Digital Imaging and Communications in Medicine (DICOM)

Part 3: Information Object Definitions

Published by

National Electrical Manufacturers Association
1300 N. 17th Street
Rosslyn, Virginia 22209 USA

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FOREWORD

The American College of Radiology (ACR) and the National Electrical Manufacturers Association (NEMA) formed a joint committee to develop a standard for Digital Imaging and Communications in Medicine (DICOM). This DICOM Standard was developed according to the NEMA procedures.

This standard is developed in liaison with other standardization organizations including CEN TC251 in Europe and JIRA in Japan, with review also by other organizations including IEEE, HL7 and ANSI in the USA.

The DICOM Standard is structured as a multi-part document using the guidelines established in the following document:

¾ ISO/IEC Directives, 1989 Part 3 : Drafting and Presentation of International Standards.

This document is one part of the DICOM Standard which consists of the following parts:

PS 3.1: Introduction and Overview

PS 3.2: Conformance

PS 3.3: Information Object Definitions

PS 3.4: Service Class Specifications

PS 3.5: Data Structures and Encoding

PS 3.6: Data Dictionary

PS 3.7: Message Exchange

PS 3.8: Network Communication Support for Message Exchange

PS 3.9: Point-to-Point Communication Support for Message Exchange

PS 3.10: Media Storage and File Format for Media Interchange

PS 3.11: Media Storage Application Profiles

PS 3.12: Formats and Physical Media

PS 3.13: Print Management Point-to-Point Communication Support

PS 3.14: Grayscale Standard Display Function

These parts are related but independent documents. Their development level and approval status may differ. Additional parts may be added to this multi-part standard. PS 3.1 should be used as the base reference for the current parts of this standard.

1 Scope and field of application

This Part of the DICOM Standard specifies the set of Information Object Definitions (IODs) which provide an abstract definition of real-world objects applicable to communication of digital medical information. For each IOD, this Part specifies:

- ¾ any necessary information for the semantic description of the IOD
- ¾ relationships to associated real-world objects relevant to the IOD
- ¾ Attributes which describe the characteristics of the IOD

For each IOD, this Part does not specify:

- ¾ the nature of any Service Class Definition intended to reference the IOD
- ¾ the nature of any interactions which result in the usage of the IOD

This Part is related to other parts of the DICOM Standard in that:

- ¾ PS 3.4, Service Class Specifications, specifies application level services by grouping DIMSE services with IODs as defined in this Part;
- ¾ PS 3.5, Data Structure and Semantics, defines the data encoding used in the DIMSE Protocol when applied to IODs defined in this Part;
- ¾ PS 3.6, Data Dictionary, contains an index by Tag of all IOD Attributes defined in this Part. This index includes the Value Representation and Value Multiplicity for each Attribute;
- ¾ PS 3.7, Message Exchange Protocol, defines the DIMSE Services and Protocol which may be applied to IODs defined in this Part.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibilities of applying the most recent editions of the standards indicated below.

ISO/IEC Directives, 1989 Part 3 - Drafting and Presentation of International Standards

ISO 7498-1, Information Processing Systems - Open Systems Interconnection - Basic Reference Model

ISO/TR 8509, Information Processing Systems - Open Systems Interconnection - Service Conventions

ISO/IEC 2022:1994 Information technology - Character code structure and extension techniques.

AIUM and NEMA Standard for Real-Time Display of Thermal and Mechanical Acoustic Output Indices on Diagnostic Ultrasound Equipment.

IEC Standard 1217, Radiotherapy Equipment - Coordinates, Movements and Scales (Reference CEI/IEC 1217: 1996)

ICRU Report 50, Prescribing, Recording, and Reporting Photon Beam Therapy, International Commission on Radiation Units and Measurements, 1993

3 Definitions

For the purposes of this Standard the following definitions apply.

3.1 Reference model definitions

This Part of the Standard is based on the concepts developed in ISO 7498-1 and makes use of the following terms defined in it:

a. Application Entity
b. Service or Layer Service

3.2 Service conventions definitions

This Part of the Standard makes use of the following terms defined in ISO/TR 8509:

a. Primitive

3.3 DICOM introduction and overview definitions

This Part of the Standard makes use of the following terms defined in PS 3.1:

a. Attribute
b. Command
c. Data Dictionary
d. Message

3.4 DICOM service class specifications

This Part of the Standard makes use of the following terms defined in PS 3.4:

a. Real-World Activity
b. Real-World Object
c. Service Class
d. Service Class User
e. Service Class Provider
f. Service-Object Pair (SOP) Class
g. Service-Object Pair (SOP) Instance
h. Preformatted Grayscale Image
I. Preformatted Color Image

3.5 DICOM data structures and encoding

This Part of the Standard makes use of the following terms defined in PS 3.5:

a. Data Element
b. Data Element Tag
c. Data Element Type
d. Data Set
e. Defined Term
f. Enumerated Value
g. Sequence of Items
h. Unique Identifier (UID)

3.6 DICOM message exchange

This Part of the Standard makes use of the following terms defined in PS 3.7:

a. DICOM Message Service Element (DIMSE)
b. DIMSE-N Services
c. DIMSE-C Services

3.7 DICOM upper layer service

This Part of the Standard makes use of the following terms defined in PS 3.8:

a. DICOM Upper Layer Service

3.8 DICOM Information Object

The following definitions are commonly used in this part of the Standard:

3.8.1 Attribute tag: A unique identifier for an Attribute of an Information Object composed of an ordered pair of numbers (a Group Number followed by an Element number).

3.8.2 Composite IOD: an Information Object Definition which represents parts of several entities in the DICOM Application Model. Such an IOD includes Attributes which are not inherent in the Real-World Object that the IOD represents but rather are inherent in related Real-World Objects.

3.8.3 Derived image: an image in which the pixel data was constructed from pixel data of one or more other images (source images).

3.8.4 DICOM information model: an Entity-Relationship diagram which is used to model the relationships between the Information Object Definitions representing classes of Real-World Objects defined by the DICOM Application Model.

3.8.5 DICOM application model: an Entity-Relationship diagram used to model the relationships between Real-World Objects which are within the area of interest of the DICOM Standard.

3.8.6 Information entity: that portion of information defined by a Composite IOD which is related to one specific class of Real-World Object. There is a one-to-one correspondence between Information Entities and entities in the DICOM Application Model**.**

3.8.7 Information object definition (IOD): a data abstraction of a class of similar Real-World Objects which defines the nature and Attributes relevant to the class of Real-World Objects represented.

3.8.8 Module: A set of Attributes within an Information Entity or Normalized IOD which are logically related to each other.

3.8.9 Multi-frame image: Image that contains multiple two-dimensional pixel planes.

3.8.10 Normalized IOD: an Information Object Definition which represents a single entity in the DICOM Application Model. Such an IOD includes Attributes which are only inherent in the Real-World Object that the IOD represents.

3.8.11 Cine run: A set of temporally related frames acquired at constant or variable frame rates. This term incorporates the general class of serialography**.**

Note: A Cine run is typically encoded as a multi-frame image.

3.9 Character Handling Definitions

This part of the standard makes use of the following terms defined in ISO/IEC 2011:1994:

a. Coded character set; code.
b. Code extension;
c. Escape sequence.

3.10 Radiotherapy

This Part of the Standard is based on the concepts developed in IEC 1217 and makes use of the following terms defined in it:

a. FIXED REFERENCE system
b. GANTRY system
c. BEAM LIMITING DEVICE system
d. WEDGE FILTER system
e. X-RAY IMAGE RECEPTOR system
f. PATIENT SUPPORT system
g. TABLE TOP ECCENTRIC system
h. TABLE TOP system

3.11 Attribute Macro: a set of Attributes that are described in a single table that is referenced by multiple Module or other tables.

4 Symbols and abbreviations

The following symbols and abbreviations are used in this Part of the Standard.

ACR	American College of Radiology
ASCII	American Standard Code for Information Interchange
AE	Application Entity
ANSI	American National Standards Institute

BEV	Beam's-eye view
Brachy	Brachytherapy
CC	Counter-clockwise
CEN TC251	Comite European de Normalisation-Technical Committee 251-Medical Informatics
CCIR	Consultative Committee, International Radio
CTV	Clinical target volume
CW	Clockwise
DICOM	Digital Imaging and Communications in Medicine
DIMSE	DICOM Message Service Element
DIMSE-C	DICOM Message Service Element-Composite
DIMSE-N	DICOM Message Service Element-Normalized
DRR	Digitally-reconstructed radiograph
DVH	Dose-volume histogram
GTV	Gross tumor volume
Gy	Gray
HISPP	Healthcare Information Standards Planning Panel
HL7	Health Level 7
ICRU	International Commission on Radiation Units
IE	Information Entity
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IOD	Information Object Definition
ISO	International Standards Organization
JIRA	Japan Industries Association of Radiation Apparatus
LUT	Lookup Table
MeV	Mega electron Volt
MLC	Multileaf (multi-element) collimator
MSDS	Healthcare Message Standard Developers Sub-Committee
MU	Monitor unit
MV	Megavolt
NEMA	National Electrical Manufacturers Association
OSI	Open Systems Interconnection
PTV	Planning target volume
R&V	Record and verify
ROI	Region of interest
RT	Radiotherapy
SAD	Source-axis distance
SCP	Service Class Provider
SCU	Service Class User
SID	Source-image distance
SOP	Service-Object Pair
UID	Unique Identifier

5 Conventions

5.1 ENTITY-RELATIONSHIP MODEL

5.1.1 ENTITY

An entity is used in an Entity-Relationship (E-R) model to represent a Real-World Object, class of Real-World Objects, or DICOM data representation (such as an IOD or Module). An entity is depicted as shown in Figure 5.1-1.

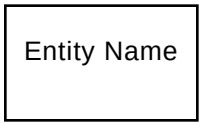


Figure 5.1-1
ENTITY CONVENTION

5.1.2 RELATIONSHIP

A relationship, which defines how entities are related, is depicted as a diamond within this Part of the DICOM Standard as shown in Figure 5.1-2.

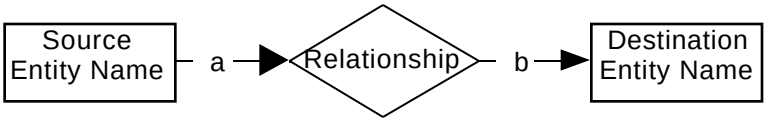


Figure 5.1-2
RELATIONSHIP CONVENTION

The relationship is read from source to destination entity as indicated by the arrows. The a and b show the source and destination cardinality of the relationship respectively. The following cardinalities are permitted:

a. (a = 1, b = 1) - one source entity is related to one destination entity
b. (a = 1, b = 0-n) - one source entity is related to zero or more destination entities
c. (a = 1, b = 1-n) - one source entity is related to one or more destination entities
d. (a = 1-n, b = 1) - one or more source entities are related to one destination entity
e. (a = 1-n, b = 0-n) - one or more source entities are related to zero or more destination entities
f. (a = 1-n, b = 1-n) - one or more source entities are related to one or more destination entities

In a relationship where (a = 1-n, b = 1-n) the values of the source and destination cardinalities may be different. The value "n" simply denotes one or more.

Note: DICOM has added the use of arrows to the E-R diagramming conventions often used in other literature. This has been done to avoid the possibility of inferring an incorrect relationship which can result from reading a relationship in the reverse order of that intended. For example, a relationship "Cat Catches Mouse" could be read "Mouse Catches Cat" if the arrows were not present.

A relationship may be bi-directional (i.e. the relationship is true in both directions). In such a case, the convention used is arrows pointing toward both the source and the destination entities.

5.2 SEQUENCES

Certain Tables in this Standard describe Sequences of Items by using the symbol: '>'. The symbol '>' precedes the Attribute (or Module) Name of the members of an Item. All marked Attributes (or Modules) belong to the generic description of an Item which may be repeated to form a Sequence of Items. This Sequence of Items is nested in the Attribute (or Module) which precedes in the table the first member marked with a '>'.

Note: The following table describes the "Referenced Series Sequences" Attribute as a Sequence of one or more Items where each Item contains the three Attributes marked by a '>'. The Sequence of Items is nested inside the value of the Referenced Series Sequence Attribute. The following Attribute (not marked) is not part of the Items of the Sequence.

.....	.....
Referenced Series Sequence	.....
> Series Date	.....
> Series Time	.....
> Series Instance UID	.....
Modality	....

This notation may be used to create nested hierarchical structures by using '>>' at the second level of nesting and so on

5.3 TRIPLET ENCODING OF STRUCTURED DATA

Structured data entry using standardized coding schemes is a fundamental requirement of a computer-based patient record. Many DICOM modules utilize sequences to allow structured data entry to convey coded entries of many types (e.g. Primary Anatomic Structure Sequence (0008,2228), Patient's Insurance Plan Code Sequence (0010,0050), Interventional Drug Sequence (0018,0029)). These sequences utilize triplets to define the coding scheme to be used (Coding Scheme Designator (0008,0102)), a code value from that scheme (Code Value (0008,0100)), and the textual translation of that code value (Code Meaning (0008,0104)).

Note: Triplet encoding of such coded entries is compatible with the ANSI HISPP Common Data Types (see the "ANSI HISPP MSDS Common Data Types" document).

The Code Value (0008,0100) is a computer readable and computer searchable identifier that is unambiguous within the Coding Scheme.

The Coding Scheme Designator (0008,0102) uniquely identifies the table (Coding Scheme) where the Code Value (0008,0100) is linked to its Code Meaning (0008,0104). Common coding schemes include

CPT, ICD-9, SNOMED, etc. Coding Scheme Designators available for use by DICOM implementations are described in Annex D.

Note: Until an internationally-recognized Coding Scheme Designator registration authority is available (such as the authority proposed in “CEN/TC251/PT005 FFV Document. Health Care Informatics Interchange - Registration of Coding Schemes”), the tables of provisional Coding Scheme Designators found in the “ANSI HISPP Common Data Types” document (duplicated in Annex D) may be used.

The Code Meaning (0008,0104) is human readable text which is provided for the convenience of the readers of the Information Object (i.e., the reader would not need to refer to the Coding Scheme to find the interpretation of the Code Value (0008,0100)).

Note: Data Elements having 1) a VR of “SQ” (Sequence of Items) and 2) containing triplet-encoded items (utilizing Coding Scheme Designator, Code Value, Code Meaning) within one or more component sequence(s) may conceivably require additional encoding and/or interpretation rules (semantic mapping for most advantageous use with a particular coding scheme in a given context). The SNOMED DICOM MICROGLOSSARY (SDM), referenced in this Standard as coding Scheme Designator 99SDM, links sets of appropriate terms from SNOMED International (College of American Pathologists, Northfield, IL) to DICOM Data Elements. The SDM lists the appropriate SNOMED terms and the semantic dependencies for DICOM triplet-encoded sequence Data Elements according to SOP Class UID and real-world functional context. The SDM maps DICOM concepts to the Unified Medical Language System (UMLS) of the United States National Library of Medicine. Each SDM record contains a UMLS unique concept identifier (CUI) that links a DICOM concept to the UMLS knowledge sources and enables information retrieval from bibliographic resources via the NLM Medical Subject Headings (MeSH). The SDM also provides a shared mapping of Data Elements among message standards.

If the Coding Scheme Designator (0008,0102) of a particular triplet encoded Data Element is 99SDM, then the Code Value (0008,0100) for that Data Element will be the Source UID value from a SNOMED DICOM Microglossary record. This record will have a Data Element UID which matches the Data Element Tag of the DICOM triplet-encoded sequence and Class UID consistent with the DICOM SOP Class UID of the Data Set being encoded. The Semantic Type of the SDM record will match the Semantic Type called for by the DICOM description of that attribute. Unless otherwise stated in this Standard, the SDM record may have any Context value.

5.4 ATTRIBUTE MACROS

Some tables contain references to Attribute Macros. This convention is used in cases where the same Attributes are used in multiple tables or multiple places in one Module. The reference means that the Attributes of the Attribute Macro shall be included in the Module in place of the row that contains the reference to the Attribute Macro.

In some cases, the Attribute Macro is used in a Sequence (the VR of the Data Element in which the Attribute is encoded is SQ, see PS 3.5). When this is done, the reference is preceded by one or more ">" characters. The number of ">" characters indicates the level in the sequence that all of the Attributes in the Attribute Macro occupy.

There may be specialization of the description of the Attributes in the Attribute Macro. In these cases, this specialization is described in the Description column of the Module.

Following is an example of this convention.

Table 5.4-1 is an example of a Module table using the Attribute Macro convention.

Table 5.4-1
Example Module Table

Attribute Name	Tag	Type	Attribute Description
Attribute A	(aaaa,aaaa)	1	This is an example.
Attribute B Sequence	(bbbb,bbbb)	1	This is an example of a Sequence Attribute
>Include 'Example Macro' Table 5.4-2			*In this Module, Attribute D (dddd,dddd) is Type 1*

Table 5.4-2 is an example of the Attribute Macro referenced in Table 5.4-1.

Table 5.4-2
Example Macro

Attribute Name	Tag	Type	Attribute Description
Attribute C	(cccc,cccc)	1	This is an example.
Attribute D	(dddd,dddd)	3	This Attribute is generally a Type 3.

The contents of the Example Module Table, if it had not been described with the Example Macro would have been as shown in Table 5.4-3

Table 5.4-3
Example Module Table without the Use of an Attribute Macro

Attribute Name	Tag	Type	Attribute Description
Attribute A	(aaaa,aaaa)	1	This is an example.
Attribute B Sequence	(bbbb,bbbb)	1	This is an example of a Sequence Attribute.
>Attribute C	(cccc,cccc)	1	This is an example.
>Attribute D	(dddd,dddd)	1	In this Module, this Attribute has been specialized to Type 1 as indicated in Table 5.4-1.

6 DICOM information model

The DICOM Information Model defines the structure and organization of the information related to the communication of medical images. Figure 6-1 shows the relationships between the major structures of the DICOM Information Model.

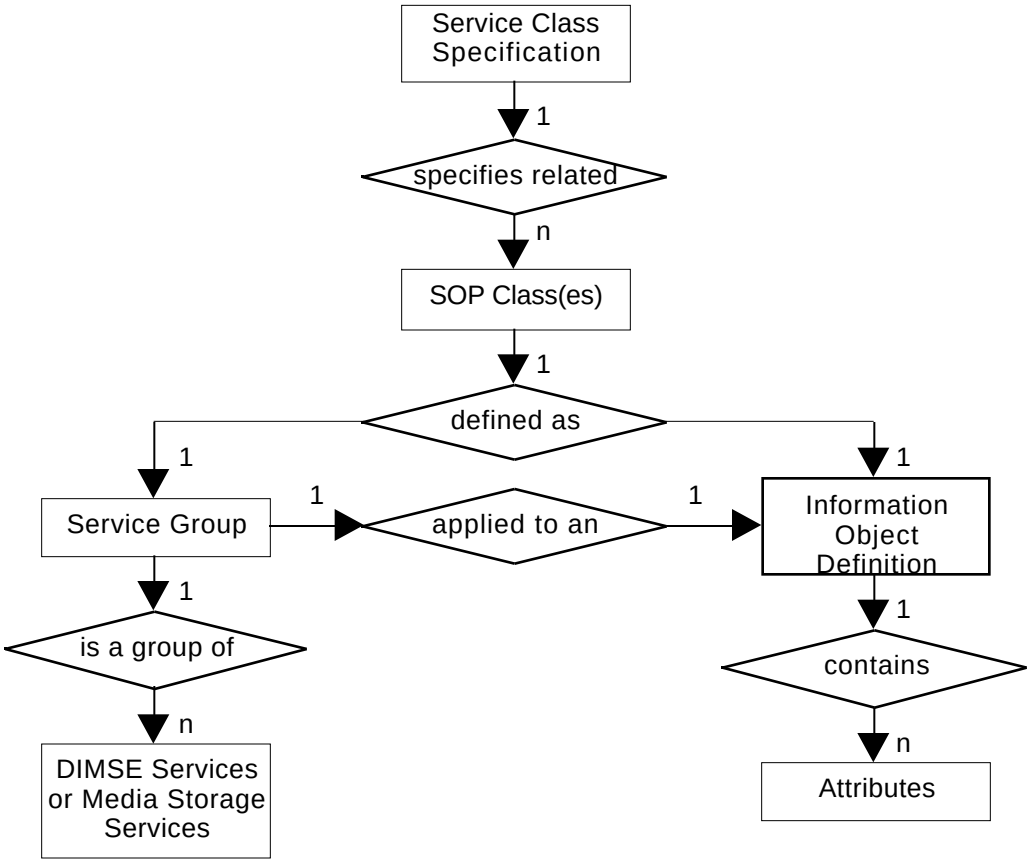


Figure 6-1
MAJOR STRUCTURES OF DICOM INFORMATION MODEL

6.1 INFORMATION OBJECT DEFINITION

An Information Object Definition (IOD) is an object-oriented abstract data model used to specify information about Real-World Objects. An IOD provides communicating Application Entities with a common view of the information to be exchanged.

An IOD does not represent a specific instance of a Real-World Object, but rather a class of Real-World Objects which share the same properties. An IOD used to generally represent a single class of Real-World Objects is called a Normalized Information Object. An IOD which includes information about related Real-World Objects is called a Composite Information Object.

6.1.1 COMPOSITE IOD

A Composite IOD is an Information Object Definition which represents parts of several entities included in the DICOM Model of the Real-World. This Model is introduced in Section 7. Such an IOD includes Attributes which are not inherent in the Real-World Object that the IOD represents but rather are inherent in related Real-World Objects.

These related Real-World Objects provide a complete context for the exchanged information. When an instance of a Composite IOD is communicated, this entire context is exchanged between Application Entities. Relationships between Composite IOD Instances shall be conveyed in this contextual information.

The Composite IODs are specified in Annex A.

6.1.2 NORMALIZED IOD

A Normalized IOD is an Information Object Definition which generally represents a single entity in the DICOM Model of the Real-World.

In this Standard, strict definition of Normalized Object Definitions has not been applied. Application of strict definitions would often result in unnecessary complexity and reduced performance of implementations for several applications.

Note: An example is the Print Queue IOD. Attributes from the Basic and Referenced Print Management IODs are combined in the Print Queue IOD. This allows an SCP to provide all relevant information in a single N-Get Service Element. Otherwise several Service Elements would be required to return the attributes from individual Normalized IODs. This requires less network traffic to convey the information, thus improving system performance.

The Print Queue IOD has been classified as a Normalized IOD to allow operations by DIMSE-N Services since most devices which support the Print Queue Management SOP Class also support the Basic Print Management Meta SOP Class in which the DIMSE-N Service Elements are used. This facilitates efficient implementations of the Print Queue Management SOP Class.

When an instance of a Normalized IOD is communicated, the context for that instance is not actually exchanged. Instead, the context is provided through the use of pointers to related Normalized IOD Instances.

The Normalized IODs are specified in Annex B.

6.2 ATTRIBUTES

The Attributes of an IOD describe the properties of a Real-World Object Instance. Related Attributes are grouped into Modules which represent a higher level of semantics documented in the Module Specifications found in Annex C.

Attributes are encoded as Data Elements using the rules, the Value Representation and the Value Multiplicity concepts specified in PS 3.5. For specific Data Elements, the Value Representation and Value Multiplicity are specified in the Data Dictionary in PS 3.6.

When multiple modules containing the same Attributes(s) are included in an IOD, the Attribute shall be encoded only once into a Data Element. If one of the modules is a specialization of the other (e.g., General Image and CT Image) the Attribute definition contained in the more specialized module shall be used.

6.3 ON-LINE COMMUNICATION AND MEDIA STORAGE SERVICES

For on-line communication the DIMSE Services allow a DICOM Application Entity to invoke an operation or notification across a network or a point-to-point interface. DIMSE Services are defined in PS 3.7.

