require to create a DICOM RDSR for these systems.	Out of scope of this supplement
2	**Issue**: Should this supplement include guidelines for encoding acquisition techniques (kV, mA…) in images and RDSR, similarly to the Encoding of Irradiation Timing Concepts of ZZZZZ.4.6. **Context**: The acquisition techniques may not have the same definition in image attributes and RDSR items (or the definitions are open or fuzzy), so the implementor can apply different calculation in images and RDSR. For example, refer to Enhanced XA Informative Annex for examples (e.g. pre-pulse radiation that does not create pixels).	Out of scope of this supplement
3	**Issue**: Should this supplement include encoding guidelines when there are multiple reference point definitions within one RDSR (traditional and enhanced)? **Context**: In Enhanced RDSR one could treat the sources as distinct from one another, allowing encoding of each reference point within the same RDSR. However, in Traditional RDSR the proposed solution would be to create separate RDSR instances for each reference point.	Out of scope of this supplement

Scope and Field of Application

This Supplement explains the creation and usage of Radiation Dose Structured Report (traditional and enhanced) within Angiography, Mammography, Radiography, Radiofluoroscopy, CT, and Dentistry modalities. This supplement excludes Radiopharmaceutical Radiation Dose Structured Report, Patient Radiation Dose Structured Report, and radiation for treatment (which is encoded in the family of Radiotherapy objects).

The content definition of the RDSR varies by modality, and there are many different types of system configurations in the field. This supplement provides 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, value ranges, presence of Content Items);
- Assess the applicability for some conditional Content Items under particular scenarios;
- Promote usage of optional Content Items under particular scenarios;
- Explain 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).

Changes to NEMA Standards Publications

Digital Imaging and Communications in Medicine (DICOM)

Part 17: Explanatory Information

Item #01: Replace the content of the Annex UUUU by the content of the following Annex ZZZZZ and add appropriate note about past content of UUUU

ZZZZZ Radiation Dose Structured Reporting (Informative)

ZZZZZ.1 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 Report (RDSR) 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. The Radiation Dose Structured Report (RDSR) Objects described in this Annex record the radiation output of the equipment.

This Annex includes Projection X-Ray RDSR, CT RDSR and Enhanced RDSR, and it excludes Radiopharmaceutical RDSR (PET, SPECT), Patient RDSR, and radiation for treatment (which is encoded in the family of 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).

This Annex describes the use of the RDSR 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).

ZZZZZ.2 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.

ZZZZZ.3 RADIATION DOSE OVERVIEW

ZZZZZ.3.1 User Needs

Due to increased attention to the radiation dose delivered during diagnostic and interventional exams, 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 dosimetry 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.

Dosimetry 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 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.

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, for a CT scan, a single RDSR may typically be created at the end of the acquisition. Conversely, 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, and thus the image header is not a reliable source of dose information. 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 dosimetry 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 X-Ray Angiography

X-Ray Angiography (XA) systems perform diagnostic and interventional procedures, typically in a catheterization lab (cath lab). These procedures primarily involve 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.

XA equipment is also used for *electrophysiology (EP)* procedures in the EP lab, where catheters and wire electrodes are passed through blood vessels to assess and treat the heart’s electrical activity. The use of fluoroscopically-guided procedures in the cath lab for minimally invasive surgical interventions led to the definition of the 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, image-guided surgical procedures may use similar XA imaging techniques on smaller mobile equipment.

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 in more detail in section ZZZZZ.4.9.

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 and Acquisition. Fluoroscopy is typically low dose and is used to place the instruments (catheters, guidewires, needles). Acquisition is typically higher dose (so-called cine run) and is used to achieve higher image quality.
   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 until 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 an individual 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 (i.e., XA 2D projection images) that are displayed on the equipment and have corresponding Irradiation Events.
      - Images resulting from Fluoroscopy exposures are shown on the screen to the operator but may or may not be a persistent DICOM object.
      - Images resulting from Acquisition exposures are shown on the screen to the operator and are typically persistent DICOM objects.
      - 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 (CBCT) 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 persistently stored or deleted during the procedure.
4) The procedure ends.
5) Following the procedure, one or more RDSR Instances are created from the irradiation 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. They are used 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. There will typically be an RDSR with the scope that covers all of the Irradiation Events during that Study.
   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 from the existing data (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. The RDSR is not typically updated to reference these images produced after the creation of the RDSR.
7) Subsequent dose analysis is based on the information of the Irradiation Events contained in the RDSRs, not on the image metadata. Images are associated with one or more Irradiation Events, but there may be Irradiation Events with no images (e.g. images that come for Fluoroscopy, or deleted Acquisition images). There may be also one Irradiation Event that ultimately results in multiple images (e.g. original and processed images, 3D reconstructions, etc.). See section ZZZZZ.4.11.4 for the importance to use the Irradiation Event UIDs in the RDSRs.

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 Radiofluoroscopy

Radiofluoroscopy (RF) systems perform 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.

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. The system may not know about the Image Receptor (e.g., CR systems), while the mechanical data related to the rad/fluoro gantry is generally known (e.g., positioner angles/column angles).

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.
    b. If the system does not know about the Image Receptor, such information is not stored in the RDSR, and may be part of a separate RDSR from the associated system. If the mechanical data related to the rad/fluoro gantry is known it may also be included in the RDSR.
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.4.1.4 for the importance to use the Irradiation Event UIDs in the RDSRs.

ZZZZZ.3.2.3 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.

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.

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

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.4.1.4 for the importance to use the Irradiation Event UIDs in the RDSRs.

ZZZZZ.3.2.4 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 tomosynthesis 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.

The equipment used in Mammography 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).

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.4.1.4 for the importance to use the Irradiation Event UIDs in the RDSRs.

ZZZZZ.3.2.5 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.

The equipment used in CT 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 in more detail in section ZZZZZ.4.9.

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.4.1.4 for the importance to use the Irradiation Event UIDs in the RDSRs.

ZZZZZ.3.2.6 Dentistry

Imaging in dentistry uses equipment specifically designed for imaging parts of the mouth (i.e., teeth, jaws, facial bones, etc.). These devices are often located in dental or orthodontic offices, but may also be in hospitals, emergency departments, urgent care centers, and surgical areas. This section briefly describes the characteristics of each device and then provides a general overview of the workflow.

ZZZZZ.3.2.6.1 Intra-Oral Radiography

Intra-oral radiography describes imaging of the teeth and related structures with an X-Ray Detector placed within the patient's mouth. 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.

ZZZZZ.3.2.6.2 Cephalometry

Cephalometry describes imaging of the head for orthodontic treatment and is typically performed in specialist orthodontic clinics. These systems use 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.

ZZZZZ.3.2.6.3 Panoramic Dental Radiography

Panoramic dental radiography describes imaging of the head for dental treatment. These systems use a panoramic X-Ray system with an 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.

ZZZZZ.3.2.6.4 Two-Dimensional Dental Imaging Workflow

For the two-dimensional dental equipment listed above (intra-oral radiography, cephalometry, panoramic dental radiography), 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., many intra-oral radiographic systems) generally have no communication between system components, resulting in an RDSR that does not have the same level of information.

The general 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. 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.4.1.4 for the importance to use the Irradiation Event UIDs in the RDSRs.

ZZZZZ.3.2.6.5 Dental CT and Cone-Beam CT (CBCT)

Computed tomography (CT) in dentistry, including cone-beam computed tomography (CBCT), describes a wide range of possible imaging procedures performed in a variety of clinical settings. Most dental 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, 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.

The equipment used in dental CT 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 in more detail in section ZZZZZ.4.9.

A general dental 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, etc. Dental CT acquisition does not require continuous actuation of a switch or pedal.
   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.

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.

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, etc. Several acquisitions may be combined to create a single CT image set, e.g., scans of the TM joints. 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.4.1.4 for the importance to use the Irradiation Event UIDs in the RDSRs.

ZZZZZ.4 RADIATION DOSE STRUCTURED REPORT ENCODING GUIDELINES

ZZZZZ.4.1 Encoding 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.

ZZZZZ.4.1.1 Basic Concepts of RDSR Encoding

ZZZZZ.4.1.1.1 Frequency of Encoding of RDSR Parameters

Traditional RDSR encodes the information based on the concept of individual Irradiation Events, which are defined by a single continuous actuation of the equipment's irradiation switch, from the start of the X-Ray tube 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 devices, 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 encoded as separate Irradiation Events. In the Traditional RDSR, 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.

In Enhanced RDSR, the Irradiation Events and the encoding intervals of the parameters are timestamped. This allows relating the values of the parameters to their corresponding Irradiation Event.

Figure ZZZZZ.4.1.1.1-1 shows a simplified example of a short XA procedure meant to illustrate the basic encoding concepts of the Enhanced RDSR timing vs. Traditional RDSR. Enhanced RDSR uses the same encoding methodology for all modalities and procedures.

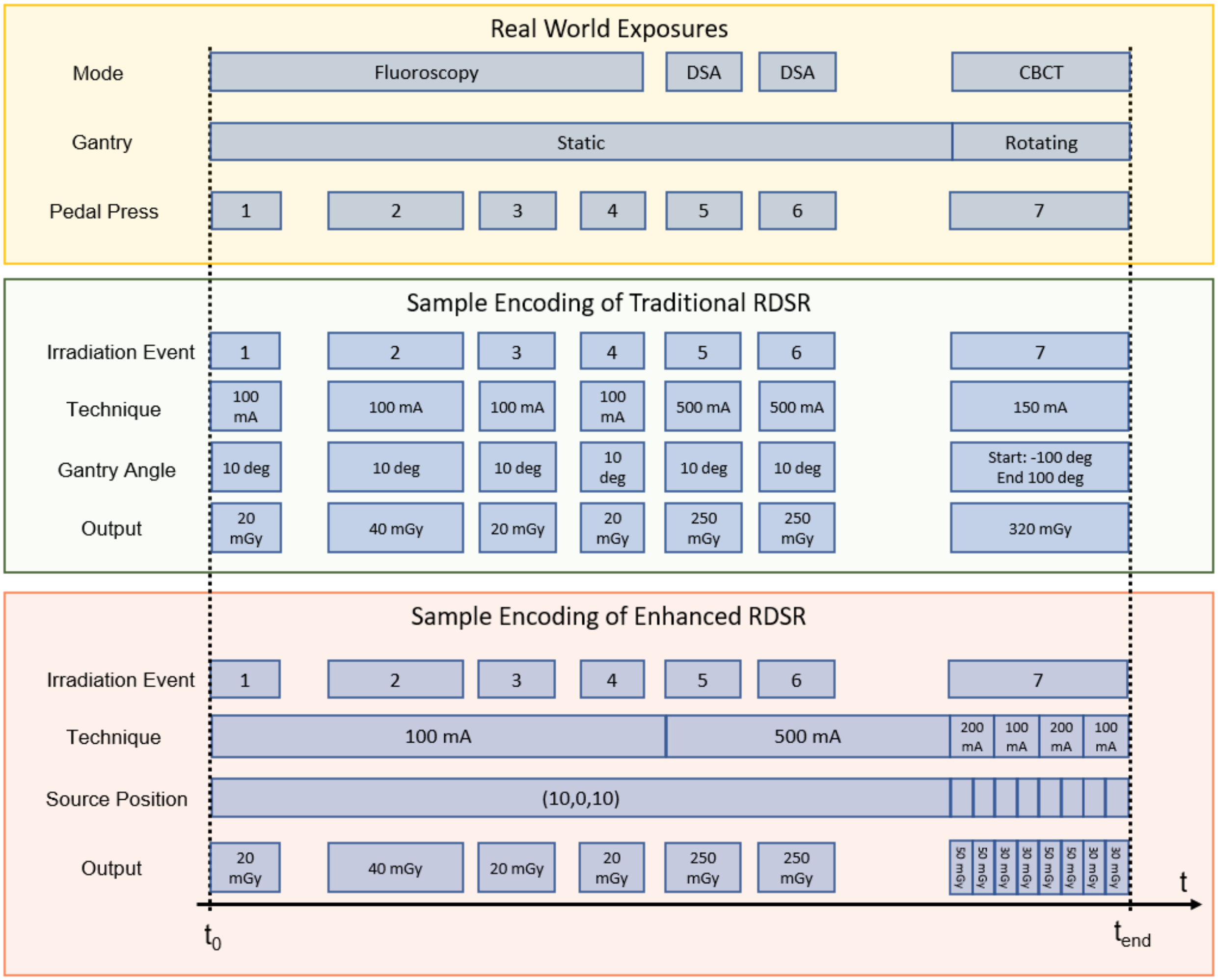

Figure ZZZZZ.4.1.1.1-1. Example of Encoding Concepts of XA Traditional and Enhanced RDSR

In this figure, the “Real World Exposures” box shows the imaging modes, gantry position, and pedal presses (i.e., X-Ray switch on/off) of an XA system. There are four presses of the pedal in regular fluoroscopy mode, two presses in DSA mode (Digital Subtraction Angiography), and one press in CBCT mode (Cone Beam CT).

The “Sample Encoding of Traditional RDSR” box shows a simplified encoding of a Traditional RDSR. Each pedal press results in a separate Irradiation Event, and all parameters are encoded within each Irradiation Event.

The “Sample Encoding of Enhanced RDSR” box shows a simplified encoding of an Enhanced RDSR. The encoding is decoupled from the Irradiation Event, allowing content to either span multiple Irradiation Events or to be encoded multiple times within a single Irradiation Event. Parameter values are encoded with a start and end DateTime, rather than being associated with an Irradiation Event. The frequency of the encoding is implementation dependent.

For example, the Technique (tube current, in this example) encodes a single item for all the fluoroscopy events (100 mA for Irradiation Events 1-4), and a second item for the DSA events. The CBCT mode

(Irradiation Event 7) tube current is modulating and is encoded as many times as needed for dosimetry purposes (four in this example).

Similar to the Technique, the Source Position is 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.

In this example, the implementation chose to encode multiple radiation output values during the CBCT event to provide a more granular record of the dose at the several positions of the X-Ray source. This granularity allows a more accurate mapping of the dose values to the different parts of the patient body, E.g. for skin dose calculations.

ZZZZZ.4.1.1.2 Encoding of Parameters Across TIDs in Enhanced RDSR

Information in the Enhanced RDSR is grouped in different TIDs, each TID contains information which often change at similar frequencies, and the parameters contained in two different TIDs could change at different frequencies.

Multiple inclusions of each TID 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. 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.

Note that it is allowed to encode values of the same content item (e.g. Air Kerma) in several inclusions of the TID (e.g. in the Radiation Output TID10048) using the Value Type TABLE in one inclusion and Value Type NUM in another inclusion. Figure ZZZZZ.4.1.1.2-1 illustrates 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 in ZZZZZ.5

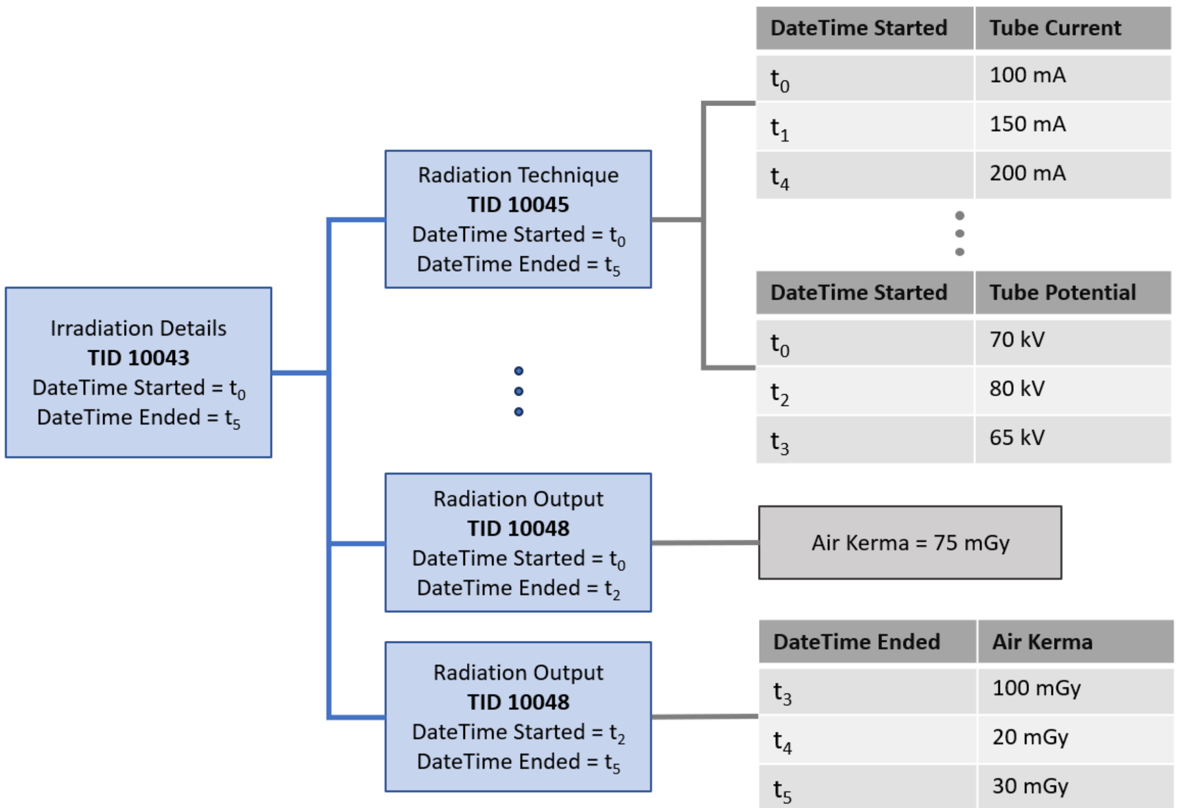

Figure ZZZZZ.4.1.1.2-1. Structure of Encoding of Content Items in TIDs and in TABLE Value Types

For TABLEs with DateTime Started as the first column, the DateTime Started of the first row matches the DateTime Started of the TID in which the content item resides. Subsequent times within each TABLE do not necessarily match each other. This is illustrated 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 as a single value, where in the second case it is provided in a TABLE. 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.

ZZZZZ.4.1.2 Information Contained in Traditional RDSR vs. Enhanced RDSR

Although the encoding of Traditional RDSR and Enhanced RDSR is different, both RDSRs contain largely equivalent information. Table ZZZZZ.4.1.2-1 provides a general comparison between the Traditional and Enhanced RDSRs and explains where various information is contained within each RDSR type.

814 **Table ZZZZZ.4.1.2-1. 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**	Same TID **10041** for all modalities, which includes accumulated data of each modality.
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. TID differs by modality. • CT: TID 10013, 10014, 10015 • Other: TID 10003, 10003A, 10003B, 10003C	TID **10042** provides summary data for each Irradiation Event for all modalities. Technical data for all modalities is described in TIDs included in TID **10043** based on the time periods through the whole RDSR.
Timing (See Figure ZZZZZ.4.1.1.1-1 and Figure ZZZZZ.4.6-1 for further details)	Irradiation Event (start time, duration). TID differs by modality. • CT: TID **10013** • Other: TID 10003, 10003B	Individual time period at the beginning of each TID included in TID **10043,** or for each row of a TABLE Value Type. These time periods do not necessarily align with the Irradiation Event time periods, as they can be defined at X-Ray pulse level, or across many Irradiation Events. Overall DateTime Started and Ended is listed in TID **10043**, providing the complete time period for all events within the Scope of Accumulation.
Geometry	Distances, angles, areas, typically patient-based. TID differs by modality.	Equipment or Room Coordinate-based description of positions and shapes in TID **10050** and **10052** for all modalities.

Concepts	Traditional RDSR Root TIDs 10001, 10011	Enhanced RDSR Root TID 10040
(Positioner, Table, Patient Orientation, Collimator, Attenuators in the beam) (See ZZZZZ.4.5 for further examples)	• CT: TID **10013** • Other: TID **10003C**	X-Ray Source Coordinate-based description of positions and shapes in TID **10049** (e.g. collimator) and **10051** (e.g. Reference Point) for all modalities.

ZZZZZ.4.1.3 Regulatory Considerations

Information that may be required by various regulatory, accreditation, and government agencies (e.g. directly or through standards like IEC) appears in both Traditional RDSR and Enhanced RDSR but in different TIDs.

Regulatory agencies sometimes state requirements for particular information by specifying particular TID numbers to be recorded by devices that create RDSRs. During maintenance of the DICOM Standard, it is rare but possible for TID numbers to be redefined. Users and regulators should refer to the current DICOM Standard for the appropriate TID numbering.

ZZZZZ.4.1.4 Importance of the Irradiation Event UID

Each RDSR Instance of both Traditional RDSR and Enhanced RDSR includes information of the Irradiation Events within its scope of accumulation, as well as accumulated dose data within that scope.

Each Irradiation Event is uniquely identified by its Irradiation Event UID.

For a given Procedure Step or a given Study, several RDSR Instances might be created. The way RDSR creators organize the Irradiation Events across instances of RDSR is implementation dependent. Consider two cases: Overlapping RDSR and Non-Overlapping RDSR, depending on whether or not any Irradiation Event appears in more than one RDSR.

ZZZZZ.4.1.4.1 Overlapping RDSR

Some implementations may duplicate Irradiation Events that exist in prior RDSR Instances in the subsequent RDSR Instances to provide a “complete” record at each point in time. In that case, there will be multiple RDSR Instances that are overlapping in the sense that some Irradiation Events are duplicated.

It is important for RDSR consumers to carefully track Irradiation Event UIDs to correctly distinguish duplicate events from new events. Duplicate Irradiation Events will have the same Irradiation Event UID allowing them to be readily identified to avoid double-counting the recorded dose.

Consider the following examples of overlapping RDSR:

1. “Real Time” procedure dose tracking:

- An external device wishes to display dose in “real time”.
- After each Irradiation Event, the equipment creates a new RDSR Instance with a Scope of Accumulation = **Procedure Step to this point** containing all the Irradiation Events since the beginning of the Procedure Step.

- At the end of the Procedure Step, the equipment creates one final RDSR Instance with the Scope of Accumulation = **Procedure Step** containing all the Irradiation Events of the whole completed Procedure Step.

2. Procedure Step and Study level accumulation:

- At the end of the first Procedure Step, the equipment creates a first RDSR Instance containing all the Irradiation Events of the first Procedure Step with a Scope of Accumulation = **Procedure Step**.
- At the end of the second Procedure Step (e.g. continue the study for the same patient), the equipment creates a second RDSR Instance for the whole study (Scope of Accumulation = **Study**) containing all the Irradiation Events of both procedure steps.

3. Append case:

- At the end of the Study, the equipment creates one RDSR Instance containing all the Irradiation Events of that study with a Scope of Accumulation = **Study**.
- The Study is reopened to perform more imaging on the same equipment (e.g. because of additional Mammo views, patient complications in XA, or CT anatomic coverage issues).
- After the new imaging is performed, the equipment creates an additional RDSR Instance with a Scope of Accumulation = **Study**, containing all the new Irradiation Events and all the previous Irradiation Events since the beginning of the Study.

4. Mixed Traditional and Enhanced RDSR:

- For interoperability reasons, two RDSR consumers expect different forms of RDSR.
- At the end of the Study, the equipment creates one Traditional RDSR Instance and one Enhanced RDSR Instance, both containing the same Irradiation Events.
- Consumers that prefer Enhanced RDSR or Traditional RDSR can Query Retrieve appropriate Instances based on the SOP Class.

ZZZZZ.4.1.4.2 Non-Overlapping RDSR

Some implementations might not duplicate prior Irradiation Events in the subsequent Instances. In this case, there will be multiple non-overlapping RDSR Instances in the sense that the Irradiation Events in one RDSR Instance are not duplicated within other RDSR Instances.

Consider the case where an external device wishes to display dose in “real time”. After each Irradiation Event, the equipment creates a new non-overlapping RDSR Instance with a Scope of Accumulation = “**Irradiation Event**” containing only the dose information of that individual Irradiation Event. During the case, the external device consumes the RDSR Instances as they become available. After the case, since dose consumers would otherwise have to retrieve all of the RDSR Instances, the equipment might be likely to create a complete overlapping RDSR at the end of the procedure step, with higher level of Scope of Accumulation, E.g. **Procedure Step, Series, or Study**.

The IHE REM Profile provides guidance on these Irradiation Event UIDs and populating the Predecessor Documents Sequence (0040,A360) to process related RDSR Instances.

Refer to Section 4.62.4.1.1 in the following link:

https://www.ihe.net/uploadedFiles/Documents/Radiology/IHE_RAD_TF_Vol2.pdf

ZZZZZ.4.1.5 Relationship Between Irradiation Events and Image Storage

Dose analysis should exclusively be based on the information of the Irradiation Events contained in the RDSRs created during and after a procedure.

DICOM RDSR Instances are designed to accurately and completely capture irradiation dose information for subsequent dose analysis and QA processes.

DICOM Image Instances are designed to accurately and completely capture medical imaging information for clinical presentation and processing. While the Image Instance metadata may contain dose-related details that are supportive of presentation and processing, they are not sufficiently complete for dose analysis purposes.

Further, some Irradiation Events (which are all captured in DICOM RDSR Instances) do not result in DICOM Image Instances. For example:

- Fluoroscopy is frequently not stored.
- Rejected images might be deleted without sending to PACS.

On the other hand, an Irradiation Event might result in multiple images (e.g. original and processed images, 3D reconstructions, etc.), so estimating dose based on image metadata would incorrectly overestimate dose.

Images are a useful part of dose management. Dose analysis should take into account the trade off between dose reduction and image quality. In order to allow proper association of images with their corresponding Irradiation Events, the Irradiation Event UID is also encoded within the image metadata.

To summarize, 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 the related acquisition 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**, (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 acquisition of an Irradiation Event was **rejected** is in **TID 10003** and **TID 10013**, (130503, DCM, "Is Rejected Acquisition"). If the value is “Yes” the reason for rejection is in (130504, DCM, "Reason for Rejecting Acquisition”).

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

In Enhanced RDSR:

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

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

The information whether the Irradiation Event was due to a **repeated** acquisition is in **TID 10042**, (128551, DCM, "Is Repeated Acquisition"). If the value is “Yes” the reason for repeating is in (128552, DCM, "Reason for Repeating Acquisition”), and the information about the previously rejected acquisition of an Irradiation Event UID resulting into this new Irradiation Event is in (113769, DCM, " Irradiation Event UID”).

ZZZZZ.4.2 Encoding of Procedure Information and Type of Equipment

For some dose analysis performed by RDSR consumers, identifying the specific type of equipment and/or clinical procedure supports more specific analysis and metrics based on the clinical practice.

This section provides guidance for RDSR encoding of procedures and type of equipment.

There are two places where procedure codes are defined in an RDSR:

- Codes for procedure in the RDSR structured content, specifically defined for the RDSR creator equipment. This is discussed in this section.

- Procedure codes provided in the SR document metadata, applicable to any SR, not discussed in this section. See PS3.3 C.17.2 SR Document General Module, Referenced Request Sequence (0040,A370), Performed Procedure Code Sequence (0040,A372).

ZZZZZ.4.2.1 Traditional RDSR

The Content Item (121058, DCM, "Procedure reported") allows distinguishing categories of X-Ray procedures such as projection X-Ray (e.g. angiography, electrophysiology, fluoroscopy, radiography, single frame acquisition etc.), mammography, and CT. Within the projection X-Ray procedures, the Content Item (122142, DCM, "Acquisition Device Type") indicates the type of equipment used, with possible values defined in the CID 10032 “Projection X-Ray Acquisition Device Types”.

The combination of the values of these two Content Items provides an indication of the modality and type of equipment used. However, the values remain quite general and do not allow inferring the precise clinical procedure performed.

Note that the (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 clinical procedure.

The values in (121058, DCM, "Procedure reported") and (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.

Table ZZZZZ.4.2.1-1 provides some examples of meaningful values of these two Content Items (121058, DCM, "Procedure reported") and (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	Root TID	Value of (121058, DCM, "Procedure reported")	Value of (122142, DCM, "Acquisition Device Type")
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 Enhanced RDSR

TID 10040 requires the content item (121058, DCM, "Procedure reported") to be present, with possible values defined in the CID 10005 “X-Ray Radiation Dose Procedure Reported”. This provides an indication of the modality and type of equipment used, similarly to the information in Traditional RDSR. Note that in Enhanced RDSR there’s no condition on other Content Items based on the value of the Procedure Reported.

CID 10005 “X-Ray Radiation Dose Procedure Reported” specifies a limited set of general procedures for the purpose of sorting/processing RDSRs based on their radiation dose reporting characteristics. This list is extensible and extension codes should follow a recognized standard for coded terminologies. There are other CIDs used in DICOM PS3.16 for “Procedure Reported” on other SR Templates, which include more detailed clinical procedures.

Enhanced RDSR does not include (122142, DCM, "Acquisition Device Type") because CID 10005 is used in (121058, DCM, "Procedure reported") and contains equivalent granularity.

Table ZZZZZ.4.2.2-1 provides the recommended values of the content item **(121058, DCM, "Procedure reported")** for the Enhanced RDSR.

Table ZZZZZ.4.2.2-1. Recommended Values for Procedure Reported

Modality (0008,0060) of the DICOM Images	**Root TID**	**Value of (121058, DCM, "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, DX, CR)	10040	(1290849002, SCT, “Dental radiography”) or (717193008, SCT, “Cone beam computed tomography”)
Computer Tomography (CT)	10040	(77477000, SCT, “Computed tomography”)
X-Ray Bone Densitometry (BMD)	10040	(241686001, SCT, “Dual energy X-ray absorptiometry”)

ZZZZZ.4.3 Encoding of the Identity of the Equipment

Medical physicists doing quality control, dose/protocol management and dose optimization of X-Ray equipment in an institution need to identify the device that is creating the RDSR. Their analysis may consider the individual device, the model of the device, and/or the manufacturer name, etc. National RDSR Registries will also be interested in such information.

The inclusion of TID 1002 “Observer Context” in the RDSR with Observer Type equal to (121007, DCM, “Device”) allows to identify the irradiating device with the information defined in TID 1004 “Device Observer Identifying Attributes”. The UDI (Unique Device Identifier) and the Serial Number are unique for each individual device for a given manufacturer and model.

The information in the Enhanced General Equipment Modules of the RDSR also specifies the Manufacturer, Model, Software Version, and Serial Number of the system that produces the data (e.g., the device providing the content of the SOP Instance).

When the system that creates the RDSR SOP Instance is the irradiating device, the values will be consistent between the TID 1002 and the Enhanced General Equipment Modules. However, the system that creates the RDSR SOP Instance might not be the irradiating device or the device that captures the dose related information.

Please note that the TID 1002 “Observer Context” is mandatory in the RDSR, but it might contain only a Person observer and not the Device, so device information is not mandatory in the structured content. RDSR creators should use TID 1002 with “Device” observer.

Table ZZZZZ.4.3-1 provides guidance on the DICOM Attributes that allow to uniquely identify the individual devices.

Table ZZZZZ.4.3-1. Guidance for Attributes to uniquely identify the individual devices

Attribute Name / Content Item Concept Name	Implementation Guidance
Device UDI	It’s globally unique to each individual device, as defined by a corresponding Issuing Agency. Refer to PS3.3 section 10.29.1. This Attribute is Optional in RDSR.
Device UID	It’s globally unique to each individual device. Is mandatory if the Observer Type equals (121007, DCM, “Device”).
Serial Number	It’s unique to the device instance of a given manufacturer and model. This is the serial number of the whole system; it does not include parts/components of the system. This Attribute is mandatory in the Enhanced General Equipment Module.

Table ZZZZZ.4.3-2 provides guidance on other DICOM Attributes that identify the devices but that might change values for the same device within the same hospital or manufacturer.

Table ZZZZZ.4.3-2. Guidance for other Attributes to identify devices

Attribute Name / Content Item Concept Name	Implementation Guidance
Manufacturer	This is mandatory in the Enhanced General Equipment Module. Be aware that for a given manufacturer, this value might change over time for the same device upon software upgrades.
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.

Attribute Name / Content Item Concept Name	Implementation Guidance
Software version	Mandatory in the Enhanced General Equipment Module. Typically, this is the version of the software creating the DICOM RDSR instances. The attribute might contain additional values to describe specific system components.

ZZZZZ.4.4 Encoding of Physicians and Operators

Processing applications may be familiar with extracting person names from the header metadata of DICOM images. Some person names in DICOM RDSRs are encoded in the header metadata, others are encoded in the structured content tree. Applications will likely need to combine both types of information.

ZZZZZ.4.4.1 RDSR Header Metadata

Some names of physicians (i.e. **Referring Physician**, **Consulting Physician**, **Reading Physician**, **Physician of Record**) are defined in the General Study Module, thus they are present in the header metadata of the RDSR objects.

The names of the persons involved in the creation of the technical data of the RDSR can be encoded using the attribute **Person Name (0040,A123)** defined in the Table C.17-3b “Identified Person or Device Macro Attributes” included in the **Author Observer Sequence (0040,A078)** and in the **Participant Sequence (0040,A07A)** of the **SR Document General Module**.

Note: The **Performing Physician's Name** (0008,1050) and the **Operator’s Name** (0008,1070), which are defined in the General Series Module of the Image IODs, are not defined in the RDSR header metadata. Refer to the next section.

ZZZZZ.4.4.2 RDSR Structured Content Tree

Person names can be encoded as structured content in DICOM SRs. The X-Ray Radiation Dose Structured Report (RDSR) provides the following mechanisms to include physician/operator names and their roles:

In the RDSR Root Templates TID 10001 and TID 10040:

- TID 1002 “**Observer Context**” encodes one or more persons/roles.
- TID 1020 “**Person Participant**” explicitly denominates the person who authorized/justified the X-Ray procedure under the role “Irradiation Authorizing”.

In the Irradiation Event X-Ray Data Template TID 10003 and in Irradiation Event Summary Data Template TID 10042:

- TID 1020 “**Person Participant**” explicitly denominates the person(s) who performed the image acquisitions and applied X-Ray under the role “Irradiation Administering” (typically the Performing Physician and Operator in X-Ray Angiography).

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 person that applies (i.e. “administers”) the radiation during performance of the procedure.

Table ZZZZZ.4.4.2-1 provides a coding example of an X-Ray Angiography procedure where *<name of the authorizer>* has done the justification of the procedure performed by *<name of the performing physician>*. The system is operated by *<name of the operator>* assisting in the procedure.

Table ZZZZZ.4.4.2-1. RDSR Person Encoding Example

	Code Meaning of Concept Name	**Concept Value**	**TID**
	…		
	Person Name	<name of the authorizer>	TID 1020
>	Person Role in Procedure	(113850, DCM, "Irradiation Authorizing")	TID 1020
>	Person Role in Organization	(309343006, SCT, "**Physician**")	TID 1020
	…		
	Person Name	<name of the performing physician>	TID 1020
>	Person Role in Procedure	(113850, DCM, "Irradiation Administering")	TID 1020
>	Person Role in Organization	(309343006, SCT, "**Physician**")	TID 1020
	Person Name	<name of the operator>	TID 1020
>	Person Role in Procedure	(113850, DCM, "Irradiation Administering")	TID 1020
>	Person Role in Organization	(159016003, SCT, "Radiologic Technologist")	TID 1020

ZZZZZ.4.5 Encoding of Distances and Geometry

To be properly interpreted, an Air Kerma value is provided with the point at which it has been measured or calculated (so-called Reference Point, or RP). Most systems define the Reference Point (RP) at an assumed radiation entrance location for a typical patient, expressed relative to equipment locations (e.g. Isocenter, tabletop, detector plane).

ZZZZZ.4.5.1 Recommended Reference Points

Table ZZZZZ.4.5.1-1 provides recommended Reference Points for different mechanical configurations as encoded in the Content Item (113780, DCM, "Reference Point Definition").

Table ZZZZZ.4.5.1-1. Recommended Reference Points

Modality	**Mechanical Configuration**	**Recommended Reference Point**
X-Ray Angiography (XA)	Interventional system with C-arm and Isocenter.	(113860, DCM, "15cm from Isocenter toward Source")

Modality	Mechanical Configuration	Recommended Reference Point
	Interventional system without Isocenter and with X-Ray source assembly fixed below table.	(113862, DCM, "1cm above Tabletop")
Radio Fluoroscopy (RF)	C-arm fluoroscopy system without integrated table.	(113861, DCM, "30cm in Front of Image Input Surface")
	Lateral-type of fluoroscopy system.	(113864, DCM, "15cm from Table Centerline")
	Fluoroscopy system with X-Ray source assembly fixed below table.	(113862, DCM, "1cm above Tabletop")
	Fluoroscopy system with X-Ray source assembly fixed above table.	(113863, DCM, "30cm above Tabletop")
Radiography (DX, CR)	Radiography system with mobile cassettes or mobile digital detectors.	(113941, DCM, "In Detector Plane")
	Mobile X-Ray sources where the information of the detector location is not available.	(113965, DCM, "100cm from X-Ray Source")
Mammography (MG)	All mammography systems including tomosynthesis.	(113865, DCM, "4.2cm above Breast Support Surface")
		(113964, DCM, "At Surface of Patient")
Dentistry (IO, PX)	All dental systems except when performing cone beam CT.	(113941, DCM, "In Detector Plane")
	Dental systems performing cone beam CT.	Reference Point is not defined.
Computer Tomography (CT)	All CT systems.	Reference Point is not defined.

ZZZZZ.4.5.2 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 different 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.

RDSR encodes the orientation of the center of the X-Ray beam, the collimated area, as well as the positions, angulations and distances between the equipment components related to the Reference Point.

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

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 encoded per Irradiation Event in TID10003C Irradiation Event X-Ray Mechanical Data, some of these distances are defined in the CID 10008 Dose Related Distance Measurement. Additionally, TID 10007 Accumulated Total Projection Radiography Dose allows encoding the Distance Source to Reference Point for the whole RDSR, but this is only applicable if this distance does not change through the RDSR.

Table ZZZZZ.4.5.2-1 shows an example of encoding equipment geometry at the Irradiation Event level in Traditional RDSR for a patient positioned Head-First Supine.

Table ZZZZZ.4.5.2-1. Example of Encoding Equipment Geometry at the Irradiation Event Level

	Concept Name	**Concept Value**	**TID**
	(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
>	(113790, DCM, "Collimated Field Area")	0.04 m2	TID 10003B
>	(113788, DCM, "Collimated Field Height")	200.0 mm	TID 10003B
>	(113789, DCM, "Collimated Field Width")	200.0 mm	TID 10003B
>	(112011, DCM, "Positioner Primary Angle")	30.0 deg	TID 10003C
>	(112012, DCM, "Positioner Secondary Angle")	0.0 deg	TID 10003C
>	(113739, DCM, "Positioner Primary End Angle")	-10.0 deg	TID 10003C
>	(113740, DCM, "Positioner Secondary End Angle")	0.0 deg	TID 10003C
>	(113754, DCM, "Table Head Tilt Angle")	0.0 deg	TID 10003C
>	(113755, DCM, "Table Horizontal Rotation Angle")	0.0 deg	TID 10003C

	Concept Name	Concept Value	TID
>	(113756, DCM, "Table Cradle Tilt Angle")	0.0 deg	TID 10003C
Next rows are multiple inclusions drawn from CID 10008 “Dose Related Distance Measurements”			
>	(113751, DCM, “Table Longitudinal Position”)	50.0 mm	TID 10003C
>	(113752, DCM, “Table Lateral Position”)	400.0 mm	TID 10003C
>	(113753, DCM, “Table Height Position”)	150.0 mm	TID 10003C
>	(113750, DCM, “Distance Source to Detector”)	1100.0 mm	TID 10003C
>	(113737, DCM, “Distance Source to Reference Point”)	650.0 mm	TID 10003C

ZZZZZ.4.5.3 X-Ray Isocenter Reference System in Traditional RDSR

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 the RDSR Instances, 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 Isocenter to allow relating the Reference Point to the surface of the patient laying on the table.

The Content Items for the Table Longitudinal, Lateral, and Height Positions in the Traditional RDSR are defined with respect to an arbitrary coordinate system which is not necessarily related to the Isocenter. To overcome this limitation, the Traditional RDSR also encodes table positions in the X-Ray Isocenter Coordinate System following the definitions in DICOM PS 3.3 Section C.8.19.6.13, for equipment that implements the X-Ray Isocenter Reference System model.

Also refer to DICOM PS 3.17 Annex Z and PS 3.17 Section FFF.2.1.3 for additional examples of the X-Ray Isocenter Reference System model.

Table ZZZZZ.4.5.3-1 shows the encoding of the X-Ray Isocenter Reference System in Traditional RDSR:

Table ZZZZZ.4.5.3-1. Example of Encoding X-Ray Isocenter Reference System in Traditional RDSR

	Concept Name	Concept Value	TID
	(113706, DCM, "Irradiation Event X-Ray Data")	<CONTAINER>	TID 10003
…			
>	(128757, DCM, "Positioner Isocenter Primary Angle")	30.0 deg	TID 10003C
>	(128758, DCM, "Positioner Isocenter Secondary Angle")	0.0 deg	TID 10003C

	Concept Name	Concept Value	TID
>	(128759, DCM, "Positioner Isocenter Detector Rotation Angle")	90.0 deg	TID 10003C
>	(128760, DCM, "Positioner Isocenter Primary End Angle")	-10.0 deg	TID 10003C
>	(128761, DCM, "Positioner Isocenter Secondary End Angle")	0.0 deg	TID 10003C
>	(128762, DCM, "Positioner Isocenter Detector Rotation End Angle")	90.0 deg	TID 10003C
>	(113754, DCM, "Table Head Tilt Angle")	0.0 deg	TID 10003C
>	(113755, DCM, "Table Horizontal Rotation Angle")	0.0 deg	TID 10003C
>	(113756, DCM, "Table Cradle Tilt Angle")	0.0 deg	TID 10003C
>	(128763, DCM, "Table Head Tilt End Angle")	0.0 deg	TID 10003C
>	(128764, DCM, "Table Horizontal Rotation End Angle")	0.0 deg	TID 10003C
>	(128765, DCM, "Table Cradle Tilt End Angle")	0.0 deg	TID 10003C
Next rows are multiple inclusions drawn from CID 10008 “Dose Related Distance Measurements”			
>	(128766, DCM, Table X Position to Isocenter)	50.0 mm	TID 10003C
>	(128767, DCM, Table Y Position to Isocenter)	150.0 mm	TID 10003C
>	(128768, DCM, Table Z Position to Isocenter)	400.0 mm	TID 10003C
>	(128769, DCM, Table X End Position to Isocenter)	50.0 mm	TID 10003C
>	(128770, DCM, Table Y End Position to Isocenter)	150.0 mm	TID 10003C
>	(128771, DCM, Table Z End Position to Isocenter)	400.0 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 relating the Isocenter Reference Point (and the Dose Reference Point) to the patient laying on the table.

Equipment Landmark

The Equipment Landmark is a point used as spatial reference in the Table Reference System. It establishes a visible location on the X-Ray Table that allows the operator to measure distances from that point to one or more parts of the patient body.

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

The Patient Fiducials are spatial references of the patient body, used by the operator to measure distances from the Equipment Landmark to these references, thus allowing to locate the patient body in the Table Reference System. They are typically traverse planes 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 top of the head, and plane through the bottom of the feet.

- Top of the head :
  - (128772, DCM, “Reference Basis”) = (88986008, SCT, “Vertex of Head”)
  - (128773, DCM, “Reference Geometry”) = (128120, DCM, “Plane through Superior Extent”)
- Bottom of the feet :
  - (128772, DCM, “Reference Basis”) = (56459004, SCT, “Foot”)
  - (128773, DCM, “Reference Geometry”) = (128121, DCM, “Plane through Inferior Extent”)

Equipment Landmark to Patient Fiducials 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 because the patient moves and changes position during the XA procedure step, and this CONTAINER is included 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.

Figure ZZZZZ.4.5.3-1 illustrates the relationship between these concepts.

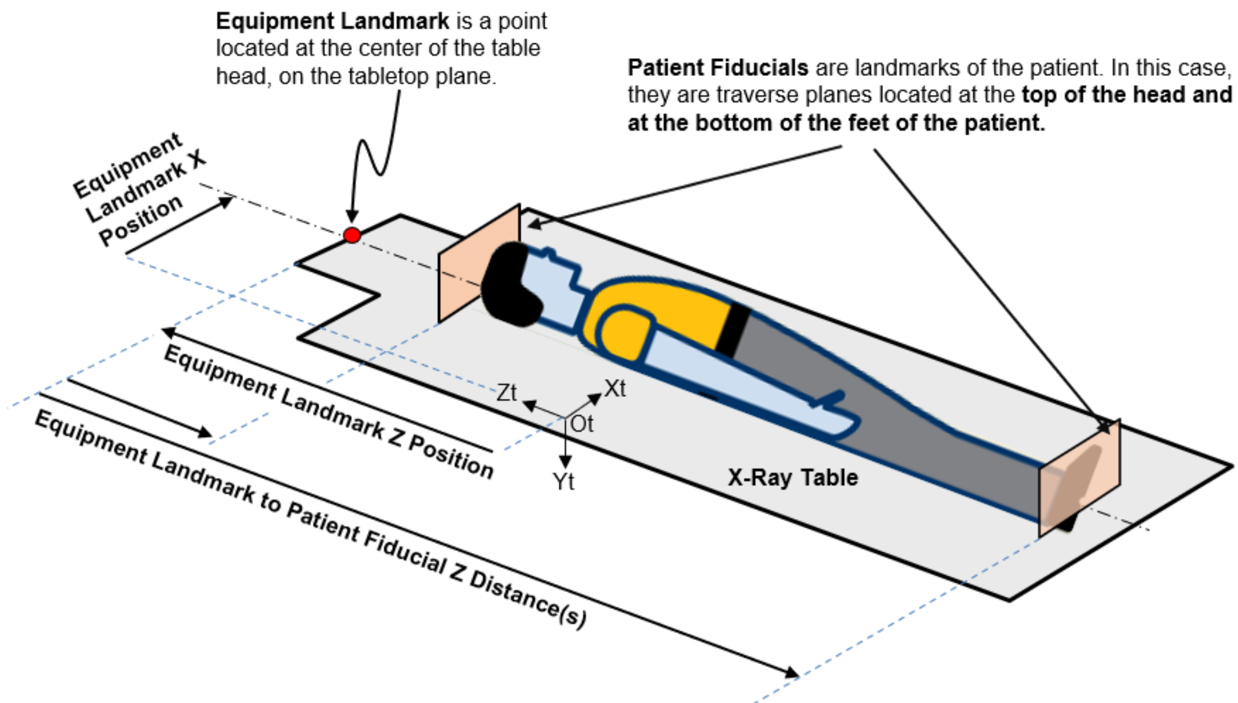

Figure ZZZZZ.4.5.3-1. Relationship Between Equipment Landmark and Patient Fiducials

The Table ZZZZZ.4.5.3-2 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.4.5.3-2. Example of Encoding Patient Position, Equipment Landmark, and Patient Fiducial

	Concept Name	Concept 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")	0.0 mm	TID 10002
>>	(128753, DCM, "Equipment Landmark Z Position")	1200.0 mm	TID 10002
>	(128754, DCM, "Patient Location Fiducial")	<CONTAINER>	TID 10002

	Concept Name	Concept Value	TID
>>	(128772, DCM, “Reference Basis”)	(88986008, SCT, “**Vertex of Head**”)	TID 400
>>	(128773, DCM, “Reference Geometry”)	(128120, DCM, “Plane through Superior Extent”)	TID 400
>>	(128756, DCM, "Equipment Landmark to Patient Fiducial Z Distance")	-150.0 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")	-1900.0 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.4.5.4 Geometry and Radiation Output Encoding in Enhanced RSDR

The Enhanced RDSR provides a complete geometric description of all equipment components, which allows more accurate understanding of dose distribution and potential patient impact in dosimetry analysis.

This geometric description defines one single RDSR Reference Coordinate System (referred to as the **RDSR RCS**) and all equipment components are described in that RCS. A second Reference Coordinate System is defined for the X-Ray Source (referred to as the **Source RCS**), and its origin and orientation are defined with respect to the RDSR RCS.

Some equipment components, such as patient support, which do not move with the X-Ray Source are described using the RDSR RCS. Other equipment components, such as collimators and X-Ray filters, which move with the X-Ray Source are described using the Source RCS.

ZZZZZ.4.5.4.1 Encoding of Reference Coordinate Systems (RCS) in Enhanced RDSR

The **TID 10043** Irradiation Details encodes the RDSR RCS as the RDSR Frame of Reference Origin and the Frame of Reference UID. The origin of this RCS is defined by the equipment manufacturer, and can be either a point fixed in the room, or a point fixed on one of the equipment components that is not directly attached to a moving X-Ray Source, such as the patient support, the Isocenter, or the patient (refer to CID 10074). For example, the origin of the RDSR RCS is not recommended to be the X-Ray Source itself, the X-Ray Filter, or the Output Measurement Point.

There are components of the equipment that are described in the **RDSR RCS**:

1. X-Ray Source RCS. The **TID 10050** X-Ray Source Reference Coordinate System defines the position and orientation of the X-Ray Source RCS with respect to the RDSR RCS with a transformation matrix. Two mechanisms might be used:

   a) Encoding one matrix at each position of the X-Ray Source over the RDSR Scope of Accumulation.
   b) Encoding one matrix at one single position of the X-Ray Source, then encoding the center of rotation, the rotation plane, and the rotation angles of the X-Ray Source through this plane.

   Note: The **TID 10044** Radiation Source Characteristics describes the inherent filtration, focal spot size, anode material, etc. The **TID 10045** Radiation Technique describes the X-Ray techniques applied, such as kVp, pulse width, half value layer, etc.

2. Attenuators that are not directly attached to the X-Ray Source, such as Patient Support, Compression Paddle etc. Their positions are encoded in **TID 10052** Attenuator Position as references to 3D data models along with a transformation matrix between the RCS of these 3D models and the RDSR RCS.

   Note: The **TID 10047** Attenuators includes the **TID 10055** Attenuator Characteristics that describes their characteristics such as material and thickness.

There are other components of the equipment that are described in the **X-Ray Source RCS**:

1. Filters: The **TID 10051** Beam Position defines the position of the attenuators that are attached to the X-Ray Source, such as X-Ray Filters and Contour Filters. They are encoded as references to 3D data models along with a transformation matrix between the RCS of these 3D models and the X-Ray Source RCS.

   Note: X-Ray Filters are described in TID 10046, and their characteristics are described in the Attenuator Characteristics TID 10055

2. Dose Reference Points: The **TID 10051** Beam Position also defines the Reference Point Position and the Output Measurement Point Position. Note that the Reference Point RP Definition is provided in TID 10041 and the iAK at Point RP is provided in TID 10048.

3. Collimator: The **TID 10049** Radiation Field Area defines the position of the collimator, encoded as a shape of 3D points in the X-Ray Source RCS.

Figure ZZZZZ.4.5.4.1-1 provides further details of the system components in the RDSR and the X-Ray Source Coordinate Systems.

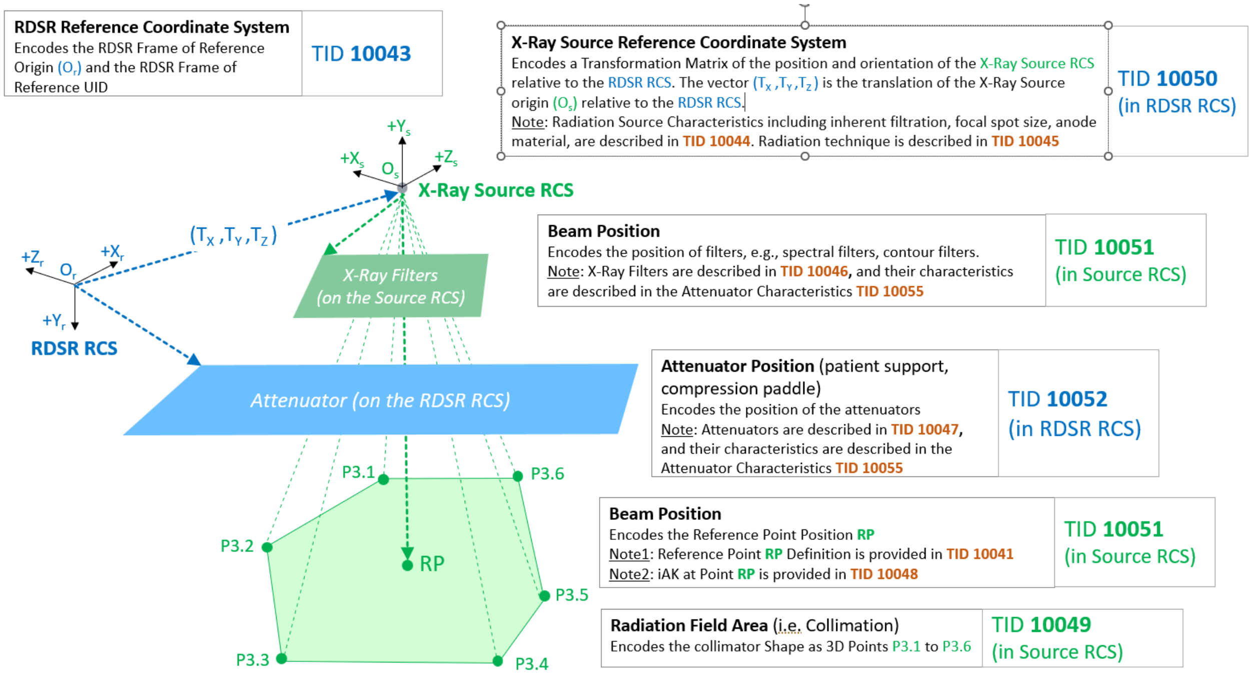

Figure ZZZZZ.4.5.4.1-1. System Components in the RDSR and Source Coordinate Systems

The Enhanced RDSR includes a transformation matrix to relate the Source RCS (which may move) to the RDSR RCS. Equipment components described in the Source RCS are fixed within this coordinate system. When the X-Ray Source moves with respect to the RDSR RCS, the X-Ray Source Transformation Matrix describes the movement of the X-Ray Source components in the RDSR RCS. Figure ZZZZZ.4.5.4.1-2 shows the relationship between the RDSR RCS and the Source RCS.