For media storage interchange, Media Storage Services allow a DICOM Application Entity to invoke media storage related operations.

Note: These Media Storage Services are discussed in PS 3.10.

6.3.1 DIMSE-C SERVICES

DIMSE-C Services are services applicable only to a Composite IOD. DIMSE-C Services provide only operation services.

6.3.2 DIMSE-N SERVICES

DIMSE-N Services are services applicable only to a Normalized IOD. DIMSE-N Services provide both operation and notification services.

6.4 DIMSE SERVICE GROUP

A DIMSE Service Group specifies one or more operations/notifications defined in PS 3.7 which are applicable to an IOD.

DIMSE Service Groups are defined in PS 3.4 in the specification of a Service-Object Pair Class.

6.5 SERVICE-OBJECT PAIR (SOP) CLASS

A Service-Object Pair (SOP) Class is defined by the union of an IOD and a DIMSE Service Group. The SOP Class definition contains the rules and semantics which may restrict the use of the services in the DIMSE Service Group and/or the Attributes of the IOD.

The selection of SOP Classes is used by Application Entities to establish an agreed set of capabilities to support their interaction. This negotiation is performed at association establishment time as described in PS 3.7. An extended negotiation allows Application Entities to further agree on specific options within a SOP Class.

Note: The SOP Class as defined in the DICOM Information Model is equivalent in ISO/OSI terminology to the Managed Object Class. Readers familiar with object oriented terminology will recognize the SOP Class operations (and notifications) as comprising the methods of an object class.

6.5.1 NORMALIZED AND COMPOSITE SOP CLASSES

DICOM defines two types of SOP Classes, Normalized and Composite. Normalized SOP Classes are defined as the union of a Normalized IOD and a set of DIMSE-N Services. Composite SOP Classes are defined as the union of a Composite IOD and a set of DIMSE-C Services.

Note: SOP Class Specifications play a central role for defining DICOM conformance requirements. It allows DICOM Application Entities to select a well-defined application level subset of the DICOM V3.0 Standard to which they may claim conformance. See PS 3.2.

6.6 ASSOCIATION NEGOTIATION

Association establishment is the first phase of communication between peer DICOM compliant Application Entities. The Application Entities shall use association establishment to negotiate which SOP Classes can be exchanged and how this data will be encoded.

Association Negotiation is defined in PS 3.7.

6.7 SERVICE CLASS SPECIFICATION

A Service Class Specification defines a group of one or more SOP Classes related to a specific function which is to be accomplished by communicating Application Entities. A Service Class Specification also defines rules which allow implementations to state some pre-defined level of conformance to one or more SOP Classes. Applications may conform to SOP Classes as either a Service Class User (SCU) or Service Class Provider (SCP).

Service Class Specifications are defined in PS 3.4.

Note: Such interaction between peer Application Entities work on a 'client/server model'. The SCU acts as the 'client', while the SCP acts as the 'server'. The SCU/SCP roles are determined during association establishment.

7 DICOM model of the real-world

Figures 7-1a, 7-1b and 7-3 depict the DICOM view of the Real-World which identifies the relevant Real-World Objects and their relationships within the scope of the DICOM Standard. It provides a common framework to ensure consistency between the various Information Objects defined by the DICOM Standard.

Note: The relationship between study and result is complex, involving other Real-World Objects (e.g. the interpreting physician). This Standard does not model these objects.

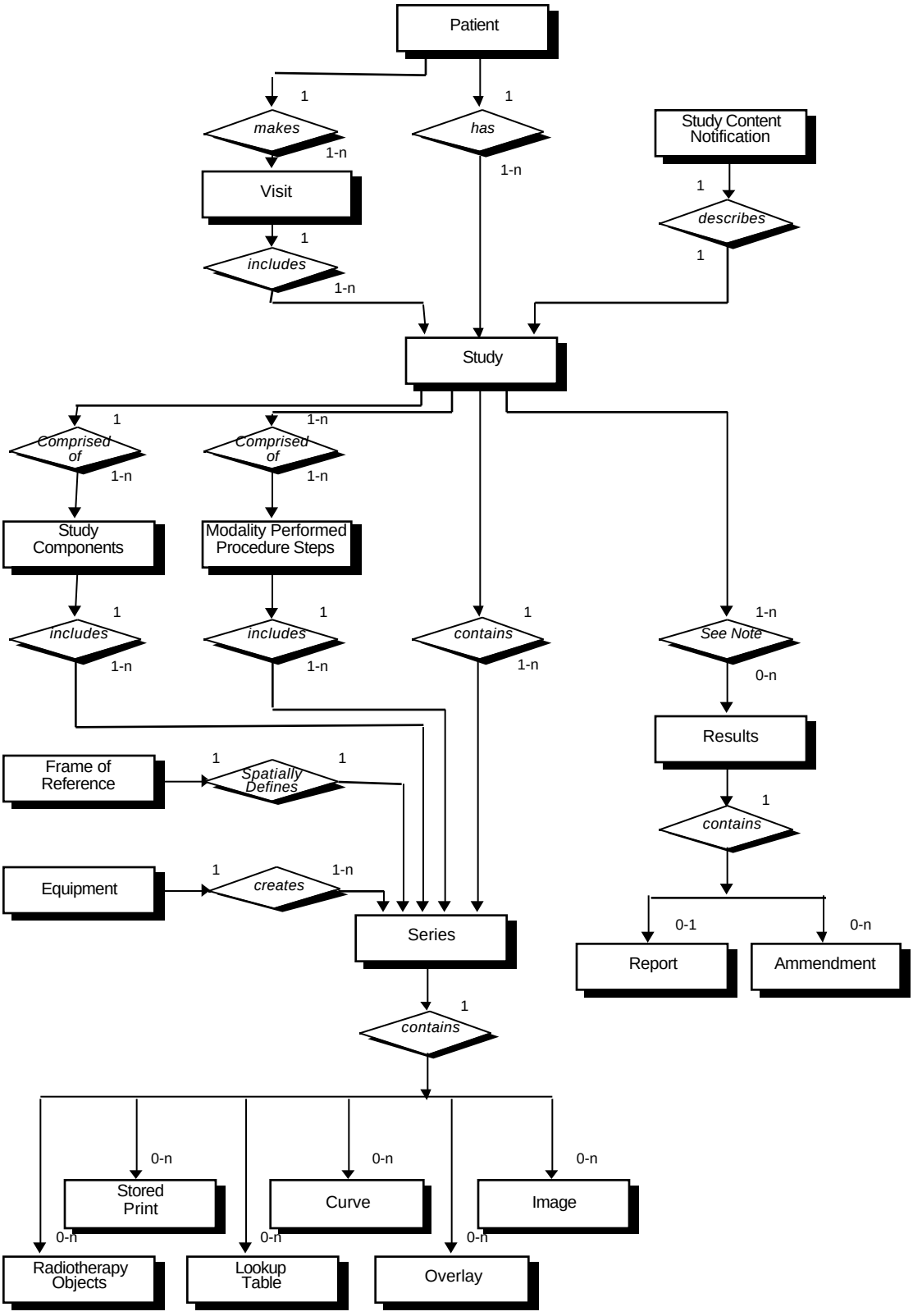


Figure 7-1a
DICOM MODEL OF THE REAL-WORLD

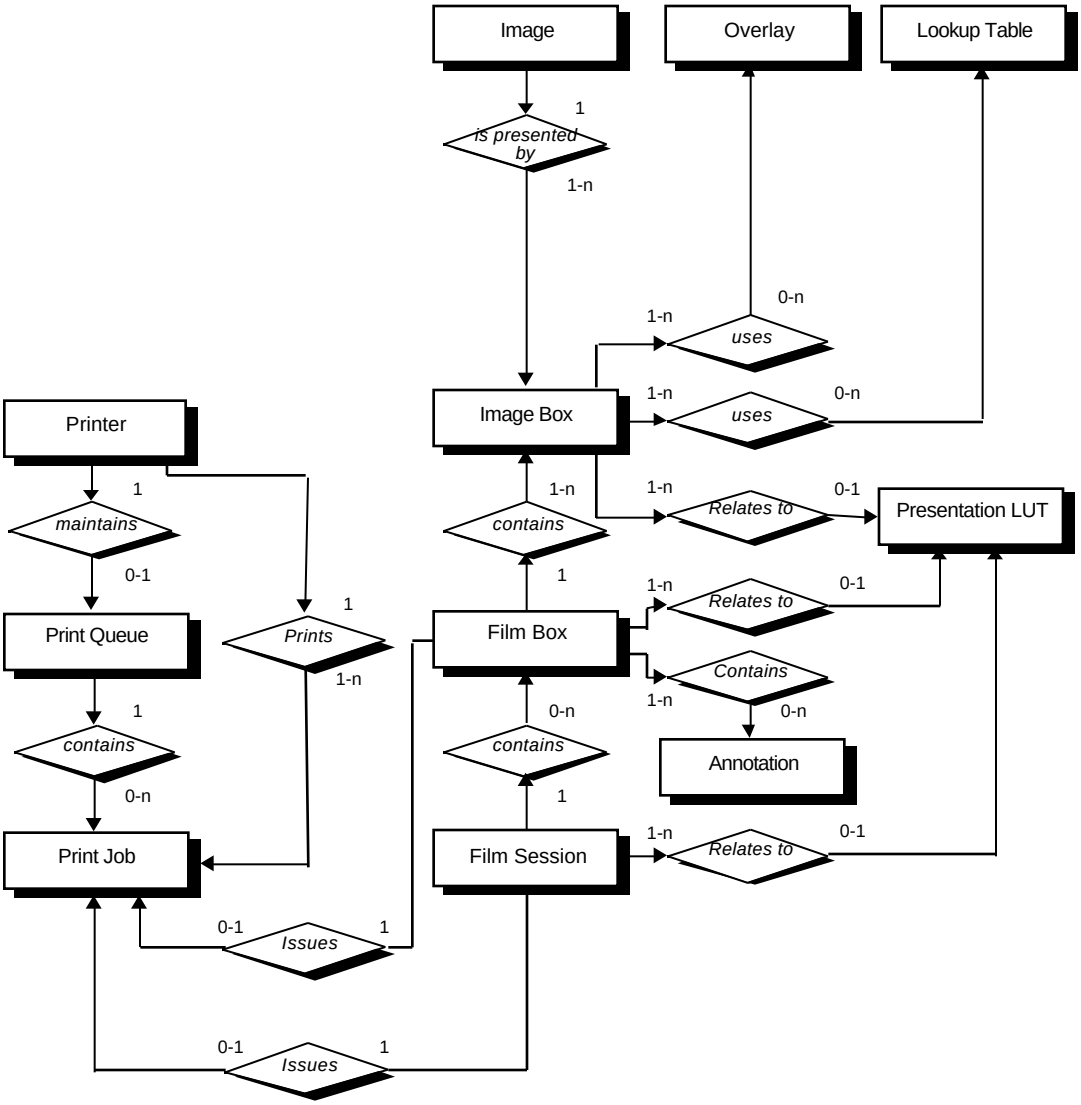


Figure 7-1b
DICOM MODEL OF THE REAL-WORLD - PRINT

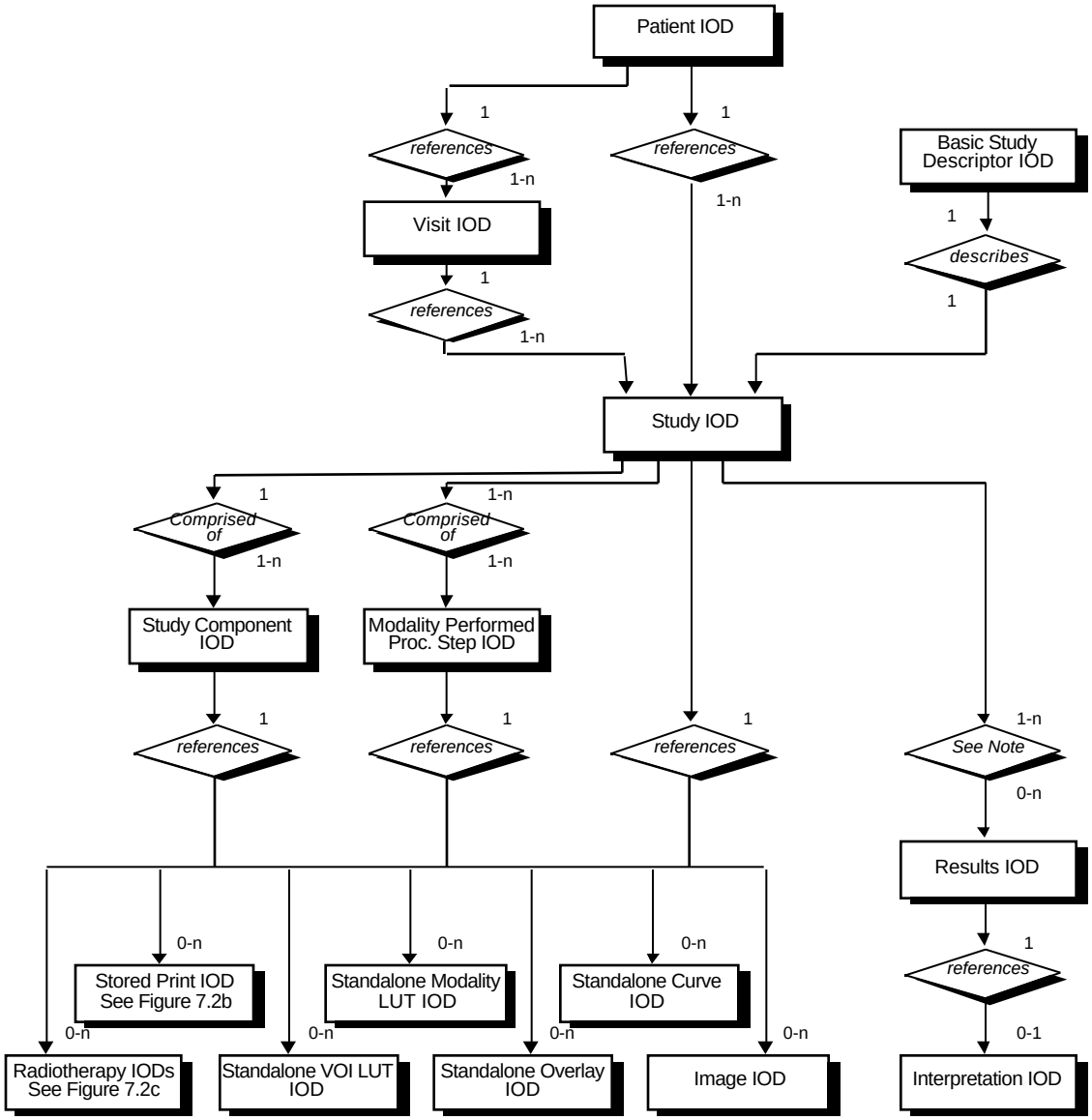


Figure 7-2a
DICOM INFORMATION MODEL

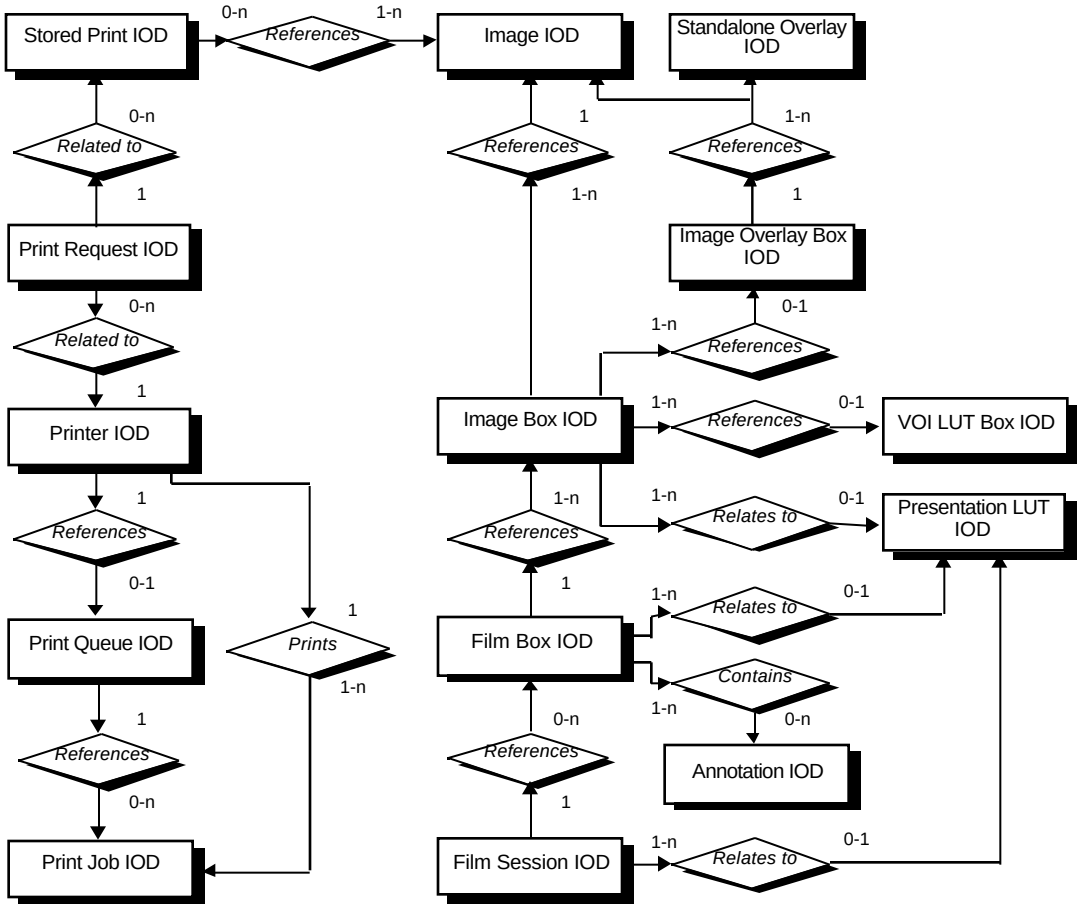


Figure 7-2b
DICOM INFORMATION MODEL - PRINT

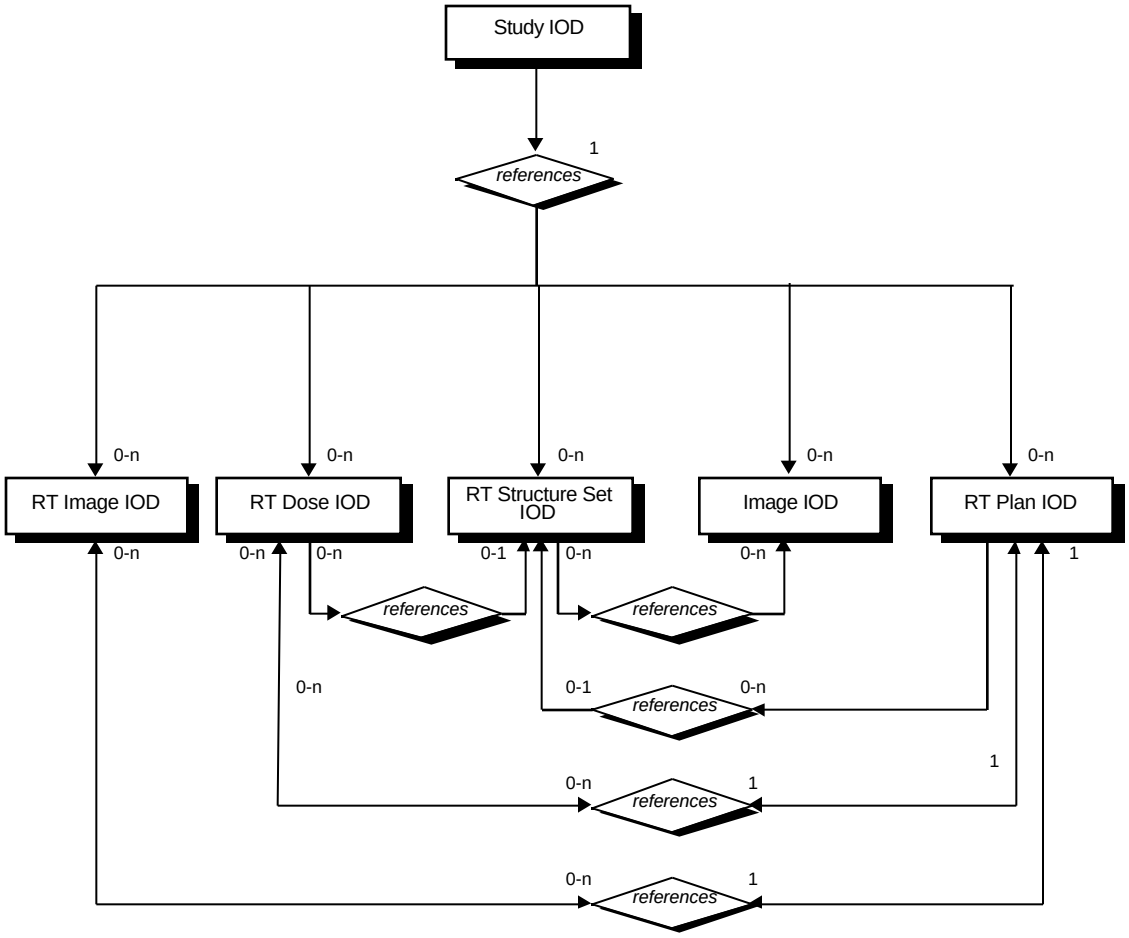


Figure 7-2c
DICOM INFORMATION MODEL - RADIOTHERAPY

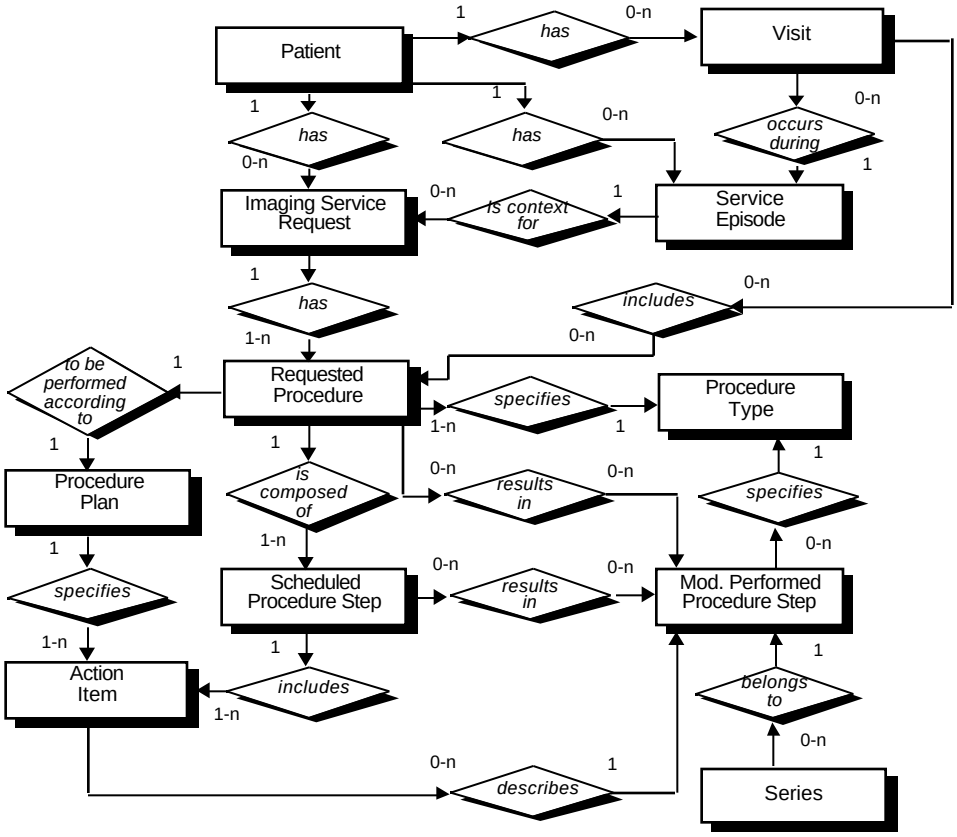


Figure 7-3.
MODEL OF THE REAL WORLD FOR THE PURPOSE OF MODALITY-IS INTERFACE

7.1 DICOM INFORMATION MODEL

The DICOM Information Model is derived from the DICOM Model of the Real-World. The DICOM Information Model presented by Figures 7-2a, 7-2b and 7-2c identify the various IODs specified by this Standard and their relationships. There is not always a one-to-one correspondence between DICOM Information Object Definitions and Real-World Objects. For example a Composite IOD contains Attributes of multiple real-world objects such as series, equipment, frame of reference, study and patient.

The entities in Figures 7-2a, 7-2b and 7-2c correspond to IODs defined in Annexes A through C.

7.2 ORGANIZATION OF ANNEXES A, B AND C

Annex A defines Composite IOD's (e.g. Images, Curves, Overlays) acquired on a number of Modalities (e.g. CT, MR, NM, US, CR, Secondary Capture). These Composite IOD's reference Modules found in Annex C.

Annex B defines Normalized IODs (e.g. Patient, Study, Results, Film Session, Print Job) for a number of Service Classes specified in PS 3.4. These Normalized IODs reference Module definitions found in Annex C.

7.3 EXTENSION OF THE DICOM MODEL OF THE REAL-WORLD

For the purpose of the Basic Worklist Management Service Class and the Modality Performed Procedure Step SOP Classes an enhancement of the original DICOM Model of the Real-World is made, as depicted in Figure 7-3.

Annex G discusses the relationship of this extension to the original DICOM model of the real world.

Figure 7-3 is an abstract description of the real world objects invoked in the Modality-IS Interface. It is not to be seen as a database scheme for an implementation.

Note: The real world model depicted in Figure 7.3 is influenced by the ISIS (Information System - Imaging System) Model. The ISIS Model is being developed by the DICOM Committee, the College of American Pathologists Image Exchange Committee (CAP-IEC), CEN/TC251/WG4/PT4-020: Modality-Information System Interface Project Team, and Health Level Seven (HL7) as the Real World Model for the domain of the Information System - Imaging System interface. The ISIS model is a common mapping of CEN/TC251/WG3/PT-022, CEN/TC251/WG4/PT-020, HL7, CAP-IEC, and ACR-NEMA DICOM Real-World-Models. The semantics of the objects and their attributes in this Standard are described in the ISIS model. This supplement uses only the subset of the ISIS Model that contains objects relevant to the Worklist. The ISIS Model ensures consistency with PT-022, CAP-IEC, and HL7.

7.3.1 Definition of the Extensions of the DICOM Real-World Model

7.3.1.1 PATIENT

A Patient is a person receiving, or registered to receive, healthcare services.

7.3.1.2 SERVICE EPISODE

A Service Episode is a collection of events, aggregated during an interval bounded by start and stop times (e.g. an outpatient visit or a hospitalization). The definition of the start time, stop time, and included events of a Service Episode is entirely arbitrary. A Service Episode is the context in which the treatment or management of an arbitrary subset of a Patient's medical conditions occurs. In the context of imaging services, a Service Episode may involve one or more Healthcare Organizations (administrative entities that authorize Healthcare Providers to provide services within their legal administrative domain, e.g. hospitals, private physician's offices, multispecialty clinics, nursing homes). A subset of Service Episode, the Facility Episode, is the collection of events that fall under the accountability of a particular Healthcare Organization. A Service Episode identifies the Certified Health Care Providers who have been delegated responsibility by one or more Healthcare Organizations to provide healthcare services to the Patient. One or more Certified Healthcare Providers (Organizations or individual persons, e.g. physician group practices, individual physicians, technologists, nurses) may be accountable for the healthcare services provided in a Service Episode. The Certified Health Care Providers are accountable to one or more Healthcare Organizations and to the Patient for the outcomes of the services provided. A Service Episode may be associated with one or more physical locations (e.g. different rooms, departments, buildings, or cities). One or more DICOM Visits may be associated with a Service Episode.

Notes: 1. The Service Episode is defined both in the ISIS model and in this extension of the DICOM model of the real world, to ensure consistency with PT3-022, CAP-IEC and HL7. The DICOM Visit is a part of the Service Episode. The Service Episode describes several administrative aspects of healthcare, while the DICOM Visit is limited to the description of one visit of a Patient to a facility.

2. In the context of the Modality Worklist SOP Class, only the DICOM Visit is of relevance, the Service Episode Modules are not defined.

7.3.1.3 IMAGING SERVICE REQUEST

An Imaging Service Request is a set of one or more Requested Procedures selected from a list of Procedure Types. An Imaging Service Request is submitted by one authorized imaging service requester to one authorized imaging service provider in the context of one Service Episode. An Imaging Service Request includes pertinent specific and general information. Each instance of an Imaging Service Request carries the information common to one or more Requested Procedures requested at the same moment. An Imaging Service Request may be associated with one or more DICOM Visits. The existence of an Imaging Service Request will typically result in the creation of one or more Imaging Service Reports and the distribution of Imaging Service Reports to one or more destinations.

7.3.1.4 PROCEDURE TYPE

A Procedure Type identifies a class of procedures. In the context of imaging services, a Procedure Type is an item in a catalog of imaging procedures that can be requested and reported upon in an imaging service facility. An instance of a Procedure Type typically has a name and one or more other identifiers. A Procedure Type is associated with one or more Procedure Plans.

Note: The information content of this entity relates to the general identification of a Procedure Type rather than to its decomposition into the action items required to perform a specific instance of a Requested Procedure for a particular Patient.

7.3.1.5 REQUESTED PROCEDURE

A Requested Procedure is an instance of a Procedure of a given Procedure Type. An instance of a Requested Procedure includes all of the items of information that are specified by an instance of a Procedure Plan that is selected for the Requested Procedure by the imaging service provider. This Procedure Plan is defined by the imaging service provider on the basis of the Procedure Plan templates associated with the considered Procedure Type. An Imaging Service Request may include requests for several different Requested Procedures. The purpose of this entity is to establish the association between Imaging Service Requests and Procedure Types, to convey the information that belongs to this association and to establish the relationships between Requested Procedures and the other entities that are needed to describe them. A single Requested Procedure of one Procedure Type is the smallest unit of service that can be requested, reported, coded and billed. Performance of one instance of a Requested Procedure is specified by exactly one Procedure Plan. A Requested Procedure leads to one or more Scheduled Procedure Steps involving Action Items as specified by a Procedure Plan. A Requested Procedure may be associated with one or more DICOM Visits. A Requested Procedure may involve one or more pieces of equipment.

7.3.1.6 SCHEDULED PROCEDURE STEP

A Scheduled Procedure Step is an arbitrarily defined scheduled unit of service, that is specified by the Procedure Plan for a Requested Procedure. A Scheduled Procedure Step prescribes one or more Action Items (events). A Scheduled Procedure Step involves equipment (e.g. imaging Modality equipment, anesthesia equipment, surgical equipment, transportation equipment), human resources, consumable supplies, location, and time (e.g. start time, stop time, duration). While in the context of imaging services the scheduling of a Procedure Step might include only a general designation of imaging Modality that could be satisfied by multiple pieces of the same equipment type, the performance of one instance of a Scheduled Procedure Step involves one and only one piece of imaging Modality equipment.

The performance of a Scheduled Procedure Step may result in the creation of zero or more Modality Performed Procedure Step instances.

Notes: 1. The Procedure Step entity is provided to support management of the logistical aspects of procedures (e.g. materials management, human resources, scheduling). The full definition of the contents of Procedure Steps and their constituent action items (events) is implementation dependent and is beyond the scope of this Standard. A single Action Item (event) contained within a given Scheduled Procedure Step might or might not be schedulable in a given facility.

2. A Scheduled Procedure Step may contribute to more than one Requested Procedure (e.g. a Scheduled Procedure Step requiring an intravenous iodine contrast injection might be shared by an intravenous pyelogram and a CT examination). However, for billing purposes an instance of a Scheduled Procedure Step is typically considered to be a part of only one Requested Procedure.

3. Typically each Scheduled Procedure Step contains at least one Action Item (event) of a magnitude that would justify an entry in the medical record.

7.3.1.7 PROCEDURE PLAN

A Procedure Plan is a protocol or specification that defines the ordered set of Action Items that must be done in order to perform the Scheduled Procedure Steps of a Requested Procedure. The distribution of Action Items over the set of Scheduled Procedure Steps that constitute a single Requested Procedure is assumed to be performed by the IS, and is not specified by this Standard. The Action Items actually performed during a Procedure Step may differ from those prescribed in the related Procedure Plan. Audit of actually performed Action Items versus the prescribed Procedure Plan is an important element of quality control, but is not specified by this Standard.

Note: The fact that Action Items are in a given order in a Procedure Plan is not evident in Figure 7.3. However, the order of Action Items is represented at the syntax level (i.e. as the sequence of items present in the Action Item Code Sequence (0040,0008)).

7.3.1.8 ACTION ITEM

An Action Item is one of the ordered set of actions prescribed by a Procedure Plan to perform an instance of a Requested Procedure. Action Items are simple (atomic) events. A Scheduled Procedure Step contains at least one Action Item. Typically, the code identifying an Action Item instance would be selected from a catalog of action types. Multiple Action Items of the same action type may exist in one Scheduled Procedure Step. The distribution of Action Items over the set of Scheduled Procedure Steps of a Single Requested Procedure is not specified by this Standard.

7.3.1.9 MODALITY PERFORMED PROCEDURE STEP

A Performed Procedure Step is an arbitrarily defined unit of service that has actually been performed (not just scheduled). Logically it corresponds to a Scheduled Procedure Step, but real-world conditions may dictate that what is actually performed does not correspond exactly with what was requested or scheduled.

Note: For example, two or more Scheduled Procedure Steps, Requested Procedures or Imaging Service Requests may have been generated by different Referring Physicians but may be satisfied be a single Performed Procedure Step at the discretion of a Performing Physician or Operator. Alternatively, a single Scheduled Procedure Step may need to be satisfied by multiple Performed Procedure Steps on different types or instances of equipment, due to clinical need or failure conditions, or over extended periods of time.

It contains information describing the type of procedure actually performed.

A Requested Procedure results in the creation of zero or more Performed Procedure Steps.

A Scheduled Procedure Step results in the creation of zero or more Performed Procedure Steps.

The Performed Procedure Step contains information about it’s state (e.g. in progress, discontinued or completed).

A Modality Performed Procedure Step is a Performed Procedure Step that results from the acquisition of images from a Patient or other Imaging Subject on a Modality.

It contains information describing the performance of a step of an imaging procedure, including data about the performance of the procedure itself, radiation dose values to which the patient has been exposed if ionizing radiation is in use, and data for billing and material management.

The Modality Performed Procedure Step contains references to zero or more Series of Images and other Composite SOP Instances that may be created as part of the procedure step. A particular Series is part of only one Modality Performed Procedure Step.

Annex A Composite information object definitions (Normative)

A.1 ELEMENTS OF AN INFORMATION OBJECT DEFINITION

Each Composite Information Object Definition is composed of the following Sections

a. IOD Description
b. IOD Entity-Relationship Model
c. IOD Module Table

Sections A.1.1 through A.1.3 of this document define the requirements of a) through c) above.

A.1.1 IOD Description

This Section provides a brief description of the IOD. Specifically, this description includes:

- The Real-World Object which is represented by the IOD
- Information as to the scope of the represented object if appropriate

A.1.2 IOD Entity-Relationship Model

This Section of an IOD provides the Entity-Relationship (E-R) Model which depicts the relationships of the components or Information Entities (IE) of the specified IOD. It forms an IOD specific information model. This E-R model provides the complete context of how the image information shall be interpreted when an image is exchanged between two DICOM Application Entities.

Even though images are sent as discrete individual components, each Composite Image IOD E-R Model requires that all images which are part of a specific study shall share the same context. That is, all images within a specific patient study share the same patient and study information; all images within the same series share the same series information; etc.

Figure A.1-1 is the DICOM Composite Image IOD Information Model. It applies to all of the Composite Image IODs defined in Annex A. However, a subset of this model may be specified by each individual Composite Image IOD to accurately define the context for specific modality image exchange.

Sections A.1.2.1 through A.1.2.10 describe the Information Entities (IE) which comprise the Composite Image IODs defined in this Annex.

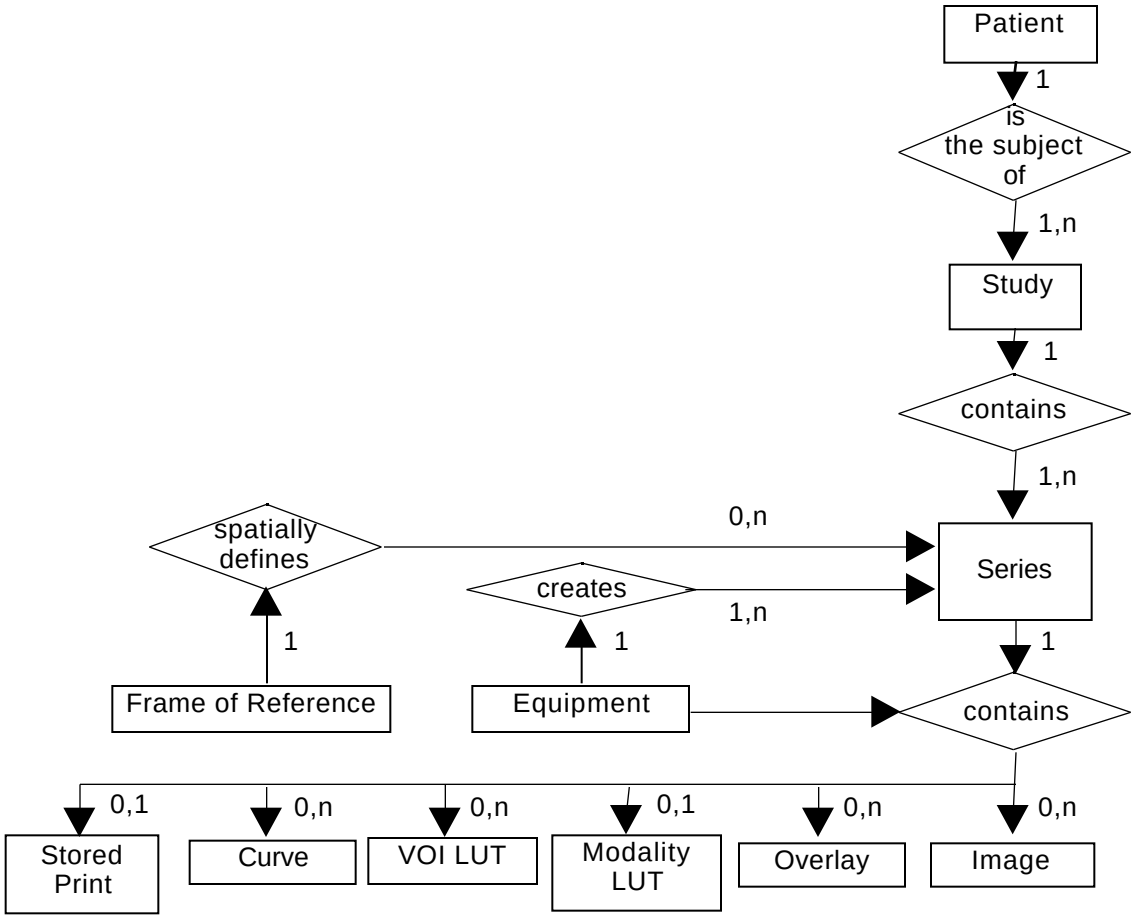


Figure A.1-1
DICOM COMPOSITE IMAGE IOD INFORMATION MODEL

Each Series shall contain at least one Curve IE, VOI Lookup Table, Overlay IE, or Image IE.

A.1.2.1 PATIENT IE

The Patient IE defines the characteristics of a patient who is the subject of one or more medical studies which produce medical images.

The Patient IE is modality independent.

A.1.2.2 STUDY IE

The Study IE defines the characteristics of a medical study performed on a patient. A study is a collection of one or more series of medical images, overlays and/or curves which are logically related for the purpose of diagnosing a patient. Each study is associated with exactly one patient.

A study may include images that are created by a single modality, multiple modalities or by multiple devices of the same modality.

The Study IE is modality independent.

A.1.2.3 SERIES IE

The Series IE defines the Attributes which are used to group images, overlays and/or curves into distinct logical sets. Each series is associated with exactly one Study.

The following criteria groups images into a specific series:

a. All images within a series must be of the same modality
b. If a specific Composite Image IOD specifies the support of a Frame of Reference IE, all images within the series shall be spatially related to each other; therefore, each series is associated with exactly one Frame of Reference IE
c. If a specific Image IOD specifies the support of the Equipment IE, all images within the series shall be created by the same equipment; therefore, each series is associated with exactly one Equipment IE
d. All images within a series shall have the same series information

Overlays and Curves may be grouped into a Series with or without Images. The Equipment IE and Frame of Reference IE are irrelevant to the Overlay IE and Curve IE.

A.1.2.4 EQUIPMENT IE

The Equipment IE describes the particular imaging device which produced the series of images. An imaging device may produce one or more series within a study. The Equipment IE does not describe the data acquisition or image creation Attributes used to generate the images within a series. These Attributes are described in the Image IE.

A.1.2.5 FRAME OF REFERENCE IE

The Frame of Reference IE identifies the coordinate system which conveys spatial and/or temporal information of images in a series.

A Frame of Reference IE may be related to one or more series. In this case, it provides the ability to spatially or temporally relate multiple series to each other.

A.1.2.6 IMAGE IE

The Image IE defines the Attributes which describe the pixel data of an image. The pixel data may be generated as a direct result of patient scanning (termed an Original Image) or the pixel data may be derived from the pixel data of one or more other images (termed a Derived Image). An image is defined by its image plane, pixel data characteristics, gray scale and/or color mapping characteristics, overlay planes and modality specific characteristics (acquisition parameters and image creation information).

An image is related to a single series within a single study.

The pixel data within an Image IE may be represented as a single frame of pixels or as multiple frames of pixel data. The frames of a Multi-frame image (a cine run or the slices of a volume) are sequentially ordered and share a number of common properties. A few Attributes may vary between frames (eg.-Time, Angular Displacement, Slice Increment). All common Image IE Attributes refer to the first frame of a multiple frame image.

Overlay, Lookup Table and Curve data may be included within an Image IE only if this information is directly associated with the image.

A.1.2.7 OVERLAY IE

The Overlay IE defines the Attributes which describe an independent set of Overlay Planes. The Overlay IE may represent in a bit-map format, graphics or text and is used to indicate such items as region of interest, reference marks and annotations. These Overlay Planes may or may not be coincident with an

image. If the Overlay Plane is coincident with an image, sufficient information shall be available to allow an overlay to be presented at a display station superimposed on a particular image with which it is associated. An Overlay IE shall be related to only one Series IE.

An Overlay Plane may be represented as a single frame (when associated with a single frame image) or as multiple frames of overlay planes (when associated with a Multi-frame image).

Notes: 1. Examples of independent overlay planes are:

a) line drawings which illustrate the equipment and patient setup prescribed

b) line drawings which represent anatomy, pointers and text

c) drawings showing the layout of images and text fields for filming formats

2. The Overlay IE is similar in concept to the 'Graphics Data Set' defined by earlier versions of this Standard.

A.1.2.8 CURVE IE

A Curve is used to represent graphical data that can be specified as a series of connected points. Curve data may or may not be superimposed on a coincident image. An independent Curve, like an independent Overlay, can exist as would an image without any Pixel Data. Curves can be used to specify multi-dimensional graphs, regions of interest, and annotation. Curve Data is not compressed in any of the DICOM Standard Transfer Syntaxes specified in PS 3.5.

Each curve is specified as a series of connected points. One or more Curves shall be described by using one or more even numbered Repeating Groups (5000-501E,eeee) whose attributes are described in the Curve Module. The Type of Data (50xx,0020) contained in the Curve shall be specified. For independent Curves, the Curve Identification Module is used to identify the Curve.

A.1.2.9 MODALITY LUT IE

The Modality LUT IE defines the Attributes which describe the transformation of manufacturer dependent pixel values into pixel values which are manufacturer independent (e.g. Hounsfield units for CT, Optical Density for film digitizers, etc.). The Modality LUT may be contained within an image or as a Standalone Modality LUT which references an image. When the transformation is linear, the Modality LUT is described by Rescale Slope (0028,10530) and Rescale Intercept (0028,1052). When the transformation is non-linear, the Modality LUT is described by Modality LUT Sequence (0028,3000).

A.1.2.10 VOI LUT IE

The VOI LUT IE defines the Attributes which describe the transformation of the modality pixel values into pixel values which are meaningful for print, display, etc. This transformation is applied after any Modality LUT. The VOI LUT may be contained within an image or as a Standalone VOI LUT which references an image. When the transformation is linear, the VOI LUT is described by the Window Center (0028,1050) and Window Width (0028,1051). When the transformation is non-linear, the VOI LUT is described by VOI LUT Sequence (0028,3010).

A.1.3 IOD Module Table

This Section of each IOD defines in a tabular form the Modules comprising the IOD. The following information must be specified for each Module in the table:

- The name of the Module
- A reference to the Section in Annex C which defines the Module
- The usage of the Module; whether it is:
  - Mandatory (see A.1.3.1)
  - Conditional (see A.1.3.2)
  - User Option (see A.1.3.3)

The Modules referenced are defined in Annex C.

A.1.3.1 MANDATORY MODULES

For each IOD, Mandatory Modules shall be supported per the definitions, semantics and requirements defined in Annex C.

A.1.3.2 CONDITIONAL MODULES

Conditional Modules are Mandatory Modules if specific conditions are met. If the specified conditions are not met, this Module shall not be supported; that is, no information defined in that Module shall be sent.

A.1.3.3 USER OPTION MODULES

User Option Modules may or may not be supported. If an optional Module is supported, the Attribute Types specified in the Modules in Annex C shall be supported.

A.1.4 Overview of the Composite IOD Module Content

Table A.1-1 provides an overview of the Modules used throughout the Composite IODs. This table is for informative purposes only. It is based on the IOD definitions found in the remaining Sections of Annex A which are normative.