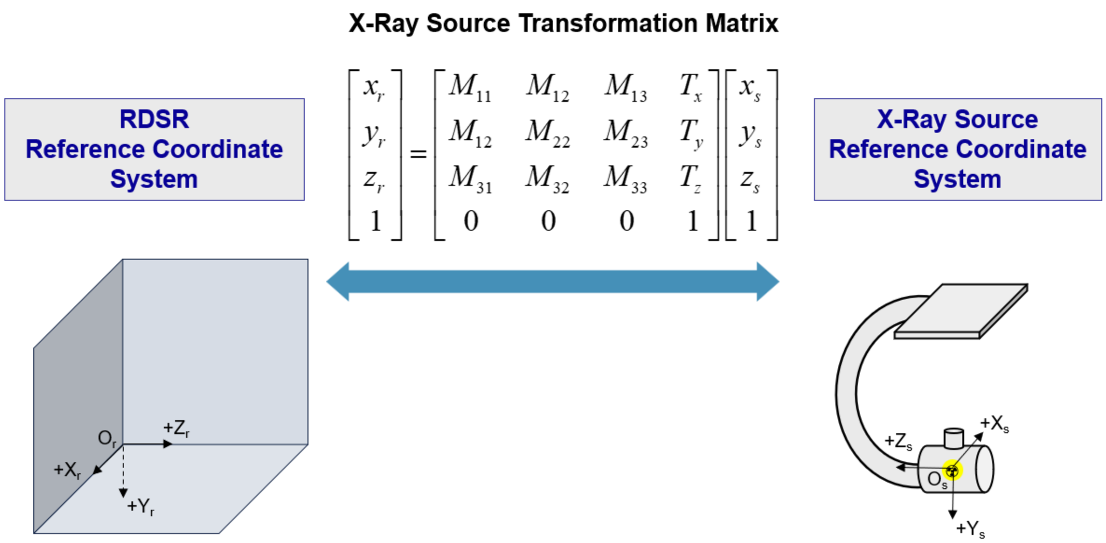

Figure ZZZZZ.4.5.4.1-2. X-Ray Source Transformation Matrix

ZZZZZ.4.5.4.2 Encoding of a Rotating Source in Enhanced RDSR

Rotating source descriptions can be simplified for many irradiations. For sources rotating in a plane (such as for CT and CBCT acquisitions), the encoding of a single transformation matrix for the position and orientation of the X-Ray Source RCS relative to the RDSR RCS, along with the center of rotation, a normal vector for the plane of rotation, and rotation angles at different points in time, is sufficient to calculate subsequent positions and transformation matrices.

This is encoded in TID 10050 X-Ray Source Reference Coordinate System. Figure ZZZZZ.4.5.4.2-1 illustrates the X-Ray Source rotating in a plane.

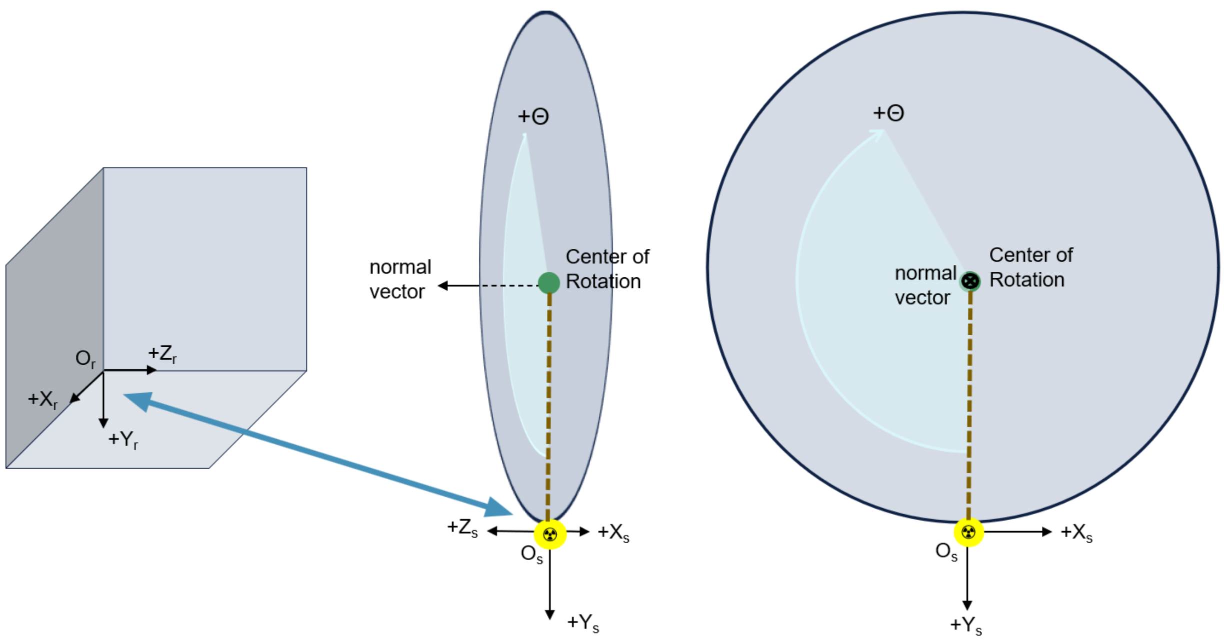

Figure ZZZZZ.4.5.4.2-1. X-Ray Source Rotating in a Plane

ZZZZZ.4.5.4.3 Encoding of Radiation Output vs. Source Position in Enhanced RDSR

The Radiation Output is the accumulated dose over the defined time period of the encoding, which can include several X-Ray exposures.

During the procedure, the equipment typically changes the position of the X-Ray Source and/or the Output Measurement Point independently from the X-Ray exposures. Therefore, in the Enhanced RDSR, the start and end times of the encoding of these positions are not necessarily aligned with the start and end times of the encoding of the Radiation Output values.

The Enhanced RDSR typically has at least one value of Radiation Output for each X-Ray Source Position or Output Measurement Point Position. It is important for RDSR implementors to ensure that one Radiation Output value does not span a period during which these positions change for the same X-Ray source.

If changes of these positions are encoded over a time period where there was no radiation (e.g. change of positioner angles to prepare for a Cone Bean rotation), any value of Radiation Output encoded during that time period will be zero.

This section provides guidance for RDSR encoding of the time periods related to the Radiation Output and the X-Ray Source Position.

Let's consider the following real-world scenario of a given time period between T_A and T_H that includes, for the same X-Ray Source, four different positions (P1 to P4) and four X-Ray exposures. The time of the exposures is not aligned with the time of the positions.

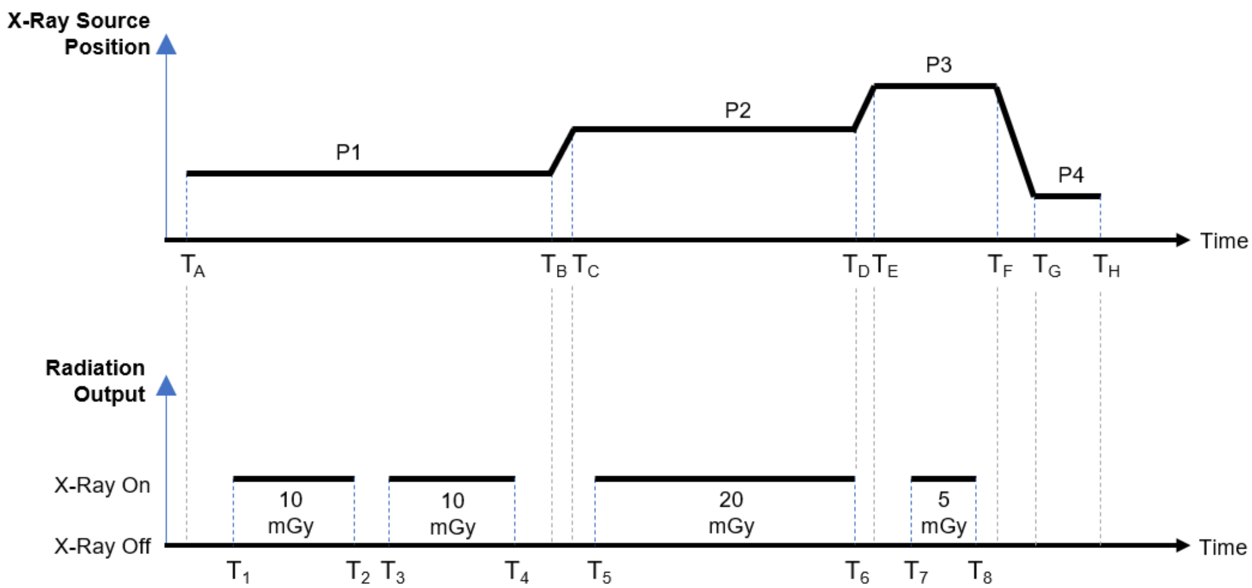

Figure ZZZZZ.4.5.4.3-1. Real-World Scenario of X-Ray Source Position and Radiation Output

The different values of the X-Ray Source position are encoded as several inclusions of the TID 10050. An implementation could decide to encode the time period of the positions when the position does not change within a given range. Table ZZZZZ.4.5.4.3-1 illustrates the encoding of TID 10050 (P1 to P4 representing the X-Ray Source Transformation Matrix).

Table ZZZZZ.4.5.4.3-1. Encoding of TID 10048 X-Ray Source Reference Coordinate System

TID 10050 X-Ray Source Reference Coordinate System CONTAINER *inclusion #1*	
DateTime Started	T_A
DateTime Ended	T_C
Transformation Matrix	P1
TID 10050 X-Ray Source Reference Coordinate System CONTAINER *inclusion #2*	
DateTime Started	T_C

DateTime Ended	T_E
Transformation Matrix	P2
TID 10050 X-Ray Source Reference Coordinate System CONTAINER *inclusion #3*	
DateTime Started	T_E
DateTime Ended	T_G
Transformation Matrix	P3
TID 10050 X-Ray Source Reference Coordinate System CONTAINER *inclusion #4*	
DateTime Started	T_G
DateTime Ended	T_H
Transformation Matrix	P4

The rules for encoding the Radiation Output during a time period depend whether the values are encoded as several inclusions of the TID 10048 or as table entries within one single inclusion of TID 10048.

When the Radiation Output values are encoded as several inclusions of the TID 10048, an implementation could decide to encode one value of the Radiation Output that includes all the exposures within each X-Ray Source position time period. However, the decision of grouping exposures also depends on other parameters such as collimated area.

Table ZZZZZ.4.5.4.3-2. Encoding of Several Inclusions of TID 10048 Radiation Output

TID 10048 Radiation Output CONTAINER *inclusion #1*	
DateTime Started	T_1
DateTime Ended	T_4
Air Kerma at Output Measurement Point	20 mGy
TID 10048 Radiation Output CONTAINER *inclusion #2*	
DateTime Started	T_5
DateTime Ended	T_6
Air Kerma at Output Measurement Point	20 mGy
TID 10048 Radiation Output CONTAINER *inclusion #3*	
DateTime Started	T_7
DateTime Ended	T_8

Air Kerma at Output Measurement Point	5 mGy

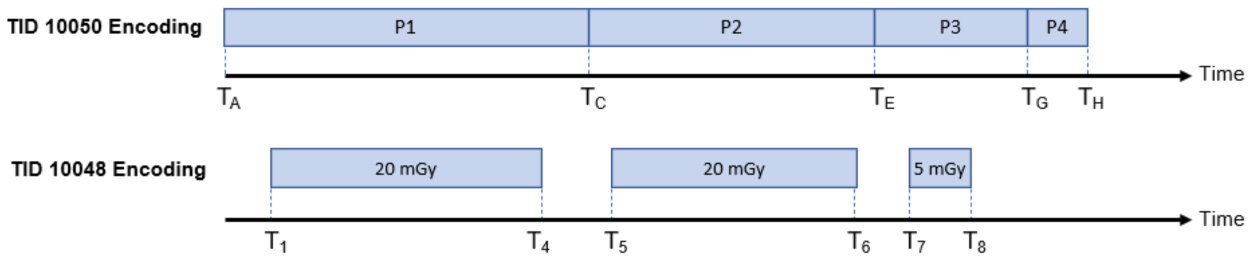

Figure ZZZZZ.4.5.4.3-2. Encoding of Several Inclusions of TID 10048 Radiation Output

When the Radiation Output values are encoded as table entries within one inclusion of the TID 10048, an implementation could decide to encode table entries based on the timing of the exposures, and encoding a zero-dose value for the periods without exposure. However, this implementation should make sure to encode several table entries with zero dose when the X-Ray Source Position changes between exposures, because one Radiation Output value cannot span a period during which this position change.

To avoid such complexity, the recommended implementation is to align the time periods of the table entries of the Radiation Output value with the time periods of the X-Ray Source Position.

Table ZZZZZ.4.5.4.3-3. Encoding of One Inclusion of TID 10048 Radiation Output

<table>
<tr><th colspan="2">TID 10048 Radiation Output CONTAINER inclusion #1</th></tr>
<tr><td>DateTime Started</td><td>T_A</td></tr>
<tr><td>DateTime Ended</td><td>T_H</td></tr>
<tr><td>Identification of the X-Ray Source</td><td>1</td></tr>
<tr><td>Air Kerma at Output Measurement Point</td><td><table><tr><td>T_C</td><td>20 mGy</td></tr><tr><td>T_E</td><td>20 mGy</td></tr><tr><td>T_G</td><td>5 mGy</td></tr><tr><td>T_H</td><td>0 mGy</td></tr></table></td></tr>
</table>

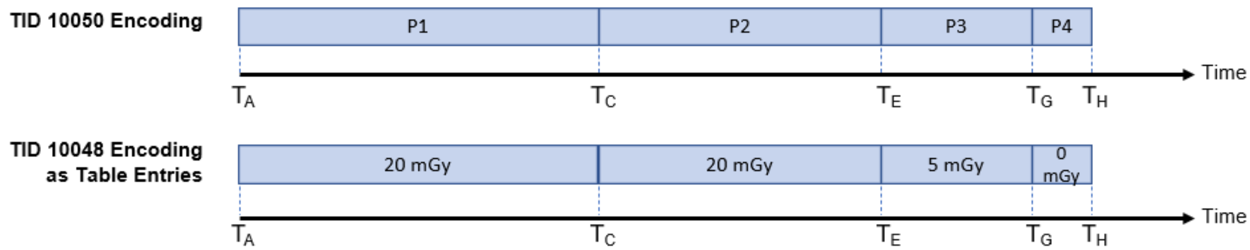

Figure ZZZZZ.4.5.4.3-3. Encoding of One Inclusion of TID 10048 Radiation Output

This encoding of Radiation Output as table entries is well suited for a rotating source (e.g. Cone Beam CT acquisitions). Refer to examples of chapter 5.2 that illustrate the encoding of a rotating source where the Radiation Output values are encoded as table entries of one inclusion of the TID 10048.

ZZZZZ.4.6 Encoding of Irradiation Timing Concepts

When optimizing dose with respect to image quality, RDSR consumers may compare data in the RDSR with data in the image metadata for the same studies, the same procedures, or the same Irradiation Events. However, similar timing information in RDSR Content Items and Image attributes are not necessarily equivalent. RDSR items describe X-Ray irradiation (i.e. tube current flowing), while Image attributes describe acquisition and image formation workflow. Moreover, different technologies and model designs of irradiating equipment may result in different information being captured in the image, e.g. pre-pulses to set up the next acquisition, frame averaging, recursive filtering etc.

As an example, Table ZZZZZ.4.6-1 compares some timing concepts between the image header of one XA image (single or multi-frame) and its corresponding Irradiation Event in the RDSR.

Table ZZZZZ.4.6-1. Comparison of Irradiation Timing Concepts Between XA Images and RDSR

Real World Concept	Traditional RDSR (X-Ray Projection) and Enhanced RDSR	XA Image Metadata (header)
X-Ray acquisition start date and time	(111526, DCM, “Date Time Started”) of the Irradiation Event in TID 10003 and TID 10042.	Acquisition Datetime (0008,002A)
	The date and time 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”).	The date and time that the acquisition of data that resulted in the image instance 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).

<table>
<tr><th>Real World Concept</th><th>Traditional RDSR (X-Ray Projection) and Enhanced RDSR</th><th>XA Image Metadata (header)</th></tr>
<tr><td></td><td colspan="2">It is not necessarily equal between image header and RDSR: typically, the image acquisition starts before the first X-Ray pulse (e.g. triggered by manual activation of an X-Ray switch before the actual X-Ray). On the other hand, when an image acquisition has applied pre-pulses before the first actual frame stored in the multi-frame image, the image acquisition starts after the pre-pulses which are not stored as image frames but they are counted in the RDSR as actual radiation.</td></tr>
<tr><td rowspan="3">Number of X-Ray pulses during the acquisition</td><td>(113768, DCM, “Number of Pulses”) of the Irradiation Event in TID 10003 and TID 10042.</td><td>Number of Frames (0028,0008)</td></tr>
<tr><td>Number of pulses applied by X-Ray systems during an irradiation event (acquisition run or pulsed fluoro).</td><td>The number of resulting 2D images (pixel data).</td></tr>
<tr><td colspan="2">In the image Instance, Number of Frames (0028,0008) typically does not correspond to the actual number of X-Ray pulses. For instance, if frame averaging or recursive filtering, the number of irradiation pulses may be higher than the number of resulting 2D images. Therefore, it is not necessarily equal between image header and RDSR.</td></tr>
<tr><td rowspan="3">X-Ray Duration since first to last X-Ray pulse</td><td>(113742, DCM, “Irradiation Duration”) of the Irradiation Event in TID 10003B.

Not encoded as is in Enhanced RDSR, but it can be calculated from (111526, DCM, “Date Time Started”) and (111527, DCM, “Date Time Ended”) in TID 10042.</td><td>Acquisition Duration (0018,9073)</td></tr>
<tr><td>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.</td><td>Duration of the single continuous gathering of data over a period of time that resulted in this instance, in seconds. Also defined as the time in seconds needed for the complete acquisition.</td></tr>
<tr><td colspan="2">In the image Instance, Acquisition Duration (0018,9073) is not accurately defined, as the trigger to start counting the time is defined by the manufacturer, and could be dictated by the protocol or by a manual activation of an X-Ray switch (pedal press) before the actual X-Ray. Therefore, it is not necessarily equal between image header and RDSR.</td></tr>
</table>

Real World Concept	Traditional RDSR (X-Ray Projection) and Enhanced RDSR	XA Image Metadata (header)
Pulse Width	(113793, DCM, "Pulse Width") of the Irradiation Event in TID 10003B and in TID 10045.	Average Pulse Width (0018,1154).
	Time of X-Ray emission (i.e. tube current flowing) of a single pulse in msec. In TID10003B it can be encoded either as a single value, or as multiple values. If a single value is provided, it contains the average pulse width. If multiple values are provided, it contains the value of the pulse width for each pulse.	Pulse width if the time of X-Ray emission (i.e. tube current flowing) of a single pulse in msec.
	The value of the Average Pulse Width (0018,1154) in the image header is the same as the value of (113793, DCM, "Pulse Width") in Traditional RDSR when encoded as a single value. Otherwise, if RDSR encodes the Pulse Width for each pulse, it will typically be different between image header and RDSR. Note that in Enhanced XA IOD, the attribute Frame Acquisition Duration (0018,9220) is the time that was used to acquire data for one frame, and is not accurately defined. It could be longer than the duration of one pulse in case of frame averaging or recursive filtering.	
Exposure Time	(113824, DCM, "Exposure Time") of the Irradiation Event in TID 10003B and TID 10042.	Exposure Time (0018,9328)
	The total time the patient has received X-Ray exposure (i.e. when the tube current is flowing) during the irradiation event. If the pulse width is provided with a single value, it could be equivalent to the multiplication of (113793, DCM, "Pulse Width") * (113768, DCM, “Number of Pulses”). If the pulse width is provided with one value per pulse, it could be equivalent to the sum of all values of pulse width.	Duration of X-Ray exposure in milliseconds, which is the time of X-Ray emission (i.e. tube current flowing) for the multi-frame image.
	It is equal between image header and RDSR.	
Total Fluoro Time	(113730, DCM, "Total Fluoro Time") in TID 10004 and TID 10041.	There is no equivalent attribute in the image.

Real World Concept	Traditional RDSR (X-Ray Projection) and Enhanced RDSR	XA Image Metadata (header)
	Total accumulated clock time of Fluoroscopy in the scope of the RDSR, defined as the SUM of (113742, DCM, “Irradiation Duration") of all Irradiation Events of type “Fluoroscopy”.	
	If all the fluoroscopy irradiations were stored in DICOM Instances, (113730, DCM, "Total Fluoro Time") would be 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).	
Total Acquisition Time	(113855, DCM, "Total Acquisition Time") in TID 10004 and TID 10041.	There is no equivalent attribute in the image.
	Total accumulated acquisition clock time in the scope of the RDSR, defined as the SUM of (113742, DCM, “Irradiation Duration") of all Irradiation Events of type “Acquisition”.	
	If all the acquisition irradiations were stored in DICOM Instances, (113855, DCM, "Total Acquisition Time") would be 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).	

Figure ZZZZZ.4.6-1 illustrates the concepts described in Table ZZZZZ.4.6-1 by representing one DICOM Irradiation Event with multiple pulses, resulting in a multi-frame DICOM image. The figure represents RDSR Concept Names as well as attributes of the image metadata.

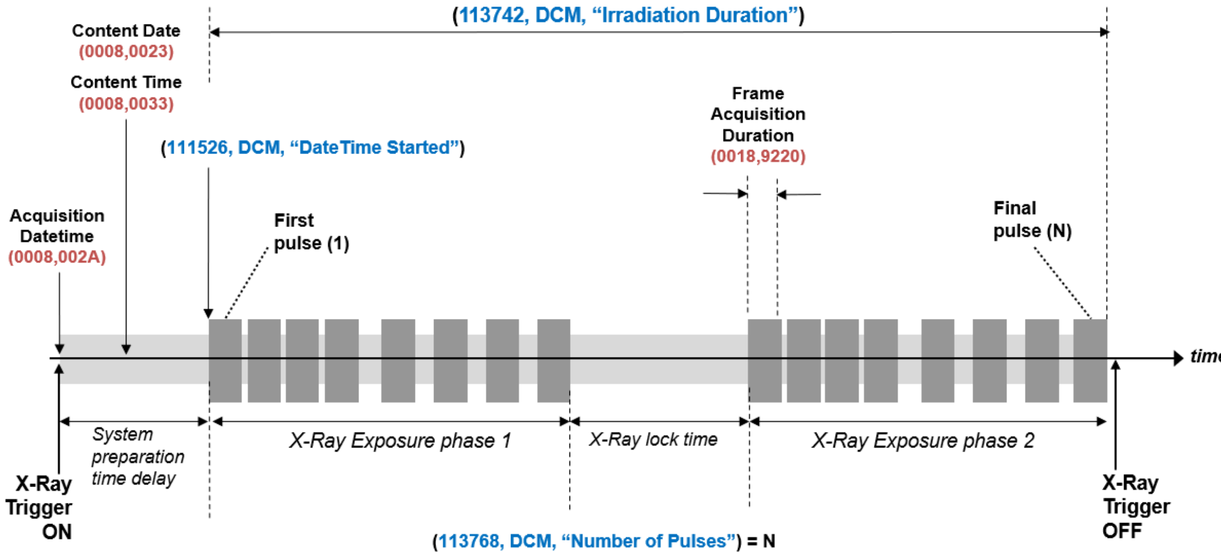

Figure ZZZZZ.4.6-1. Representation of a single DICOM Irradiation Event

ZZZZZ.4.7 Encoding of X-Ray Filters, Collimator, X-Ray Grid, and X-Ray Attenuators

In medical imaging, diverse types of X-Ray attenuators are employed to influence the quality and characteristics of ionizing radiation. These devices play a critical role in optimizing image quality, reducing patient dose, and ensuring diagnostic accuracy. While the physical diversity of attenuators is broad, the DICOM standard classifies them into four distinct categories for consistent encoding and interoperability:

- **X-Ray Filters** modify the energy spectrum of the X-Ray beam. They can be uniform (e.g., spectral filters) or non-uniform (e.g., wedge filters), and help optimize image quality and reduce patient dose.
- **Collimators** are devices that limit the X-Ray beam to the area of interest, reducing unnecessary exposure and enhancing image contrast. They are essential for precise beam shaping.
- **X-Ray Grids** (anti-scatter grids) are placed between the patient and detector to absorb scattered radiation, improving image clarity and contrast.
- **X-Ray Attenuators** include other objects in the beam path, such as patient tables or support devices, which affect radiation attenuation and must be accounted for in imaging and dose calculations.

ZZZZZ.4.7.1 X-Ray Filters and other Attenuation Devices in Traditional RSDR

TID 10003B Irradiation Event X-Ray Source Data encodes the 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 codes for filter types and filter material are defined in **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.

Non-uniform filters are listed in the filter types, but the Concept Items 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.

TID 10003B also encodes concepts to specify the collimation, such as height, width, and area, but it cannot fully describe the profile and geometry of the collimation which typically include multiple blades.

TID 10003B also encodes the X-Ray Grid to indicate if an anti-scatter grid was used by describing the related grid type (see **CID 10017**). A value of “No grid” is available to indicate it was removed or it is not supported by the equipment.

Other X-Ray attenuators such as patient support (e.g. X-Ray Table) are described in **TID10003C** Irradiation Event X-Ray Mechanical Data.

ZZZZZ.4.7.2 X-Ray Filters and other Attenuation Devices in Enhanced RSDR

The X-Ray Filters in Enhanced RDSR are described in **TID 10046** “Filtration” which references the X-Ray Source to which they are applied. Detailed X-Ray Filters characteristics are described in **TID 10055** “Attenuator Characteristics” and it covers the technical description of the filters (e.g. Material, Type and Thickness). Note that TID 10055 is also used to describe any other attenuator such as patient support.

If the 3D position and shape of the X-Ray Filter is known, a 3D model of the filter can be referenced in **TID 10051** “Beam Position”, which includes the Transformation Matrix for the referenced filter 3D model into the Source Coordinate System of the referenced X-Ray Source. If the X-Ray Filter position is unknown and no model can be supplied, the X-Ray Filter is assumed to cover the complete Field of View of the X-Ray beam.

The position of the collimator blades in Enhanced RDSR is encoded as a shape (i.e. POLYGON or ELLIPSE) in **TID 10049** “Radiation Field Area” which references the X-Ray Source to which this collimator is applied. The shape is defined in the Source Coordinate System of the referenced X-Ray Source. When multiple shapes are encoded for the same X-Ray Source, the actual radiation field surface is the intersection of the shapes.

TID 100054 “Procedure Characteristics” encodes the X-Ray Grid to indicate if an anti-scatter grid was used by describing the related grid type (see **CID 10017**). A value of “No grid” is available to indicate it was removed or it is not supported by the equipment.

Other attenuators not defined in the Source Coordinate System are described in **TID 10047** “Attenuators” and their characteristics are described in **TID 10055** “Attenuator Characteristics”. Similarly to the X-Ray Filters, if the 3D position and shape of the attenuator is known, a 3D model of the attenuator can be referenced in **TID 10052** “Attenuator Position”, which includes the 3D model of the Attenuator and the related Transformation Matrix to transform the Attenuator coordinates to the RDSR Reference Coordinate System. If the Attenuator position is unknown and no model can be supplied, the Attenuator is assumed to cover the complete Field of View of the X-Ray beam.

ZZZZZ.4.8 Encoding of Pulse Rate and Number of Pulses in Fluoroscopy and Angiography

Traditional RDSR requires a single pulse rate value in fluoroscopy Irradiation Events if the fluoro mode is provided and equals “Pulsed”. Pulse rate is not supported for acquisition Irradiation Events.