Table A.1-1
COMPOSITE INFORMATION OBJECT MODULES OVERVIEW

IODs Modules	CR	CT	MR	NM	US	US-mf	Sec. Capt.	St. Over-lay	St. Curve	Basic Study Descr.	St. Mod LUT	St. VOI LUT	XA	XA Bi-plane	RF	RT Image	RT Dose	RT Struct Set	RT Plan	PET	PET Curve
Patient	M	M	M	M	M	M	M	M	M		M	M	M	M	M	M	M	M	M	M	M
Patient Summary										M											
General Study	M	M	M	M	M	M	M	M	M		M	M	M	M	M	M	M	M	M	M	M
Patient Study	U	U	U	U	U	U	U	U	U		U	U	U	U	U	U	U	U	U	U	U
Study Content										M											
General Series	M	M	M	M	M	M	M	M	M		M	M	M	M	M					M	M
CR Series	M																				
NM/PET Patient Orientation				M																M	
PET Series																				M	M
PET Isotope																				M	M
PET Multi-gated Acquisition																				C	C
RT Series																M	M	M	M		
Frame Of Reference		M	M	U	U	U										U	M			M	
U S Frame of Ref.					C	C															
General Equipment	M	M	M	M	M	M	U	M	M		M	M	M	M	M	M	M	M	M	M	M
SC Equipment							M														
General Image	M	M	M	M	M*	M	M						M	M	M	M	C			M	
Image Plane		M	M														C			M	

IODs Modules	CR	CT	MR	NM	US	US-mf	Sec. Capt.	St. Over-lay	St. Curve	Basic Study Descr.	St. Mod LUT	St. VOI LUT	XA	XA Bi-plane	RF	RT Image	RT Dose	RT Struct Set	RT Plan	PET	PET Curve
Image Pixel	M	M	M	M	M*	M	M						M	M	M	M	C			M	
NM Image Pixel				M																	
PaletteColor Lookup Table					C	C															
Contrast/ Bolus	C	C	C		C*	C							C	C	C	C					
Cine						M							C	C	C	C					
Multi-frame				M		M							C	C	C	C	C				
NM Multi-frame				M																	
Frame Pointers													U	U	U						
Mask													C	C	C						
Display Shutter													U	U	U						
Device													U	U	U						
Therapy													U	U	U						
CR Image	M																				
CT Image		M																			
MR Image			M																		
NM Image				M																	
NM Isotope				M																	
NM Detector				M																	
NM TOMO Acquisition				C																	

IODs Modules	CR	CT	MR	NM	US	US-mf	Sec. Capt.	St. Over-lay	St. Curve	Basic Study Descr.	St. Mod LUT	St. VOI LUT	XA	XA Bi-plane	RF	RT Image	RT Dose	RT Struct Set	RT Plan	PET	PET Curve
NM Multi-Gated Acquisition				C																	
NM Phase				C																	
NM Reconstruction				C																	
US Region Calibration					U*	U															
US Image					M*	M															
SC Image							M														
PET Image																				M	
X-Ray Image													M	M	M						
X-Ray Acquisition													M	M	M						
X-Ray Collimator													U	U	U						
X-Ray Table													C	C	U						
XRF Positioner															U						
XRF Tomo Acquisition															C						
XA Positioner													M	M							
Bi-Plane Sequence														M							
Bi-Plane Image														M							
RT Image																M					

IODs Modules	CR	CT	MR	NM	US	US-mf	Sec. Capt.	St. Over-lay	St. Curve	Basic Study Descr.	St. Mod LUT	St. VOI LUT	XA	XA Bi-plane	RF	RT Image	RT Dose	RT Struct Set	RT Plan	PET	PET Curve
RT Dose																	M				
RT DVH																	U				
Structure Set																	C	M			
ROI Contour																	C	M			
RT Dose ROI																	C				
RT ROI Observations																		M			
RT General Plan																			M		
RT Prescription																			U		
RT Tolerance Tables																			U		
RT Patient Setup																			U		
RT Fraction Scheme																			U		
RT Beams																			C		
RT Brachy Application Setups																			C		
Approval																U		U	U		
Overlay Identification								M													
Overlay Plane	U	U	U	U	U*		U	M					U	U	U		U			U	
Multi-frame Overlay				U									C	C	C		U				
Bi-Plane Overlay														C							
Curve					M*	M*			M												M

IODs Modules	CR	CT	MR	NM	US	US-mf	Sec. Capt.	St. Over-lay	St. Curve	Basic Study Descr.	St. Mod LUT	St. VOI LUT	XA	XA Bi-plane	RF	RT Image	RT Dose	RT Struct Set	RT Plan	PET	PET Curve
Identification																					
Curve	U			U	M*	M*			M				U	U	U	U					M
PET Curve																					M
Audio					U	U										U	U	U	U		
Modality LUT	U						U				M		C*	C*	C*	U	U				
VOI LUT	U	U	U	U	U*	U	U					M	U	U	U	U				U	
LUT Identification											M	M									
SOP Common	M	M	M	M	M*	M*	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M

* The notation next to M and U indicates a special condition for these modules. Refer to the corresponding Information Object Definitions in this Annex for details.

Notes: 1. The original US Image IOD and US multi-frame IOD, and the associated US and US multi-frame Storage SOP Class UID have been retired. New US and US multi-frame Image IODs are defined, as shown in Table A.1-1 which includes the Palette Color Lookup Table module.

2. The original NM Image IOD and the associated NM Storage SOP Class UID have been retired. A completely new NM Image IOD is defined, as shown in Table A.1-1.

A.2 COMPUTED RADIOGRAPHY IMAGE INFORMATION OBJECT DEFINITION

A.2.1 CR Image IOD Description

The Computed Radiography (CR) Image Information Object Definition specifies an image which has been created by a computed radiography imaging device.

Note: Digital Luminescence Radiography is an equivalent term for computed Radiography.

A.2.2 CR Image IOD Entity-Relationship Model

The E-R Model in Section A.1.2 depicts those components of the DICOM Information Model which directly reference the CR Image IOD. The Frame of Reference IE, Overlay IE, Modality LUT IE, VOI LUT IE and Curve IE are not components of the CR Image IOD.

A.2.3 CR Image IOD Module Table

Table A.2-1
CR IMAGE IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	General Series	C.7.3.1	M
	CR Series	C.8.1.1	M
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	Image Pixel	C.7.6.3	M
	Contrast/bolus	C.7.6.4	C - Required if contrast media was used in this image
	CR Image	C.8.1.2	M
	Overlay Plane	C.9.2	U
	Curve	C.10.2	U
	Modality LUT	C.11.1	U
	VOILUT	C.11.2	U
	SOP Common	C.12.1	M

A.3 COMPUTED TOMOGRAPHY IMAGE INFORMATION OBJECT DEFINITION

A.3.1 CT Image IOD Description

The Computed Tomography (CT) Image Information Object Definition (IOD) specifies an image which has been created by a computed tomography imaging device.

A.3.2 CT image IOD Entity-Relationship Model

The E-R Model in Section A.1.2 depicts those components of the DICOM Information Model which directly reference the CT Image IOD. The Overlay IE, Modality LUT IE, VOI LUT IE and Curve IE are not components of the CT Image IOD.

A.3.3 CT Image IOD Module Table

Table A.3-1
CT IMAGE IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	General Series	C.7.3.1	M
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	Image Plane	C.7.6.2	M
	Image Pixel	C.7.6.3	M
	Contrast/bolus	C.7.6.4	C - Required if contrast media was used in this image
	CT Image	C.8.2.1	M
	Overlay Plane	C.9.2	U
	VOI LUT	C.11.2	U
	SOP Common	C.12.1	M

A.4 MAGNETIC RESONANCE IMAGE INFORMATION OBJECT DEFINITION

A.4.1 MR Image IOD Description

The Magnetic Resonance (MR) Image Information Object Definition (IOD) specifies an image which has been created by a magnetic resonance imaging device.

A.4.2 MR image IOD Entity-Relationship Model

The E-R Model in Section A.1.2 depicts those components of the DICOM Information Model which directly reference the MR Image IOD. The Overlay IE, Modality LUT IE, VOI LUT IE and Curve IE are not components of the MR Image IOD.

A.4.3 MR Image IOD Module Table

Table A.4-1
MR IMAGE IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	General Series	C.7.3.1	M
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	Image Plane	C.7.6.2	M
	Image Pixel	C.7.6.3	M
	Contrast/bolus	C.7.6.4	C - Required if contrast media was used in this image
	MR Image	C.8.3.1	M
	Overlay Plane	C.9.2	U
	VOI LUT	C.11.2	U
	SOP Common	C.12.1	M

A.5 NUCLEAR MEDICINE IMAGE INFORMATION OBJECT DEFINITION

A.5.1 NM Image IOD Description

The Nuclear Medicine (NM) Image Information Object Definition (IOD) specifies an image which has been created by a nuclear medicine imaging device. This includes data created by external detection devices which create images of the distribution of administered radioactive materials in the body. Depending on the specific radio pharmaceutical administered and the particular imaging procedure performed, problems involving changes in metabolism, function, or physiology can be investigated and various regional pathologies can be studied.

A.5.2 NM Image IOD Entity-Relationship Model

The E-R Model in Section A.1.2 depicts those components of the DICOM Information Model which directly reference the NM Image IOD. The Modality LUT IE and VOI LUT IE are not components of the NM Image IOD.

A.5.3 NM Image IOD Module Table (Retired)

Section A.5.3 was defined in a previous version of the DICOM Standard. The Section is now retired and has been moved to Annex H.1.

A.5.4 NM Image IOD Module Table

Table A.5-1
NM IMAGE IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	General Series	C.7.3.1	M
	NM/PET Patient Orientation	C.8.4.6	M
Frame of Reference	Frame of Reference	C.7.4.1	U
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	Image Pixel	C.7.6.3	M
	NM Image Pixel	C.8.4.7	M
	Multi-frame	C.7.6.6	M
	NM Multi-frame	C.8.4.8	M
	NM Image	C.8.4.9	M
	NM Isotope	C.8.4.10	M
	NM Detector	C.8.4.11	M
	NM TOMO Acquisition	C.8.4.12	C - Required if Image Type (0008,0008) Value 3 is TOMO, GATED TOMO, RECON TOMO or RECON GATED TOMO
	NM Multi-gated Acquisition	C.8.4.13	C - Required if Image Type (0008,0008) Value 3 is GATED, GATED TOMO, or RECON GATED TOMO
	NM Phase	C.8.4.14	C - Required if Image Type (0008,0008) Value 3 is DYNAMIC
	NM Reconstruction	C.8.4.15	C - Required if Image Type (0008,0008) Value 3 is RECON TOMO or RECON GATED TOMO
	Overlay Plane	C.9.2	U
	Multi-frame Overlay	C.9.3	U
	Curve	C.10.2	U
	VOI LUT	C.11.2	U
	SOP Common	C.12.1	M

A.6 ULTRASOUND IMAGE INFORMATION OBJECT DEFINITION

A.6.1 US Image IOD Description

The Ultrasound (US) Image Information Object Definition specifies an image which has been created by an ultrasound imaging device.

A.6.2 US Image IOD Entity-Relationship Model

The E-R Model in Section A.1.2 depicts those components of the DICOM Information Model which directly reference the US Image IOD. The Overlay IE, Modality LUT IE and VOI LUT IE are not components of the US Image IOD.

A.6.3 US Image IOD Module Table (Retired)

Section A.6.3 was defined in a previous version of the DICOM Standard. The Section is now retired and has been moved to Annex H.2.

A.6.4 US Image IOD Module Table

Table A.6-1
US IMAGE IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	General Series	C.7.3.1	M
Frame of Reference	Frame of Reference	C.7.4.1	U
	US Frame of Reference	C.8.5.4	C - Required if images are spatially related
Equipment	General Equipment	C.7.5.1	M
Image (See A.6.4.1)	General Image	C.7.6.1	M
	Image Pixel	C.7.6.3	M
	Contrast/bolus	C.7.6.4	C - Required if contrast media was used in this image
	Palette Color Lookup Table	C.7.9	C - Required if Photometic Interpretation (0028,0004) has a value of PALETTE COLOR
	US Region Calibration	C.8.5.5	U
	US Image	C.8.5.6	M
	Overlay Plane	C.9.2	U
	VOI LUT	C.11.2	U
	SOP Common	C.12.1	M
Curve (See A.6.4.1)	Curve Identification	C.10.1	M
	Curve	C.10.2	M
	Audio	C.10.3	U
	SOP Common	C.12.1	M

A.6.4.1 Mutually Exclusive IEs

The Image and Curve IEs are mutually exclusive. Each SOP Instance using this IOD shall contain exactly one of these IEs.

A.7 ULTRASOUND MULTI-FRAME IMAGE INFORMATION OBJECT DEFINITION

A.7.1 US Image IOD Description

The Ultrasound (US) Multi-frame Image Information Object Definition specifies a Multi-frame image which has been created by an ultrasound imaging device.

A.7.2 US Multi-Frame Image IOD Entity-Relationship Model

The E-R Model in Section A.1.2 depicts those components of the DICOM Application Information Model which directly reference the US Multi-frame Image IOD. The Overlay IE, Modality LUT IE and VOI LUT IE are not components of the US Multi-frame Image IOD.

A.7.3 US Image IOD Module Table (Retired)

Section A.7.3 was defined in a previous version of the DICOM Standard. The Section is now retired and has been moved to Annex H.3.

A.7.4 US Multi-Frame Image IOD Module Table

Table A.7-1
US MULTI-FRAME IMAGE IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	General Series	C.7.3.1	M
Frame of Reference	Frame of Reference	C.7.4.1	U
	US Frame of Reference	C.8.5.4	C - Required if images are spatially related
Equipment	General Equipment	C.7.5.1	M
Image (See A.7.4.1)	General Image	C.7.6.1	M
	Image Pixel	C.7.6.3	M
	Contrast/bolus	C.7.6.4	C - Required if contrast media was used in this image.
	Cine	C.7.6.5	M
	Multi-frame	C.7.6.6	M
	Palette Color Lookup Table	C.7.9	C - Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR
	US Region Calibration	C.8.5.5	U
	US Image	C.8.5.6	M
	VOI LUT	C.11.2	U
	SOP Common	C.12.1	M
Curve (see A.7.4.1)	Curve Identification	C.10.1	M
	Curve	C.10.2	M
	Audio	C.10.3	U
	SOP Common	C.12.1	M

A.7.4.1 MUTUALLY EXCLUSIVE IES

The Image and Curve IEs are mutually exclusive. Each SOP Instance using this IOD shall contain exactly one of these IEs.

A.8 SECONDARY CAPTURE IMAGE INFORMATION OBJECT DEFINITION

A.8.1 SC Image IOD Description

The Secondary Image (SC) Image Information Object Definition (IOD) specifies images that are converted from a non-DICOM format to a modality independent DICOM format.

Examples of types of equipment that create Secondary Capture Images include:

a. Video interfaces that convert an analog video signal into a digital image
b. Digital interfaces that are commonly used to transfer non-DICOM digital images from an imaging device to a laser printer
c. Film digitizers that convert an analog film image to digital data
d. Workstations that construct images that are sent out as a screen dump

A.8.2 SC Image IOD Entity-Relationship Model

The E-R Model in Section A.1.2 depicts those components of the DICOM Information Model which directly reference the Secondary Capture Image IOD. The Frame of Reference IE, Overlay IE, Modality LUT IE, VOI LUT IE and Curve IE are not components of the Secondary Capture IOD.

A.8.3 SC Image IOD Module Table

Table A.8-1
SC IMAGE IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	General Series	C.7.3.1	M
Equipment	General Equipment	C.7.5.1	U
	SC Equipment	C.8.6.1	M
Image	General Image	C.7.6.1	M
	Image Pixel	C.7.6.3	M
	SC Image	C.8.6.2	M
	Overlay Plane	C.9.2	U
	Modality LUT	C.11.1	U
	VOI LUT	C.11.2	U
	SOP Common	C.12.1	M

A.9 STANDALONE OVERLAY INFORMATION OBJECT DEFINITION

A.9.1 Standalone Overlay IOD Description

A Standalone Overlay IOD is the specification of an overlay which may be related to an Image, but also may have its own existence within a Series. The Standalone Overlay IOD is modality independent. It provides a mechanism to convey bit-mapped text, graphical information, etc. included in a Series.

A.9.2 Standalone Overlay IOD Entity-Relationship Model

The E-R Model in Section A.1.2 depicts those components of the DICOM Information Model which directly reference the Standalone Overlay IOD. The Frame of Reference IE, Image IE, Modality LUT IE, VOI LUT IE and Curve IE are not components of the Standalone Overlay IOD.

A.9.3 Standalone Overlay IOD Module Table

Table A.9-1
STANDALONE OVERLAY IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	General Series	C.7.3.1	M
Equipment	General Equipment	C.7.5.1	M
Overlay	Overlay Identification	C.9.1	M
	Overlay Plane (see note)	C.9.2	M
	SOP Common	C.12.1	M

Note: The Attribute Overlay Data (60xx,3000) allows for overlay data to be encoded in the pixel data in Group 7FE0H. For this Standalone Overlay IOD, Group 7FE0H does not exist and therefore the overlay data is contained in the Overlay Data Attribute.

A.10 STANDALONE CURVE INFORMATION OBJECT DEFINITION

A.10.1 Standalone Curve IOD Description

A Standalone Curve IOD is the specification of an curve which may be related to an Image, but also may have its own existence within a Series. The Standalone Curve IOD is modality independent.

A.10.2 Standalone Curve IOD Entity-Relationship Model

The E-R Model in Section A.1.2 depicts those components of the DICOM Information Model which directly reference the Standalone Curve IOD. The Frame of Reference IE, Overlay IE, Modality LUT IE, VOI LUT IE and Image IE are not components of the Standalone Curve IOD.

A.10.3 Standalone Curve IOD Module Table

Table A.10-1
STANDALONE CURVE IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	General Series	C.7.3.1	M
Equipment	General Equipment	C.7.5.1	M
Curve	Curve Identification	C.10.1	M
	Curve	C.10.2	M
	SOP Common	C.12.1	M

A.11 BASIC STUDY DESCRIPTOR INFORMATION OBJECT DEFINITION

A.11.1 Basic Study Descriptor IOD Description

A Basic Study Descriptor IOD is the specification of an abstract information model of summary information for a Study, which may be exchanged between connecting devices which claim conformance to the DICOM Standard. This Basic Study Descriptor is intended to be modality independent. It is intended to provide a simple "directory" for a study to explicitly convey references to the content of a study.

A.11.2 Basic Study Descriptor Entity-Relationship Model

The E-R model for the Basic Study Descriptor Information Object Definition is shown in Figure A.11-1.

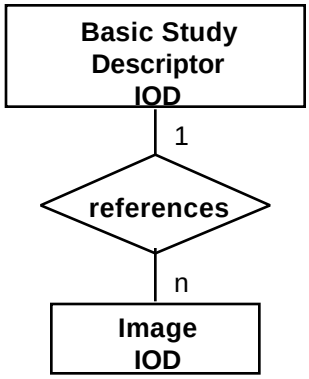


Figure A.11-1
BASIC STUDY DESCRIPTOR INFORMATION OBJECT DEFINITION E-R MODEL

A.11.3 Basic Study Descriptor IOD Module Table

Table A.11-1
BASIC STUDY DESCRIPTOR IOD MODULE TABLE

Module	Reference	Usage
Patient Summary	C.7.7	M
Study Content	C.7.8	M
SOP Common	C.12.1	M

A.12 STANDALONE MODALITY LUT INFORMATION OBJECT DEFINITION

A.12.1 Standalone Modality LUT IOD Description

The Standalone Modality LUT IOD specifies one or more Modality LUTs that are related to an Image.

A.12.2 Standalone Modality LUT IOD Entity-Relationship Model

The E-R Model in Section A.1.2 depicts those components of the DICOM Information Model which directly reference the Standalone Modality LUT IOD. The Frame of Reference IE, Overlay IE, Curve IE, VOI LUT IE and Image IE are not components of the Standalone Modality LUT IOD.

A.12.3 Standalone Modality LUT IOD Module Table

Table A.12-1
STANDALONE MODALITY LUT IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	General Series	C.7.3.1	M
Equipment	General Equipment	C.7.5.1	M
Modality LUT	Modality LUT Module	C.11.1	M
	LUT Identification	C.11.3	M
	SOP Common	C.12.1	M

A.13 STANDALONE VOI LUT INFORMATION OBJECT DEFINITION

A.13.1 Standalone VOI LUT IOD Description

The Standalone VOI LUT IOD specifies one or more VOI LUTs that are related to an Image.

A.13.2 Standalone VOI LUT IOD Entity-Relationship Model

The E-R Model in Section A.1.2 depicts those components of the DICOM Information Model which directly reference the Standalone VOI LUT IOD. The Frame of Reference IE, Overlay IE, Curve IE, Modality LUT IE and Image IE are not components of the Standalone VOI LUT IOD.

A.13.3 Standalone VOI LUT IOD Module Table

Table A.13-1
STANDALONE VOI LUT IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	General Series	C.7.3.1	M
Equipment	General Equipment	C.7.5.1	M
VOI LUT	VOI LUT Module	C.11.2	M
	LUT Identification	C.11.3	M
	SOP Common	C.12.1	M

A.14 X-RAY ANGIOGRAPHIC IMAGE INFORMATION OBJECT DEFINITION

A.14.1 XA Image IOD Description

This Section defines the Information Object for single plane X-Ray Angiographic Imaging which includes those data elements and information objects necessary for the interchange of digital X-Ray Angiographic data. This includes images of the heart and all blood vessels.

The XA IOD share a significant amount of common information with the XRF IOD. The differences between the two IODs are that the XRF Image IOD includes a tomography module; and the two IODs utilize different methods to specify positioner angles. The XRF Image IOD contains a single column angulation Data Element which uses an equipment based coordinate system, while XA Image IOD c-arm positioner angles are specified in a patient based coordinate system. RF applications which support a patient-based coordinate system with cranial/caudal, LAO/RAO angles may utilize the XA IOD.

The XA IOD is also applicable to clinical areas other than angiography (e.g. Interventional Procedures, Myelography, Biopsy/Localization, and Neurology).

Note: 1. For the purpose of X-Ray Angiography (XA), this IOD can be used to encode a single frame image, or a Cine Run encoded in a single multi-frame image.

2. A typical study might include all the images generated between the time a patient gets on and gets off the procedure table. As several separable diagnostic or therapeutic processes may occur during a single study (e.g., pre-intervention CA, left ventriculography, and post-intervention CA), a series may be defined as comprising a set of images (single or Multi-Frame) associated with one such process within a study.

3. This IOD can be used to encode a single plane acquisition, or one plane of a biplane acquisition.

A.14.2 XA Image IOD Entity-Relationship Model

The E-R Model in Section A.1.2 depicts those components of the DICOM Application Information Model which directly reference the X-Ray Angiographic Image IOD, with exception of the Frame of Reference and Modality LUT entities which are not used. Additionally, "Image" in Figure A.1-1 may represent a Single Frame or a Multi-Frame image. A frame denotes a two-dimensional organization of pixels recorded as a single exposure.

A.14.3 XA Image IOD Module Table

Table A.14.-1
X-RAY ANGIOGRAPHIC IMAGE IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	General Series	C.7.3.1	M
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	Image Pixel	C.7.6.3	M
	Contrast/Bolus	C.7.6.4	C - Required if contrast media was used in this Image
	Cine	C.7.6.5	C - Required if pixel data is Multi-Frame Cine data
	Multi-Frame	C.7.6.6	C - Required if pixel data is Multi-Frame Cine data
	Frame Pointers	C.7.6.9	U
	Mask	C.7.6.10	C - Required if the Image may be subtracted
	Display Shutter	C.7.6.11	U
	Device	C.7.6.12	U
	Therapy	C.7.6.13	U
	X-Ray Image	C.8.7.1	M
	X-Ray Acquisition	C.8.7.2	M
	X-Ray Collimator	C.8.7.3	U
	X-Ray Table	C.8.7.4	C - Required if Image is created with table motion
	XA Positioner	C.8.7.5	M
	Overlay Plane	C.9.2	U
	Multi-Frame Overlay	C.9.3	C - Required if Overlay data contains multiple frames.
	Curve	C.10.2	U (See C.8.7.1.1.9)
	Modality LUT	C.11.1	C - Required if Pixel Intensity Relationship (0028,1040) is LOG U - Optional if Pixel Intensity Relationship (0028,1040) is DISP
	VOI LUT	C.11.2	U
	SOP Common	C.12.1	M

A.15 X-RAY ANGIOGRAPHIC BI-PLANE IMAGE INFORMATION OBJECT DEFINITION

A.15.1 XA Bi-Plane Image IOD Description

This Section defines the Information Object for bi-plane X-Ray Angiographic Imaging which includes those data elements and information objects necessary for the interchange of digital X-Ray Angiographic data. This includes images of the heart and all blood vessels acquired simultaneously in two (nominally orthogonal) planes.

Notes: 1. For the purpose of X-Ray Angiography (XA), this IOD can be used to encode a single bi-plane frame image, or a Cine Run encoded in a single bi-plane multi-frame image.

2. A typical study might include all the images generated between the time a patient gets on and gets off the procedure table. As several separable diagnostic or therapeutic processes may occur during a single study (e.g., pre-intervention CA, left ventriculography, and post-intervention CA), a series may be defined as comprising a set of images (single or Multi-Frame) associated with one such process within a study.

A.15.2 XA Bi-Plane Image IOD Entity-Relationship Model

The E-R Model in Section A.1.2 depicts those components of the DICOM Application Information Model which directly reference the X-Ray Angiographic Bi-plane Image IOD, with exception of the Frame of Reference and Modality LUT entities which are not used. Additionally, "Image" in Figure A.1-1 may represent a single Bi-plane Frame or a Bi-plane Multi-Frame image. A bi-plane frame denotes two, two-dimensional organizations of pixels recorded at a single time.

A.15.3 X-Ray Angiographic Bi-Plane Image IOD Module Table

Table A.15.-1
X-RAY ANGIOGRAPHY BI-PLANE IMAGE IOD

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	General Series	C.7.3.1	M
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	Image Pixel	C.7.6.3	M
	Contrast/Bolus	C.7.6.4	C - Required if contrast media was used in this Image
	Cine	C.7.6.5	C - Required if pixel data is Multi-Frame Cine date
	Multi-Frame	C.7.6.6	C - Required if pixel data is Multi-Frame Cine date
	Bi-Plane Sequence	C.7.6.7	M
	> Bi-Plane Image	C.7.6.8	M
	> Frame Pointers	C.7.6.9	U
	> Mask	C.7.6.10	C - Required if the Image may be subtracted

	> Display Shutter	C.7.6.11	U
	> X-Ray Acquisition	C.8.7.2	M
	> X-Ray Collimator	C.8.7.3	U
	> XA Positioner	C.8.7.5	M
	> VOI LUT	C.11.2	U
	Device	C.7.6.12	U
	Therapy	C.7.6.13	U
	X-Ray Image	C.8.7.1	M
	X-Ray Table	C.8.7.4	C - Required if Image is created with table motion
	Overlay Plane	C.9.2	U
	Multi-Frame Overlay	C.9.3	C - Required if Overlay data contains multiple frames.
	Bi-Plane Overlay	C.9.4	C - Required if Overlay data is present
	Curve	C.10.2	U (See C.8.7.1.1.9)
	Modality LUT	C.11.1	C - Required if Pixel Intensity Relationship (0028,1040) is LOG U - Optional if Pixel Intensity Relationship (0028,1040) is DISP
	SOP Common	C.12.1	M

A.16 X-RAY RF IMAGE INFORMATION OBJECT DEFINITION

A.16.1 XRF Image IOD Description

The focus for this X-Ray RF Image IOD (XRF IOD) is to address the requirements for image transfer found in general Radiofluoroscopic applications performed on a table with a column. For applications performed on X-Ray RF acquisition systems which support a patient based coordinate system with cranial/caudal, LAO/RAO angles, etc. the XA Image IOD may be used.

Note: An example of a case where the XA IOD may be preferred to the RF IOD are RF acquisition system equipped with an X-Ray source and an image Receptor positioned by what is generally called a c-arm (e.g. Interventional Procedures, Myelography, Biopsy, and Neurology).

This Section defines the Information Object for X-Ray Radiofluoroscopic Imaging which includes those data elements and information objects necessary for the interchange of digital X-Ray RF Image data. The XRF IOD is applicable to X-Ray acquisition systems equipped with an image receptor whose plane is parallel to the table plane where the patient is. This Table has in general the ability to be tilted. Furthermore the X-Ray source may be supported by a column which can be angulated to adjust the incidence of the X-Ray beam on the image receptor plan. An equipment based coordinated system is used to track these angles.

Notes: 1. For the purpose of X-Ray Radiofluoroscopy, this IOD can be used to encode a single frame image, or a cine run encoded in a single multi-frame image.

2. A typical study might include all the images generated between the time a patient gets on and gets off the procedure table. As several separable diagnostic or therapeutic processes may occur during a single study, a series may be defined as comprising a set of images (single or Multi-Frame) associated with one such process within a study.

A.16.2 XRF Image IOD Entity-Relationship Model

The E-R Model in Section A.1.2 depicts those components of the DICOM Application Information Model which directly reference the X-Ray RF Image IOD, with exception of the Frame of Reference entity which is not used. Additionally, "Image" in figure A.1-1 may represent a Single Frame or a Multi-Frame image. A frame denotes a two-dimensional organization of pixels recorded as a single exposure.

Note: When a Study (or Study Component) contains a number of Multi-frame images which do not need to be grouped under different Series, a single Series may be used with a series number containing an arbitrary value (e.g. 1).

A.16.3 XRF Image IOD Module Table

Table A.16-1
XRF IMAGE IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	General Series	C.7.3.1	M
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	Image Pixel	C.7.6.3	M
	Contrast/bolus	C.7.6.4	C - Required if contrast media was used in this Image
	Cine	C.7.6.5	C - Required if pixel data is Multi-Frame Cine Data
	Multi-Frame	C.7.6.6	C - Required if pixel data is Multi-Frame Cine Data
	Frame Pointers	C.7.6.9	U
	Mask	C.7.6.10	C - Required if the Image may be subtracted
	X-Ray Image	C.8.7.1	M
	X-Ray Acquisition	C.8.7.2	M
	X-Ray Collimator	C.8.7.3	U
	Display Shutter	C.7.6.11	U
	Therapy	C.7.6.12	U
	Device	C.7.6.13	U
	X-Ray Table	C.8.7.4	U
	XRF Positioner	C.8.7.6	U
	XRF Tomo Acquisition	C.8.7.7	C - Required if Scan Option (0018,0022) is TOMO
	Overlay Plane	C.9.2	U
	Multi-frame Overlay	C.9.3	C - Required if Overlay Data contains multiple frames
	Curve	C.10.2	U
	Modality LUT	C.11.1	C - Required if Pixel Intensity Relationship (0028,1040) is LOG U - Optional if Pixel Intensity Relationship (0028,1040) is DISP
	VOI LUT	C.11.2	U
	SOP Common	C.12.1	M

A.17 RT IMAGE INFORMATION OBJECT DEFINITION

A.17.1 RT Image IOD Description

The focus for this Radiotherapy Image IOD (RT Image IOD) is to address the requirements for image transfer found in general radiotherapy applications performed on conventional simulators, virtual simulators, and portal imaging devices. Such images have a conical imaging geometry and may either be acquired directly from the device, or digitized using a film digitizer. They may or may not have superimposed curves describing beam limiting device (collimator) openings, beam modifying devices, patient structures and target volumes. Numeric beam data parameters may also be recorded with the image, indicating the parameter values at the time the image was taken or created.

A.17.2 RT Image IOD entity-relationship model

The E-R model for the RT Image IOD is illustrated in Figure A.17-1.

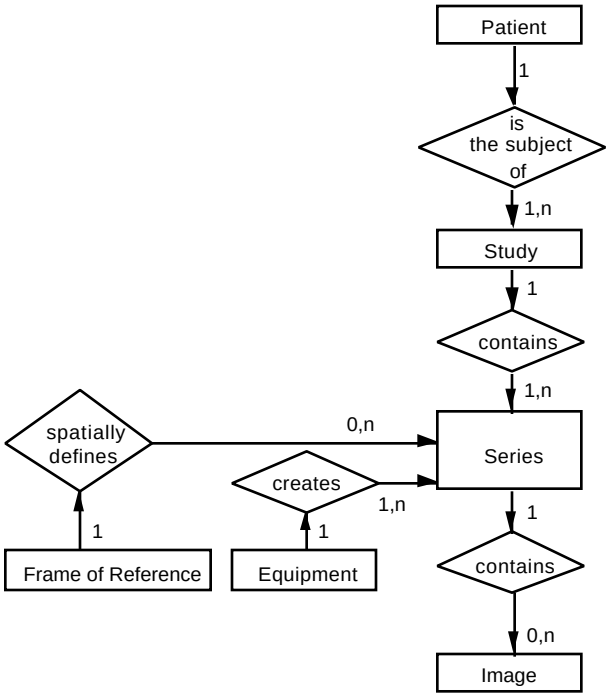


Figure A.17-1—DICOM RT Image IOD information model

A.17.3 RT Image IOD Module Table

Table A.17.3-1—RT IMAGE IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	RT Series	C.8.8.1	M
Frame of Reference	Frame of Reference	C.7.4.1	U
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	Image Pixel	C.7.6.3	M
	Contrast/bolus	C.7.6.4	C-Required if contrast media was used in this image.
	Cine	C.7.6.5	C - Required if multi-frame image is a cine image.
	Multi-Frame	C.7.6.6	C - Required if pixel data is multi-frame data.
	RT Image	C.8.8.2	M
	Modality LUT	C.11.1	U
	VOI LUT	C.11.2	U
	Approval	C.8.8.16	U
	Curve	C.10.2	U
	Audio	C.10.3	U
	SOP Common	C.12.1	M

Notes: 1. The inclusion of the Multi-Frame module allows for the expression of time-dependent image series or multiple exposures of identical beam geometries (i.e. multiple exposure portal images). If a time-dependent series of images (such as port images or DRRs) is represented the Cine module is used to indicate this. This would subsequently allow analysis of patient movement during treatment. Multiple exposure images allow individual images of treatment ports and open field ports to be grouped into a single multi-frame image.

2. The Modality LUT module has been included to allow the possibility of conversion between portal image pixel values and dose transmitted through the patient. The VOI LUT module has been included to allow the possibility of translation between stored pixel values (after the Modality LUT has been applied if specified) and display levels.

3. The Curve module has been included to allow the possibility of storing one or more curves overlaid with a given image. Generally these curves would represent patient structures, target volumes, or beam limiting device (collimator) openings, although they could also be used to store other data such as axis information. Such curves would be stored in pixel units (i.e. the coordinates would represent pixel indices in the image data). For example, patient structures might have the following attribute assignments:

Curve Dimensions (50xx,0005) = 2

Number of Points (50xx,0010) = Number of data points in curve

Type of Data (50xx,0020)	= ROI
Data Value Representation (50xx,0103)	= US (unsigned short)
Curve Data (50xx,3000)	= (x,y) pixel coordinates
Curve Description (50xx,0022)	= Structure/Target name

Note that there is no facility for representing multi-frame curves (i.e. all curves are interpreted as being related to the first image frame in a multi-frame image). Curves other than patient structures might also be represented using the HIST, POLY or TABL curve types (see C.10.2.1).

4. The Equipment module contains information describing the equipment used to acquire or generate the RT Image (such as a portal imager, conventional simulator or treatment planning system). However, the equipment attributes in the RT Image module describe the equipment on which the treatment has been or will be given, typically an electron accelerator.

5. For RT Images which contain no relevant pixel data, such as BEV images without DRR information, Pixel Data (7FE0,0010) should be filled with a sequence of zeros.

6. The Frame of Reference module has been included to allow the indication of spatial association of two or more RT Image instances (e.g. where the images have been acquired in the same frame of reference, or have been resampled to share the same frame of reference). If the Frame of Reference occurs within a SOP Instance within a given series, then all SOP Instances within that series will be spatially related. For example, two RT Images may share the same Frame of Reference if they are located on the same physical plane, as determined by the treatment machine Gantry Angle (300A,011E) and source to image plane distance specified by RT Image SID (3002,0026).

A.18 RT DOSE INFORMATION OBJECT DEFINITION

A.18.1 RT Dose IOD Description

The focus for this Radiotherapy Dose IOD (RT Dose IOD) is to address the requirements for transfer of dose distributions calculated by radiotherapy treatment planning systems. These distributions may be represented as 2D or 3D grids, as isodose curves, or as named or unnamed dose points scattered throughout the volume. This IOD may also contain dose-volume histogram data, single or multi-frame overlays, audio annotations, and application-defined lookup tables. This IOD does not provide for definition of doses in beam or other coordinate systems. The application is responsible for transforming data in other, non-patient based coordinate systems to the patient based coordinate system described in C.7.6.2.1.1.

A.18.2 RT Dose IOD entity-relationship model

The E-R model for the RT Dose IOD is illustrated in Figure A.18-1.

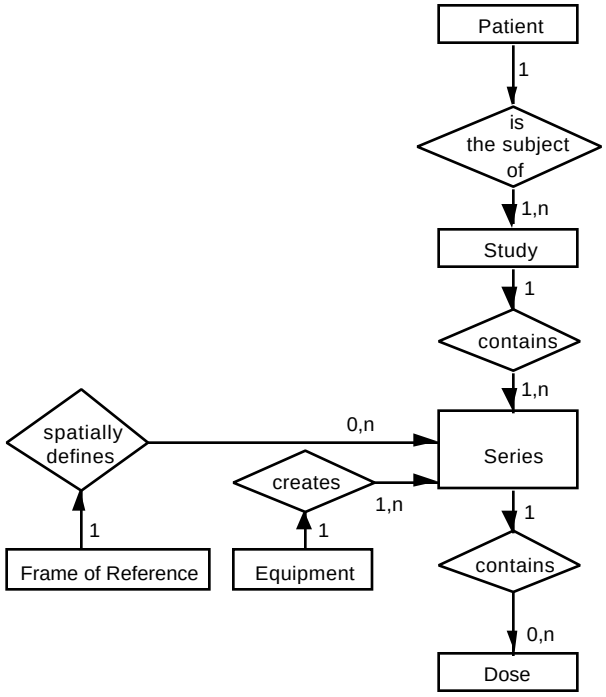


Figure A.18-1—DICOM RT Dose IOD information model

A.18.3 RT Dose IOD Module Table

Table A.18.3-1—RT DOSE IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	RT Series	C.8.8.1	M
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
Dose	General Image	C.7.6.1	C - Required if dose data contains grid-based doses.
	Image Plane	C.7.6.2	C - Required if dose data contains grid-based doses.
	Image Pixel	C.7.6.3	C - Required if dose data contains grid-based doses.
	Multi-Frame	C.7.6.6	C - Required if dose data contains grid-based doses and pixel data is multi-frame data.
	Overlay Plane	C.9.2	U
	Multi-Frame Overlay	C.9.3	U
	Modality LUT	C.11.1	U
	RT Dose	C.8.8.3	M
	RT DVH	C.8.8.4	U
	Structure Set	C.8.8.5	C - Required if dose data contains dose points or isodose curves
	ROI Contour	C.8.8.6	C - Required if dose data contains dose points or isodose curves
	RT Dose ROI	C.8.8.7	C - Required if dose data contains dose points or isodose curves
	Audio	C.10.3	U
	SOP Common	C.12.1	M

Notes: 1. Within the RT Dose IOD, the RT Dose module supports 2D and 3D dose grids. The Structure Set, ROI Contour and RT Dose ROI modules together support isodose curves and points, and the RT DVH module supports dose-volume histogram data. They are not mutually exclusive: all four representations may be included in a single instance of the object or they may be included in any combination. Product Conformance Statements should clearly state which of these mechanisms is supported and under what conditions.

2. The RT Dose IOD has been defined as a composite IOD, separate from the RT Plan IOD. This has been done for the following reasons:

– to allow for the multiplicity of possible dose calculations using beam models for the same basic plan,

– to avoid undesirable transmission of large amounts of data with the treatment plan, and

– to accommodate the fact that CT Simulation and other “beam geometry” generating devices which use the RT Plan IOD do not have or require access to this data, either for transmission or storage.

A.19 RT STRUCTURE SET INFORMATION OBJECT DEFINITION

A.19.1 RT Structure Set IOD Description

The focus for this Radiotherapy Structure Set IOD (RT Structure Set IOD) is to address the requirements for transfer of patient structures and related data defined on CT scanners, virtual simulation workstations, treatment planning systems and similar devices. This IOD may also contain audio curve annotations.

A.19.2 RT Structure Set IOD entity-relationship model

The E-R model for the RT Structure Set IOD is illustrated in Figure A.19-1.

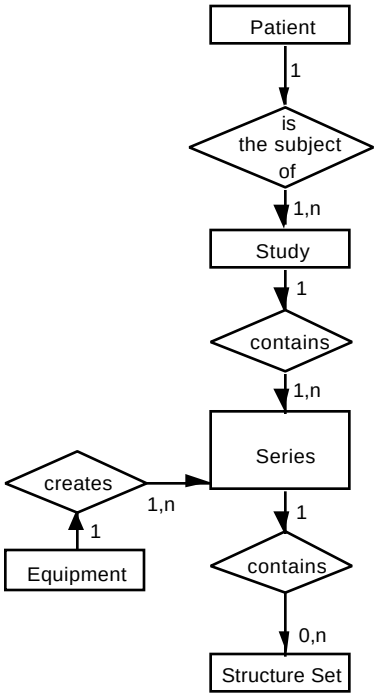


Figure A.19-1—DICOM RT Structure Set IOD information model

A.19.3 RT Structure Set IOD Module Table

Table A.19.3-1—RT STRUCTURE SET IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	RT Series	C.8.8.1	M
Equipment	General Equipment	C.7.5.1	M
Structure Set	Structure Set	C.8.8.5	M
	ROI Contour	C.8.8.6	M
	RT ROI Observations	C.8.8.8	M
	Approval	C.8.8.16	U
	Audio	C.10.3	U
	SOP Common	C.12.1	M

A.20 RT PLAN INFORMATION OBJECT DEFINITION

A.20.1 RT Plan IOD Description

The focus for this Radiotherapy Plan IOD (RT Plan IOD) is to address the requirements for transfer of treatment plans generated by manual entry, a virtual simulation system, or a treatment planning system before or during a course of treatment. Such plans may contain fractionation information, and define external beams and/or brachytherapy application setups. This IOD may also contain audio curve annotations.

A.20.2 RT Plan IOD entity-relationship model

The E-R model for the RT Plan IOD is illustrated in Figure A.20-1.

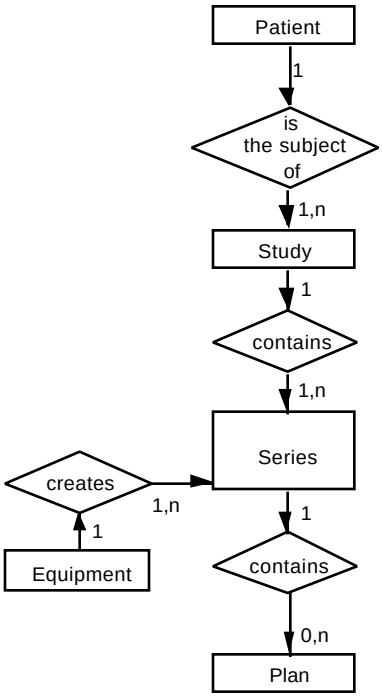


Figure A.20-1—DICOM RT Plan IOD information model

A.20.3 RT Plan IOD Module Table

Table A.20.3-1—RT PLAN IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	RT Series	C.8.8.1	M
Equipment	General Equipment	C.7.5.1	M
Plan	RT General Plan	C.8.8.9	M
	RT Prescription	C.8.8.10	U
	RT Tolerance Tables	C.8.8.11	U
	RT Patient Setup	C.8.8.12	U
	RT Fraction Scheme	C.8.8.13	U
	RT Beams	C.8.8.14	C - Required if RT Fraction Scheme Module exists and Number of Beams (300A,0080) is greater than zero for one or more fraction groups
	RT Brachy Application Setups	C.8.8.15	C - Required if RT Fraction Scheme Module exists and Number of Brachy Application Setups (300A,00A0) is greater than zero for one or more fraction groups
	Approval	C.8.8.16	U
	Audio	C.10.3	U
	SOP Common	C.12.1	M

A.20.3.1 RT FRACTION SCHEME MODULE

The RT Fraction Scheme module is structured to be used together with the RT Beams or RT Brachy Application Setups module. If beams are referenced in the RT Fraction Scheme module, all such beams shall be included in the RT Beams module if it is present. Similarly, if brachy application setups are referenced in the RT Fraction Scheme module, all such setups shall be included in the RT Brachy Application Setups module if it is present. However, the RT Fraction Scheme module can be used without the RT Beams or RT Brachy Application Setups modules if no beams or brachy application setups are referenced, and the RT Beams or RT Brachy Application Setups modules can also be used without the RT Fraction Scheme module if no fraction scheme information is available.

A.20.3.2 RT PRESCRIPTION MODULE

The RT Prescription module provides for the inclusion of dose prescription information pertinent to the complete plan, which may comprise several fraction schemes, themselves consisting of many beams.

A.20.3.3 RT TOLERANCE TABLES MODULE

The RT Tolerance Tables module provides information concerning machine tolerances as they apply to the whole treatment plan. Tolerances are applied by reference to a tolerance table within the RT Tolerance Tables module for beams contained within the RT Beams module.

A.20.3.4 RT PATIENT SETUP MODULE

The RT Patient Setup module provides information concerning patient setup parameters and fixation devices as they apply to the whole treatment plan. Patient setup information within the RT Patient Setup module is referenced by beams contained within the RT Beams module.

A.21 POSITRON EMISSION TOMOGRAPHY IMAGE INFORMATION OBJECT DEFINITION

A.21.1 PET Image IOD Description

The Positron Emission Tomography (PET) Image Information Object Definition specifies an image which has been created by a Positron Tomograph imaging device, including dedicated PET cameras and Nuclear Medicine imaging devices operating in coincidence mode. This includes data created by external detection devices which create images of the distribution of administered radioactive materials, specifically positron emitters, in the body. Depending on the specific radiopharmaceuticals administered and the particular imaging procedure performed, problems involving changes in metabolism, function, or physiology can be investigated and various region pathologies can be studied. For these problems, quantitation of image data in absolute activity and physiological units is important. In addition, the PET Image IOD specifies attenuation (transmission) images used for correction and anatomical reference of emission images.

A.21.2 PET Image IOD Entity-Relationship Model

The E-R model in Section A.1.2 of this part depicts those components of the DICOM Information Model which directly reference the PET Image IOD. The overlay IE, modality LUT IE, VOI LUT IE, and curve IE are not components of the PET Image IOD.

A.21.3 PET Image IOD Module Table

Table A.21.3-1 - PET IMAGE IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	General Series	C.7.3.1	M
	PET Series	C.8.9.1	M
	PET Isotope	C.8.9.2	M
	PET Multi-gated Acquisition	C.8.9.3	C - Required if Series Type (0054,1000) Value 1 is GATED.
	NM/PET Patient Orientation	C.8.4.6	M
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	Image Plane	C.7.6.2	M
	Image Pixel	C.7.6.3	M
	PET Image	C.8.9.4	M
	Overlay Plane	C.9.2	U
	VOI LUT	C.11.2	U
	SOP Common	C.12.1	M

A.22 STANDALONE PET CURVE INFORMATION OBJECT DEFINITION

A.22.1 Standalone PET Curve IOD Description

A standalone PET curve IOD is the specification of a PET curve which may be related to an image, but also may have its own existence within a PET Series.

A.22.2 Standalone PET Curve IOD Entity-Relationship Model

The E-R model in Section A.1.2 of this part depicts those components of the DICOM Information Model which directly reference the standalone PET curve IOD. The frame of reference IE, overlay IE, modality LUT IE, VOI LUT IE and Image IE are not components of the standalone PET curve IOD.

A.22.3 Standalone PET Curve IOD Module Table

Table A.22.3-1 - STANDALONE PET CURVE IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	General Series	C.7.3.1	M
	PET Series	C.8.9.1	M
	PET Isotope	C.8.9.2	M
	PET Multi-gated Acquisition	C.8.9.3	C - Required if Series Type (0054,1000) Value 1 is GATED.
Equipment	General Equipment	C.7.5.1	M
Curve	Curve Identification	C.10.1	M
	Curve	C.10.2	M
	PET Curve	C.8.9.5	M
	SOP Common	C.12.1	M

A.23 STORED PRINT INFORMATION OBJECT DEFINITION

A.23.1 IOD Description

The Stored Print IOD describes all the print parameters to print a single film. The Stored Print IOD contains one or more references to Image SOP Instances. There is a many to one relationship between the Stored Print IOD and the Printer IOD.