Enhanced RDSR supports pulse rate for both types of Irradiation Events. Multiple values of pulse rate can be provided for a given Irradiation Event when the pulse rate changes during an Irradiation Event.

ZZZZZ.4.8.1 Traditional RDSR

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

Table ZZZZZ.4.8.1-1 shows an example pulsed Fluoroscopy Irradiation Event of 4 seconds at 7.5 pulses per second. In this case the pulse rate and the number of pulses are required.

Table ZZZZZ.4.8.1-1. Example of Pulsed Fluoroscopy Irradiation Event

Code Meaning of Concept Name	Code or Example Value	TID
(113721, DCM, “Irradiation Event Type”)	(44491008, SCT, “**Fluoroscopy**”)	TID 10003
(113732, DCM, “Fluoro Mode”)	(113631, DCM, “**Pulsed**”)	TID 10003B
(113791, DCM, “Pulse Rate”)	***7.5*** pulse/s	TID 10003B
(113768, DCM, “Number of Pulses”)	30	TID 10003B
(113742, DCM, "Irradiation Duration")	4 s	TID 10003B

Since it is not possible to encode several pulse rates in one Fluoroscopy Irradiation Event in the Traditional RDSR, it is recommended to encode an average pulse rate when the pulse rate is variable.

Table ZZZZZ.4.8.1-2 shows an example continuous Fluoroscopy Irradiation Event. In this case the pulse rate and the number of pulses are not relevant.

Table ZZZZZ.4.8.1-2. Example Continuous Fluoroscopy Irradiation Event

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

Table ZZZZZ.4.8.1-3 shows an example stationary Acquisition Irradiation Event of 5 seconds at 30 pulses per second. In this case the number of pulses is required, and fluoro mode and pulse rate are not permitted.

Table ZZZZZ.4.8.1-3. Example Stationary Acquisition Irradiation Event

Code Meaning of Concept Name	Code or Example Value	TID
(113721, DCM, "Irradiation Event Type")	(11361, DCM, “Stationary Acquisition”)	TID 10003

Code Meaning of Concept Name	Code or Example Value	TID
(113768, DCM, "Number of Pulses")	150	TID 10003B
(113742, DCM, "Irradiation Duration")	5 s	TID 10003B

The pulse rate value is not encoded when the Irradiation Event Type is Acquisition. In such case, the average pulse rate can be calculated from the number of pulses (113768, DCM, "Number of Pulses") and the acquisition duration (113742, DCM, “Irradiation Duration”).

ZZZZZ.4.8.2 Enhanced RDSR

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

There are two mechanisms to encode several values of pulse rate:

1. Encode the item (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 (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 (113791, DCM, "Pulse Rate") of Value Type NUM with one value of pulse rate within the time period over which the CONTAINER (130511, DCM, “Radiation Technique”) is applicable. Then repeat the CONTAINER (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).

In both mechanisms 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.4.9 Integrated vs. Non-Integrated Radiography Equipment

The Traditional X-Ray Dose Structured Report (RDSR) is designed to accommodate radiographic imaging systems with varying levels of integration between the X-Ray source, X-Ray detector, and mechanical components. The integration level is specified using the coded concept (122142, DCM, “Acquisition Device Type”), which determines the required sub templates. If this value is not provided, the RDSR includes details for the entire system.

For radiographic equipment, there are two possible values:

- (113958, DCM, Integrated Projection Radiography System)
- (113959, DCM, Cassette-based Projection Radiography System) which should be used for all non-integrated systems, not just those using cassettes

ZZZZZ.4.9.1 Accumulated Dose Information Based on Acquisition Device Type

The Acquisition Device Type (from CID 10032 “Projection X-Ray Acquisition Device Types”) determines which TIDs are required.

Table ZZZZZ.4.9.1-1. Required TIDs by Acquisition Device Type

(122142, DCM, “Acquisition Device Type”)	Required TIDs
Absent	TID 10002 “Accumulated X-Ray Dose” TID 10004 “Accumulated Fluoroscopy and Acquisition Projection X-Ray Dose” TID 10007 “Accumulated Total Projection Radiography Dose”
“Fluoroscopy-Guided Projection Radiography System”	TID 10002 “Accumulated X-Ray Dose” TID 10004 “Accumulated Fluoroscopy and Acquisition Projection X-Ray Dose” TID 10007 “Accumulated Total Projection Radiography Dose”
“Integrated Projection Radiography System”	TID 10002 “Accumulated X-Ray Dose” TID 10007 “Accumulated Total Projection Radiography Dose”
“Cassette-based Projection Radiography System”	TID 10002 “Accumulated X-Ray Dose” TID 10006 “Accumulated Cassette-based Projection Radiography Dose”

ZZZZZ.4.9.2 Irradiation Event Dose Information Based on System Capability

Three flags in **TID 10001 “Projection X-Ray Radiation Dose”** indicate which technical data a system is capable of providing for each Irradiation Event:

Table ZZZZZ.4.9.2-1. Required TIDs by System Capability Flags

TID 10001	Required TIDs
(113945, DCM, “X-Ray Detector Data Available”) = “YES”	TID 10003A “Irradiation Event X-Ray Detector Data”
(113943, DCM, “X-Ray Source Data Available”) = “YES”	TID 10003B “Irradiation Event X-Ray Source Data”
(113944, DCM, “X-Ray Mechanical Data Available”) = “YES”	TID 10003C “Irradiation Event X-Ray Mechanical Data”

Table ZZZZZ.4.9.2-2 shows examples of when the flags should be set to YES or NO, and recommended value for (113876, DCM, "Device Role in Procedure") in Procedure in TID 1004 Device Observer Identifying Attributes (refer to CID 7445 Device Participating Role):

Table ZZZZZ.4.9.2-2. Examples of System Capability Flags

System Capability	X-Ray Detector Data Available	X-Ray Source Data Available	X-Ray Mechanical Data Available	Device Role in Procedure
Exposure index capability (detector) but no generator integration.	YES	NO	any	(113942, DCM, “X-Ray Reading Device”)
Generator integration regardless other capabilities	any	YES	any	(113859, DCM, “Irradiating Device”)
No detector nor generator integration	NO	NO	any	(121097, DCM, “Recording”)

ZZZZZ.4.10 Encoding of Irradiation Event Type

For RDSR consumers it is useful to distinguish between several X-Ray modes applied during the Irradiation Event (e.g. Fluoroscopy or Acquisition). Both Traditional and Enhanced RDSR include a content item that is a basic classification of X-Ray modes used as a condition for the presence of other content items.

The Content Item (113721, DCM, "Irradiation Event Type") in TID 10003 “Irradiation Event X-Ray Data” and in TID 10042 “Irradiation Event Summary Data” is mandatory in both traditional RDSR and enhanced RDSR. It distinguishes between X-Ray modes that distinct types of equipment can apply.

Table ZZZZZ.4.10-1 describes the **CID 10002 “Irradiation Event Types”** and their applicability to the different modalities.

Table ZZZZZ.4.10-1. Applicability of Irradiation Event Type to Different Modalities

Irradiation Event Type	Applicable Modalities
(44491008, SCT, “Fluoroscopy”)	Applicable to X-Ray Angiography and Radio Fluoroscopy modalities
(113611, DCM, “Stationary Acquisition”)	Applicable to any X-Ray modality (including Mammography, Angiography etc.)
(113612, DCM, “Stepping Acquisition”)	Applicable to X-Ray Angiography and Mammo Tomosynthesis (DBT) modalities
(113613, DCM, “Rotational Acquisition”)	Applicable to X-Ray Angiography, Dentistry, CT, Mammo Tomosynthesis (DBT) modalities

In the Traditional RDSR for X-Ray Projection, when the X-Ray source moves angularly on a free trajectory (i.e. not necessarily following a planar rotation around an axis), the Irradiation Event Type should be (113613, DCM, “Rotational Acquisition”), regardless of whether or not the X-Ray source moves laterally in relation to the patient. This satisfies the condition for the presence of the Content Items (113739, DCM, "Positioner Primary End Angle") and (113740, DCM, "Positioner Secondary End Angle") in **TID10003C “Irradiation Event X-Ray Mechanical Data”** that otherwise are prohibited. In the Enhanced RDSR, the position of the X-Ray Source can be encoded at any period of time during the movement, which allows full description of the X-Ray source trajectory.

In the Traditional RDSR for CT the Content Item (113721, DCM, "Irradiation Event Type") is not defined. In the Enhanced RDSR, the Content Item (113721, DCM, "Irradiation Event Type") in **TID 10042 “Irradiation Event Summary Data”** 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 10042 to specify the details of the CT rotation as defined in the **CID 10013 “CT Acquisition Type”** (e.g. spiral, sequenced, constant angle, free, cone beam).

ZZZZZ.4.11 Encoding of User Dose Calibration

The radiation output values provided by the X-Ray irradiating equipment (which are estimated or calculated) can be different from the actual real world radiation output measured by the users. Users such as local medical physicists might perform dose calibration to support reducing this difference and to obtain more accurate dose values.

Encoding of this user dose calibration in RDSR is defined in TID 10002 (Traditional RDSR) and TID 10041 (Enhanced RDSR) and includes a calibration factor which is intended to be multiplied by the radiation output values provided by the X-Ray equipment to obtain the real-world radiation output values.

Dose calibration in RDSR also includes free text describing the calibration protocols, however the definitions of such protocols are outside the scope of the DICOM standard and are not covered in this section.

The radiation output values in the RDSR are exactly as provided by the X-Ray irradiating Equipment, i.e. without the described user calibration being applied. It is the responsibility of the recipients of the RDSR to take this calibration into account as appropriate when interpreting the provided radiation output values.

The interpreter of the RDSR might apply user dose calibration factors to radiation output when performing dose management. Since the relation between the user dose calibration factors in the RDSR and the provided radiation output values can be complex, the user performing the dose calibration is recommended to inform the interpreter of the RDSR of its intended use by specifying the intended dose index and the intended acquisition protocol to which the dose calibration applies. Multiple dose calibrations may be performed under different equipment configurations. It is the responsibility of the RDSR interpreter to properly apply the calibration data based on the calibration date and time, calibration protocols, calibration intentions, etc.

Consider the following use cases:

Use Case 1: No user dose calibration is performed. The CONTAINER (122505, DCM, "Calibration") is not included in the RDSR.

Use Case 2: Local medical physicist creates one calibration factor applicable to all dose indices and all acquisition conditions. The CONTAINER (122505, DCM, "Calibration") is included once with values defined by the user. Making the factor applicable to all dose indices and all acquisition protocols is encoded by leaving the two corresponding Concept Items out of the Container.

Table ZZZZZ.4.11-1. User Dose Calibration Use Case 2 Example Values

Concept Name	Example values
Calibration Factor	1.15
Calibration Uncertainty	10%
Calibration Responsible Party	Hugh Mann
Calibration Protocol	Protocol XXX, based on YYY guideline (2025)
Intended Dose Index for this Calibration	<The Content Item is absent>
Intended Acquisition Protocol for this Calibration	<The Content Item is absent>

If the local medical physicist creates a new calibration factor, it is recommended that only the newest calibration factor is encoded in subsequent RDSR objects. The existing RDSR objects with the prior calibration factor are not affected.

Use Case 3: Local medical physicist creates multiple calibration factors applicable to specific dose indices and/or acquisition protocols. The CONTAINER (122505, DCM, "Calibration") is included multiple times, once for each corresponding dose index and/or acquisition protocol.

Case 3A: Two calibration factors applicable to the Dose Area Product dose index for two different protocols that differ by the imaging technique.

Table ZZZZZ.4.11-2. User Dose Calibration Use Case 3A Example Values

Concept Name	Example values of CONTAINER #1	Example values of CONTAINER #2
Calibration Factor	1.15	1.20
Calibration Uncertainty	10%	12%
Calibration Responsible Party	Hugh Mann	Hugh Mann
Calibration Protocol	Protocol for dental panoramic devices	Protocol for dental CBCT devices
Intended Dose Index for this Calibration	Dose Area Product	Dose Area Product
Intended Acquisition Protocol for this Calibration	Dental Panoramic Acquisition	Cone Beam CT Acquisition

Case 3B: Two calibration factors applicable to the CBCT Acquisition protocol for two different dose indices.

Table ZZZZZ.4.11-3. User Dose Calibration Use Case 3B Example Values

Concept Name	Example of encoded value of CONTAINER #1	Example of encoded value of CONTAINER #2
Calibration Factor	1.11	1.18
Calibration Uncertainty	13%	14%
Calibration Responsible Party	Hugh Mann	Hugh Mann
Calibration Protocol	DAP calibration protocol	CTDI calibration protocol
Intended Dose Index for this Calibration	Dose Area Product	CTDIvol
Intended Acquisition Protocol for this Calibration	CBCT Acquisition	CBCT Acquisition

Case 3C: Two calibration factors applicable to all dose indices for two different protocols that differ by the X-Ray geometries.

Table ZZZZZ.4.11-4. User Dose Calibration Use Case 3C Example Values

Concept Name	Example of encoded value of CONTAINER #1	Example of encoded value of CONTAINER #2
Calibration Factor	1.16	1.22
Calibration Uncertainty	5%	6%
Calibration Responsible Party	Hugh Mann	Hugh Mann
Calibration Protocol	Dose calibration for endodontics scan	Dose calibration for full head scan
Intended Dose Index for this Calibration	<The Content Item is absent>	<The Content Item is absent>
Intended Acquisition Protocol for this Calibration	W40xH40 CBCT	W200xH200 CBCT

The user should not create an RDSR where more than one inclusions of the CONTAINER (122505, DCM, "Calibration") would apply to a given Dose Index and Acquisition Protocol, since that would result in two different calibration factors to be applied making it unclear what the correct factor is.

ZZZZZ.5 RADIATION DOSE STRUCTURED REPORT EXAMPLES

This section contains examples of encoding of Radiation Dose Structured Report.

In these examples, the following convention is used to describe the content items and values:

- Each Content Item is described by the Code Meaning of the Concept Name
- TID number in which the Content Item is defined appears in the right column
- If the value of the Content Item is a code, the example shows the code triplet
- If the value of the Content Item is a number, the example shows the unit with its Code Meaning
- Spanning rows that provide context in the examples are not encoded in the RDSR

Note that other alternative implementation patterns exist for these examples; The normative text in PS3.16 is constraining, these examples are not.

ZZZZZ.5.1 Examples of Traditional RDSR

ZZZZZ.5.1.1 Example of Traditional RDSR for XA

The following is an example RDSR for a routine XA procedure step combining diagnostic and interventional treatment. 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.
- The top of the patient head is located at 25 cm from the table head in the direction of the table foot.
- One focused anti-scatter grid is fixed on the detector housing.
- One pulsed fluoroscopy Irradiation Event lasting 10 seconds, with no XA image recorded.
- One rotational acquisition (CBCT) Irradiation Event, rotating at 10 degrees per second and acquiring 30 frames per second over an arc of 200 degrees. An XA image is recorded.
- A dose map image is created at the end of the procedure step.
- The irradiation is administered by the performing physician Dr. Hugh Mann and by the operator John Doe.
- The irradiation is authorized by the performing physician Dr. Hugh Mann.

Table ZZZZZ.5.1.1-1 illustrates one possible encoding of this example. Note that other alternative implementation patterns exist.

Table ZZZZZ.5.1.1-1. XA Traditional RDSR Example

Node	Code Meaning of Concept Name	Code or Example Value	TID
1	X-Ray Radiation Dose Report	<CONTAINER>	Section TID 10001
1.1	Language of Content Item and Descendants	(en, RFC5646, “English”)	Section TID 1204
1.2	Procedure reported	(113704, DCM, "Projection X-Ray")	Section TID 10001
1.2.1	Has Intent	(1279505009, SCT, "Combined Diagnostic and Therapeutic Intent")	Section TID 10001
1.3	Acquisition Device Type	(113957, DCM, “Fluoroscopy-Guided Projection Radiography System”)	Section TID 10001
Start Observer Context			
Observer #1: Irradiating device			

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.4	Observer Type	(121007, DCM, “Device”)	Section TID 1002
1.5	Device Observer UID	2.999.1	Section TID 1004
1.6	Device Observer Name	MyStationName	Section TID 1004
1.7	Device Observer Manufacturer	Manufacturer X	Section TID 1004
1.8	Device Observer Model Name	Model Y	Section TID 1004
1.9	Device Observer Serial Number	SerialNumber123	Section TID 1004
1.10	Device Role in Procedure	(113859, DCM, “Irradiating Device”)	Section TID 1004
<End Observer Context>			
1.11	Scope of Accumulation	(113016, DCM, "Performed Procedure Step")	Section TID 10001
1.12	Performed Procedure Step SOP Instance UID	2.999.2	Section TID 10001
1.13	X-Ray Detector Data Available	(373066001, SCT, “Yes”)	Section TID 10001
1.14	X-Ray Source Data Available	(373066001, SCT, “Yes”)	Section TID 10001
1.15	X-Ray Mechanical Data Available	(373066001, SCT, “Yes”)	Section TID 10001
1.16	Accumulated X-Ray Dose Data	<CONTAINER>	Section TID 10002
1.16.1	Acquisition Plane	(113622, DCM, "Single Plane")	Section TID 10002
1.16.2	Fluoro Dose Area Product Total	0.00000350 Gy.m2	Section TID 10004
1.16.3	Fluoro Dose (RP) Total	0.00007700 Gy	Section TID 10004
1.16.4	Total Fluoro Time	10 s	Section TID 10004
1.16.5	Acquisition Dose Area Product Total	0.00003000 Gy.m2	Section TID 10004
1.16.6	Acquisition Dose (RP) Total	0.00081700 Gy	Section TID 10004
1.16.7	Total Acquisition Time	30 s	Section TID 10004
1.16.8	Dose Area Product Total	0.00003410 Gy.m2	Section TID 10007
1.16.9	Dose (RP) Total	0.00089400 Gy	Section TID 10007
1.16.10	Distance Source to Reference Point	570.00 mm	Section TID 10007
1.16.11	Total Number of Radiographic Frames	600 no units	Section TID 10007
1.16.12	Reference Point Definition	(113860, DCM, “15cm from Isocenter toward Source”)	Section TID 10007
1.16.13	Equipment Landmark	(128751, DCM, "Center of Table Head")	Section TID 10002
1.16.13.1	Equipment Landmark X Position	50.00 mm	Section TID 10002
1.16.13.2	Equipment Landmark Z Position	400.00 mm	Section TID 10002
1.16.14	Patient Location Fiducial"	<CONTAINER>	Section TID 10002
1.16.14.1	Reference Basis	(88986008, SCT, “Vertex of Head”)	Section TID 400
1.16.14.2	Reference Geometry	(128120, DCM, “Plane through Superior Extent”)	Section TID 400
1.16.14.3	Equipment Landmark to Patient Fiducial Z Distance	-250.00 mm	Section TID 10002

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.17	Irradiation Event X-Ray Data	<CONTAINER>	Section TID 10003
1.17.1	Acquisition Plane	(113622, DCM, "Single Plane")	Section TID 10003
1.17.2	Irradiation Event UID	2.999.3	Section TID 10003
1.17.3	DateTime Started	20231020125921.000	Section TID 10003
1.17.4	Irradiation Event Type	(44491008, SCT, “Fluoroscopy”)	Section TID 10003
1.17.5	Acquisition Protocol	Cardiac and Vascular FLUORO	Section TID 10003
1.17.6	Patient Table Relationship	(102540008, SCT, “headfirst”)	Section TID 10003
1.17.7	Patient Orientation	(102538003, SCT, “recumbent”)	Section TID 10003
1.17.7.1	Patient Orientation Modifier	(40199007, SCT, “supine”)	Section TID 10003
1.17.8	Target Region	(80891009, SCT, ”Heart”)	Section TID 10003
1.17.9	Dose Area Product	0.00000310 Gy.m2	Section TID 10003
1.17.10	Patient Equivalent Thickness	300.0 mm	Section TID 10003
1.17.11	Comment	Fluoro Loop	Section TID 10003
Start Person Participant within Section TID 10003: Irradiation Administering are the performing physician and the operator.			
1.17.12	Person Name	Mann^Hugh^^Dr	Section TID 1020
1.17.12.1	Person Role in Procedure	(113851, DCM, “Irradiation Administering”)	Section TID 1020
1.17.12.2	Person Role in Organization	(309343006, SCT, “Physician”)	Section TID 1020
1.17.13	Person Name	Doe^John	Section TID 1020
1.17.13.1	Person Role in Procedure	(113851, DCM, “Irradiation Administering”)	Section TID 1020
1.17.13.2	Person Role in Organization	(159016003, SCT, “Radiologic Technologist”)	Section TID 1020
End Person Participant			
Irradiation Event X-Ray Source Data TID 10003B			
1.17.14	Dose (RP)	0.00007700 Gy	Section TID 10003B
1.17.15	Reference Point Definition	(113860, DCM, “15cm from Isocenter toward Source”)	Section TID 10003B
1.17.16	Fluoro Mode	(113631, DCM, “Pulsed”)	Section TID 10003B
1.17.17	Pulse Rate	15 pulse/s	Section TID 10003B
1.17.18	Number of Pulses	150 no units	Section TID 10003B
1.17.19	Pulse Width	2.01 ms	Section TID 10003B
1.17.20	Irradiation Duration	10.000 s	Section TID 10003B
1.17.21	KVP	71 kV	Section TID 10003B
1.17.22	X-Ray Tube Current	12 mA	Section TID 10003B
1.17.23	Average X-Ray Tube Current	12 mA	Section TID 10003B
1.17.24	Exposure Time	20 ms	Section TID 10003B
1.17.25	Exposure	250 uA.s	Section TID 10003B

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.17.26	Focal Spot Size	0.6 mm	Section TID 10003B
1.17.27	Anode Target Material	(26194003, SCT, ”Tungsten”)	Section TID 10003B
1.17.28	X-Ray Filters	<CONTAINER>	Section TID 10003B
1.17.28.1	X-Ray Filter Type	(113653, DCM, “Flat filter”)	Section TID 10003B
1.17.28.2	X-Ray Filter Material	(66925006, SCT, “Copper”)	Section TID 10003B
1.17.28.3	X-Ray Filter Thickness Minimum	0.300000 mm	Section TID 10003B
1.17.28.4	X-Ray Filter Thickness Maximum	0.300000 mm	Section TID 10003B
1.17.29	X-Ray Filters	<CONTAINER>	Section TID 10003B
1.17.29.1	X-Ray Filter Type	(113651, DCM, “Wedge filter”)	Section TID 10003B
1.17.29.2	X-Ray Filter Material	(66925006, SCT, “Copper”)	Section TID 10003B
1.17.29.3	X-Ray Filter Thickness Minimum	1.000000 mm	Section TID 10003B
1.17.29.4	X-Ray Filter Thickness Maximum	2.000000 mm	Section TID 10003B
1.17.30	Collimated Field Area	0.010781 m^2	Section TID 10003B
1.17.31	Collimated Field Height	129 mm	Section TID 10003B
1.17.32	Collimated Field Width	83 mm	Section TID 10003B
1.17.33	X-Ray Grid	(111641, DCM, “Fixed grid”)	Section TID 10003B
1.17.34	X-Ray Grid	(111642, DCM, “Focused grid”)	Section TID 10003B
Irradiation Event X-Ray Mechanical Data TID 10003C			
1.17.35	Positioner Primary Angle	23.70 deg	Section TID 10003C
1.17.36	Positioner Secondary Angle	10.30 deg	Section TID 10003C
1.17.37	Table Head Tilt Angle	0.0 deg	Section TID 10003C
1.17.38	Table Horizontal Rotation Angle	0.0 deg	Section TID 10003C
1.17.39	Table Cradle Tilt Angle	0.0 deg	Section TID 10003C
Start CID 10008 Dose Related Distance Measurement			
1.17.40	Distance Source to Isocenter	720 mm	Section TID 10003C
1.17.41	Distance Source to Reference Point	570.00 mm	Section TID 10003C
1.17.42	Distance Source to Detector	1195 mm	Section TID 10003C
1.17.43	Table Longitudinal Position	727.90 mm	Section TID 10003C
1.17.44	Table Lateral Position	50.90 mm	Section TID 10003C
1.17.45	Table Height Position	87.5 mm	Section TID 10003C
1.17.46	Table X Position to Isocenter	727.90 mm	Section TID 10003C
1.17.47	Table Y Position to Isocenter	87.5 mm	Section TID 10003C
1.17.48	Table Z Position to Isocenter	50.90 mm	Section TID 10003C
End CID 10008 Dose Related Distance Measurement			
1.17.49	Positioner Isocenter Primary Angle	23.70 deg	Section TID 10003C
1.17.50	Positioner Isocenter Secondary Angle	10.30 deg	Section TID 10003C
1.17.51	Positioner Isocenter Detector Rotation Angle	0.0 deg	Section TID 10003C

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.18	Irradiation Event X-Ray Data	<CONTAINER>	Section TID 10003
1.18.1	Acquisition Plane	(113622, DCM, "Single Plane")	Section TID 10003
1.18.2	Irradiation Event UID	2.999.4	Section TID 10003
1.18.3	DateTime Started	20231020130412.000	Section TID 10003
1.18.4	Irradiation Event Type	(113613, DCM, “Rotational Acquisition”)	Section TID 10003
1.18.5	Acquisition Protocol	Cardiac and Vascular FLUORO	Section TID 10003
1.18.6	Patient Table Relationship	(102540008, SCT, “headfirst”)	Section TID 10003
1.18.7	Patient Orientation	(102538003, SCT, “recumbent”)	Section TID 10003
1.18.7.1	Patient Orientation Modifier	(40199007, SCT, “supine”)	Section TID 10003
1.18.8	Target Region	(80891009, SCT, ”Heart”)	Section TID 10003
1.18.9	Dose Area Product	0.00003100 Gy.m2	Section TID 10003
1.18.10	Patient Equivalent Thickness	300.0 mm	Section TID 10003
1.18.11	Comment	Rotational CBCT	Section TID 10003
Start Person Participant within TID 10003			
Person #1: Performing physician			
1.18.12	Person Name	Mann^Hugh^^Dr	Section TID 1020
1.18.12.1	Person Role in Procedure	(113851, DCM, “Irradiation Administering”)	Section TID 1020
1.18.12.2	Person Role in Organization	(309343006, SCT, “Physician”)	Section TID 1020
Person #2: Operator			
1.18.13	Person Name	Doe^John	Section TID 1020
1.18.13.1	Person Role in Procedure	(113851, DCM, “Irradiation Administering”)	Section TID 1020
1.18.13.2	Person Role in Organization	(159016003, SCT, “Radiologic Technologist”)	Section TID 1020
End Person Participant			
Irradiation Event X-Ray Detector Data TID 10003A			
1.18.14	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 10003A
Irradiation Event X-Ray Source Data TID 10003B			
1.18.15	Dose (RP)	0.00081700 Gy	Section TID 10003B
1.18.16	Reference Point Definition	(113860, DCM, “15cm from Isocenter toward Source”)	Section TID 10003B
1.18.17	Number of Pulses	600 no units	Section TID 10003B
1.18.18	Pulse Width	5.00 ms	Section TID 10003B
1.18.19	Irradiation Duration	20.000 s	Section TID 10003B
1.18.20	KVP	75 kV	Section TID 10003B
1.18.21	X-Ray Tube Current	20 mA	Section TID 10003B