Images referenced by the Stored Print IOD shall be Preformatted Grayscale or Preformatted Color Images or other grayscale images where all grayscale transformations up to and including VOI LUT have been applied.

A.23.2 Stored Print IOD Entity-Relationship Model

The E-R Model in Section A.1.2 depicts those components of the DICOM Information Model which directly reference the Stored Print IOD. The Frame of Reference IE, Overlay IE, Curve IE, VOI LUT IE, and Modality LUT IE are not components of the Stored Print IOD.

A.23.3 IOD Module Table

Table A.23-1
STORED PRINT IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	General Series	C.7.3.1	M
Equipment	General Equipment	C.7.5.1	M
	Printer Characteristics	C.16.1	M
Image	Film Box	C.16.2	M
	Image Box List	C.16.3	M
	Annotation List	C.16.4	U
	Image Overlay Box List	C.16.5	U
	Presentation LUT List	C.16.6	U
	SOP Common Information	C.16.1	M

A.24 HARDCOPY GRAYSCALE IMAGE INFORMATION OBJECT DEFINITION

A.24.1 IOD Description

The Hardcopy Grayscale IOD is an abstraction of a printable 8 or 12 bit grayscale image where annotation, overlays, graphics may be burned in and where the LUT operations up to and including VOI LUT have already been performed.

Notes: 1. A hardcopy grayscale image corresponds with a Preformatted Grayscale Image (see PS 3.4) and is a specialization of the Secondary Capture Image.

2. The optional Annotation List and Image Overlay Box Modules in the Stored Print IOD provide additional overlay, graphic, and annotation information that will be burnt into the printed image only if both the SCU and SCP support the Attributes in these Modules. See the Pull Print Request N-CREATE Behavior Section in PS 3.4.

A.24.2 Hardcopy Grayscale Image IOD Entity-Relationship Model

The E-R Model in Section A.1.2 depicts those components of the DICOM Information Model which are related to the Hardcopy Grayscale Image IOD.

A.24.3 IOD Module Table

Table A.24-1
HARDCOPY GRAYSCALE IMAGE IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	General Series	C.7.3.1	M
Equipment	General Equipment	C.7.5.1	U
	Hardcopy Equipment	C.8.10.1	M
Image	General Image	C.7.6.1	M
	HC Grayscale Image	C.8.10.2	M
	Overlay Plane	C.9.2	U
	SOP Common Information	C.12.1	M

A.25 HARDCOPY COLOR IMAGE INFORMATION OBJECT DEFINITION

A.25.1 IOD Description

The Hardcopy Color IOD is an abstraction of a printable 8 bit color image where annotation, overlays, and graphics may be burned in.

Note : A hardcopy color image corresponds with a Preformatted Color Image (see PS 3.4) and is a specialization of the Secondary Capture Image.

A.25.2 Hardcopy Color Image IOD Entity-Relationship Model

The E-R Model in Section A.1.2 depicts those components of the DICOM Information Model which are related to the Hardcopy Color Image IOD.

A.25.3 IOD Module Table

Table A.25-1
HARDCOPY COLOR IMAGE IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	General Series	C.7.3.1	M
Equipment	General Equipment	C.7.5.1	U
	Hardcopy Equipment	C.8.10.1	M
Image	General Image	C.7.6.1	M
	HC Color Image	C.8.10.3	M
	Overlay Plane	C.9.2	U
	SOP Common Information	C.12.1	M

Annex B Normalized Information Object Definitions (Normative)

B.1 PATIENT INFORMATION OBJECT DEFINITION

B.1.1 IOD description

The Patient Information Object Definition is an abstraction of the information describing a patient upon whom medical imaging services are performed. The Patient IOD is tailored by Service Class Definitions that use services which facilitate the exchange of patient-related information between DICOM Application Entities.

A Patient SOP Instance uses the Patient IOD as a basis to describe a real world patient. Each Patient SOP Instance references related Visit SOP Instances and Study SOP Instances as described by the Entity-Relationship diagram in Section 7.

B.1.2 Patient IOD modules

Table B.1-1 identifies and defines the Modules that comprise this IOD. Modules listed are either mandatory or optional as specified in PS 3.4. Mandatory Modules contain Attributes that are included in all SOP Instances employing this IOD.

Table B.1-1
PATIENT IOD MODULES

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP common information
Patient Relationship	C.2.1	References to related SOPs
Patient Indentification	C.2.2	Identifies the real world patient
Patient Demographic	C.2.3	Describe the patient
Patient Medical	C.2.4	Medical information about patient

B.2 VISIT INFORMATION OBJECT DEFINITION

B.2.1 IOD description

The Visit Information Object Definition is an abstraction of the information that describes a patient attendance to a healthcare provider. Because it is defined generically, this IOD may be used in applications ranging from inpatient hospital to outpatient radiological attendances. It includes such information as the admitting date and time, the admitting diagnosis, and the physician who referred the patient. The Visit IOD is tailored by Service Class Definitions that use services which facilitate the exchange of visit-related information between DICOM Application Entities.

A Visit SOP Instance uses the Visit Information Object Definition as a basis to describe a real world patient visit. Each Visit SOP Instance references related Patient SOP Instances and Study SOP Instances as described by the Entity-Relationship diagram in Section 7.

B.2.2 IOD modules

Table B.2-1 identifies and defines the Modules that comprise this IOD. Modules listed are either mandatory or optional as specified in PS 3.4. Mandatory Modules contain Attributes that are included in all SOP Instances employing this IOD.

Table B.2-1
VISIT IOD MODULES

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP common information
Visit Relationship	C.3.1	Reference to related SOPs
Visit Identification	C.3.2	Identifies the real world visit
Visit Admission	C.3.3	Describes patient's admission
Visit Stay	C.3.4	Describes patient's stay
Visit Discharge	C.3.5	Describes patient's discharge
Visit Scheduling	C.3.6	Describes scheduling information for the patient's stay

B.3 STUDY INFORMATION OBJECT DEFINITION

B.3.1 IOD description

The Study Information Object Definition is an abstraction of the information which describes a diagnostic imaging study. It includes such information as the reason for performing the study, the radiological procedure performed, and the time and date of the radiological procedure. The Study IOD is tailored by Service Class Definitions which use services which facilitate the exchange of Study-related information between DICOM Application Entities.

A Study SOP Instance uses the Study Information Object Definition as a basis to describe a real world diagnostic imaging study for a patient. Each Study SOP Instance references related Visit SOP Instances and Patient SOP Instances as described by the Entity-Relationship diagram in Section 7.

B.3.2 IOD modules

Table B.3-1 identifies and defines the Modules which comprise this IOD. Modules listed are either mandatory or optional as specified in PS 3.4. Mandatory Modules contain Attributes which are included in all SOP Instances employing this IOD.

Table B.3-1
STUDY IOD MODULES

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP Common information
Study Relationship	C.4.1	References to related SOP's
Study Indentification	C.4.2	Indentifies the real world study
Study Classification	C.4.3	Classifies the real world study
Study Scheduling	C.4.4	Times and dates to perform study
Study Acquisition	C.4.5	Information acquired in study
Study Read	C.4.6	Reading related information

B.4 STUDY COMPONENT INFORMATION OBJECT DEFINITION

B.4.1 IOD description

A Study Component Information Object Definition is the specification of an abstract information model of summary information for a Study, which may be exchanged between connecting devices which claim conformance to the DICOM Standard. This Study Component is intended to be modality independent.

Each Study IOD as defined in Section B.3 relates to one or more Study Component IOD. This relationship is maintained by the Study Component Relationship Module. A Study Component represents one modality's contribution to a Study which may include additional components contributed by other modalities.

B.4.2 IOD modules

Table B.4-1
STUDY COMPONENT IOD MODULES

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP common information
Study Component Relationship	C.4.8	References to related SOPs
Study Component Acquisition	C.4.9	Status and acquisition information
Study Component	C.4.7	Identifies the related series

B.5 RESULTS INFORMATION OBJECT DEFINITION

B.5.1 IOD description

The Results Information Object Definition is an abstraction of the information resulting from the analysis of a diagnostic imaging study. This information consists of an initial report, some number of amendments to the initial report, and associated general Attributes. The Results IOD is tailored

by Service Class Definitions which use services which facilitate the exchange of results-related information between DICOM Application Entities.

A Results SOP Instance uses the Results Information Object Definition as a basis to describe real world diagnostic imaging results for a patient. Each Results SOP Instance references related Interpretation SOP Instances which represent diagnoses made during interpretation of the related studies. There may be one report (i.e. original interpretation) and many amendments (i.e. additional interpretations). The full results for a diagnostic study are hence the sum of the original report and all of its associated amendments.

Each Results SOP Instance references related Study SOP Instances and Interpretation SOP Instances as described by the Entity-Relationship diagram in Section 7.

B.5.2 IOD modules

Table B.5-1 identifies and defines the Modules which comprise this IOD. Modules listed are either mandatory or optional as specified in PS 3.4. Mandatory Modules contain Attributes which are included in all SOP Instances employing this IOD.

Table B.5-1
RESULTS IOD MODULES

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP common information
Results Relationship	C.5.1	References to related SOPs
Results Indentification	C.5.2	Indentifies the real world results
Results Impressions	C.5.3	Classifies the real world results

B.6 INTERPRETATION INFORMATION OBJECT DEFINITION

B.6.1 IOD description

The Interpretation Information Object Definition is an abstraction of the information resulting from a single interpretation of a diagnostic imaging study. This interpretation may be either a report (initial interpretation) or an amendment to a report for a diagnostic imaging study. The Interpretation IOD is tailored by Service Class Definitions which use services which facilitate the exchange of interpretation-related information between DICOM Application Entities.

An Interpretation SOP Instance uses the Interpretation Information Object Definition as a basis to describe real world interpretation of a diagnostic imaging study. Each Interpretation SOP Instance references one Results SOP Instance which represent the total diagnosis made for the related study. There may be one report interpretation and many amendment interpretations. The full results for a diagnostic study are hence the sum of the original report and all of its associated amendments.

B.6.2 IOD modules

Table B.6-1 identifies and defines the Modules which comprise this IOD. Modules listed are either mandatory or optional as specified in PS 3.4. Mandatory Modules contain Attributes which are included in all SOP Instances of this IOD.

Table B.6-1
INTERPRETATION IOD MODULES

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP Common information
Interpretation Relationship	C.6.1	References to related SOPs
Interpretation Identification	C.6.2	Indentifies the real world interpretation
Interpretation State	C.6.3	State of real world interpretation
Interpretation Recording	C.6.4	When, by whom the interpretation was recorded
Interpretation Transcription	C.6.5	When, by whom the interpretation was transcribed
Interpretation Approval	C.6.6	When, by whom the interpretation was approved

B.7 BASIC FILM SESSION INFORMATION OBJECT DEFINITION

B.7.1 IOD description

The Basic Film Session Information Object Definition describes the presentation parameters, which are common for all the films of a film session (e.g. number of films, film destination).

B.7.2 IOD modules

Table B.7-1
FILM SESSION IOD MODULES

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP Common information
Basic Film Session Presentation	C.13.1	Contains Film Session presentations information
Basic Film Session Relationship	C.13.2	References to related SOPs

B.8 BASIC FILM BOX INFORMATION OBJECT DEFINITION

B.8.1 IOD description

The Basic Film Box Information Object Definition is an abstraction of the presentation of one film of the film session. The Basic Film Box IOD describes the presentation parameters which are common for all images on a given sheet of film.

B.8.2 IOD modules

Table B.8-1
BASIC FILM BOX IOD MODULES

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP Common information
Basic Film Box Presentation Module	C.13.3	Contains Film Box presentation information
Basic Film Box Relationship	C.13.4	References to related SOPs

B.9 BASIC IMAGE BOX INFORMATION OBJECT DEFINITION

B.9.1 IOD description

The Basic Image Box Information Object Definition is an abstraction of the presentation of an image and image related data in the image area of a film. The Basic Image Box IOD describes the presentation parameters and image pixel data which apply to a single image of a sheet of film.

B.9.2 IOD modules

Table B.9-1
BASIC IMAGE BOX IOD MODULES

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP Common information
Image Box Presentation Module	C.13.5	Contains Image Box presentation information
Image Box Relationship Module	C.13.6	References to related SOPs

B.10 BASIC ANNOTATION INFORMATION OBJECT DEFINITION

B.10.1 IOD description

The Basic Annotation Box Information Object Definition is an abstraction of the presentation of an annotation (e.g. text string) on a film. The Basic Annotation Box IOD describes the most used text related presentation parameters.

B.10.2 IOD modules

Table B.10-1
BASIC ANNOTATION IOD MODULES

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP Common information
Basic Annotation Presentation Module	C.13.7	Contains annotation presentation information

B.11 PRINT JOB INFORMATION OBJECT DEFINITION

B.11.1 IOD description

The Print Job Information Object Definition is an abstraction of the print job transaction and is the basic information entity to monitor the execution of the print process. A print job contains one film or multiple films, all belonging to the same film session.

B.11.2 IOD modules

Table B.11-1
PRINT JOB IOD MODULES

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP Common information
Print Job Module	C.13.8	Contains print job transaction information

B.12 PRINTER INFORMATION OBJECT DEFINITION

B.12.1 IOD description

The Printer Information Object Definition is an abstraction of the hardcopy printer and is the basic information entity to monitor the status of the printer.

B.12.2 IOD modules

Table B.12-1
PRINTER IOD MODULES

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP Common information
Printer Module	C.13.9	Contains status information to monitor the printer

B.13 VOI LUT BOX INFORMATION OBJECT DEFINITION

B.13.1 IOD description

The VOI LUT Box Information Object Definition is an abstraction of a Value Of Interest LUT. The VOI LUT transforms the modality pixel values into pixel values which are meaningful for the user or the application.

B.13.2 IOD modules

Table B.13-1
VOI LUT BOX IOD MODULES

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP Common information
VOI LUT Module	C.11.2	Contains VOI LUT information

B.14 IMAGE OVERLAY BOX INFORMATION OBJECT DEFINITION

B.14.1 IOD description

The Image Overlay Box Information Object Definition is an abstraction of the presentation of an image overlay in an image box.

B.14.2 IOD modules

Table B.14-1
IMAGE OVERLAY BOX IOD MODULES

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP Common information
Image Overlay Box Presentation Module	C.13.10	Contains Film Box presentation information
Image Overlay Box Relationship Module	C.13.11	References to related SOPs

B.15 STORAGE COMMITMENT INFORMATION OBJECT DEFINITION

B.15.1 Storage Commitment IOD Description

The Storage Commitment IOD describes the Attributes which may be present in a Storage Commitment Request or Response. The SOP Instances referenced by the Storage Commitment IOD are not restricted to images and may include other SOP Instances.

B.15.2 Storage Commitment IOD Modules

Table B.15-1 identifies and defines the Modules which comprise this IOD. The requirements for whether Attributes in these Modules are mandatory or optional are as specified in PS 3.4.

Table B.15-1
STORAGE COMMITMENT IOD MODULES

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP common information
Storage Commitment	C.14	Contains references to the SOP Instances and associated information which are contained in Storage Commitment.

B.16 PRINT QUEUE INFORMATION OBJECT DEFINITION

B.16.1 IOD Description

The Print Queue IOD is an abstraction of a print queue. The Print Queue IOD is related to the Printer IOD, which corresponds to one printer or a group of printers (see also PS 3.4).

The Print Queue IOD describes the content and status of the queue. The Print Queue IOD contains a list of queue entries. A queue entry is an abstraction of the print job transaction and is the basic information entity to monitor the execution of the print process. A print job contains one film or multiple films, all belonging to the same film session.

With the Print Queue IOD, an SCU can monitor all jobs in the queue. In addition, the SCU can manage jobs for which it knows the Owner ID.

B.16.2 IOD Modules

Table B.16-1
PRINT QUEUE IOD MODULES

Module	Reference
SOP Common Information	C.12.1
General Queue Module	C.15.1
Print Queue Module	C.15.2

B.17 MODALITY PERFORMED PROCEDURE STEP INFORMATION OBJECT DEFINITION

B.17.1 IOD Description

A "Modality Performed Procedure Step Information Object Definition" is an abstraction of the information that describes the activities, conditions and results of an imaging procedure performed on a modality. It contains information about the Modality Performed Procedure Step (MPPS) and its relations to other Information Entities of the DICOM real-world model as introduced in this Part.

A Modality Performed Procedure Step is related to the actual imaging procedure carried out at the modality. Other types of Performed Procedure Steps, e.g. reporting or image processing, are not covered by the Modality Performed Procedure Step IOD. The information gathered includes data about the performance of the procedure itself, radiation dose values to which the patient has been exposed, and data for billing and material management. The Modality Performed Procedure

Step IOD includes general PPS modules and image acquisition specific ones, such as Image Acquisition Results, Radiation Dose and Billing and Material Management.

B.17.2 IOD Modules

Table B.17.2-1 lists the modules which make up the Modality Performed Procedure Step IOD.

Table B.17.2-1
MODALITY PERFORMED PROCEDURE STEP IOD MODULES

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP common information
Performed Procedure Step Relationship	C.4.13	References the related SOPs and IEs.
Performed Procedure Step Information	C.4.14	Includes identifying and status information as well as place and time
Image Acquisition Results	C.4.15	Identifies Series, Images, Standalone LUTs, Overlays and Curves related to this PPS and specific image acquisition conditions.
Radiation Dose	C.4.16	Contains radiation dose information related to this Performed Procedure Step.
Billing and Material Management Codes	C.4.17	Contains codes for billing and material management.

Notes: The Radiation Dose Module (C.4.16) does not have meaning if the modality does not generate ionizing radiation or if the generator does not provide the area dose product.

B.18 PRESENTATION LUT INFORMATION OBJECT DEFINITION

B.18.1 IOD Description

The Presentation LUT Information Object is an abstraction of a Presentation LUT. The objective of the Presentation LUT is to realize image display tailored for specific modalities, applications, and user preferences. It is used to prepare image pixel data for display on devices that conform to the Grayscale Standard Display Function defined in PS 3.14.

The output of the Presentation LUT is Presentation Values (P-Values). P-Values are approximately related to human perceptual response. They are intended to facilitate common input for both hardcopy and softcopy display devices. P-Values are intended to be independent of the specific class or characteristics of the display device.

B.18.2 IOD Modules

Module	Reference
SOP Common Information	C.12.1
Presentation LUT Module	C.11.4

B.19 PULL PRINT REQUEST INFORMATION OBJECT DEFINITION

B.19.1 IOD description

The Pull Print Request IOD is an abstraction of a request to print one or more films, based on the information stored in the Stored Print IOD.

The Pull Print Request IOD contains print transaction related information (e.g. priority, number of copies) and a reference to the Stored Print IOD, which contains the print presentation parameters and references to images.

Note: The Film Session IOD is split into 2 IODs :

- Stored Print IOD, containing layout information and references to images. It contains information which remains invariant during subsequent re-prints (of the same film session). The Stored Print IOD may be archived.
- Print Request IOD, which contains information that may change during subsequent re-prints.

The E-R Model in Section A.1.2 depicts those components of the DICOM Information Model which are related to the Pull Print Request IOD.

B.19.2 IOD module table

Table B.19-1
PULL PRINT REQUEST IOD MODULES

Module	Reference	Usage
Print Request	C.13.12	M
SOP Common Information	C.12.1	M

Annex C INFORMATION MODULE DEFINITIONS (NORMATIVE)

C.1 ELEMENTS OF A MODULE DEFINITION

A Module Definition is composed of the following Sections

a. Module Description

b. Module Definition

c. Attribute Description (Optional)

Sections C.1.1 through C.1.3 define the requirements of a. through c. above.

C.1.1 Module Description

This Section briefly describes the Module and references the Module Definition.

C.1.2 Module Definition

This Section contains a table which enumerates each Attribute contained in the Module. For each Attribute in the table the following information is given:

a. Attribute Name (see C.1.2.1)

b. Data Element Tag (see C.1.2.2)

c. Type Designation (see C.1.2.3)

d. Attribute Definition (see C.1.2.4)

C.1.2.1 Attribute Name

This name shall be used whenever referencing the Attribute. This name shall also identify the Attribute in PS 3.6.

C.1.2.2 Attribute Tag

Each Attribute has a tag which uniquely identifies the Attribute (also used for encoding into a Data Set - see PS 3.5). This tag also serves as an index into the Data Dictionary of PS 3.6.

C.1.2.3 Type Designation

Each Attribute contained in a Module referenced by a Composite IOD defines a Type designation which indicates if a specific Attribute is required for all DIMSE operations/notifications associated with a SOP Class using this Module. PS 3.5 defines a choice of generic Type designations available for DICOM Attributes.

Note: The Type designation specified is generally determined by the value most appropriate for the C-STORE DIMSE Service.

The Type designation given in a Module is a default value and as such may be overridden by an IOD referencing the Module. Some Attributes may also be contained in more than one Module for the IOD. In that case, the Type designation applicable for the Attribute of the specific IOD is the lowest Type value (e.g. if type 2 is specified in one Module and type 3 in another, then type 2 shall apply).

The Type designation given in a Module (and/or IOD) may also be overridden by Service Class Definitions referencing the IOD containing the Module. PS 3.4 specifies the Service Class Definitions.

C.1.2.4 Attribute Definition

A brief definition will be provided for each attribute in the Module definition table. The description shall provide a context for the use of the Attribute and provide general elucidation. Defined Terms and Enumerated Values applicable to the Attribute may also be listed in the Attribute Description.

C.1.3 Attribute Descriptions

Additional information may be provided if necessary for selected Attributes. Such information shall be placed following the Module definition table. Dependencies between Attributes may be specified in this Section.

C.2 PATIENT MODULES

The following Sections specify Modules used for patient management.

C.2.1 Patient Relationship Module

Table C.2-1 defines the Attributes that reference SOP Instances related to this SOP Class.

Table C.2-1
PATIENT RELATIONSHIP MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Referenced Study Sequence	(0008,1110)	Uniquely identifies the Study SOP Instances associated with the Patient SOP Instance. One or more Items may be included in this Sequence.
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
Referenced Visit Sequence	(0008,1125)	Uniquely identifies the Visit SOP Instances associated with this Patient SOP Instance. One or more Items may be included in this Sequence.
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
Referenced Patient Alias Sequence	(0038,0004)	Uniquely identifies any Patient SOP Instances which also describe this patient. These SOP Instances are aliases. Zero or more Items may be included in this Sequence.
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.

C.2.2 Patient Identification Module

Table C.2-2 defines the Attributes relevant to identifying a patient.

Table C.2-2
PATIENT IDENTIFICATION MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Patient's Name	(0010,0010)	Patient's full name
Patient ID	(0010,0020)	Primary hospital identification number or code for the patient
Issuer of Patient ID	(0010,0021)	Name of healthcare provider which issued the Patient ID
Other Patient IDs	(0010,1000)	Other identification numbers or codes used to identify the patient
Other Patient Names	(0010,1001)	Other names used to identify the patient
Patient's Birth Name	(0010,1005)	Patient's birth name
Patient's Mother's Birth Name	(0010,1060)	Birth name of patient's mother
Medical Record Locator	(0010,1090)	An identifier used to find the patient's existing medical record (e.g. film jacket)

C.2.3 Patient Demographic Module

Table C.2-3 defines the Attributes relevant to generally describing a patient.

Table C.2-3
PATIENT DEMOGRAPHIC MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Patient's Age	(0010,1010)	Age of the Patient.
Occupation	(0010,2180)	Occupation of the Patient.
Patient Data Confidentiality Constraint Description	(0040,3001)	Special indication to the modality operator about confidentiality of patient information (e.g., that he should not use the patients name where other patients are present).
Patient's Birth Date	(0010,0030)	Date of birth of the named patient
Patient's Birth Time	(0010,0032)	Time of birth of the named patient
Patient's Sex	(0010,0040)	Sex of the named patient. Enumerated Values: M = male F = female O = other
Patient's Insurance Plan Code Sequence	(0010,0050)	A sequence that conveys the patient's insurance plan. Zero or more Items may be included in this Sequence.
>Code Value	(0008,0100)	The code value (defined by the coding scheme) that presents the patient's insurance plan name.
>Coding Scheme Designator	(0008,0102)	The code from table D-1 designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104).
>Code Meaning	(0008,0104)	The patient's insurance plan name that is represented by the Code Value (0008,0100).
Patient's Size	(0010,1020)	Patient's height or length in meters
Patient's Weight	(0010,1030)	Weight of the patient in kilograms
Patient's Address	(0010,1040)	Legal address of the named patient
Military Rank	(0010,1080)	Military rank of patient
Branch of Service	(0010,1081)	Branch of the military. The country allegiance may also be included (e.g. U.S. Army).
Country of Residence	(0010,2150)	Country in which patient currently resides
Region of Residence	(0010,2152)	Region within patient's country of residence
Patient's Telephone Numbers	(0010,2154)	Telephone numbers at which the patient can be reached
Ethnic Group	(0010,2160)	Ethnic group or race of patient
Patient's Religious Preference	(0010,21F0)	The religious preference of the patient
Patient Comments	(0010,4000)	User-defined comments about the patient

C.2.4 Patient Medical Module

Table C.2-4 defines the Attributes relevant to a patient's medical state or history.

Table C.2-4
PATIENT MEDICAL MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Medical Alerts	(0010,2000)	Conditions to which medical staff should be alerted (e.g. contagious condition, drug allergies, etc.)
Contrast Allergies	(0010,2110)	Description of prior reaction to contrast agents.
Smoking Status	(0010,21A0)	Indicates whether patient smokes. Enumerated Values: YES NO UNKNOWN
Additional Patient History	(0010,21B0)	Additional information about the patient's medical history
Pregnancy Status	(0010,21C0)	Describes pregnancy state of patient. Enumerated Values: 0001 = not pregnant 0002 = possibly pregnant 0003 = definitely pregnant 0004 = unknown
Last Menstrual Date	(0010,21D0)	Date of onset of last menstrual period
Special Needs	(0038,0050)	Medical and social needs (e.g. wheelchair, oxygen, non-English-speaking etc.)
Patient State	(0038,0500)	Description of patient state (comatose, disoriented, vision impaired etc.)

C.3 VISIT MODULES

The following Sections specify Modules relevant to a real world patient visit.

C.3.1 Visit Relationship Module

Table C.3-1 defines the Attributes which reference SOP Instances related to this SOP Class.

Table C.3-1
VISIT RELATIONSHIP MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Referenced Study Sequence	(0008,1110)	Uniquely identifies the Study SOP Instances associated with the Visit SOP Instance. One or more Items may be included in this Sequence.
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
Referenced Patient Sequence	(0008,1120)	Uniquely identifies the Patient SOP Instance that relates to the Visit SOP Instance. Only a single Item shall be permitted in this Sequence.
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.

C.3.2 Visit Identification Module

Table C.3-2 defines the Attributes relevant to identifying a visit.

Table C.3-2
VISIT IDENTIFICATION MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Institution Name	(0008,0080)	Institution where the equipment is located
Institution Address	(0008,0081)	Mailing Address of the institution where the equipment is located
Institution Code Sequence	(0008,0082)	A sequence that conveys the healthcare facility identification. Only a single Item shall be permitted in this Sequence.
>Code Value	(0008,0100)	The code value (defined by the coding scheme) that represents the healthcare facility name.
>Coding Scheme Designator	(0008,0102)	The code from table D-1 designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104)
>Code Meaning	(0008,0104)	The healthcare facility name that is represented by the Code Value (0008,0100)
Admission ID	(0038,0010)	Identification number of the visit as assigned by the healthcare provider
Issuer of Admission ID	(0038,0011)	Name of healthcare provider which issued the Admission ID

C.3.3 Visit Status Module

Table C.3-3 defines the Attributes relevant to the patient's stay with the healthcare provider.

Table C.3-3
VISIT STATUS MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Visit Status ID	(0038,0008)	Identifies the state of the visit. Defined Terms: CREATED = Created but not yet scheduled SCHEDULED = Scheduled but not yet admitted ADMITTED = Patient admitted to institution DISCHARGED = Patient Discharged
Current Patient Location	(0038,0300)	Describes the current known location of the patient
Patient’s Institution Residence	(0038,0400)	Primary location where patient resides (ward, floor, room, etc. or outpatient)
Visit Comments	(0038,4000)	User-defined comments about the visit

C.3.4 Visit Admission Module

Table C.3-4 defines the Attributes relevant to admitting a patient during a visit.

Table C.3-4
VISIT ADMISSION MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Referring Physician's Name	(0008,0090)	Patient's primary referring physician for this visit
Referring Physician's Address	(0008,0092)	Referring physician's address
Referring Physician's Phone Numbers	(0008,0094)	Referring physician's phone numbers
Admitting Diagnosis Description	(0008,1080)	Description of admitting diagnosis
Admitting Diagnosis Code Sequence	(0008,1084)	A sequence that conveys the admitting diagnosis. One or more Items may be included in this Sequence.
>Code Value	(0008,0100)	The code value (defined by the coding scheme) that represents the admitting diagnosis.
>Coding Scheme Designator	(0008,0102)	The code from Table D-1 designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104)
>Code Meaning	(0008,0104)	The admitting diagnosis that is represented by the Code Value (0008,0100)
Route of Admissions	(0038,0016)	Mode of admission: emergency, normal
Admitting Date	(0038,0020)	Date patient visit began
Admitting Time	(0038,0021)	Time patient visit began

C.3.5 Visit Discharge Module

Table C.3-5 defines the Attributes relevant to the discharging of a patient from a visit.

Table C.3-5
VISIT DISCHARGE MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Discharge Date	(0038,0030)	Date patient visit ended or is scheduled to end.
Discharge Time	(0038,0032)	Time patient visit ended or is scheduled to end.
Discharge Diagnosis Description	(0038,0040)	Institution-generated description of discharge diagnosis.
Discharge Diagnosis Code Sequence	(0038,0044)	A sequence that conveys the discharge diagnosis. One or more Items may be included in this Sequence.
>Code Value	(0008,0100)	The code value (defined by the coding scheme) that represents the discharge diagnosis.
>Coding Scheme Designator	(0008,0102)	The code from Table D-1 designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104).
>Code Meaning	(0008,0104)	The discharge diagnosis that is represented by the Code Value (0008,0100).

C.3.6 Visit Scheduling Module

Table C.3-6 defines the Attributes relevant to the scheduling of a patient visit.

Table C.3-6
VISIT SCHEDULING MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Scheduled Admission Date	(0038,001A)	Date patient visit is scheduled to start
Scheduled Admission Time	(0038,001B)	Time patient visit is scheduled to start
Scheduled Discharge Date	(0038,001C)	Date patient visit is scheduled to end
Scheduled Discharge Time	(0038,001D)	Time patient visit is scheduled to end
Scheduled Patient Institution Residence	(0038,001E)	Scheduled location where patient is to reside (ward, floor, room, etc. or outpatient)

C.4 STUDY MODULES

The following Sections specify Modules relevant to a real world diagnostic imaging study performed on a patient.

C.4.1 Study Relationship Module

Table C.4-1 defines the Attributes which reference SOP Instances Subordinate or Superior to this SOP Class in the Naming Hierarchy.

Table C.4-1
STUDY RELATIONSHIP MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Referenced Visit Sequence	(0008,1125)	Uniquely identifies the Visit SOP Instances associated with this Study SOP Instance. One or more Items may be included in this Sequence.
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
Referenced Patient Sequence	(0008,1120)	Uniquely identifies the Patient SOP Instance that relates to the Study SOP Instance. Only a single Item shall be permitted in this Sequence.
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
Referenced Results Sequence	(0008,1100)	Uniquely identifies the results SOP Instance for which the interpretation SOP Instance applies. Zero or more Items may be included in this Sequence.
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
Referenced Study Component Sequence	(0008,1111)	Uniquely identifies the Study Component SOP Instances to which the Study SOP Instance is related.
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
Study Instance UID	(0020,000D)	Unique identifier for the Study
Accession Number	(0008,0050)	A RIS generated number which identifies the order for the Study.

C.4.2 Study Identification Module

Table C.4-2 defines the Attributes relevant to identifying a study.

Table C.4-2
STUDY IDENTIFICATION MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Study ID	(0020,0010)	User or equipment generated Study identifier
Study ID Issuer	(0032,0012)	Name of healthcare provider that issued the Study ID
Other Study Numbers	(0020,1070)	Other identifiers assigned to study by institution

C.4.3 Study Classification Module

Table C.4-3 defines the Attributes relevant to classifying a study.

Table C.4-3
STUDY CLASSIFICATION MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Study Status ID	(0032,000A)	Identifies the state of the study. Enumerated Values: CREATED = Created but not yet scheduled SCHEDULED = Scheduled but not yet started ARRIVED = Patient Arrived but study not started STARTED = Started but not yet finished COMPLETED = Complete but image quality not verified VERIFIED = Complete and image quality verified READ = Read by the Physicians
Study Priority ID	(0032,000C)	Identifies the priority of the study. Enumerated values: LOW, MED, HIGH
Study Comments	(0032,4000)	User-defined comments about the study

C.4.4 Study Scheduling Module

Table C.4-4 defines the Attributes relevant to scheduling a study.

Table C.4-4
STUDY SCHEDULING MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Scheduled Study Start Date	(0032,1000)	Date on which the study is scheduled to start
Scheduled Study Start Time	(0032,1001)	Time at which the study is scheduled to start
Scheduled Study Stop Date	(0032,1010)	Date on which the patient examination for the study is scheduled to end
Scheduled Study Stop Time	(0032,1011)	Time at which the patient examination for the study is scheduled to end
Scheduled Study Location	(0032,1020)	User-defined location at which the study will be performed
Scheduled Study Location AE Title	(0032,1021)	A list of Application Entity Title(s) of the location at which the study will be performed
Reason for Study	(0032,1030)	Describes the reason for performing study
Requesting Physician	(0032,1032)	Physician who requested the study
Requesting Service	(0032,1033)	Institutional department where the request initiated.
Requested Procedure Description	(0032,1060)	Institution-generated description or classification of requested procedure
Requested Procedure Code Sequence	(0032,1064)	A sequence that conveys the requested procedure. One or more Items may be included in this Sequence.
>Code Value	(0008,0100)	The code value (defined by the coding scheme) that represents the type of procedure requested.
>Coding Scheme Designator	(0008,0102)	The code from Table D-2 designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104)
>Code Meaning	(0008,0104)	The requested procedure that is represented by the Code Value (0008,0100)
Requested Contrast Agent	(0032,1070)	Contrast agent requested for use in the procedure

C.4.5 Study Acquisition Module

Table C.4-5 defines the Attributes relevant to acquiring a study.

Table C.4-5
STUDY ACQUISITION MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Study Arrival Date	(0032,1040)	Date that patient arrived at study check-in location
Study Arrival Time	(0032,1041)	Time at which patient arrived at study check-in location
Study Date	(0008,0020)	Date on which the acquisition of the study information was started
Study Time	(0008,0030)	Time at which the acquisition of the study information was started
Study Completion Date	(0032,1050)	Date on which the acquisition of study information was completed
Study Completion Time	(0032,1051)	Time at which the acquisition of study information was completed
Study Verified Date	(0032,0032)	Date on which the image quality for the patient examination was verified
Study Verified Time	(0032,0033)	Time at which the image quality for the patient examination was verified
Modalities in Study	(0008,0061)	This Attribute may take one or more of the values defined for Modality (0008,0060)
Series in Study	(0020,1000)	Number of series in the study
Acquisitions in Study	(0020,1004)	Number of image data acquisitions used in performing the study

C.4.6 Study Read Module

Table C.4-6 defines the Attributes relevant to the reading of a study.

Table C.4-6
STUDY READ MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Name of Physician (s) Reading Study	(0008,1060)	Physician(s) reading the study
Study Read Date	(0032,0034)	Date on which the study was read
Study Read Time	(0032,0035)	Time at which the study was read

C.4.7 Study Component Module

Table C.4-7 defines the Attributes relevant to the study component.

Table C.4-7
STUDY COMPONENT MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Study ID	(0020,0010)	User or equipment generated Study identifier
Study Instance UID	(0020,000D)	Unique identifier for the Study
Referenced Series Sequence	(0008,1115)	Sequence of Repeating Items where each Item includes the Attributes of a Series. Zero or more Items may be included in this Sequence.
>Series Date	(0008,0021)	Date the Series started.
>Series Time	(0008,0031)	Time the Series started.
>Series Instance UID	(0020,000E)	Unique identifier of the Series.
>Retrieve AE Title	(0008,0054)	Title of the DICOM Application Entity where the Image(s) may be retrieved on the network.
>Storage Media File-Set ID	(0088,0130)	The user or implementation specific human readable identifier that identifies the Storage Media on which the Image(s) reside.
>Storage Media File-Set UID	(0088,0140)	Uniquely identifies the Storage Media on which the Image(s) reside.
>Referenced Image Sequence	(0008,1140)	Sequence of Repeating Items where each Item provides reference to a set of Image SOP Class/SOP Instance pairs that are contained in the Series identified by the Series Instance UID (0020,000E). One or more Items may be included in this Sequence.
>>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class. This Attribute is used only if Images may be retrieved as Single Image SOP Classes.
>>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance. This Attribute is used only if Images may be retrieved as Single Image SOP Classes.
>>Retrieve AE Title	(0008,0054)	Title of the DICOM Application Entity where the Image(s) may be retrieved on the network.
>>Storage Media File-Set ID	(0088,0130)	The user or implementation specific human readable identifier that identifies the Storage Media on which the Image(s) reside.
>>Storage Media File-Set UID	(0088,0140)	Uniquely identifies the Storage Media on which the Image(s) reside.

C.4.8 Study Component Relationship Module

Table C.4-8
STUDY COMPONENT RELATIONSHIP MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Referenced Study Sequence	(0008,1110)	Uniquely identifies the Study SOP Instances associated with this SOP Instance.
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the SOP Instance.

C.4.9 Study Component Acquisition Module

Table C.4-9
STUDY COMPONENT ACQUISITION MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Modality	(0008,0060)	Type of equipment that acquired the data used to create the images in this Study Component. See C.7.3.1.1.1 for Defined Terms.
Study Description	(0008,1030)	Institution-generated description or classification of the Study (component) performed.
Procedure Code Sequence	(0008,1032)	A sequence that conveys the (single) type of procedure performed. Only a single Item shall be permitted in this Sequence.
>Code Value	(0008,0100)	The code value (defined by the coding scheme) that represents the procedure performed.
>Coding Scheme Designator	(0008,0102)	The code from table D-2 designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104)
>Code Meaning	(0008,0104)	The procedure performed that is represented by the Code Value (0008,0100)
Performing Physician's Name	(0008,1050)	Physician administering the study
Study Component Status ID	(0032,1055)	Identifies the state of the Study Component. Enumerated values: CREATED = Instance created but not yet complete INCOMPLETE = Acquisition not complete COMPLETED = Acquisition complete VERIFIED = Acquisition complete and Quality Control review complete POSTINTERPRET = Instance created or updated after referenced Study Instance status = COMPLETED

C.4.10 Scheduled Procedure Step Module

Table C.4-10
SCHEDULED PROCEDURE STEP MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Scheduled Procedure Step Sequence	(0040,0100)	One or more Scheduled Procedure Steps for one Requested Procedure.
>Scheduled Station AE Title	(0040,0001)	The AE title of the modality on which the Scheduled Procedure Step is scheduled to be performed.
>Scheduled Station Name	(0040,0010)	An institution defined name for the modality on which the Scheduled Procedure Step is scheduled to be performed.
>Scheduled Procedure Step Location	(0040,0011)	The location at which the Procedure Step is scheduled to be performed.
>Scheduled Procedure Step Start Date	(0040,0002)	Date on which the Scheduled Procedure Step is scheduled to start.
>Scheduled Procedure Step Start Time	(0040,0003)	Time at which the Scheduled Procedure Step is scheduled to start.
>Scheduled Procedure Step End Date	(0040,0004)	Date on which the Scheduled Procedure Step is scheduled to end.
>Scheduled Procedure Step End Time	(0040,0005)	Time at which the Scheduled Procedure Step is scheduled to end.
>Scheduled Performing Physician's Name	(0040,0006)	Name of the physician scheduled to administer the Scheduled Procedure Step.
>Scheduled Procedure Step Description	(0040,0007)	Institution-generated description or classification of the Scheduled Procedure Step to be performed. Note: The purpose of this attribute is to store a description or classification that is used at a local level (e.g., a hospital or a managed care network), and this description need not comply to an accepted standard.
>Scheduled Action Item Code Sequence	(0040,0008)	Sequence describing the Scheduled Action Item(s) following a specified coding scheme. This sequence contains one or more Action Items.
>>Code Value	(0008,0100)	The code value (defined by the coding scheme) that represents the type of Scheduled Action Item
>>Coding Scheme Designator	(0008,0102)	The code from Table D-2 designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104).
>>Code Meaning	(0008,0104)	The Scheduled Procedure Step that is represented by the Code Value (0008,0100).
>Scheduled Procedure Step ID	(0040,0009)	Identifier which identifies the Scheduled Procedure Step.

>Scheduled Procedure Step Status	(0040,0020)	Defines the state of the Scheduled Procedure Step. Defined Terms: SCHEDULED ARRIVED
>Comments on the Scheduled Procedure Step	(0040,0400)	User-defined comments on the Scheduled Procedure Step. Note: The Comments attribute is intended to transmit non-structured information, which can be displayed to the operator of the Modality.
>Modality	(0008,0060)	Source equipment for the image. See Section C.7.3.1.1.1 for Enumerated Values.
>Requested Contrast Agent	(0032,1070)	Contrast agent requested for use in the Scheduled Procedure Step.
>Pre-Medication	(0040,0012)	Medication to be administered at the beginning of the Scheduled Procedure Step, e.g. Nuclear Medicine radiopharmaceutical.

C.4.11 Requested Procedure Module

Table C.4-11
REQUESTED PROCEDURE MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Requested Procedure ID	(0040,1001)	Identifier which identifies the Requested Procedure in the Imaging Service Request.
Reason for the Requested Procedure	(0040,1002)	Reason for requesting this imaging procedure. Note: This reason is more specific to the requested procedure than the reason mentioned in the imaging service request (0040,2001).
Requested Procedure Comments	(0040,1400)	User-defined comments on the Requested Procedure. Note: The Comments attribute is intended to transmit non-structured information, which can be displayed to the operator of the equipment (e.g. Modality).
Requested Procedure Code Sequence	(0032,1064)	A sequence that conveys the Requested Procedure of one Procedure Type.
>Code Value	(0008,0100)	The code value (defined by the coding scheme) that represents the type of Requested Procedure.
>Coding Scheme Designator	(0008,0102)	The code from table D-2 designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104)
>Code Meaning	(0008,0104)	The requested procedure that is represented by the Code Value (0008,0100)
Study Instance UID	(0020,000D)	Unique identifier to be used to identify the Study

Referenced Study Sequence	(0008,1110)	Uniquely identifies the Study SOP Instances associated with this SOP Instance.
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the SOP Instance.
Requested Procedure Description	(0032,1060)	Institution-generated administrative description or classification of Requested Procedure
Requested Procedure Priority	(0040,1003)	Requested Procedure Type Urgency. Defined Terms: STAT, HIGH, ROUTINE, MEDIUM, LOW
Patient Transport Arrangements	(0040,1004)	Mode of transportation of the patient to the location of examination.
Requested Procedure Location	(0040,1005)	Physical location at which the Requested Procedure is to be performed.
Placer Order Number / Procedure	(0040,1006)	The order number assigned to the Requested Procedure by the party placing the order.
Filler Order Number / Procedure	(0040,1007)	The order number assigned to the Requested Procedure by the party filling the order.
Confidentiality Code	(0040,1008)	Confidentiality Constraints on the Requested Procedure by the party filling the order.
Reporting Priority	(0040,1009)	Requested Reporting Priority. Defined Terms: HIGH, ROUTINE, MEDIUM, LOW
Names of Intended Recipients of results	(0040,1010)	Names of the physicians, who are intended recipients of results.

C.4.12 Imaging Service Request Module

Table C.4-12
IMAGING SERVICE REQUEST MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Reason for the Imaging Service Request	(0040,2001)	Reason for the Imaging Service Request. Note: This reason is less specific to the requested procedure than the reason mentioned in the Requested Procedure (0040,1002).
Imaging Service Request Comments	(0040,2400)	User-defined comments on the Imaging Service Request. Note: The Comments attribute is intended to transmit non-structured information, which can be displayed to the operator of the equipment (e.g. Modality).
Requesting Physician	(0032,1032)	Physician who requested the Imaging Service Request.
Referring Physician's Name	(0008,0090)	Patient's primary physician for this Imaging Service Request.

Requesting Service	(0032,1033)	Institutional department where the request initiated.
Accession Number	(0008,0050)	A departmental IS generated number which identifies the order for the Imaging Service Request.
Issuing Date of Imaging Service Request	(0040,2004)	Date on which the Imaging Service Request was issued by the requester.
Issuing Time of Imaging Service Request	(0040,2005)	Time at which the Imaging Service Request was issued by the requester.
Placer Order Number / Imaging Service Request	(0040,2006)	The order number assigned to the Imaging Service Request by the party placing the order.
Filler Order Number / Imaging Service Request	(0040,2007)	The order number assigned to the Imaging Service Request by the party filling the order.
Order entered by ...	(0040,2008)	The person who entered the Imaging Service Request into an Information System.
Order Enterer's Location	(0040,2009)	The location at which the Imaging Service Request was entered.
Order Callback Phone Number	(0040,2010)	Telephone Number at which additional information can be retrieved.

C.4.13 Performed Procedure Step Relationship

Table C.4-13 specifies the Attributes used to reference other SOP Classes and other Information Entities of the DICOM real-world model as defined in Section 7.3.1.6.

Table C.4-13
PERFORMED PROCEDURE STEP RELATIONSHIP MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Patient's Name	(0010,0010)	Patient's full legal name.
Patient ID	(0010,0020)	Primary hospital identification number or code for the patient.
Patient's Birth Date	(0010,0030)	Date of birth of the named patient
Patient's Sex	(0010,0040)	Sex of the named Patient. Enumerated Values: M = male F = female O = other
Referenced Patient Sequence	(0008,1120)	Uniquely identifies the Patient SOP Instance.
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
Scheduled Step Attribute Sequence	(0040,0270)	Sequence containing attributes that are related to the scheduling of the Procedure Step. The Sequence may have one or more Items.
>Study Instance UID	(0020,000D)	Unique identifier for the Study.

>Referenced Study Sequence	(0008,1110)	Uniquely identifies the Study SOP Instance associated with this Scheduled Procedure Step. This Sequence shall have only one Item.
>>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the SOP Class.
>>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the SOP Instance.
>Accession Number	(0008,0050)	A departmental IS generated number which identifies the order for the Study.
>Placer Order Number/Imaging Service Request	(0040,2006)	The order number assigned to the Imaging Service Request by the party placing the order.
>Filler Order Number/Imaging Service Request	(0040,2007)	The order number assigned to the Imaging Service Request by the party filling the order.
>Requested Procedure ID	(0040,1001)	Identifier of the related Requested Procedure.
>Requested Procedure Description	(0032,1060)	Institution-generated administrative description or classification of Requested Procedure.
>Placer Order Number/Procedure	(0040,1006)	The order number assigned to the Requested Procedure by the party placing the order.
>Filler Order Number/Procedure	(0040,1007)	The order number assigned to the Requested Procedure by the party filling the order.
>Scheduled Procedure Step ID	(0040,0009)	Identifier of the related Scheduled Procedure Step.
>Scheduled Procedure Step Description	(0040,0007)	Institution-generated description or classification of the Scheduled Procedure Step to be performed.
>Scheduled Action Item Code Sequence	(0040,0008)	Sequence describing the Scheduled Action Item(s) following a specific coding scheme. This sequence contains one or more Action Items.
>>Code Value	(0008,0100)	The code value (defined by the coding scheme) that represents the type of Scheduled Action Item.
>>Coding Scheme designator	(0008,0102)	The code from table D-2 designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104).
>>Code Meaning	(0008,0104)	The Scheduled Procedure Step that is represented by the Code Value (0008,0100).