Node	**Code Meaning of Concept Name**	**Code or Example Value**	**TID**
1.18.22	Average X-Ray Tube Current	20 mA	Section TID 10003B
1.18.23	Exposure Time	3000 ms	Section TID 10003B
1.18.24	Exposure	940 uA.s	Section TID 10003B
1.18.25	Focal Spot Size	0.6 mm	Section TID 10003B
1.18.26	Anode Target Material	(26194003, SCT, ”Tungsten”)	Section TID 10003B
1.18.27	X-Ray Filters	<CONTAINER>	Section TID 10003B
1.18.27.1	X-Ray Filter Type	(113653, DCM, “Flat filter”)	Section TID 10003B
1.18.27.2	X-Ray Filter Material	(66925006, SCT, “Copper”)	Section TID 10003B
1.18.27.3	X-Ray Filter Thickness Minimum	0.300000 mm	Section TID 10003B
1.18.27.4	X-Ray Filter Thickness Maximum	0.300000 mm	Section TID 10003B
1.18.28	Collimated Field Area	0.010781 m2	Section TID 10003B
1.18.29	Collimated Field Height	129 mm	Section TID 10003B
1.18.30	Collimated Field Width	83 mm	Section TID 10003B
1.18.31	X-Ray Grid	(111641, DCM, “Fixed grid”)	Section TID 10003B
1.18.32	X-Ray Grid	(111642, DCM, “Focused grid”)	Section TID 10003B
Irradiation Event X-Ray Mechanical Data TID 10003C			
1.18.33	Positioner Primary Angle	-100.00 deg	Section TID 10003C
1.18.34	Positioner Secondary Angle	0.0 deg	Section TID 10003C
1.18.35	Positioner Primary End Angle	100.00 deg	Section TID 10003C
1.18.36	Positioner Secondary End Angle	0.0 deg	Section TID 10003C
1.18.37	Table Head Tilt Angle	0.0 deg	Section TID 10003C
1.18.38	Table Horizontal Rotation Angle	0.0 deg	Section TID 10003C
1.18.39	Table Cradle Tilt Angle	0.0 deg	Section TID 10003C
Start CID 10008 Dose Related Distance Measurement			
1.18.40	Distance Source to Isocenter	720 mm	Section TID 10003C
1.18.41	Distance Source to Reference Point	570.00 mm	Section TID 10003C
1.18.42	Distance Source to Detector	1195 mm	Section TID 10003C
1.18.43	Table Longitudinal Position	727.90 mm	Section TID 10003C
1.18.44	Table Lateral Position	50.90 mm	Section TID 10003C
1.18.45	Table Height Position	87.5 mm	Section TID 10003C
1.18.46	Table X Position to Isocenter	727.90 mm	Section TID 10003C
1.18.47	Table Y Position to Isocenter	87.5 mm	Section TID 10003C
1.18.48	Table Z Position to Isocenter	50.90 mm	Section TID 10003C
End CID 10008 Dose Related Distance Measurement			
1.18.49	Positioner Isocenter Primary Angle	-100.0 deg	Section TID 10003C
1.18.50	Positioner Isocenter Secondary Angle	0.0 deg	Section TID 10003C
1.18.51	Positioner Isocenter Detector Rotation Angle	0.0 deg	Section TID 10003C

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.18.52	Positioner Isocenter Primary End Angle	100.00 deg	Section TID 10003C
1.18.53	Positioner Isocenter Secondary End Angle	0.00 deg	Section TID 10003C
1.18.54	Positioner Isocenter Detector Rotation End Angle	0.0 deg	Section TID 10003C
1.19	Dose Image	SOP Class UID: 1.2.840.10008.5.1.4.1.1.7 SOP Instance UID: 2.999.6	Section TID 10001
Start Person Participant within TID 10001: Irradiation Authorizing is the performing physician.			
1.20	Person Name	Mann^Hugh^^Dr	Section TID 1020
1.20.1	Person Role in Procedure	(113850, DCM, “Irradiation Authorizing”)	Section TID 1020
1.20.2	Person ID	5321611	Section TID 1020
1.20.3	Person ID Issuer	Institution A	Section TID 1020
1.20.4	Person Role in Organization	(309343006, SCT, “Physician”)	Section TID 1020
End Person Participant			
1.21	Source of Dose Information	(113856, DCM, “Automated Data Collection”)	Section TID 10001

ZZZZZ.5.1.2 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.

In this example,

- The irradiation is authorized by the referring physician who ordered the CT scan, Dr. Marcus Welby.
- The irradiation is administered by the technologist, John Doe.
- The dose check alert was configured for CTDIvol of 1 Gy, and the dose notification was configured for CTDIvol of 45 mGy. Neither the alert nor the notification was triggered during this study.

Table ZZZZZ.5.1.2-1 illustrates one possible encoding of this example. Note that other alternative implementation patterns exist.

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, RFC5646, “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			

Node	Code Meaning of Concept Name	Code or Example Value	TID
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
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
End Observer Context			
1.11	Start of X-Ray Irradiation	20230725120000.000	Section TID 10011
1.12	End of X-Ray Irradiation	20230725120300.000	Section TID 10011
1.13	Scope of Accumulation	(113014, DCM, "Study")	Section TID 10011
1.13.1	Study Instance UID	2.999.2.3.4.5	Section TID 10011
1.14	CT Accumulated Dose Data	<CONTAINER>	Section TID 10012
1.14.1	Total Number of Irradiation Events	2 events	Section TID 10012
1.14.2	CT Dose Length Product Total	220 mGy.cm	Section TID 10012
Start first Irradiation Event			
1.15	CT Acquisition	<CONTAINER>	Section TID 10013
1.15.1	Acquisition Protocol	CT Abdomen W contrast IV	Section TID 10013
1.15.2	Target Region	(818981001, SCT, "Abdomen")	Section TID 10013
1.15.3	CT Acquisition Type	(113805, DCM, "Constant Angle Acquisition")	Section TID 10013
1.15.4	Irradiation Event UID	2.999.3.4.5.6	Section TID 10013
1.15.5	DateTime Started	20230725120000.000	Section TID 10013
1.15.6	CT Acquisition Parameters	<CONTAINER>	Section TID 10013
1.15.6.1	Exposure Time	3.00 s	Section TID 10013
1.15.6.2	Scanning Length	250 mm	Section TID 10014
1.15.6.3	Top Z Location of Scanning Length	0.00 mm	Section TID 10014
1.15.6.4	Bottom Z Location of Scanning Length	-250.00 mm	Section TID 10014
1.15.6.5	Frame of Reference UID	2.999.4.5.6.7	Section TID 10014
1.15.6.6	Nominal Single Collimation Width	0.625 mm	Section TID 10013
1.15.6.7	Nominal Total Collimation Width	5.0 mm	Section TID 10013
1.15.6.8	Number of X-Ray Sources	1 X-Ray sources	Section TID 10013
1.15.6.9	CT X-Ray Source Parameters	<CONTAINER>	Section TID 10013
1.15.6.9.1	Identification of the X-Ray Source	1	Section TID 10013
1.15.6.9.2	KVP	120.0 kV	Section TID 10013

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.15.6.9.3	Maximum X-Ray Tube Current	40 mA	Section TID 10013
1.15.6.9.4	X-Ray Tube Current	40 mA	Section TID 10013
1.15.7	Comment	Localizer	Section TID 10013
Start Person Participant within TID 10013			
1.15.8	Person Name	Doe^John	Section TID 1020
1.15.8.1	Person Role in Procedure	(113851, DCM, “Irradiation Administering”)	Section TID 1020
1.15.8.2	Person Role in Organization	(159016003, SCT, “Radiologic Technologist”)	Section TID 1020
End Person Participant			
End first Irradiation Event			
Start second Irradiation Event			
1.16	CT Acquisition	<CONTAINER>	Section TID 10013
1.16.1	Acquisition Protocol	CT Abdomen W contrast IV	Section TID 10013
1.16.2	Target Region	(818981001, SCT, "Abdomen")	Section TID 10013
1.16.3	CT Acquisition Type	(116152004, SCT, "Spiral Acquisition")	Section TID 10013
1.16.4	Irradiation Event UID	2.999.5.6.7.8	Section TID 10013
1.16.5	DateTime Started	20230725120258.000	Section TID 10013
1.16.6	CT Acquisition Parameters	<CONTAINER>	Section TID 10013
1.16.6.1	Exposure Time	2.00 s	Section TID 10013
Start Scanning Length TID 10014			
1.16.6.2	Scanning Length	220 mm	Section TID 10014
1.16.6.3	Length of Reconstructable Volume	200 mm	Section TID 10014
1.16.6.4	Exposed Range	260 mm	Section TID 10014
1.16.6.5	Top Z Location of Reconstructable Volume	-25.00 mm	Section TID 10014
1.16.6.6	Bottom Z Location of Reconstructable Volume	-225.00 mm	Section TID 10014
1.16.6.7	Top Z Location of Scanning Length	-15.00 mm	Section TID 10014
1.16.6.8	Bottom Z Location of Scanning Length	-235.00 mm	Section TID 10014
1.16.6.9	Frame of Reference UID	2.999.6.7.8.9	Section TID 10014
End Scanning Length			
1.16.6.10	Nominal Single Collimation Width	0.625 mm	Section TID 10013
1.16.6.11	Nominal Total Collimation Width	40.0 mm	Section TID 10013
1.16.6.12	Pitch Factor	1.375	Section TID 10013
1.16.6.13	Number of X-Ray Sources	1 X-Ray sources	Section TID 10013
1.16.6.14	CT X-Ray Source Parameters	<CONTAINER>	Section TID 10013
1.16.6.14.1	Identification of the X-Ray Source	1	Section TID 10013
1.16.6.14.2	KVP	120.0 kV	Section TID 10013

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.16.6.14.3	Maximum X-Ray Tube Current	500 mA	Section TID 10013
1.16.6.14.4	X-Ray Tube Current	394 mA	Section TID 10013
1.16.6.14.5	Exposure Time per Rotation	0.5 s	Section TID 10013
1.16.7	CT Dose	<CONTAINER>	Section TID 10013
1.16.7.1	Mean CTDIvol	10.00 mGy	Section TID 10013
1.16.7.2	CTDIw Phantom Type	(113691, DCM, "IEC Body Dosimetry Phantom")	Section TID 10013
1.16.7.3	CTDIfreeair Calculation Factor	0.25 mGy/mA.s	Section TID 10013
1.16.7.4	Mean CTDIfreeair	49.25 mGy	Section TID 10013
1.16.7.5	DLP	220.00 mGy.cm	Section TID 10013
1.16.7.6	Size Specific Dose Estimate	12.30 mGy	Section TID 10013
1.16.7.6.1	Measurement Method	(113988, DCM, "Estimated from Water Equivalent Diameter")	Section TID 10013
1.16.7.6.2	Water Equivalent Diameter	300 mm	Section TID 10013
1.16.7.6.2.1	Measurement Method	(113984, DCM, "Water Equivalent Diameter From Localizer")	Section TID 10013
Start CT Dose Check Details TID 10015			
1.16.7.4	Dose Check Alert Details	<CONTAINER>	Section TID 10015
1.16.7.4.1	DLP Alert Value Configured	(373067005, SCT, "No")	Section TID 10015
1.16.7.4.2	CTDIvol Alert Value Configured	(373066001, SCT, "Yes")	Section TID 10015
1.16.7.4.3	CTDIvol Alert Value	1000.0 mGy	Section TID 10015
1.16.7.5	Dose Check Notification Details	<CONTAINER>	Section TID 10015
1.16.7.5.1	DLP Notification Value Configured	(373067005, SCT, "No")	Section TID 10015
1.16.7.5.2	CTDIvol Notification Value Configured	(373066001, SCT, "Yes")	Section TID 10015
1.16.7.5.3	CTDIvol Notification Value	45.00 mGy	Section TID 10015
End CT Dose Check Details			
Start Person Participant within TID 10013			
1.16.8	Person Name	Doe^John	Section TID 1020
1.16.8.1	Person Role in Procedure	(113851, DCM, "Irradiation Administering")	Section TID 1020
1.16.8.2	Person Role in Organization	(159016003, SCT, "Radiologic Technologist")	Section TID 1020
End Person Participant			
End Second Irradiation Event			
1.17	Source of Dose Information	(113856, DCM, "Automated Data Collection")	Section TID 10011
Start Person Participant within TID 10011			
1.18	Person Name	Welby^Marcus^^Dr	Section TID 1020
1.18.1	Person Role in Procedure	(113850, DCM, "Irradiation Authorizing")	Section TID 1020

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.18.2	Person Role in Organization	(309343006, SCT, “Physician”)	Section TID 1020
End Person Participant			

ZZZZZ.5.1.2.1 Example of Traditional RDSR for CT with Notification Event

The following is an example RDSR for a routine CT study where the CTDIvol dose notification value is triggered (see NEMA XR 25). This example is largely identical to the example in ZZZZZ.5.1.2. except for exceeding the notification value due to a change in scanning parameters.

In this example,

- The dose check alert was configured for CTDIvol of 1 Gy, and the dose check notification was configured for CTDIvol of 20 mGy (lower than the previous example).
- The X-Ray Tube Current and Exposure Time per Rotation are both increased from the previous example, resulting in a proportional increase in Mean CTDIvol, CTDIfreeair, DLP, and Size Specific Dose Estimate. As a result of the increase in reported dose metrics and the decrease in CTDIvol Notification Value, a notification event is triggered.
- Exceeding a notification value allows the encoding of a Reason for Proceeding and a Person Participant for the RDSR encoding. This example includes a reason (patient with high body mass index (BMI)) and the technologist initials (from the scanner console log in). Note that following the NEMA XR 25 standard describing CT Dose Check capabilities, a reason need not necessarily be entered by the operator to proceed with a scan, meaning this row may be blank or absent in some instances.
- The remaining content of the RDSR is identical for all other nodes to the example in ZZZZZ.5.1.2.

Table ZZZZZ.5.1.2.1-1 illustrates one possible encoding of this example. Note that other alternative implementation patterns exist.

Table ZZZZZ.5.1.2.1-1. CT Traditional RDSR with Notification Event

Node	Code Meaning of Concept Name	Code or Example Value	TID
1	X-Ray Radiation Dose Report	<CONTAINER>	Section TID 10011
<Identical Content to Nodes 1.1-1.16.6.13 from Table ZZZZZ.5.1.2-1>			
1.16.6.14	CT X-Ray Source Parameters	<CONTAINER>	Section TID 10013
1.16.6.14.1	Identification of the X-Ray Source	1	Section TID 10013
1.16.6.14.2	KVP	120.0 kV	Section TID 10013
1.16.6.14.3	Maximum X-Ray Tube Current	500 mA	Section TID 10013
1.16.6.14.4	X-Ray Tube Current	400 mA	Section TID 10013
1.16.6.14.5	Exposure Time per Rotation	1.0 s	Section TID 10013
1.16.7	CT Dose	<CONTAINER>	Section TID 10013
1.16.7.1	Mean CTDIvol	20.30 mGy	Section TID 10013
1.16.7.2	CTDIw Phantom Type	(113691, DCM, "IEC Body Dosimetry Phantom")	Section TID 10013
1.16.7.3	CTDIfreeair Calculation Factor	0.25 mGy/mA.s	Section TID 10013
1.16.7.4	Mean CTDIfreeair	100.0 mGy	Section TID 10013

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.16.7.5	DLP	446.70 mGy.cm	Section TID 10013
1.16.7.6	Size Specific Dose Estimate	24.97 mGy	Section TID 10013
1.16.7.6.1	Measurement Method	(113988, DCM, "Estimated from Water Equivalent Diameter")	Section TID 10013
1.16.7.6.2	Water Equivalent Diameter	300 mm	Section TID 10013
1.16.7.6.2.1	Measurement Method	(113984, DCM, "Water Equivalent Diameter From Localizer”)	Section TID 10013
Start CT Dose Check Details TID 10015			
1.16.7.4	Dose Check Alert Details	<CONTAINER>	Section TID 10015
1.16.7.4.1	DLP Alert Value Configured	(373067005, SCT, “No”)	Section TID 10015
1.16.7.4.2	CTDIvol Alert Value Configured	(373066001, SCT, "Yes")	Section TID 10015
1.16.7.4.3	CTDIvol Alert Value	1000.0 mGy	Section TID 10015
1.16.7.5	Dose Check Notification Details	<CONTAINER>	Section TID 10015
1.16.7.5.1	DLP Notification Value Configured	(373067005, SCT, “No”)	Section TID 10015
1.16.7.5.2	CTDIvol Notification Value Configured	(373066001, SCT, "Yes")	Section TID 10015
1.16.7.5.3	CTDIvol Notification Value	20.00 mGy	Section TID 10015
1.16.7.5.4	CTDIvol Forward Estimate	20.30 mGy	Section TID 10015
1.16.7.5.5	Reason for Proceeding	High BMI patient	Section TID 10015
Start Person Participant within TID 10015			
1.18	Person Name	NBB	Section TID 1020
1.18.1	Person Role in Procedure	(113850, DCM, “Irradiation Authorizing”)	Section TID 1020
End Person Participant			
End CT Dose Check Details			
<Identical Content to Nodes 1.16.8-1.18.2 from Table ZZZZZ.5.1.2-1>			

ZZZZZ.5.1.3 Example of Traditional RDSR for DX

The following is an example RDSR for a routine radiography study. In this example, an X-Ray system performs the acquisitions with the following characteristics:

- This is an integrated system, therefore the conditions of TIDs (i.e. X-Ray Detector Data Available, X-Ray Source Data Available, X-Ray Mechanical Data Available) are satisfied.
- Two acquisitions are performed: one lateral and one Anterior-Posterior (AP) views of the lumbar spine, with the patient standing.
- The dose is estimated at the detector plane (dose reference point definition).
- The irradiation is administered by the operator John Doe.
- The irradiation is authorized by the physician Dr. Hugh Mann.

Table ZZZZZ.5.1.3-1 illustrates one possible encoding of this example. Note that other alternative implementation patterns exist.

Table ZZZZZ.5.1.3-1. DX Traditional RDSR of a Fully Integrated System

Node	Code Meaning of Concept Name	Code or Example Value	TID
1	X-Ray Radiation Dose Report	<CONTAINER>	**Section TID 10001**
1.1	Language of Content Item and Descendants	(en, RFC5646, "English")	Section TID 1204
1.2	Procedure reported	(113704, DCM, "Projection X-Ray")	Section TID 10001
1.2.1	Has Intent	(261004008, SCT, "Diagnostic Intent")	Section TID 10001
1.3	Acquisition Device Type	(113958, DCM, "Integrated Projection Radiography System")	Section TID 10001
Start Observer Context			
Observer #1: Irradiating device			
1.4	Observer Type	(121007, DCM, "Device")	Section TID 1002
1.5	Device Observer UID	2.999.1	Section TID 1004
1.6	Device Observer Name	MyStationName	Section TID 1004
1.7	Device Observer Manufacturer	Manufacturer X	Section TID 1004
1.8	Device Observer Model Name	Model Y	Section TID 1004
1.9	Device Observer Serial Number	SerialNumber123	Section TID 1004
1.10	Device Role in Procedure	(113859, DCM, "Irradiating Device")	Section TID 1004
End Observer Context			
1.11	Scope of Accumulation	(113014, DCM, "Study")	Section TID 10001
1.11.1	Study Instance UID	2.999.2	Section TID 10001
1.12	X-Ray Detector Data Available	(373066001, SCT, "Yes")	Section TID 10001
1.13	X-Ray Source Data Available	(373066001, SCT, "Yes")	Section TID 10001
1.14	X-Ray Mechanical Data Available	(373066001, SCT, "Yes")	Section TID 10001
1.15	Accumulated X-Ray Dose Data	<CONTAINER>	Section TID 10002
1.15.1	Acquisition Plane	(113622, DCM, "Single Plane")	Section TID 10002
1.15.2	Dose Area Product Total	0.000178600000 Gy.m2	Section TID 10007
1.15.3	Dose (RP) Total	0.00211933 Gy	Section TID 10007
1.15.4	Distance Source to Reference Point	1150 mm	Section TID 10007
1.15.5	Total Number of Radiographic Frames	2 no units	Section TID 10007
1.15.6	Reference Point Definition	(113941, DCM, "In Detector Plane")	Section TID 10007
Start Irradiation Event X-Ray Data of LATERAL acquisition			
1.16	Irradiation Event X-Ray Data	<CONTAINER>	Section TID 10003
1.16.1	Acquisition Plane	(113622, DCM, "Single Plane")	Section TID 10003
1.16.2	Irradiation Event UID	2.999.3	Section TID 10003
1.16.3	DateTime Started	20241016213726.000	Section TID 10003
1.16.4	Irradiation Event Type	(113611, DCM, "Stationary Acquisition")	Section TID 10003
1.16.5	Acquisition Protocol	Wallstand L-Spine Lateral	Section TID 10003

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.16.6	Image View	(399198007, SCT, “right lateral”)	Section TID 10003
1.16.7	Patient Orientation	(C86043, NCIt, “erect”)	Section TID 10003
1.16.7.1	Patient Orientation Modifier	(10904000, SCT, “standing”)	Section TID 10003
1.16.8	Target Region	(122496007, SCT, “Lumbar spine”)	Section TID 10003
1.16.9	Dose Area Product	0.0001156000 Gy.m2	Section TID 10003
Start Person Participant within Section TID 10003: Irradiation Administering is the operator.			
1.16.10	Person Name	Doe^John	Section TID 1020
1.16.10.1	Person Role in Procedure	(113851, DCM, “Irradiation Administering”)	Section TID 1020
1.16.10.2	Person Role in Organization	(159016003, SCT, “Radiologic Technologist”)	Section TID 1020
End Person Participant			
1.16.11	Exposure Index	227.00 no units	Section TID 10003A
1.16.12	Target Exposure Index	250.00 no units	Section TID 10003A
1.16.13	Deviation Index	-0.41914 no units	Section TID 10003A
1.16.14	Acquired Image	2.999.4	Section TID 10003A
1.16.15	Dose (RP)	0.00123015 Gy	Section TID 10003B
1.16.16	Reference Point Definition	(113941, DCM, “In Detector Plane”)	Section TID 10003B
1.16.17	Number of Pulses	1 no units	Section TID 10003B
1.16.18	KVP	89.800000 kV	Section TID 10003B
1.16.19	X-Ray Tube Current	724.00 mA	Section TID 10003B
1.16.20	Exposure Time	32.00 ms	Section TID 10003B
1.16.21	Exposure	23160.00 uA.s	Section TID 10003B
1.16.22	Focal Spot Size	1.6 mm	Section TID 10003B
1.16.23	X-Ray Filters	<CONTAINER>	Section TID 10003B
1.16.23.1	X-Ray Filter Type	(111609, DCM, “No filter”)	Section TID 10003B
1.16.24	Collimated Field Area	0.0886542 m2	Section TID 10003B
1.16.25	Collimated Field Height	425.2 mm	Section TID 10003B
1.16.26	Collimated Field Width	208.5 mm	Section TID 10003B
1.16.27	X-Ray Grid	(111642, DCM, “Focused grid”)	Section TID 10003B
1.16.28	Distance Source to Detector	1150.00 mm	Section TID 10003C
Start Irradiation Event X-Ray Data of ANTERIOR-POSTERIOR acquisition			
1.17	Irradiation Event X-Ray Data	<CONTAINER>	Section TID 10003
1.17.1	Acquisition Plane	(113622, DCM, "Single Plane")	Section TID 10003
1.17.2	Irradiation Event UID	2.999.5	Section TID 10003
1.17.3	DateTime Started	20241016214647.000	Section TID 10003
1.17.4	Irradiation Event Type	(113611, DCM, “Stationary Acquisition”)	Section TID 10003
1.17.5	Acquisition Protocol	Wallstand L-Spine AP	Section TID 10003

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.17.6	Image View	(399348003, SCT, “antero-posterior”)	Section TID 10003
1.17.7	Patient Orientation	(C86043, NCIt, “erect”)	Section TID 10003
1.17.7.1	Patient Orientation Modifier	(10904000, SCT, “standing”)	Section TID 10003
1.17.8	Target Region	(122496007, SCT, “Lumbar spine”)	Section TID 10003
1.17.9	Dose Area Product	0.000063000 Gy.m2	Section TID 10003
Start Person Participant within Section TID 10003: Irradiation Administering is the operator.			
1.16.10	Person Name	Doe^John	Section TID 1020
1.16.10.1	Person Role in Procedure	(113851, DCM, “Irradiation Administering”)	Section TID 1020
1.16.10.2	Person Role in Organization	(159016003, SCT, “Radiologic Technologist”)	Section TID 1020
End Person Participant			
1.17.11	Exposure Index	243.00 no units	Section TID 10003A
1.17.12	Target Exposure Index	250.00 no units	Section TID 10003A
1.17.13	Deviation Index	-0.123 no units	Section TID 10003A
1.17.14	Acquired Image	2.999.6	Section TID 10003A
1.17.15	Dose (RP)	0.00088918 Gy	Section TID 10003B
1.17.16	Reference Point Definition	(113941, DCM, “In Detector Plane”)	Section TID 10003B
1.17.17	Number of Pulses	1 no units	Section TID 10003B
1.17.18	KVP	80.90 kV	Section TID 10003B
1.17.19	X-Ray Tube Current	780.00 mA	Section TID 10003B
1.17.20	Exposure Time	26.00 ms	Section TID 10003B
1.17.21	Exposure	20360 uA.s	Section TID 10003B
1.17.22	Focal Spot Size	1.6 mm	Section TID 10003B
1.17.23	X-Ray Filters	<CONTAINER>	Section TID 10003B
1.17.23.1	X-Ray Filter Type	(111609, DCM, “No filter”)	Section TID 10003B
1.17.24	Collimated Field Area	0.067497 m2	Section TID 10003B
1.17.25	Collimated Field Height	372.500 mm	Section TID 10003B
1.17.26	Collimated Field Width	181.200 mm	Section TID 10003B
1.17.27	X-Ray Grid	(111642, DCM, “Focused grid”)	Section TID 10003B
1.17.28	Distance Source to Detector	1150.00 mm	Section TID 10003C
End Irradiation Event X-Ray Data			
Start Person Participant within Section TID 10001: Irradiation Authorizing is the physician.			
1.18	Person Name	Mann^Hugh^^Dr	Section TID 1020
1.18.1	Person Role in Procedure	(113850, DCM, “Irradiation Authorizing”)	Section TID 1020
1.18.2	Person ID	5321611	Section TID 1020
1.18.3	Person ID Issuer	Institution A	Section TID 1020

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.18.4	Person Role in Organization	(309343006, SCT, “Physician”)	Section TID 1020
End Person Participant			
1.19	Source of Dose Information	(113856, DCM, “Automated Data Collection”)	Section TID 10001

ZZZZZ.5.1.3.1 Example of Traditional RDSR for DX Non-Integrated Equipment

The following is an example of the previous routine radiography study, but performed on a less integrated equipment. In this example, a system performs the acquisitions with the following characteristics:

- The system is a radiography system with mobile digital detector, which has Exposure Index capability but there is no X-Ray generator integration. Only X-Ray Detector Data is available. Other data such as X-Ray Source Data and X-Ray Mechanical Data are not available.

Table ZZZZZ.5.1.3-2 includes values that are different vs. the fully integrated example.

Table ZZZZZ.5.1.3-2. DX Traditional RDSR with only X-Ray Detector Data Available

Node	Code Meaning of Concept Name	Code or Example Value	TID
	X-Ray Radiation Dose Report	<CONTAINER>	**Section TID 10001**
	…		Section TID 10001
	Procedure reported	(113704, DCM, “Projection X-Ray”)	Section TID 10001
	Acquisition Device Type	(113959, DCM, “Cassette-based Projection Radiography System”)	Section TID 10001
Start Observer Context			
Observer #1: Reading Device			
	Observer Type	(121007, DCM, “Device”)	Section TID 1002
	…		Section TID 1004
	Device Role in Procedure	(113942, DCM, “X-Ray Reading Device”)	Section TID 1004
End Observer Context			
	…		Section TID 10001
	X-Ray Detector Data Available	(373066001, SCT, “Yes”)	Section TID 10001
	X-Ray Source Data Available	(373067005, SCT, “No”)	Section TID 10001
	X-Ray Mechanical Data Available	(373067005, SCT, “No”)	Section TID 10001
Include Section TID 10002 “Accumulated X-Ray Dose”			
	…		Section TID 10002
Include Section TID 10006 “Accumulated Cassette-based Projection Radiography Dose”			
	Detector Type	(113948, DCM, “Direct Detector”)	Section TID 10006
	Total Number of Radiographic Frames	2	Section TID 10006
	…		Section TID 10006
Include Section **TID 10003** “**Irradiation Event X-Ray Data**” for irradiation #1			

Node	Code Meaning of Concept Name	Code or Example Value	TID
	…		Section TID 10003
Include Section TID 10003A “Irradiation Event X-Ray Detector Data” for irradiation #1 (Section TIDs 10003B and 10003C are not allowed)			
	Exposure Index	227.00 no units	Section TID 10003A
	Target Exposure Index	250.00 no units	Section TID 10003A
	Deviation Index	-0.41914 no units	Section TID 10003A
	…		Section TID 10003A
Include Section **TID 10003** “**Irradiation Event X-Ray Data**” for irradiation #2			
	…		Section TID 10003
Include Section TID 10003A “Irradiation Event X-Ray Detector Data” for irradiation #2 (Section TIDs 10003B and 10003C are not allowed)			
	Exposure Index	243.00 no units	Section TID 10003A
	Target Exposure Index	250.00 no units	Section TID 10003A
	Deviation Index	-0.123 no units	Section TID 10003A
	…		Section TID 10003A

The following is an example of the previous routine radiography study, but performed on a less integrated equipment. In this example, a system performs the acquisitions with the following characteristics:

- The system is a mobile X-Ray source which has generator integration. Only X-Ray Source Data is available. Other data such as X-Ray Detector Data and X-Ray Mechanical Data are not available.

Table ZZZZZ.5.1.3-3 includes values that are different vs. the fully integrated example.

Table ZZZZZ.5.1.3-3. DX Traditional RDSR with only X-Ray Source Data Available

Node	Code Meaning of Concept Name	Code or Example Value	TID
	X-Ray Radiation Dose Report	<CONTAINER>	**Section TID 10001**
	…		Section TID 10001
	Procedure reported	(113704, DCM, “Projection X-Ray”)	Section TID 10001
	Acquisition Device Type	(113959, DCM, “Cassette-based Projection Radiography System”)	Section TID 10001
Start Observer Context			
Observer #1: Irradiating Device			
	Observer Type	(121007, DCM, “Device”)	Section TID 1002
	…		Section TID 1004
	Device Role in Procedure	(113859, DCM, “Irradiating Device”)	Section TID 1004
End Observer Context			
	X-Ray Detector Data Available	(373067005, SCT, “No”)	Section TID 10001
	X-Ray Source Data Available	(373066001, SCT, “Yes”)	Section TID 10001

Node	Code Meaning of Concept Name	Code or Example Value	TID
	X-Ray Mechanical Data Available	(373067005, SCT, "No")	Section TID 10001
Include Section TID 10002 "Accumulated X-Ray Dose"			
	…		Section TID 10002
Include Section TID 10006 "Accumulated Cassette-based Projection Radiography Dose"			
	Dose Area Product Total	0.000178600000 Gy.m2	Section TID 10006
Include Section **TID 10003** "**Irradiation Event X-Ray Data**" for irradiation #1			
	Dose Area Product	0.0001156000 Gy.m2	Section TID 10003
	…		Section TID 10003
Include Section TID 10003B "Irradiation Event X-Ray Source Data" for irradiation #1 (Section TIDs 10003A and 10003C are not allowed)			
	Dose (RP)	0.00123015 Gy	Section TID 10003B
	Reference Point Definition	(113965, DCM, "100cm from X-Ray Source")	Section TID 10003B
	Number of Pulses	1 no units	Section TID 10003B
	…		Section TID 10003B
Include Section **TID 10003** "**Irradiation Event X-Ray Data**" for irradiation #2			
	Dose Area Product	0.000063000 Gy.m2	Section TID 10003
	…		Section TID 10003
Include Section TID 10003B "Irradiation Event X-Ray Source Data" for irradiation #2 (Section TIDs 10003A and 10003C are not allowed)			
	Dose (RP)	0.00088918 Gy	Section TID 10003B
	Reference Point Definition	(113965, DCM, "100cm from X-Ray Source")	Section TID 10003B
	Number of Pulses	1 no units	Section TID 10003B
	…		Section TID 10003B

The following is an example of the previous routine radiography study, but performed on a less integrated equipment. In this example, a system performs the acquisitions with the following characteristics:

- The system has no detector and no generator integration. Only X-Ray Mechanical Data is Available. Other data such as X-Ray Detector Data and X-Ray Source Data are not available.
- The Dose Area Product (DAP) is measured with a DAP meter.

Table ZZZZZ.5.1.3-4 includes values that are different vs. the fully integrated example.

Table ZZZZZ.5.1.3-4. DX Traditional RDSR with only X-Ray Mechanical Data Available

Node	Code Meaning of Concept Name	Code or Example Value	TID
	X-Ray Radiation Dose Report	<CONTAINER>	**Section TID 10001**
	…		
	Procedure reported	(113704, DCM, "Projection X-Ray")	Section TID 10001

Node	Code Meaning of Concept Name	Code or Example Value	TID
	Acquisition Device Type	(113959, DCM, “Cassette-based Projection Radiography System”)	Section TID 10001
Start Observer Context			
Observer #1: Recording Device			
	Observer Type	(121007, DCM, “Device”)	Section TID 1002
	…		
	Device Role in Procedure	(121097, DCM, “Recording”)	Section TID 1004
End Observer Context			
	X-Ray Detector Data Available	(373067005, SCT, “No”)	Section TID 10001
	X-Ray Source Data Available	(373067005, SCT, “No”)	Section TID 10001
	X-Ray Mechanical Data Available	(373066001, SCT, “Yes”)	Section TID 10001
Include Section TID 10002 “Accumulated X-Ray Dose”			
	…		Section TID 10002
Include Section TID 10006 “Accumulated Cassette-based Projection Radiography Dose”			
	Dose Area Product Total	0.000178600000 Gy.m2	Section TID 10006
Include Section **TID 10003** “**Irradiation Event X-Ray Data**” for irradiation #1			
	Dose Area Product	0.0001156000 Gy.m2	Section TID 10003
	…		Section TID 10003
Include Section TID 10003C “Irradiation Event X-Ray Mechanical Data” for irradiation #1 (Section TIDs 10003A and 10003B are not allowed)			
	Distance Source to Detector	1150.00 mm	Section TID 10003C
Include Section **TID 10003** “**Irradiation Event X-Ray Data**” for irradiation #2			
	Dose Area Product	0.000063000 Gy.m2	Section TID 10003
	…		Section TID 10003
Include Section TID 10003C “Irradiation Event X-Ray Mechanical Data” for irradiation #2 (Section TIDs 10003A and 10003B are not allowed)			
	Distance Source to Detector	1150.00 mm	Section TID 10003C

ZZZZZ.5.1.4 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 the following characteristics*:*

- This is an integrated system: X-Ray Detector / Source / Mechanical data is available.
- One focused anti-scatter grid is fixed on the detector housing.
- Four acquisitions are performed with CC and MLO views for both the left and right breasts.
- The irradiation is administered by the operator John Doe.
- The irradiation is authorized by the physician Dr. Hugh Mann.

Table ZZZZZ.5.1.4-1 illustrates one possible encoding of this example. Note that other alternative implementation patterns exist.

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>	Section TID 10001
1.1	Language of Content Item and Descendants	(en, RFC5646, “English”)	Section TID 1204
1.2	Procedure reported	(71651007, SCT, "Mammography")	Section TID 10001
1.2.1	Has Intent	(360156006, SCT, "Screening Intent")	Section TID 10001
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	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	SerialNumber123	Section TID 1004
1.9	Device Role in Procedure	(113859, DCM, “Irradiating Device”)	Section TID 1004
End Observer Context			
1.10	Scope of Accumulation	(113014, DCM, “Study”)	Section TID 10001
1.11	Study Instance UID	2.999.2	Section TID 10001
1.12	X-Ray Detector Data Available	(373066001, SCT, “Yes”)	Section TID 10001
1.13	X-Ray Source Data Available	(373066001, SCT, “Yes”)	Section TID 10001
1.14	X-Ray Mechanical Data Available	(373066001, SCT, “Yes”)	Section TID 10001
1.15	Accumulated X-Ray Dose Data	<CONTAINER>	Section TID 10002
1.15.1	Acquisition Plane	(113622, DCM, "Single Plane")	Section TID 10002
1.15.2	Accumulated Average Glandular Dose	2.50 mGy	Section TID 10005
1.15.2.1	Laterality	(80248007, SCT, "Left Breast")	Section TID 10005
1.15.3	Accumulated Average Glandular Dose	2.80 mGy	Section TID 10005
1.15.3.1	Laterality	(73056007, SCT, "Right Breast")	Section TID 10005
1.16	Irradiation Event X-Ray Data	<CONTAINER>	Section TID 10003
1.16.1	Acquisition Plane	(113622, DCM, "Single Plane")	Section TID 10003
1.16.2	Irradiation Event UID	2.999.3	Section TID 10003
1.16.3	DateTime Started	20240418123000.000	Section TID 10003
1.16.4	Irradiation Event Type	(113611, DCM, “Stationary Acquisition”)	Section TID 10003
1.16.5	Image View	(SCT, 399162004, “cranio-caudal”)	Section TID 10003
1.16.6	Target Region	(76752008, SCT, “Breast”)	Section TID 10003
1.16.6.1	Laterality	(7771000, SCT, “Left”)	Section TID 10003

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.16.7	Half Value Layer	0.50 mm	Section TID 10003
1.16.8	Patient Equivalent Thickness	44.0 mm	Section TID 10003
1.16.9	Entrance Exposure at RP	4.10 mGy	Section TID 10003
1.16.10	Reference Point Definition	(113865, DCM, “4.2cm above Breast Support Surface”)	Section TID 10003
Start Person Participant within Section TID 10003: Irradiation Administering is the operator.			
1.16.11	Person Name	Doe^John	Section TID 1020
1.16.11.1	Person Role in Procedure	(113851, DCM, “Irradiation Administering”)	Section TID 1020
1.16.11.2	Person Role in Organization	(159016003, SCT, “Radiologic Technologist”)	Section TID 1020
End Person Participant			
Irradiation Event X-Ray Detector Data Section TID 10003A			
1.16.12	Acquired Image	SOP Class UID: 1.2.840.10008.5.1.4.1.1.1.2 SOP Instance UID: 2.999.6	Section TID 10003A
Irradiation Event X-Ray Source Data Section TID 10003B			
1.16.13	Average Glandular Dose	1.20 mGy	Section TID 10003B
1.16.14	KVP	28.00 kV	Section TID 10003B
1.16.15	X-Ray Tube Current	160.00 mA	Section TID 10003B
1.16.16	Exposure Time	625.00 ms	Section TID 10003B
1.16.17	Exposure	100000 uA.s	Section TID 10003B
1.16.18	Focal Spot Size	0.3 mm	Section TID 10003B
1.16.19	Anode Target Material	(26194003, SCT, “Tungsten”)	Section TID 10003B
1.16.20	X-Ray Filters	<CONTAINER>	Section TID 10003B
1.16.20.1	X-Ray Filter Type	(113653, DCM, “Flat filter”)	Section TID 10003B
1.16.20.2	X-Ray Filter Material	(59801003, SCT, “Rhodium”)	Section TID 10003B
1.16.20.3	X-Ray Filter Thickness Minimum	0.050 mm	Section TID 10003B
1.16.20.4	X-Ray Filter Thickness Maximum	0.050 mm	Section TID 10003B
1.16.21	Collimated Field Area	0.0696 m2	Section TID 10003B
1.16.22	Collimated Field Height	240 mm	Section TID 10003B
1.16.23	Collimated Field Width	290 mm	Section TID 10003B
1.16.24	X-Ray Grid	(111642, DCM, “Focused grid”)	Section TID 10003B
1.16.25	X-Ray Grid	(111642, DCM, “Reciprocating grid”)	Section TID 10003B
Irradiation Event X-Ray Mechanical Data Section TID 10003C			
1.16.26	Positioner Primary Angle	0.00 deg	Section TID 10003C
1.16.27	Compression Thickness	44.00 mm	Section TID 10003C
1.16.28	Compression Force	70 Newton	Section TID 10003C
Start CID 10008 Dose Related Distance Measurement			

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.16.29	Distance Source to Reference Point	633.00 mm	Section TID 10003C
1.16.30	Distance Source to Detector	700.00 mm	Section TID 10003C
End CID 10008 Dose Related Distance Measurement			
1.17	Irradiation Event X-Ray Data	<CONTAINER>	Section TID 10003
Irradiation Event X-Ray Data Section TID 10003 for LMLO Acquisition not shown for brevity			
1.18	Irradiation Event X-Ray Data	<CONTAINER>	Section TID 10003
Irradiation Event X-Ray Data Section TID 10003 for RCC Acquisition not shown for brevity			
1.19	Irradiation Event X-Ray Data	<CONTAINER>	Section TID 10003
Irradiation Event X-Ray Data Section TID 10003 for RMLO Acquisition not shown for brevity			
Start Person Participant within Section TID 10001: Irradiation Authorizing is the physician.			
1.20	Person Name	Mann^Hugh^^Dr	Section TID 1020
1.20.1	Person Role in Procedure	(113850, DCM, "Irradiation Authorizing")	Section TID 1020
1.20.2	Person ID	5321611	Section TID 1020
1.20.3	Person ID Issuer	Institution A	Section TID 1020
1.20.4	Person Role in Organization	(309343006, SCT, "Physician")	Section TID 1020
End Person Participant			
1.21	Source of Dose Information	(113856, DCM, "Automated Data Collection")	Section TID 10001

ZZZZZ.5.2 Examples of Enhanced RDSR

ZZZZZ.5.2.1 Example of Enhanced RDSR for XA

The following is an example RDSR for a diagnostic XA procedure step in neuroradiology. In this example, a single plane (i.e. 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
- One focused anti-scatter grid is fixed on the detector housing
- One pulsed fluoroscopy Irradiation Event lasting 10 seconds and irradiating at 15 pulses per second, with no XA image recorded
- One rotational acquisition (CBCT) Irradiation Event, rotating at 10 degrees per second and acquiring 30 frames per second over an arc of 180 degrees. An XA image is recorded.
- A dose map image is created at the end of the procedure step
- The irradiation administering are the performing physician Dr. Hugh Mann and the operator John Doe
- The irradiation authorizing is the performing physician Dr. Hugh Mann

The timing and rotation angles for these acquisitions is the following, on the date of 2025-03-25.

Table ZZZZZ.5.2.1-1. Timing and Rotation angles of the XA Enhanced RDSR Example

	Actual Rotation Angle
Irradiation Event #1: Fluoroscopy	

Start Time	12 h, 30 min, 00 s, 000 ms	Fixed gantry PA (Posterior Anterior) position
End Time	12 h, 30 min, 10 s, 000 ms	Fixed gantry PA (Posterior Anterior) position
Irradiation Event #2: Rotational Acquisition		
Start Time	12 h, 32 min, 00 s, 000 ms	-90 deg
Continuous rotation from -90 deg to +90 deg during 18 seconds, with X-Ray pulses every 33 ms. The position of the X-Ray Source is encoded in the RDSR every two seconds. The radiation output value is also encoded in the RDSR every two seconds as the accumulated value between the two encoded positions of the X-Ray source.		
End Time	12 h, 32 min, 18 s, 000 ms	+90 deg

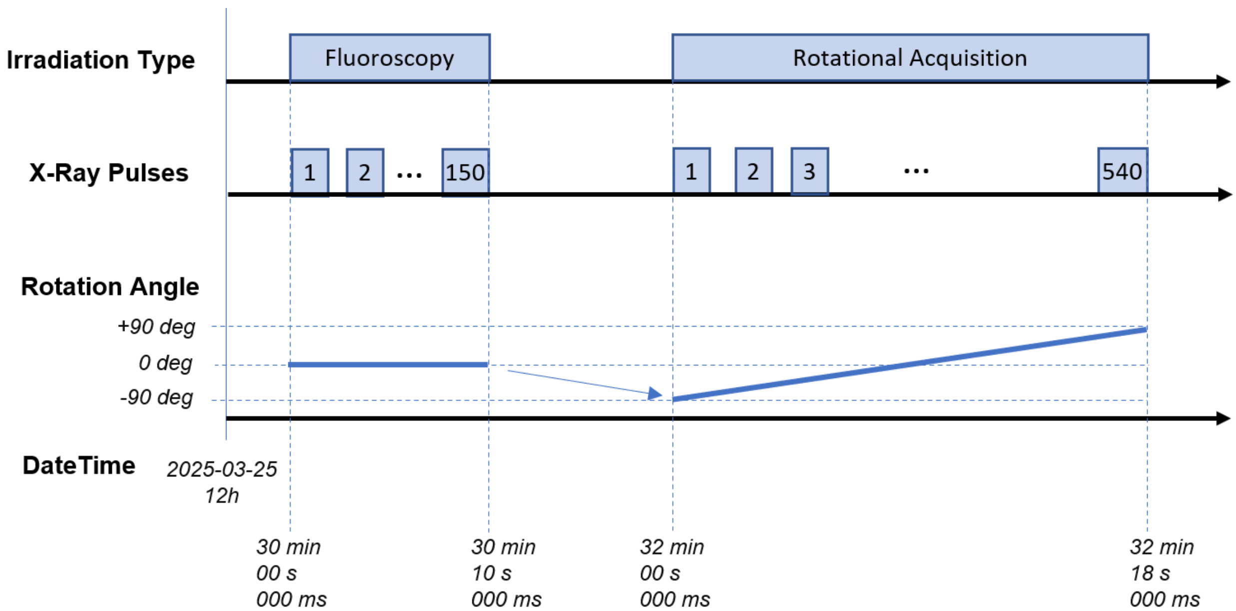

Figure ZZZZZ.5.2.1-1. Timing and rotation angles of the enhanced RDSR example for XA

The geometry of the equipment for this example is illustrated in Figure ZZZZZ.5.2.1-2:

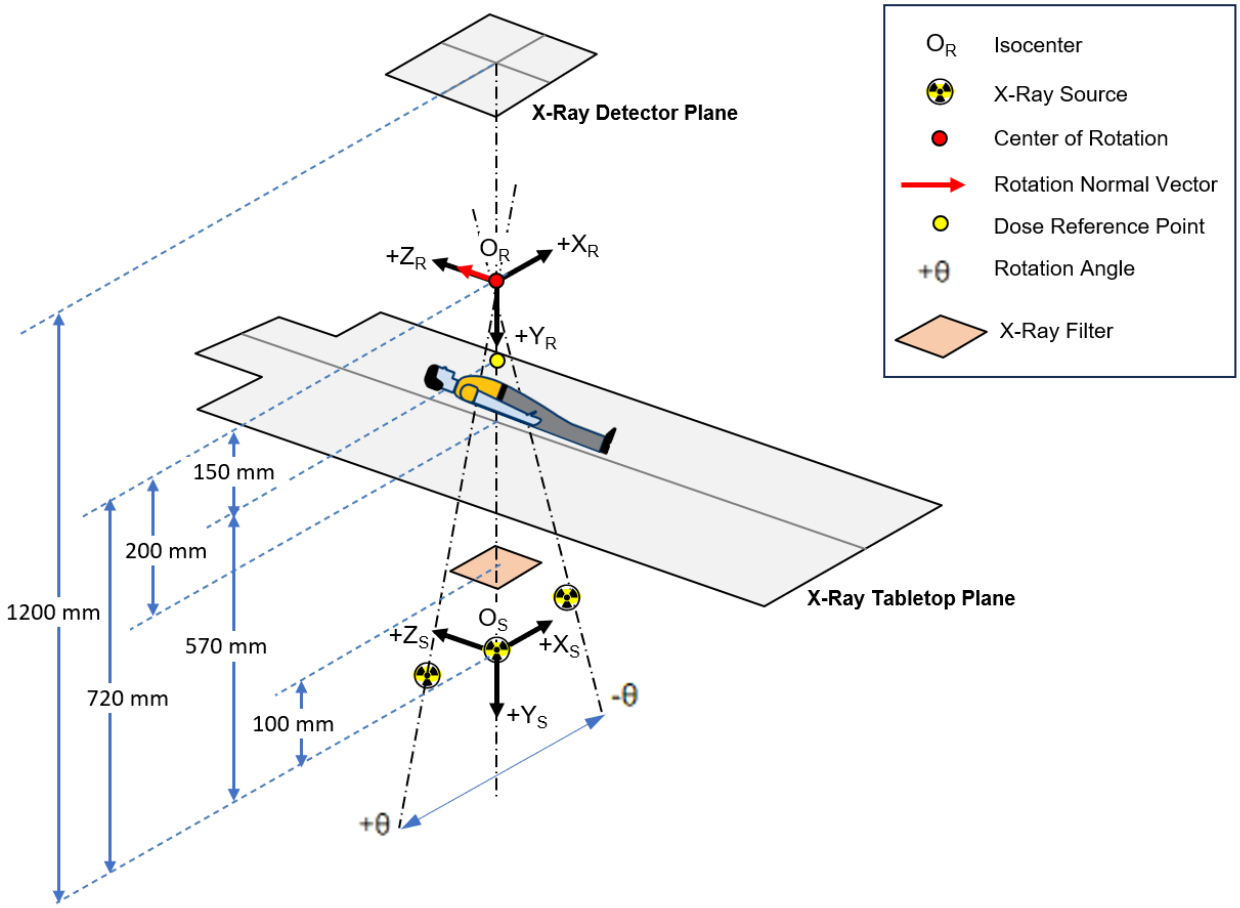

Figure ZZZZZ.5.2.1-2. Geometry of the enhanced RDSR example for XA

Table ZZZZZ.5.2.1-2 illustrates one possible encoding of this example. Note that other alternative implementation patterns exist.

Table ZZZZZ.5.2.1-2. XA Enhanced RDSR Example

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, RFC5646, “English”)	Section TID 1204
1.2	Procedure reported	(113704, DCM, "Projection X-Ray")	Section TID 10040
1.2.1	Has Intent	(261004008, SCT, "Diagnostic 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

Node	Code Meaning of Concept Name	Code or Example Value	TID
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
<End Observer Context>			
1.9	Scope of Accumulation	(113016, DCM, "Performed Procedure Step")	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	Dose Area Product Total	0.00003410 Gy.m2	Section TID 10041
1.10.3	Fluoro Dose Area Product Total	0.00000310 Gy.m2	Section TID 10041
1.10.4	Acquisition Dose Area Product Total	0.00003100 Gy.m2	Section TID 10041
1.10.5	Total Fluoro Time	10 s	Section TID 10041
1.10.6	Total Acquisition Time	18 s	Section TID 10041
1.10.7	Detector Type	(113948, DCM, "Direct Detector")	Section TID 10041
1.10.8	Total Number of Radiographic Frames	540 no units	Section TID 10041
1.10.9	Reference Point Dosimetry	<CONTAINER>	Section TID 10041
1.10.9.1	Reference Point Definition	(113860, DCM, “15cm from Isocenter toward Source”)	Section TID 10041
1.10.9.2	Dose (RP) Total	0.0120600 Gy	Section TID 10041
1.10.9.3	Fluoro Dose (RP) Total	0.0050000 Gy	Section TID 10041
1.10.9.4	Acquisition Dose (RP) Total	0.0070600 Gy	Section TID 10041
1.10.9.5	Distance Source to Reference Point	570.00 mm	Section TID 10041
1.11	Irradiation Event Summary Data	<CONTAINER>	Section TID 10042
<Start summary information of Irradiation Event #1 (fluoroscopy acquisition)>			
1.11.1	Irradiation Event UID	2.999.2.3.4	Section TID 10042
1.11.2	DateTime Started	20250325123000.000	Section TID 10042
1.11.3	DateTime Ended	20250325123010.000	Section TID 10042
1.11.4	Identification of the X-Ray Source	1	Section TID 10042
1.11.5	Irradiation Event Label	1	Section TID 10042
1.11.5.1	Label Type	(113608, DCM, “Acquisition Number”)	Section TID 10042
1.11.6	Irradiation Event Type	(44491008, SCT, “Fluoroscopy”)	Section TID 10042
1.11.7	Dose (RP)	0.0050000 Gy	Section TID 10042
1.11.8	Number of Pulses	150 no units	Section TID 10042
1.11.9	Exposure Time	4950 ms	Section TID 10042
1.11.10	Comment	Fluoro Loop	Section TID 10042
Start Person Participant within TID 10042			

Node	Code Meaning of Concept Name	Code or Example Value	TID
Person #1: Performing physician			
1.11.11	Person Name	Mann^Hugh^^Dr	Section TID 1020
1.11.11.1	Person Role in Procedure	(113851, DCM, “Irradiation Administering”)	Section TID 1020
1.11.11.2	Person Role in Organization	(309343006, SCT, “Physician”)	Section TID 1020
Person #2: Operator			
1.11.12	Person Name	Doe^John	Section TID 1020
1.11.12.1	Person Role in Procedure	(113851, DCM, “Irradiation Administering”)	Section TID 1020
1.11.12.2	Person Role in Organization	(159016003, SCT, “Radiologic Technologist”)	Section TID 1020
<End summary information of Irradiation Event #1 (fluoroscopy acquisition)>			
1.12	Irradiation Event Summary Data	<CONTAINER>	Section TID 10042
<Start summary information of Irradiation Event #2 (Cone Beam CT acquisition)>			
1.12.1	Irradiation Event UID	2.999.2.3.5	Section TID 10042
1.12.2	DateTime Started	20250325123200.000	Section TID 10042
1.12.3	DateTime Ended	20250325123218.000	Section TID 10042
1.12.4	Identification of the X-Ray Source	1	Section TID 10042
1.12.5	Irradiation Event Label	2	Section TID 10042
1.12.5.1	Label Type	(113608, DCM, “Acquisition Number”)	Section TID 10042
1.12.6	Irradiation Event Type	(113613, DCM, “Rotational Acquisition”)	Section TID 10042
1.12.7	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
1.12.8	Dose (RP)	0.007060 Gy	Section TID 10042
1.12.9	Number of Pulses	540 no units	Section TID 10042
1.12.10	Exposure Time	3000 ms	Section TID 10042
1.12.11	Comment	CBCT	Section TID 10042
Start Person Participant within TID 10042			
Person #1: Performing physician			
1.12.12	Person Name	Mann^Hugh^^Dr	Section TID 1020
1.12.12.1	Person Role in Procedure	(113851, DCM, “Irradiation Administering”)	Section TID 1020
1.12.12.2	Person Role in Organization	(309343006, SCT, “Physician”)	Section TID 1020
Person #2: Operator			
1.12.13	Person Name	Doe^John	Section TID 1020
1.12.13.1	Person Role in Procedure	(113851, DCM, “Irradiation Administering”)	Section TID 1020
1.12.13.2	Person Role in Organization	(159016003, SCT, “Radiologic Technologist”)	Section TID 1020
<End summary information of Irradiation Event #2 (Cone Beam CT acquisition)>			
1.13	Irradiation Details	<CONTAINER>	Section TID 10043
1.13.1	DateTime Started	20250325123000.000	Section TID 10043
1.13.2	DateTime Ended	20250325123218.000	Section TID 10043

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.13.3	Frame of Reference UID	2.999.1.2.3	Section TID 10043
1.13.4	RDSR Frame of Reference Origin	(130539, DCM, "Isocenter Origin")	Section TID 10043
1.13.5	Radiation Source Characteristics	<CONTAINER>	Section TID 10044
1.13.5.1	DateTime Started	20250325123000.000	Section TID 10044
1.13.5.2	DateTime Ended	20250325123218.000	Section TID 10044
1.13.5.3	Identification of the X-Ray Source	1	Section TID 10044
1.13.5.4	Focal Spot Size	0.6 mm	Section TID 10044
1.13.5.5	Anode Target Material	(26194003, SCT, "Tungsten")	Section TID 10044
1.13.5.6	Attenuator Characteristics	<CONTAINER>	Section TID 10044
1.13.5.6.1	X-Ray Filter Material	(66925006, SCT, "Cooper")	Section TID 10044
1.13.5.6.2	X-Ray Filter Thickness	0.1 mm	Section TID 10044
1.13.6	Radiation Technique	<CONTAINER>	Section TID 10045
1.13.6.1	DateTime Started	20250325123000.000	Section TID 10045
1.13.6.2	DateTime Ended	20250325123010.000	Section TID 10045
1.13.6.3	Identification of the X-Ray Source	1	Section TID 10045
1.13.6.5	KVP	75.00 kV	Section TID 10045
1.13.6.6	X-Ray Tube Current	30.0 mA	Section TID 10045
1.13.6.7	Pulse Rate	15 pulse/s	Section TID 10045
1.13.6.8	Pulse Width	33 ms	Section TID 10045
1.13.7	Radiation Technique	<CONTAINER>	Section TID 10045
1.13.7.1	DateTime Started	20250325123200.000	Section TID 10045
1.13.7.2	DateTime Ended	20250325123218.000	Section TID 10045
1.13.7.3	Identification of the X-Ray Source	1	Section TID 10045
1.13.7.5	KVP	75.00 kV	Section TID 10045
1.13.7.6	X-Ray Tube Current	25.0 mA	Section TID 10045
1.13.7.7	Pulse Rate	30 pulse/s	Section TID 10045
1.13.7.8	Pulse Width	5.555 ms	Section TID 10045
1.13.8	Filtration	<CONTAINER>	Section TID 10046
1.13.8.1	DateTime Started	20250325123000.000	Section TID 10046
1.13.8.2	DateTime Ended	20250325123218.000	Section TID 10046
1.13.8.3	Identification of the X-Ray Source	1	Section TID 10046
1.13.8.4	Attenuator Characteristics	<CONTAINER>	Section TID 10055
1.13.8.4.1	Identification of the Attenuator	1	Section TID 10055
1.13.8.4.2	Attenuator Category	(113771, DCM, "X-Ray Filters")	Section TID 10055
1.13.8.4.3	X-Ray Filter Material	(66925006, SCT, "Cooper")	Section TID 10055
1.13.8.4.4	X-Ray Filter Type	(113653, DCM, "Flat filter")	Section TID 10055
1.13.8.4.5	X-Ray Filter Thickness	0.1 mm	Section TID 10055
1.13.9	Attenuators	<CONTAINER>	Section TID 10047

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.13.9.1	DateTime Started	20250325123000.000	Section TID 10047
1.13.9.2	DateTime Ended	20250325123218.000	Section TID 10047
1.13.9.3	Attenuator Characteristics	<CONTAINER>	Section TID 10055
1.13.9.3.1	Identification of the Attenuator	2	Section TID 10055
1.13.9.3.2	Attenuator Category	(128459, DCM, “Table”)	Section TID 10055
1.13.9.3.3	Equivalent Attenuator Material	(412154003, SCT, “Polycarbonate”)	Section TID 10055
1.13.10	Radiation Output	<CONTAINER>	Section TID 10048
1.13.10.1	DateTime Started	20250325123000.000	Section TID 10048
1.13.10.2	DateTime Ended	20250325123010.000	Section TID 10048
1.13.10.3	Identification of the X-Ray Source	1	Section TID 10048
1.13.10.4	Air Kerma at Output Measurement Point	5.0 mGy	Section TID 10048
1.13.11	Radiation Output	<CONTAINER>	Section TID 10048
1.13.11.1	DateTime Started	20250325123200.000	Section TID 10048
1.13.11.2	DateTime Ended	20250325123218.000	Section TID 10048
1.13.11.3	Identification of the X-Ray Source	1	Section TID 10048
1.13.11.4	Air Kerma at Output Measurement Point	20250325123200.000 | 0.000 mGy 20250325123202.000 | 0.820 mGy 20250325123204.000 | 0.810 mGy 20250325123206.000 | 0.800 mGy 20250325123208.000 | 0.750 mGy 20250325123210.000 | 0.700 mGy 20250325123212.000 | 0.750 mGy 20250325123214.000 | 0.800 mGy 20250325123216.000 | 0.810 mGy 20250325123218.000 | 0.820 mGy	Section TID 10048
1.13.12	Radiation Field Area	<CONTAINER>	Section TID 10049
1.13.12.1	DateTime Started	20250325123000.000	Section TID 10049
1.13.12.2	DateTime Ended	20250325123218.000	Section TID 10049
1.13.12.3	Identification of the X-Ray Source	1	Section TID 10049
1.13.12.4	Radiation Field Outline	SCOORD3D POLYGON	Section TID 10049
1.13.13	X-Ray Source Reference Coordinate System	<CONTAINER>	Section TID 10050
1.13.13.1	DateTime Started	20250325123000.000	Section TID 10050
1.13.13.2	DateTime Ended	20250325123010.000	Section TID 10050
1.13.13.3	Identification of the X-Ray Source	1	Section TID 10050
1.13.13.4	Transformation Matrix	1.0 | 0.0 | 0.0 | 0 0.0 | 1.0 | 0.0 | 720 0.0 | 0.0 | 1.0 | 0	Section TID 10050

<table>
<tr><th>Node</th><th>Code Meaning of Concept Name</th><th>Code or Example Value</th><th>TID</th></tr>
<tr><td></td><td></td><td><table><tr><td>0.0</td><td>0.0</td><td>0.0</td><td>1.0</td></tr></table></td><td></td></tr>
<tr><td>1.13.14</td><td>X-Ray Source Reference Coordinate System</td><td><CONTAINER></td><td>Section TID 10050</td></tr>
<tr><td>1.13.14.1</td><td>DateTime Started</td><td>20250325123200.000</td><td>Section TID 10050</td></tr>
<tr><td>1.13.14.2</td><td>DateTime Ended</td><td>20250325123218.000</td><td>Section TID 10050</td></tr>
<tr><td>1.13.14.3</td><td>Identification of the X-Ray Source</td><td>1</td><td>Section TID 10050</td></tr>
<tr><td>1.13.14.3</td><td>Transformation Matrix</td><td><table><tr><td>1.0</td><td>0.0</td><td>0.0</td><td>0</td></tr><tr><td>0.0</td><td>1.0</td><td>0.0</td><td>720</td></tr><tr><td>0.0</td><td>0.0</td><td>1.0</td><td>0</td></tr><tr><td>0.0</td><td>0.0</td><td>0.0</td><td>1.0</td></tr></table></td><td>Section TID 10050</td></tr>
<tr><td>1.13.14.4</td><td>Center of Rotation</td><td>[0,-720,0]</td><td>Section TID 10050</td></tr>
<tr><td>1.13.14.5</td><td>Rotation Plane Normal Point</td><td>[0,-720,1]</td><td>Section TID 10050</td></tr>
<tr><td>1.13.14.6</td><td>Rotation Angle</td><td><table><tr><td>20250325123200.000</td><td>-90.00 deg</td></tr><tr><td>20250325123202.000</td><td>-70.00 deg</td></tr><tr><td>20250325123204.000</td><td>-50.00 deg</td></tr><tr><td>20250325123206.000</td><td>-30.00 deg</td></tr><tr><td>20250325123208.000</td><td>-10.00 deg</td></tr><tr><td>20250325123210.000</td><td>+10.00 deg</td></tr><tr><td>20250325123212.000</td><td>+30.00 deg</td></tr><tr><td>20250325123214.000</td><td>+50.00 deg</td></tr><tr><td>20250325123216.000</td><td>+70.00 deg</td></tr><tr><td>20250325123218.000</td><td>+90.00 deg</td></tr></table></td><td>Section TID 10050</td></tr>
<tr><td>1.13.15</td><td>Beam Position</td><td><CONTAINER></td><td>Section TID 10051</td></tr>
<tr><td>1.13.15.1</td><td>DateTime Started</td><td>20250325123000.000</td><td>Section TID 10051</td></tr>
<tr><td>1.13.15.2</td><td>DateTime Ended</td><td>20250325123218.000</td><td>Section TID 10051</td></tr>
<tr><td>1.13.15.3</td><td>Identification of the X-Ray Source</td><td>1</td><td>Section TID 10051</td></tr>
<tr><td>1.13.15.4</td><td>Reference Point Position</td><td>[0,-570,0]</td><td>Section TID 10051</td></tr>
<tr><td>1.13.15.5</td><td>X-Ray Beam Attenuator Model</td><td><CONTAINER></td><td>Section TID 10051</td></tr>
<tr><td>1.13.15.5.1</td><td>Identification of the Attenuator</td><td>1</td><td>Section TID 10051</td></tr>
<tr><td>1.13.15.5.2</td><td>X-Ray Attenuator Model Data</td><td>2.999.3.4.5</td><td>Section TID 10051</td></tr>
<tr><td>1.13.15.5.3</td><td>Transformation Matrix</td><td><table><tr><td>1.0</td><td>0.0</td><td>0.0</td><td>0.0</td></tr><tr><td>0.0</td><td>1.0</td><td>0.0</td><td>-10</td></tr><tr><td>0.0</td><td>0.0</td><td>1.0</td><td>0.0</td></tr><tr><td>0.0</td><td>0.0</td><td>0.0</td><td>1.0</td></tr></table></td><td>Section TID 10051</td></tr>
<tr><td>1.13.16</td><td>Attenuator Position</td><td><CONTAINER></td><td>Section TID 10052</td></tr>
<tr><td>1.13.16.1</td><td>DateTime Started</td><td>20250325123000.000</td><td>Section TID 10052</td></tr>
<tr><td>1.13.16.2</td><td>DateTime Ended</td><td>20250325123218.000</td><td>Section TID 10052</td></tr>
<tr><td>1.13.16.3</td><td>X-Ray Beam Attenuator Model</td><td><CONTAINER></td><td>Section TID 10052</td></tr>
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Node	Code Meaning of Concept Name	Code or Example Value	TID
1.13.16.3.1	Identification of the Attenuator	2	Section TID 10052
1.13.16.3.2	X-Ray Attenuator Model Data	2.999.3.4.5.6	Section TID 10052
1.13.16.3.3	Transformation Matrix	1.0 0.0 0.0 0.0 0.0 1.0 0.0 200 0.0 0.0 1.0 0.0 0.0 0.0 0.0 1.0	Section TID 10052
1.13.17	Patient Attenuation Characteristics	<CONTAINER>	Section TID 10053
1.13.17.1	DateTime Started	20250325123000.000	Section TID 10053
1.13.17.2	DateTime Ended	20250325123218.000	Section TID 10053
1.13.17.3	Identification of the X-Ray Source	1	Section TID 10053
1.13.17.4	Patient Equivalent Thickness	300 mm	Section TID 10053
1.13.18	Procedure Characteristics	<CONTAINER>	Section TID 10054
1.13.18.1	DateTime Started	20250325123000.000	Section TID 10054
1.13.18.2	DateTime Ended	20250325123218.000	Section TID 10054
1.13.18.3	Identification of the X-Ray Source	1	Section TID 10054
1.13.18.4	Acquisition Protocol	Neuro Protocol	Section TID 10054
1.13.18.5	Patient Table Relationship	(102540008, SCT, "headfirst")	Section TID 10054
1.13.18.6	Patient Orientation	(102538003, SCT, " recumbent")	Section TID 10054
1.13.18.6.1	Patient Orientation Modifier	(40199007, SCT, "supine")	Section TID 10054
1.13.18.7	Target Region	(12738006, SCT, “Brain”)	Section TID 10054
1.13.18.8	X-Ray Grid	(111642, DCM, “Focused grid”)	Section TID 10054
1.13.18.9	Distance Source to Detector	1200 mm	Section TID 10054
Start Person Participant within TID 10040			
1.14	Person Name	Mann^Hugh^^Dr	Section TID 1020
1.14.1	Person Role in Procedure	(113850, DCM, “Irradiation Authorizing”)	Section TID 1020
1.14.2	Person ID	5321611	Section TID 1020
1.14.3	Person ID Issuer	Institution A	Section TID 1020
1.14.4	Person Role in Organization	(309343006, SCT, “Physician”)	Section TID 1020
End Person Participant			
1.15	Source of Dose Information	(113856, DCM, "Automated Data Collection")	Section TID 10040

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

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 illustrates one possible encoding of this example. Note that other alternative implementation patterns exist.

Table ZZZZZ.5.2.2-1. Cone Beam CT (CBCT) Enhanced RDSR Example

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, RFC5646, "English")	Section TID 1204
1.2	Procedure reported	(702569007, SCT, "Cone Beam Acquisition")	Section TID 10040
1.2.1	Has Intent	(261004008, SCT, "Diagnostic Intent")	Section TID 10040
1.3	Observer Type	(121007, DCM, "Device")	Section TID 1002
1.4	Device Observer UID	2.999.1.2.3.4	Section TID 1004
1.5	Device Observer Manufacturer	Manufacturer X	Section TID 1004
1.6	Device Observer Model Name	Model Y	Section TID 1004
1.7	Device Observer Serial Number	123456789	Section TID 1004
1.8	Scope of Accumulation	(113014, DCM, "Study")	Section TID 10040
1.9	Accumulated Dose Data	<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

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.11.6.1	DateTime Started	20200101120000	Section TID 10044
1.11.6.2	DateTime Ended	20200101120030	Section TID 10044
1.11.6.3	Identification of the X-Ray Source	1	Section TID 10044
1.11.6.4	Focal Spot Size	1.2 mm	Section TID 10044
1.11.6.5	Anode Target Material	(26194003, SCT, "Tungsten")	Section TID 10044
1.11.6.6	Attenuator Characteristics	<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 (m 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
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	Section TID 10047
1.11.9.2	DateTime Ended	20200101120030	Section TID 10047
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

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<tr><td>1.11.9.3.4</td><td>Filter Type</td><td>(113650, DCM, "Strip Filter")</td><td>Section TID 10055</td></tr>
<tr><td>1.11.9.3.5</td><td>X-Ray Filter Thickness</td><td>30 mm</td><td>Section TID 10055</td></tr>
<tr><td>1.11.10</td><td>Radiation Output</td><td><CONTAINER></td><td>Section TID 10048</td></tr>
<tr><td>1.11.10.1</td><td>DateTime Started</td><td>20200101120000</td><td>Section TID 10048</td></tr>
<tr><td>1.11.10.2</td><td>DateTime Ended</td><td>20200101120030</td><td>Section TID 10048</td></tr>
<tr><td>1.11.10.3</td><td>Identification of the X-Ray Source</td><td>1</td><td>Section TID 10048</td></tr>
<tr><td>1.11.10.4</td><td>Air Kerma at Output Measurement Point</td><td><table>
<tr><td>DateTime Ended</td><td>Air Kerma at Output Measurement Point (mGy)</td></tr>
<tr><td>20200101120005</td><td>10.0</td></tr>
<tr><td>20200101120010</td><td>15.0</td></tr>
<tr><td>20200101120015</td><td>20.0</td></tr>
<tr><td>20200101120020</td><td>15.0</td></tr>
<tr><td>20200101120025</td><td>10.0</td></tr>
<tr><td>20200101120030</td><td>15.0</td></tr>
</table></td><td>Section TID 10048</td></tr>
<tr><td>1.11.11</td><td>Radiation Field Area</td><td><CONTAINER></td><td>Section TID 10049</td></tr>
<tr><td>1.11.11.1</td><td>DateTime Started</td><td>20200101120000</td><td>Section TID 10049</td></tr>
<tr><td>1.11.11.2</td><td>DateTime Ended</td><td>20200101120030</td><td>Section TID 10049</td></tr>
<tr><td>1.11.11.3</td><td>Identification of the X-Ray Source</td><td>1</td><td>Section TID 10049</td></tr>
<tr><td>1.11.11.4</td><td>Radiation Field Outline</td><td>SCOORD3D POLYGON 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>
</table></td><td>Section TID 10050</td></tr>
<tr><td>1.11.12.5</td><td>Center of Rotation</td><td>SCOORD3D POINT</td><td>Section TID 10050</td></tr>
<tr><td>1.11.12.6</td><td>Rotation Plane Normal Point</td><td>SCOORD3D POINT</td><td>Section TID 10050</td></tr>
<tr><td>1.11.12.7</td><td>Rotation Angle</td><td><table>
<tr><td>DateTime Started</td><td>Rotation Angle (deg)</td></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>
</table></td><td>Section TID 10050</td></tr>
</table>

Node	Code Meaning of Concept Name	Code or Example Value	TID
		20200101120020	160.0 20200101120025	200.0 20200101120030	240.0	
1.11.13	Beam Position	<CONTAINER>	Section TID 10051
1.11.13.1	DateTime Started	20200101120000	Section TID 10051
1.11.13.2	DateTime Ended	20200101120030	Section TID 10051
1.11.13.3	Identification of the X-Ray Source	1	Section TID 10051
1.11.13.4	Output Measurement Point Position	SCOORD3D POINT	Section TID 10051
1.11.13.5	Reference Point Position	SCOORD3D POINT	Section TID 10051
1.11.13.6	X-Ray Beam Attenuator Model	<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
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

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.12	Source of Dose Information	(113856, DCM, "Automated Data Collection")	Section TID 10040

ZZZZZ.5.2.3 Example of Enhanced RDSR for MG

The following is an example RDSR for a routine mammography imaging procedure. In this example, a digital breast tomosynthesis four-view screening exam is performed with a CC (cranio-caudal) and MLO (medio-lateral oblique) view for both the left and right breast with the following characteristics:

- No grid is used during the tomosynthesis acquisitions.
- Compression is different for each acquisition. The distance from the compression paddle to the patient support top plane is 58 mm for the left breast, and 52 mm for the right breast.
- The irradiation administering person name is not encoded.
- The irradiation authorizing is the physician Dr. Hugh Mann.

The timing and rotation angles for these acquisitions is the following, on the date of 2024-04-18.

Table ZZZZZ.5.2.3-1. Timing and Rotation angles of the MG Enhanced RDSR Example

		Actual Rotation Angle
Irradiation Event #1: LCC Tomosynthesis		
Start Time	17 h, 03 min, 15 s, 000 ms	Rotation to the initial angle
Start Time of the first X-Ray pulse	17 h, 03 min, 18 s, 010 ms	-7.72 deg
Start Time of the second X-Ray pulse	17 h, 03 min, 18 s, 276 ms	-6.65 deg
Start Time of the last X-Ray pulse	17 h, 03 min, 21 s, 734 ms	+7.43 deg
End Time of the last X-Ray pulse	17 h, 03 min, 22 s, 000 ms	+7.43 deg
End Time	17 h, 03 min, 22 s, 000 ms	+7.43 deg
Irradiation Event #2: RCC Tomosynthesis		
Start Time	17 h, 04 min, 29 s, 000 ms	Rotation back to the initial angle
Start Time of the first X-Ray pulse	17 h, 04 min, 32 s, 010 ms	-7.73 deg
Start Time of the second X-Ray pulse	17 h, 04 min, 32 s, 276 ms	-6.66 deg
Start Time of the last X-Ray pulse	17 h, 04 min, 35 s, 734 ms	+7.44 deg
End Time of the last X-Ray pulse	17 h, 04 min, 36 s, 000 ms	+7.44 deg
End Time	17 h, 04 min, 36 s, 000 ms	+7.44 deg
Irradiation Event #3: RMLO Tomosynthesis		
Start Time	17 h, 06 min, 21 s, 000 ms	Rotation back to the initial angle
Start Time of the first X-Ray pulse	17 h, 06 min, 24 s, 010 ms	-7.72 deg
Start Time of the second X-Ray pulse	17 h, 06 min, 24 s, 276 ms	-6.65 deg
Start Time of the last X-Ray pulse	17 h, 06 min, 27 s, 734 ms	+7.43 deg
End Time of the last X-Ray pulse	17 h, 06 min, 28 s, 000 ms	+7.43 deg
End Time	17 h, 06 min, 28 s, 000 ms	+7.43 deg
Irradiation Event #4: LMLO Tomosynthesis		
Start Time	17 h, 08 min, 04 s, 000 ms	Rotation back to the initial angle
Start Time of the first X-Ray pulse	17 h, 08 min, 07 s, 010 ms	-7.73 deg
Start Time of the second X-Ray pulse	17 h, 08 min, 07 s, 276 ms	-6.66 deg

Start Time of the last X-Ray pulse	17 h, 08 min, 10 s, 734 ms	+7.44 deg
End Time of the last X-Ray pulse	17 h, 08 min, 11 s, 000 ms	+7.44 deg
End Time	17 h, 08 min, 11 s, 000 ms	+7.44 deg

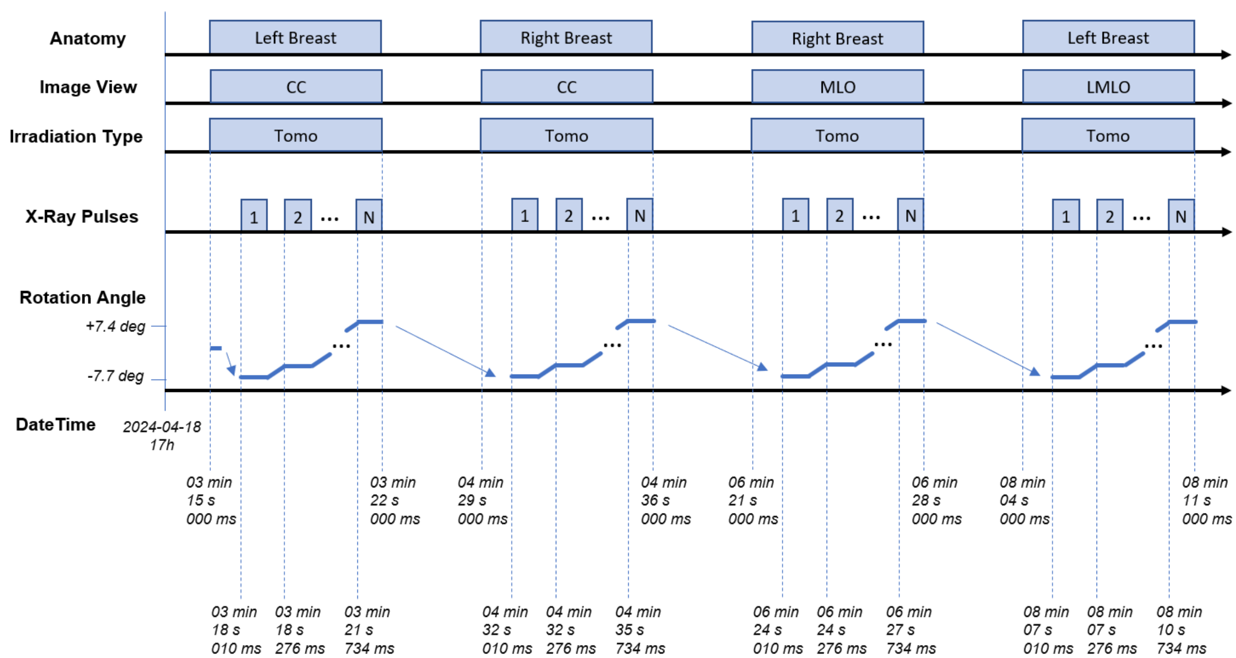

Figure ZZZZZ.5.2.3-1. Timing and rotation angles of the enhanced RDSR example for MG

The geometry of the equipment for this example is illustrated in Figure ZZZZZ.5.2.3-2:

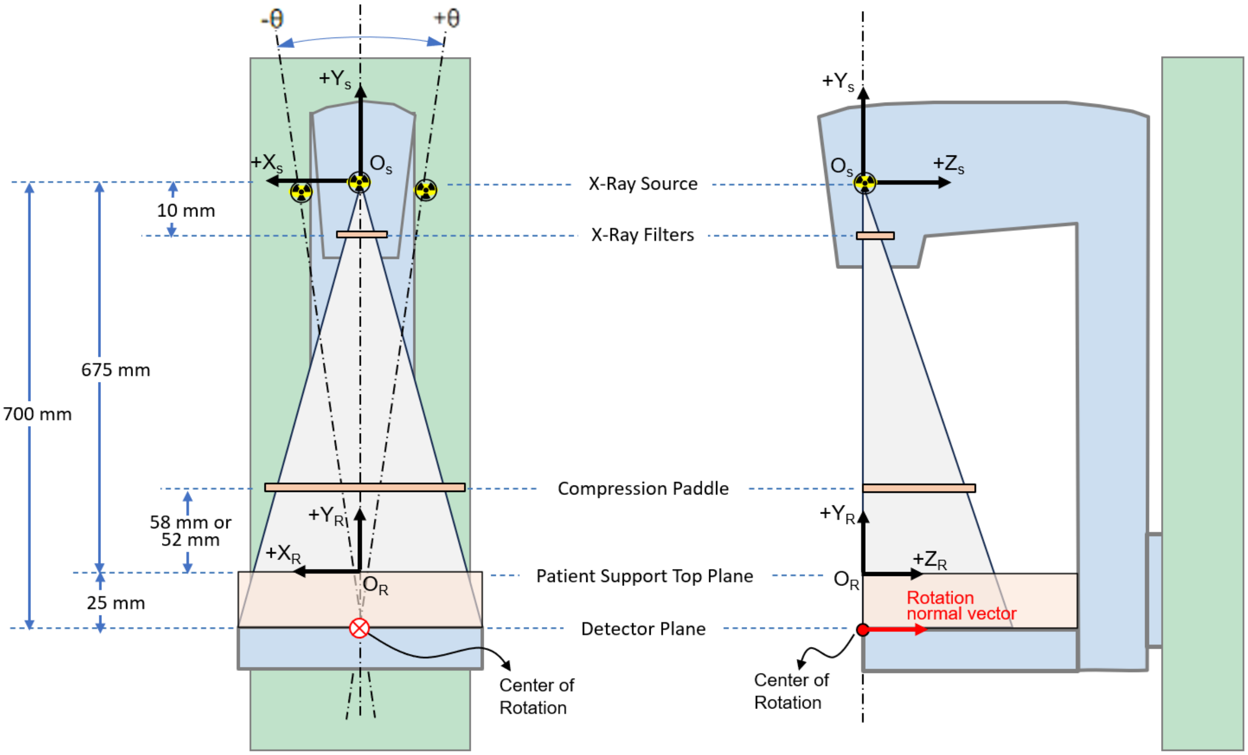

Figure ZZZZZ.5.2.3-2. Geometry of the enhanced RDSR example for MG

Table ZZZZZ.5.2.3-2 illustrates one possible encoding of this example. Note that other alternative implementation patterns exist.

Table ZZZZZ.5.2.3-2. MG Enhanced RDSR Example

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, RFC5646, "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

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.10.1	Identification of the X-Ray Source	1	Section TID 10041
1.10.2	Accumulated Average Glandular Dose	4.65 mGy	Section TID 10041
1.10.2.1	Laterality	(7771000, SCT, “Left”)	Section TID 10041
1.10.3	Accumulated Average Glandular Dose	4.23 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	(113964, DCM, “At Surface of Patient”)	Section TID 10041
<Start Irradiation Event Summary Data TID 10042 for LCC Tomosynthesis (Irradiation Event #1)>			
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	20240418170315.000	Section TID 10042
1.11.3	DateTime Ended	20240418170322.000	Section TID 10042
1.11.4	Identification of the X-Ray Source	1	Section TID 10042
1.11.5	Irradiation Event Type	(113613, DCM, “Rotational Acquisition”)	Section TID 10042
1.11.6	Image View	(SCT, 399162004, “cranio-caudal”)	Section TID 10042
1.11.7	Exposure Index	319	Section TID 10042
1.11.8	Dose (RP)	0.00771 Gy	Section TID 10042
1.11.9	Average Glandular Dose	2.37 mGy	Section TID 10042
1.11.10	Is Rejected Acquisition	No	Section TID 10042
1.11.11	Exposure Time	355.263 ms	Section TID 10042
<Start Irradiation Event Summary Data TID 10042 for RCC Tomosynthesis (Irradiation Event #2)>			
1.12	Irradiation Event Summary Data	<CONTAINER>	Section TID 10042
1.12.1	Irradiation Event UID	2.999.2.3.5	Section TID 10042
1.12.2	DateTime Started	20240418170429.000	Section TID 10042
1.12.3	DateTime Ended	20240418170436.000	Section TID 10042
1.12.4	Identification of the X-Ray Source	1	Section TID 10042
1.12.5	Irradiation Event Type	(113613, DCM, “Rotational Acquisition”)	Section TID 10042
1.12.6	Image View	(SCT, 399162004, “cranio-caudal”)	Section TID 10042
1.12.7	Exposure Index	277	Section TID 10042
1.12.8	Dose (RP)	0.0067 Gy	Section TID 10042
1.12.9	Average Glandular Dose	2.15 mGy	Section TID 10042
1.12.10	Is Rejected Acquisition	No	Section TID 10042
1.12.11	Exposure Time	356.667 ms	Section TID 10042
<Start Irradiation Event Summary Data TID 10042 for RMLO Tomosynthesis (Irradiation Event #3)>			
1.13	Irradiation Event Summary Data	<CONTAINER>	Section TID 10042
1.13.1	Irradiation Event UID	2.999.2.3.6	Section TID 10042
1.13.2	DateTime Started	20240418170621.000	Section TID 10042

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.13.3	DateTime Ended	20240418170628.000	Section TID 10042
1.13.4	Identification of the X-Ray Source	1	Section TID 10042
1.13.5	Irradiation Event Type	(113613, DCM, “Rotational Acquisition”)	Section TID 10042
1.13.6	Image View	(SCT, 399368009, “medio-lateral oblique”)	Section TID 10042
1.13.7	Exposure Index	279	Section TID 10042
1.13.8	Dose (RP)	0.00648 Gy	Section TID 10042
1.13.9	Average Glandular Dose	2.08 mGy	Section TID 10042
1.13.10	Is Rejected Acquisition	No	Section TID 10042
1.13.11	Exposure Time	344.444 ms	Section TID 10042
<Start Irradiation Event Summary Data TID 10042 for LMLO Tomosynthesis (Irradiation Event #4)>			
1.14	Irradiation Event Summary Data	<CONTAINER>	Section TID 10042
1.14.1	Irradiation Event UID	2.999.2.3.7	Section TID 10042
1.14.2	DateTime Started	20240418170804.000	Section TID 10042
1.14.3	DateTime Ended	20240418170811.000	Section TID 10042
1.14.4	Identification of the X-Ray Source	1	Section TID 10042
1.14.5	Irradiation Event Type	(113613, DCM, “Rotational Acquisition”)	Section TID 10042
1.14.6	Image View	(SCT, 399368009, “medio-lateral oblique”)	Section TID 10042
1.14.7	Exposure Index	315	Section TID 10042
1.14.8	Dose (RP)	0.00741 Gy	Section TID 10042
1.14.9	Average Glandular Dose	2.28 mGy	Section TID 10042
1.14.10	Is Rejected Acquisition	No	Section TID 10042
1.14.11	Exposure Time	340.526 ms	Section TID 10042
1.15	Irradiation Details	<CONTAINER>	Section TID 10043
1.15.1	DateTime Started	20240418170315.000	Section TID 10043
1.15.2	DateTime Ended	20240418170811.000	Section TID 10043
1.15.3	Frame of Reference UID	2.999.1.2.3	Section TID 10043
1.15.4	RDSR Frame of Reference Origin	(130538, DCM, "Patient Support Origin")	Section TID 10043
1.15.5	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 C-arm 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 10043
1.15.6	Radiation Source Characteristics	<CONTAINER>	Section TID 10044
1.15.6.1	DateTime Started	20240418170315.000	Section TID 10044
1.15.6.2	DateTime Ended	20240418170811.000	Section TID 10044
1.15.6.3	Identification of the X-Ray Source	1	Section TID 10044
1.15.6.4	Focal Spot Size	0.3 mm	Section TID 10044

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.15.6.5	Anode Target Material	(26194003, SCT, "Tungsten")	Section TID 10044
1.15.6.6	Attenuator Characteristics	<CONTAINER>	Section TID 10044
1.15.6.6.1	Equivalent Attenuator Material	(12503006, SCT, "Aluminum")	Section TID 10044
1.15.6.6.2	Equivalent Attenuator Thickness	0.03 mm	Section TID 10044
1.15.7	Radiation Technique	<CONTAINER>	Section TID 10045
1.15.7.1	DateTime Started	20240418170315.000	Section TID 10045
1.15.7.2	DateTime Ended	20240418170811.000	Section TID 10045
1.15.7.3	Identification of the X-Ray Source	1	Section TID 10045
1.15.7.4	Half Value Layer	20240418170315.000 0.622 mm 20240418170429.000 0.592 mm 20240418170621.000 0.592 mm 20240418170804.000 0.622 mm	Section TID 10045
1.15.7.5	KVP	20240418170315.000 32 kV 20240418170429.000 31 kV 20240418170621.000 31 kV 20240418170804.000 32 kV	Section TID 10045
1.15.7.6	X-Ray Tube Current	20240418170315.000 190 mA 20240418170429.000 180 mA 20240418170621.000 180 mA 20240418170804.000 190 mA	Section TID 10045
1.15.8	Filtration	<CONTAINER>	Section TID 10046
1.15.8.1	DateTime Started	20240418170315.000	Section TID 10046
1.15.8.2	DateTime Ended	20240418170811.000	Section TID 10046
1.15.8.3	Identification of the X-Ray Source	1	Section TID 10046
1.15.8.4	Attenuator Characteristics	<CONTAINER>	Section TID 10055
1.15.8.4.1	Identification of the Attenuator	1	Section TID 10055
1.15.8.4.2	Attenuator Category	(113771, DCM, "X-Ray Filters")	Section TID 10055
1.15.8.4.3	X-Ray Filter Material	(12503006, SCT, “Aluminum”)	Section TID 10055
1.15.8.4.4	X-Ray Filter Type	(113653, DCM, "Flat filter")	Section TID 10055
1.15.8.4.5	X-Ray Filter Thickness	0.7 mm	Section TID 10055
1.15.9	Attenuators	<CONTAINER>	Section TID 10047
1.15.9.1	DateTime Started	20240418170315.000	Section TID 10047
1.15.9.2	DateTime Ended	20240418170811.000	Section TID 10047
1.15.9.3	Attenuator Characteristics	<CONTAINER>	Section TID 10055
1.15.9.3.1	Identification of the Attenuator	2	Section TID 10055
1.15.9.3.2	Attenuator Category	(129460009, SCT, “Compression Paddle”)	Section TID 10055
1.15.9.3.3	X-Ray Filter Material	(412154003, SCT, “Polycarbonate”)	Section TID 10055
1.15.9.3.4	X-Ray Filter Type	(113650, DCM, "Strip Filter")	Section TID 10055
1.15.9.3.5	X-Ray Filter Thickness	2.5 mm	Section TID 10055

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.15.10	Radiation Output	<CONTAINER>	Section TID 10048
1.15.10.1	DateTime Started	20240418170315.000	Section TID 10048
1.15.10.2	DateTime Ended	20240418170811.000	Section TID 10048
1.15.10.3	Identification of the X-Ray Source	1	Section TID 10048
1.15.10.4	Air Kerma at Output Measurement Point	20240418170318.010 0 mGy 20240418170318.276 0.514 mGy 20240418170318.542 0.514 mGy 20240418170318.808 0.514 mGy 20240418170319.074 0.514 mGy 20240418170319.340 0.514 mGy 20240418170319.606 0.514 mGy 20240418170319.872 0.514 mGy 20240418170320.138 0.514 mGy 20240418170320.404 0.514 mGy 20240418170320.670 0.514 mGy 20240418170320.936 0.514 mGy 20240418170321.202 0.514 mGy 20240418170321.468 0.514 mGy 20240418170321.734 0.514 mGy 20240418170322.000 0.514 mGy 20240418170432.010 0 mGy 20240418170432.276 0.447 mGy 20240418170432.542 0.447 mGy 20240418170432.808 0.447 mGy 20240418170433.074 0.447 mGy 20240418170433.340 0.447 mGy 20240418170433.606 0.447 mGy 20240418170433.872 0.447 mGy 20240418170434.138 0.447 mGy 20240418170434.404 0.447 mGy 20240418170434.670 0.447 mGy 20240418170434.936 0.447 mGy 20240418170435.202 0.447 mGy 20240418170435.468 0.447 mGy 20240418170435.734 0.447 mGy 20240418170436.000 0.447 mGy 20240418170624.010 0 mGy 20240418170624.276 0.432 mGy 20240418170624.542 0.432 mGy 20240418170624.808 0.432 mGy 20240418170625.074 0.432 mGy 20240418170625.340 0.432 mGy 20240418170625.606 0.432 mGy 20240418170625.872 0.432 mGy 20240418170626.138 0.432 mGy 20240418170626.404 0.432 mGy 20240418170626.670 0.432 mGy	Section TID 10048

Node	Code Meaning of Concept Name	Code or Example Value	TID
		20240418170626.936 | 0.432 mGy 20240418170627.202 | 0.432 mGy 20240418170627.468 | 0.432 mGy 20240418170627.734 | 0.432 mGy 20240418170628.000 | 0.432 mGy 20240418170807.010 | 0 mGy 20240418170807.276 | 0.494 mGy 20240418170807.542 | 0.494 mGy 20240418170807.808 | 0.494 mGy 20240418170808.074 | 0.494 mGy 20240418170808.340 | 0.494 mGy 20240418170808.606 | 0.494 mGy 20240418170808.872 | 0.494 mGy 20240418170809.138 | 0.494 mGy 20240418170809.404 | 0.494 mGy 20240418170809.670 | 0.494 mGy 20240418170809.936 | 0.494 mGy 20240418170810.202 | 0.494 mGy 20240418170810.468 | 0.494 mGy 20240418170810.734 | 0.494 mGy 20240418170811.000 | 0.494 mGy	
1.15.11	Radiation Field Area	<CONTAINER>	Section TID 10049
1.15.11.1	DateTime Started	20240418170315.000	Section TID 10049
1.15.11.2	DateTime Ended	20240418170811.000	Section TID 10049
1.15.11.3	Identification of the X-Ray Source	1	Section TID 10049
1.15.11.4	Radiation Field Outline	SCOORD3D POLYGON	Section TID 10049
1.15.12	X-Ray Source Reference Coordinate System	<CONTAINER>	Section TID 10050
1.15.12.1	DateTime Started	20240418170315.000	Section TID 10050
1.15.12.2	DateTime Ended	20240418170811.000	Section TID 10050
1.15.12.3	Identification of the X-Ray Source	1	Section TID 10050
1.15.12.4	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 10050
1.15.12.5	Center of Rotation	[0, -700, 0]	Section TID 10050
1.15.12.6	Rotation Plane Normal Point	[0, -700, 1]	Section TID 10050
1.15.12.6	Rotation Angle	20240418170318.010 | -7.72 deg 20240418170318.276 | -6.65 deg 20240418170318.542 | -5.58 deg 20240418170318.808 | -4.49 deg 20240418170319.074 | -3.40 deg	

Node	Code Meaning of Concept Name	Code or Example Value		TID
		20240418170319.340	-2.32 deg	
		20240418170319.606	-1.22 deg	
		20240418170319.872	-0.14 deg	
		20240418170320.138	0.93 deg	
		20240418170320.404	2.01 deg	
		20240418170320.670	3.11 deg	
		20240418170320.936	4.18 deg	
		20240418170321.202	5.25 deg	
		20240418170321.468	6.35 deg	
		20240418170321.734	7.43 deg	
		20240418170432.010	-7.73 deg	
		20240418170432.276	-6.66 deg	
		20240418170432.542	-5.58 deg	
		20240418170432.808	-4.49 deg	
		20240418170433.074	-3.40 deg	
		20240418170433.340	-2.33 deg	
		20240418170433.606	-1.23 deg	
		20240418170433.872	-0.14 deg	
		20240418170434.138	0.93 deg	
		20240418170434.404	2.00 deg	
		20240418170434.670	3.11 deg	
		20240418170434.936	4.18 deg	
		20240418170435.202	5.25 deg	
		20240418170435.468	6.35 deg	
		20240418170435.734	7.44 deg	
		20240418170624.010	-7.72 deg	
		20240418170624.276	-6.65 deg	
		20240418170624.542	-5.58 deg	
		20240418170624.808	-4.49 deg	
		20240418170625.074	-3.40 deg	
		20240418170625.340	-2.32 deg	
		20240418170625.606	-1.22 deg	
		20240418170625.872	-0.14 deg	
		20240418170626.138	0.93 deg	
		20240418170626.404	2.01 deg	
		20240418170626.670	3.11 deg	
		20240418170626.936	4.18 deg	
		20240418170627.202	5.25 deg	
		20240418170627.468	6.35 deg	
		20240418170627.734	7.43 deg	
		20240418170807.010	-7.73 deg	
		20240418170807.276	-6.66 deg	
		20240418170807.542	-5.58 deg	
		20240418170807.808	-4.49 deg	
		20240418170808.074	-3.40 deg	
		20240418170808.340	-2.33 deg	
		20240418170808.606	-1.23 deg	
		20240418170808.872	-0.14 deg	

Node	Code Meaning of Concept Name	Code or Example Value	TID
		20240418170809.138 0.93 deg 20240418170809.404 2.00 deg 20240418170809.670 3.11 deg 20240418170809.936 4.18 deg 20240418170810.202 5.25 deg 20240418170810.468 6.35 deg 20240418170810.734 7.44 deg	
<Start Beam Position TID 10051 for LCC Tomosynthesis (Irradiation Event #1)>			
1.15.13	Beam Position	<CONTAINER>	Section TID 10051
1.15.13.1	DateTime Started	20240418170315.000	Section TID 10051
1.15.13.2	DateTime Ended	20240418170322.000	Section TID 10051
1.15.13.3	Identification of the X-Ray Source	1	Section TID 10051
1.15.13.4	Output Measurement Point Position	SCOORD3D POINT	Section TID 10051
1.15.13.5	Reference Point Position	SCOORD3D POINT	Section TID 10051
1.15.13.6	X-Ray Beam Attenuator Model	<CONTAINER>	Section TID 10051
1.15.13.6.1	Identification of the Attenuator	1	Section TID 10051
1.15.13.6.2	X-Ray Attenuator Model Data	2.999.3.4.5	Section TID 10051
1.15.13.6.3	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
<Start Beam Position TID 10051 for RCC Tomosynthesis (Irradiation Event #2)>			
1.15.14	Beam Position	<CONTAINER>	Section TID 10051
1.15.14.1	DateTime Started	20240418170429.000	Section TID 10051
1.15.14.2	DateTime Ended	20240418170436.000	Section TID 10051
1.15.14.3	Identification of the X-Ray Source	1	Section TID 10051
1.15.14.4	Output Measurement Point Position	SCOORD3D POINT	Section TID 10051
1.15.14.5	Reference Point Position	SCOORD3D POINT	Section TID 10051
1.15.14.6	X-Ray Beam Attenuator Model	<CONTAINER>	Section TID 10051
1.15.14.6.1	Identification of the Attenuator	1	Section TID 10051
1.15.14.6.2	X-Ray Attenuator Model Data	2.999.3.4.5	Section TID 10051
1.15.14.6.3	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
<Start Beam Position TID 10051 for RMLO Tomosynthesis (Irradiation Event #3)>			
1.15.15	Beam Position	<CONTAINER>	Section TID 10051
1.15.15.1	DateTime Started	20240418170621.000	Section TID 10051

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.15.15.2	DateTime Ended	20240418170628.000	Section TID 10051
1.15.15.3	Identification of the X-Ray Source	1	Section TID 10051
1.15.15.4	Output Measurement Point Position	SCOORD3D POINT	Section TID 10051
1.15.15.5	Reference Point Position	SCOORD3D POINT	Section TID 10051
1.15.15.6	X-Ray Beam Attenuator Model	<CONTAINER>	Section TID 10051
1.15.15.6.1	Identification of the Attenuator	1	Section TID 10051
1.15.15.6.2	X-Ray Attenuator Model Data	2.999.3.4.5	Section TID 10051
1.15.15.6.3	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
<Start Beam Position TID 10051 for LMLO Tomosynthesis (Irradiation Event #4)>			
1.15.16	Beam Position	<CONTAINER>	Section TID 10051
1.15.16.1	DateTime Started	20240418170804.000	Section TID 10051
1.15.16.2	DateTime Ended	20240418170811.000	Section TID 10051
1.15.16.3	Identification of the X-Ray Source	1	Section TID 10051
1.15.16.4	Output Measurement Point Position	SCOORD3D POINT	Section TID 10051
1.15.16.5	Reference Point Position	SCOORD3D POINT	Section TID 10051
1.15.16.6	X-Ray Beam Attenuator Model	<CONTAINER>	Section TID 10051
1.15.16.6.1	Identification of the Attenuator	1	Section TID 10051
1.15.16.6.2	X-Ray Attenuator Model Data	2.999.3.4.5	Section TID 10051
1.15.16.6.3	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
<Start Attenuator Position TID 10052 for LCC Tomosynthesis (Irradiation Event #1)>			
1.15.17	Attenuator Position	<CONTAINER>	Section TID 10052
1.15.17.1	DateTime Started	20240418170315.000	Section TID 10052
1.15.17.2	DateTime Ended	20240418170322.000	Section TID 10052
1.15.17.3	X-Ray Beam Attenuator Model	<CONTAINER>	Section TID 10052
1.15.17.3.1	Identification of the Attenuator	2	Section TID 10052
1.15.17.3.2	X-Ray Attenuator Model Data	2.999.3.4.6	Section TID 10052
1.15.17.3.3	Transformation Matrix	1.0 0.0 0.0 0.0 0.0 1.0 0.0 58 0.0 0.0 1.0 0.0 0.0 0.0 0.0 1.0	Section TID 10052

Node	Code Meaning of Concept Name	Code or Example Value	TID
<Start Attenuator Position TID 10052 for RCC Tomosynthesis (Irradiation Event #2)>			
1.15.18	Attenuator Position	<CONTAINER>	Section TID 10052
1.15.18.1	DateTime Started	20240418170429.000	Section TID 10052
1.15.18.2	DateTime Ended	20240418170436.000	Section TID 10052
1.15.18.3	X-Ray Beam Attenuator Model	<CONTAINER>	Section TID 10052
1.15.18.3.1	Identification of the Attenuator	2	Section TID 10052
1.15.18.3.2	X-Ray Attenuator Model Data	2.999.3.4.6	Section TID 10052
1.15.18.3.3	Transformation Matrix	1.0 | 0.0 | 0.0 | 0.0 0.0 | 1.0 | 0.0 | 52 0.0 | 0.0 | 1.0 | 0.0 0.0 | 0.0 | 0.0 | 1.0	Section TID 10052
<Start Attenuator Position TID 10052 for RMLO Tomosynthesis (Irradiation Event #3)>			
1.15.19	Attenuator Position	<CONTAINER>	Section TID 10052
1.15.19.1	DateTime Started	20240418170621.000	Section TID 10052
1.15.19.2	DateTime Ended	20240418170628.000	Section TID 10052
1.15.19.3	X-Ray Beam Attenuator Model	<CONTAINER>	Section TID 10052
1.15.19.3.1	Identification of the Attenuator	2	Section TID 10052
1.15.19.3.2	X-Ray Attenuator Model Data	2.999.3.4.6	Section TID 10052
1.15.19.3.3	Transformation Matrix	1.0 | 0.0 | 0.0 | 0.0 0.0 | 1.0 | 0.0 | 52 0.0 | 0.0 | 1.0 | 0.0 0.0 | 0.0 | 0.0 | 1.0	Section TID 10052
<Start Attenuator Position TID 10052 for LMLO Tomosynthesis (Irradiation Event #4)>			
1.15.20	Attenuator Position	<CONTAINER>	Section TID 10052
1.15.20.1	DateTime Started	20240418170804.000	Section TID 10052
1.15.20.2	DateTime Ended	20240418170811.000	Section TID 10052
1.15.20.3	X-Ray Beam Attenuator Model	<CONTAINER>	Section TID 10052
1.15.20.3.1	Identification of the Attenuator	2	Section TID 10052
1.15.20.3.2	X-Ray Attenuator Model Data	2.999.3.4.6	Section TID 10052
1.15.20.3.3	Transformation Matrix	1.0 | 0.0 | 0.0 | 0.0 0.0 | 1.0 | 0.0 | 58 0.0 | 0.0 | 1.0 | 0.0 0.0 | 0.0 | 0.0 | 1.0	Section TID 10052
1.15.21	Patient Attenuation Characteristics	<CONTAINER>	Section TID 10053
1.15.21.1	DateTime Started	20240418170315.000	Section TID 10053
1.15.21.2	DateTime Ended	20240418170811.000	Section TID 10053

Node	Code Meaning of Concept Name	Code or Example Value	TID
1.15.21.3	Identification of the X-Ray Source	1	Section TID 10053
1.15.21.4	Patient Equivalent Thickness	20240418170315.000 58 mm 20240418170429.000 52 mm 20240418170621.000 52 mm 20240418170804.000 58 mm	Section TID 10053
1.15.21.5	Breast composition	(129717001, SCT, “Scattered fibroglandular densities”)	Section TID 10053
<Start Procedure Characteristics TID 10054 for LCC Tomosynthesis (Irradiation Event #1)>			
1.15.22	Procedure Characteristics	<CONTAINER>	Section TID 10054
1.15.22.1	DateTime Started	20240418170315.000	Section TID 10054
1.15.22.2	DateTime Ended	20240418170322.000	Section TID 10054
1.15.22.3	Identification of the X-Ray Source	1	Section TID 10054
1.15.22.4	Acquisition Protocol	L CC Tomo	Section TID 10054
1.15.22.5	Target Region	(76752008, SCT, “Breast”)	Section TID 10054
1.15.22.5.1	Laterality	(7771000, SCT, “Left”)	Section TID 10054
1.15.22.6	X-Ray Grid	(111646, DCM, “No grid”)	Section TID 10054
1.15.22.7	Distance Source to Detector	700 mm	Section TID 10054
<Start Procedure Characteristics TID 10054 for RCC Tomosynthesis (Irradiation Event #2)>			
1.15.23	Procedure Characteristics	<CONTAINER>	Section TID 10054
1.15.23.1	DateTime Started	20240418170429.000	Section TID 10054
1.15.23.2	DateTime Ended	20240418170436.000	Section TID 10054
1.15.23.3	Identification of the X-Ray Source	1	Section TID 10054
1.15.23.4	Acquisition Protocol	R CC Tomo	Section TID 10054
1.15.23.5	Target Region	(76752008, SCT, “Breast”)	Section TID 10054
1.15.23.5.1	Laterality	(24028007, SCT, “Right”)	Section TID 10054
1.15.23.6	X-Ray Grid	(111646, DCM, “No grid”)	Section TID 10054
1.15.23.7	Distance Source to Detector	700 mm	Section TID 10054
<Start Procedure Characteristics TID 10054 for RMLO Tomosynthesis (Irradiation Event #3)>			
1.15.24	Procedure Characteristics	<CONTAINER>	Section TID 10054
1.15.24.1	DateTime Started	20240418170621.000	Section TID 10054
1.15.24.2	DateTime Ended	20240418170628.000	Section TID 10054
1.15.24.3	Identification of the X-Ray Source	1	Section TID 10054
1.15.24.4	Acquisition Protocol	R MLO Tomo	Section TID 10054
1.15.24.5	Target Region	(76752008, SCT, “Breast”)	Section TID 10054
1.15.24.5.1	Laterality	(24028007, SCT, “Right”)	Section TID 10054
1.15.24.6	X-Ray Grid	(111646, DCM, “No grid”)	Section TID 10054
1.15.24.7	Distance Source to Detector	700 mm	Section TID 10054

Node	Code Meaning of Concept Name	Code or Example Value	TID
<Start Procedure Characteristics TID 10054 for LMLO Tomosynthesis (Irradiation Event #4)>			
1.15.25	Procedure Characteristics	<CONTAINER>	Section TID 10054
1.15.25.1	DateTime Started	20240418170804.000	Section TID 10054
1.15.25.2	DateTime Ended	20240418170811.000	Section TID 10054
1.15.25.3	Identification of the X-Ray Source	1	Section TID 10054
1.15.25.4	Acquisition Protocol	L MLO Tomo	Section TID 10054
1.15.25.5	Target Region	(76752008, SCT, “Breast”)	Section TID 10054
1.15.25.5.1	Laterality	(7771000, SCT, “Left”)	Section TID 10054
1.15.25.6	X-Ray Grid	(111646, DCM, “No grid”)	Section TID 10054
1.15.25.7	Distance Source to Detector	700 mm	Section TID 10054
Start Person Participant within TID 10040			
1.16	Person Name	Mann^Hugh^^Dr	Section TID 1020
1.16.1	Person Role in Procedure	(113850, DCM, “Irradiation Authorizing”)	Section TID 1020
1.16.2	Person ID	5321611	Section TID 1020
1.16.3	Person ID Issuer	Institution A	Section TID 1020
1.16.4	Person Role in Organization	(309343006, SCT, “Physician”)	Section TID 1020
End Person Participant			
1.17	Source of Dose Information	(113856, DCM, "Automated Data Collection")	Section TID 10040