Note: The patient information is included in order to relate the Modality Performed Procedure Step SOP Instance to the Study Management SOP Instance and other associated IODs in case the SCU (the modality) is unable to obtain or use the Study Instance UID created by the Information System.

C.4.14 Performed Procedure Step Information

Table C.4-14 defines the general attributes which may be used by all specific Procedure Steps.

Table C.4-14
PERFORMED PROCEDURE STEP INFORMATION MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Performed Station AE Title	(0040,0241)	AE title of the modality on which the Performed Procedure Step was performed.
Performed Station Name	(0040,0242)	An institution defined name for the modality on which the Performed Procedure Step was performed.
Performed Location	(0040,0243)	Description of the location at which the Performed Procedure Step was performed.
Performed Procedure Step Start Date	(0040,0244)	Date on which the Performed Procedure Step started.
Performed Procedure Step Start Time	(0040,0245)	Time at which the Performed Procedure Step started.
Performed Procedure Step ID	(0040,0253)	User or equipment generated identifier of that part of a Procedure that has been carried out within this step.
Performed Procedure Step End Date	(0040,0250)	Date on which the Performed Procedure Step ended.
Performed Procedure Step End Time	(0040,0251)	Time at which the Performed Procedure Step ended.
Performed Procedure Step Status	(0040,0252)	Contains the state of the Performed Procedure Step. Enumerated Values: IN PROGRESS = Started but not complete DISCONTINUED = Canceled or unsuccessfully terminated COMPLETED = Successfully completed
Performed Procedure Step Description	(0040,0254)	Institution-generated description or classification of the Procedure Step that was performed.
Comments on the Performed Procedure Step	(0040,0280)	User-defined comments on the Performed Procedure Step.
Performed Procedure Type Description	(0040,0255)	A description of the type of procedure performed.
Procedure Code Sequence	(0008,1032)	A sequence that conveys the (single) type of procedure performed.
>Code Value	(0008,0100)	The code value (defined by the coding scheme) that represents the procedure performed.
>Coding Scheme Designator	(0008,0102)	The code from Table D-2 designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104).
>Code Meaning	(0008,0104)	The procedure performed that is represented by the Code Value (0008,0100).

C.4.15 Image Acquisition Results

Table C.4-15 specifies attributes that describe the acquisition of images during the performance of the Procedure Step and that provide references to the Series, Images and Standalone SOP Instances associated with this Modality Performed Procedure Step.

Table C.4-15
IMAGE ACQUISITION RESULTS MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Modality	(0008,0060)	Type of equipment that originally acquired the data used to create the images associated with this Modality Performed Procedure Step. See C.7.3.1.1.1 for Defined Terms.
Study ID	(0020,0010)	User or equipment generated Study Identifier.
Performed Action Item Sequence	(0040,0260)	Sequence describing the Action Items performed for this Procedure Step. This sequence may have zero or more Items.
>Code Value	(0008,0100)	The code value (defined by the coding scheme) that represents the type of Performed Action Item.
>Coding Scheme Designator	(0008,0102)	The code from Annex D designating the coding scheme that maps the Code Value (0008,0100) onto the Code Meaning (0008,0104).
>Code Meaning	(0008,0104)	The Action Item that is represented by the Code Value (0008,0100).
Performed Series Sequence	(0040,0340)	Attributes of the Series that comprise this Modality Performed Procedure Step. The Sequence may have zero or more Items.
>Performing Physician's Name	(0008,1050)	Name of the physician administering this Series.
>Operator's Name	(0008,1070)	Name of the operator who performed this Series.
>Protocol Name	(0018,1030)	User-defined description of the conditions under which the Series was performed.
>Series Instance UID	(0020,000E)	Unique Identifier of the Series.
>Series Description	(0008,103E)	User provided description of the Series
>Retrieve AE Title	(0008,0054)	Title of the DICOM Application Entity where the Images and Standalone SOP Instances in this Series may be retrieved on the network. Note: The duration for which this location remains valid is unspecified.
>Referenced Image Sequence	(0008,1140)	A Sequence that provides reference to one or more sets of Image SOP Class/SOP Instance pairs. The sequence may have zero or more Items.
>>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
>Referenced Standalone SOP Instance Sequence	(0040,0220)	Uniquely identifies Standalone IODs such as LUTs, Curves or Overlays related to these images. The sequence may have zero or more Items.

>>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.

Note: The term “Standalone IOD” is used as a generic name for all IODs other than images that conform to the DICOM Composite IOD Information Model, such as Curves, Overlays, LUTs.

C.4.16 Radiation Dose

Table C.4-16 defines the Attributes that may be used to communicate information related to radiation dose values. The attributes are intended to enable the Information System to store Patient exposure to ionizing radiation for legal purposes. Though these attributes are not intended to be used to accurately calculate volume dose distribution, they may serve for some quality control purposes.

This module provides a means to communicate radiation dose values but DICOM does not define any requirements for the accuracy of these values, which may be defined in other professional, national or international standards.

The scope of the attributes contained in this module covers the entire acquisition that comprises the Modality Performed Procedure Step. Attributes that relate to single images, such as mAs or kVP, may be included in the Image IODs. It is beyond the scope of DICOM to define what attributes may be required to calculate or estimate area dose product values.

Table C.4-16
RADIATION DOSE MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Anatomic Structure, Space or Region Sequence	(0008,2229)	Anatomic structure, space or region that has been exposed to ionizing radiation. The sequence may have zero or one Items.
>Code Value	(0008,0100)	The code value that represents the anatomic region.
>Coding Scheme Designator	(0008,0102)	The code value from Part 3 Annex D designating the coding scheme for anatomic regions that maps the Code Value (0008,0100) onto the Code Meaning (0008,0104).
>Code Meaning	(0008,0104)	The anatomic region that is represented by the Code Value (0008,0100).
Total Time of Fluoroscopy	(0040,0300)	Total duration of X-Ray exposure during fluoroscopy in seconds (pedal time) during this Performed Procedure Step.
Total Number of Exposures	(0040,0301)	Total number of exposures made during this Performed Procedure Step. The number includes non-digital and digital exposures.
Distance Source to Detector (SID)	(0018,1110)	Distance in mm from the source to detector center; SID: Source Image Distance.

Distance Source to Entrance	(0040,0306)	Distance in mm from the source to the surface of the patient closest to the source during this Performed Procedure Step. Note: This may be an estimated value based on assumptions about the patient's body size and habitus.
Entrance Dose	(0040,0302)	Average entrance dose value measured in dGy at the surface of the patient during this Performed Procedure Step. Note: This may be an estimated value based on assumptions about the patient's body size and habitus.
Exposed Area	(0040,0303)	Typical dimension of the exposed area at the detector plane. If Rectangular: row dimension followed by column; if Round: diameter. Measured in mm. Note: This may be an estimated value based on assumptions about the patient's body size and habitus.
Image Area Dose Product	(0018,115E)	Total area-dose-product to which the patient was exposed, accumulated over the complete Performed Procedure Step and measured in dGy*cm*cm, including fluoroscopy. Notes: 1. The sum of the Image Area Dose Product of all images of a Series or a Study may not result in the actual area dose product to which the patient was exposed. 2. This may be an estimated value based on assumptions about the patient's body size and habitus.
Comments on Radiation Dose	(0040,0310)	User-defined comments on any special conditions related to radiation dose encountered during this Performed Procedure Step.

Notes: 1. The Anatomic Region may be deduced from attribute values available within the Modality Worklist Management SOP Class, such as Reason for Service Request, Reasons for Requested Procedure, Scheduled Procedure Step Description and Scheduled Action Item Code Sequence.

2. The Image Area Dose Product should take into account collimator position and filters, and the value for the Exposed Area should also take into account collimator position. If the equipment does not provide the Entrance Dose, it may be calculated using Area Dose Product, Exposed Area, SID and an assumed body thickness.

3. The Distance Source to Detector (0018,1110) and Exposed Area (0040,0303) are only meaningful if they remain constant for all acquisitions during this Performed Procedure Step.

C.4.17 Billing and Material Management Codes

The Attributes defined in Table C.4-17 provide a means to transmit billing and material management codes from a modality to an Information System. It is beyond the scope of this Standard to define all the required coding schemes and the relevant codes.

Table C.4-17
BILLING AND MATERIAL MANAGEMENT CODE MODULE ATTRIBUTES

Attribute name	Tag	Attribute Description
Billing Procedure Step Sequence	(0040,0320)	Contains billing codes for the Procedure Type performed within the Procedure Step. The sequence may have zero or more Items.
>Code Value	(0008,0100)	A code value (defined by the coding scheme) that represents information for billing.
>Coding Scheme Designator	(0008,0102)	A designator for a coding scheme used for billing that maps the Code Value (0008,0100) onto the Code Meaning (0008,0104).
>Code Meaning	(0008,0104)	Text description of the billing procedure represented by Code Value (0008,0100).
Film Consumption Sequence	(0040,0321)	Information about the film consumption for this Performed Procedure Step. The sequence may have zero or more Items.
>Number of Films	(2100,0170)	Number of films actually printed.
>Medium Type	(2000,0030)	Type(s) of medium on which images were printed. For Defined Terms see Table C.13-1.
>Film Size ID	(2010,0050)	Size(s) of film on which images were printed. For Defined Terms see Table C.13-3.
Billing Supplies and Devices Sequence	(0040,0324)	Chemicals, supplies and devices for billing used in the Performed Procedure Step. The sequence may have one or more Items.
>Billing Item Sequence	(0040,0296)	Code values of chemicals, supplies or devices required for billing. The sequence may have zero or one Items.
>>Code Value	(0008,0100)	The code value (defined by the coding scheme) that represents the chemicals, supplies or devices.
>>Coding Scheme Designator	(0008,0102)	The identification of a hospital-selected coding scheme.
>>Code Meaning	(0008,0104)	Text description of the chemical, supply or device represented by Code Value (0008,0100).
>Quantity Sequence	(0040,0293)	Sequence containing the quantity of used chemicals or devices. The sequence may have zero or one Items.
>>Quantity	(0040,0294)	Numerical quantity value.
>>Measuring Units Sequence	(0040,0295)	Unit of measurement. The sequence may have zero or one Items.
>>>Code Value	(0008,0100)	A code value (defined by the coding scheme) that represents information for the unit of measurement.
>>>Coding Scheme Designator	(0008,0102)	The code from PS 3.3 Annex D designating the coding scheme applied.
>>>Code Meaning	(0008,0104)	Text description of the unit of measurement represented by Code Value (0008,0100).

C.5 RESULTS MODULES

The following Sections specify Modules relevant to a real world diagnostic imaging results performed on a patient.

C.5.1 Results Relationship Module

Table C.5-1 defines the Attributes which reference SOP Instances Subordinate or Superior to this SOP Class in the Naming Hierarchy.

Table C.5-1
RESULTS RELATIONSHIP MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Referenced Study Sequence	(0008,1110)	Uniquely identifies the Study SOP Instances associated with the Results SOP Instance.
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
Referenced Interpretation Sequence	(4008,0050)	Uniquely identifies the report SOP Instances and amendment SOP Instances which comprise the results SOP Instance. Zero or more Items may be included in this Sequence.
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.

C.5.2 Results Identification Module

Table C.5-2 defines the Attributes relevant to identifying results.

Table C.5-2
RESULTS IDENTIFICATION MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Results ID	(4008,0040)	Healthcare provider generated number used to reference the results
Results ID Issuer	(4008,0042)	Name of healthcare provider which issued the results ID

C.5.3 Results Impressions Module

Table C.5-3 defines the Attributes relevant to the result's impressions.

Table C.5-3
RESULTS IMPRESSION MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Impressions	(4008,0300)	Short impressions summarizing the full results
Results Comments	(4008,4000)	User-defined comments about the results

C.6 INTERPRETATION MODULES

The following Sections specify Modules relevant to a real world results interpretation.

C.6.1 Interpretation Relationship Module

Table C.6-1 defines the Attributes which reference SOP Instances Subordinate or Superior to this SOP Class in the Naming Hierarchy.

Table C.6-1
INTERPRETATION RELATIONSHIP MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Referenced Results Sequence	(0008,1100)	Uniquely identifies the results SOP Instances for which the interpretation SOP Instance applies. Only a single Item shall be permitted in this Sequence.
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance ID	(0008,1155)	Uniquely identifies the referenced SOP Instance.

C.6.2 Interpretation Identification Module

Table C.6-2 defines the Attributes relevant to identifying an interpretation.

Table C.6-2
INTERPRETATION IDENTIFICATION MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Interpretation ID	(4008,0200)	Healthcare provider generated number used to reference the interpretation
Interpretation ID Issuer	(4008,0202)	Name of healthcare provider which issued the interpretation ID

C.6.3 Interpretation State Module

Table C.6-3 defines the Attributes relevant to the state of an interpretation.

Table C.6-3
INTERPRETATION STATE MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Interpretation Type ID	(4008,0210)	The type of interpretation. Defined Terms: REPORT = Report AMENDMENT = Amendment
Interpretation Status ID	(4008,0212)	An Enumerated Value element used to track production status of the interpretation. Defined Terms: CREATED = Interpretation Created RECORDED = Interpretation captured in a format external to the information system which handles reports. TRANSCRIBED = Interpretation converted into or entered in the internal format of the information system which handles reports. APPROVED = Interpretation Approved

C.6.4 Interpretation Recording Module

Table C.6-4 defines the Attributes relevant to the recording of an interpretation.

Table C.6-4
INTERPRETATION RECORDING MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Interpretation Recorded Date	(4008,0100)	Date interpretation was dictated or entered
Interpretation Recorded Time	(4008,0101)	Time interpretation was dictated or entered
Interpretation Recorder	(4008,0102)	Name of the person who recorded the interpretation
Reference to Recorded Sound	(4008,0103)	A reference used to identify or locate the sound recording of the interpretation

C.6.5 Interpretation Transcription Module

Table C.6-5 defines the Attributes relevant to the transcription of an interpretation recording.

Table C.6-5
INTERPRETATION TRANSCRIPTION MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Interpretation Transcription Date	(4008,0108)	Date interpretation was transcribed.
Interpretation Transcription Time	(4008,0109)	Time interpretation was transcribed.
Interpretation Transcriber	(4008,010A)	Name of person who transcribed the interpretation.
Interpretation Text	(4008,010B)	Text of the interpretation.
Interpretation Author	(4008,010C)	Name of author of interpretation.

C.6.6 Interpretation Approval Module

Table C.6-6 defines the Attributes relevant to the approval of an interpretation.

Table C.6-6
INTERPRETATION APPROVAL MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Interpretation Approver Sequence	(4008,0111)	Identifies the approvers of the interpretation. Zero or more Items may be included in this Sequence. Encoded as a sequence of items: (4008,0112), (4008,0113), and (4008,0114).
>Interpretation Approval Date	(4008,0112)	Date the report or amendment was approved.
>Interpretation Approval Time	(4008,0113)	Time the report or amendment was approved.
>Physicians Approving Interpretation	(4008,0114)	Physician approving the report or amendment.
Interpretation Diagnosis Description	(4008,0115)	Diagnosis produced by the Physician.
Interpretation Diagnosis Codes Sequence	(4008,0117)	A sequence that conveys the interpretation diagnosis. One or more Items may be included in this Sequence.
>Code Value	(0008,0100)	The code value (defined by the coding scheme) that represents the interpretation diagnosis.
>Coding Scheme Designator	(0008,0102)	The code from table D-1 designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104).
>Code Meaning	(0008,0104)	The interpretation diagnosis that is represented by the Code Value (0008,0100).
Results Distribution List Sequence	(4008,0118)	Names and addresses of persons to receive a copy of the report and amendments. Zero or more Items may be included in this Sequence. Encoded as a sequence of items: (4008,0119) and (4008,011A).
>Distribution Name	(4008,0119)	Name of one of the persons to receive a copy of the report and amendments.
>Distribution Address	(4008,011A)	Address of one of the persons to receive a copy of the report and amendments.

C.7 COMMON COMPOSITE IMAGE IOD MODULES

This Section defines the Modules which are common to all Composite Image IODs.

C.7.1 Common Patient IE Modules

The following Patient IE Module is common to all Composite Image IODs which reference the Patient IE.

C.7.1.1 Patient Module

Table C.7-1 specifies the Attributes of the Patient that describe and identify the Patient who is the subject of a diagnostic Study. This Module contains Attributes of the patient that are needed

for diagnostic interpretation of the Image and are common for all studies performed on the patient. It contains Attributes that are also included in the Patient Modules in Section C.2.

Table C.7-1
PATIENT MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Patient's Name	(0010,0010)	2	Patient's full name.
Patient ID	(0010,0020)	2	Primary hospital identification number or code for the patient.
Patient's Birth Date	(0010,0030)	2	Birth date of the patient.
Patient's Sex	(0010,0040)	2	Sex of the named patient. Enumerated Values: M = male F = female O = other
Referenced Patient Sequence	(0008,1120)	3	A sequence which provides reference to a Patient SOP Class/Instance pair. Only a single Item shall be permitted in this Sequence. Encoded as sequence of items: (0008,1150) and (0008,1155)
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Patient Sequence (0008,1120) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Patient Sequence (0008,1120) is sent.
Patient's Birth Time	(0010,0032)	3	Birth time of the Patient.
Other Patient IDs	(0010,1000)	3	Other identification numbers or codes used to identify the patient.
Other Patient Names	(0010,1001)	3	Other names used to identify the patient.
Ethnic Group	(0010,2160)	3	Ethnic group or race of the patient.
Patient Comments	(0010,4000)	3	User-defined additional information about the patient.

C.7.2 Common Study IE Modules

The following Study IE Modules are common to all Composite Image IODs which reference the Study IE. These Module contain Attributes of the patient and study that are needed for diagnostic interpretation of the image. They contain Attributes that are also in the Patient Modules in Section C.2 and Study Modules in Section C.4.

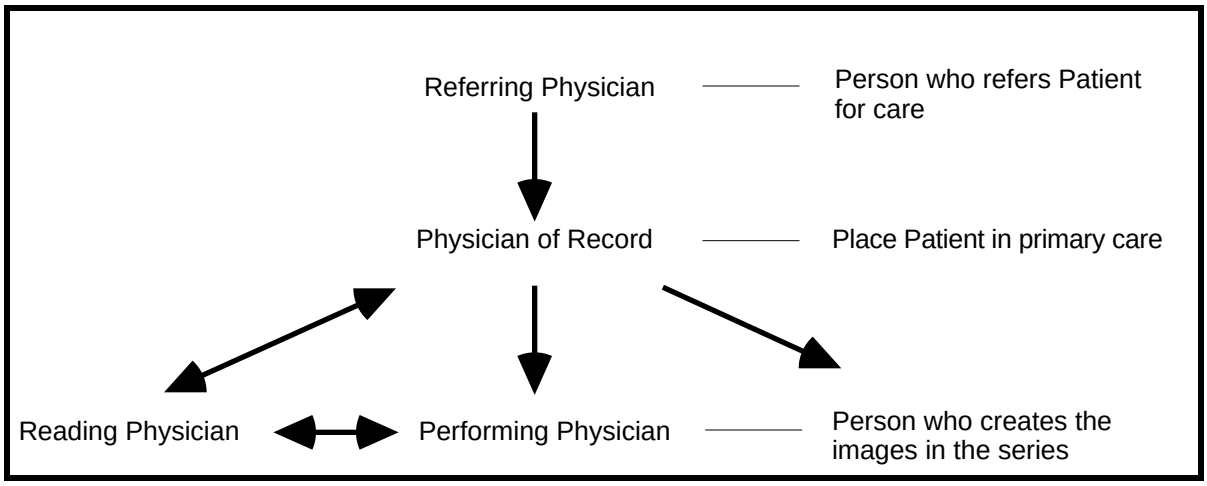
C.7.2.1 General Study Module

Table C.7-2 specifies the Attributes which describe and identify the Study performed upon the Patient.

Table C.7-2
GENERAL STUDY MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Study Instance UID	(0020,000D)	1	Unique identifier for the Study.
Study Date	(0008,0020)	2	Date the Study started.
Study Time	(0008,0030)	2	Time the Study started.
Referring Physician's Name	(0008,0090)	2	Patient's referring physician
Study ID	(0020,0010)	2	User or equipment generated Study identifier.
Accession Number	(0008,0050)	2	A RIS generated number which identifies the order for the Study.
Study Description	(0008,1030)	3	Institution-generated description or classification of the Study (component) performed.
Physician(s) of Record	(0008,1048)	3	Physician(s) who are responsible for overall patient care at time of Study (see Section C.7.3.1 for Performing Physician)
Name of Physician(s) Reading Study	(0008,1060)	3	Physician(s) reading the Study.
Referenced Study Sequence	(0008,1110)	3	A sequence which provides reference to a Study SOP Class/Instance pair. The sequence may have zero or more Items. Encoded as sequence of items: (0008,1150) and (0008,1155)
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Study Sequence (0008,1110) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Study Sequence (0008,1110) is sent.

Note: The model used for application of attributes related to different functions of Physicians involved in the care is as follows:



There can be an overlap of functions provided by any given physician. In this case, the field entries would convey the same physician name under different roles.

C.7.2.2 Patient Study Module

Table C.7-3 defines Attributes that provide information about the Patient at the time the Study was performed.

Table C.7-3
PATIENT STUDY MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Admitting Diagnoses Description	(0008,1080)	3	Description of the admitting diagnosis (diagnoses)
Patient's Age	(0010,1010)	3	Age of the Patient.
Patient's Size	(0010,1020)	3	Length or size of the Patient, in meters.
Patient's Weight	(0010,1030)	3	Weight of the Patient, in kilograms.
Occupation	(0010,2180)	3	Occupation of the Patient.
Additional Patient’s History	(0010,21B0)	3	Additional information about the Patient's medical history.

C.7.3 Common Series IE Modules

The following Series IE Modules are common to all Composite Image IODs which reference the Series IE.

C.7.3.1 General Series Module

Table C.7-4 specifies the Attributes which identify and describe general information about the Series within a Study.

Table C.7-4
GENERAL SERIES MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. See C.7.3.1.1.1 for Defined Terms.
Series Instance UID	(0020,000E)	1	Unique identifier of the Series.
Series Number	(0020,0011)	2	A number that identifies this Series.
Laterality	(0020,0060)	2C	Laterality of (paired) body part examined. Required if the body part examined is a paired structure. Enumerated Values: R = right L = left
Series Date	(0008,0021)	3	Date the Series started.
Series Time	(0008,0031)	3	Time the Series started.
Performing Physicians' Name	(0008,1050)	3	Name of the physicians administering the Series.
Protocol Name	(0018,1030)	3	User-defined description of the conditions under which the Series was performed.
Series Description	(0008,103E)	3	User provided description of the Series
Operators' Name	(0008,1070)	3	Technologist(s) supporting the Series.
Referenced Study Component Sequence	(0008,1111)	3	Uniquely identifies the Study Component SOP Instance or Modality Performed Procedure Step SOP Instance to which the Series is related. The Sequence shall have zero or one Item.
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Study Component Sequence (0008,1111) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Study Component Sequence (0008,1111) is sent.

Body Part Examined	(0018,0015)	3	Text description of the part of the body examined. Defined Terms: SKULL, CSPINE, TSPINE, LSPINE, SSPINE, COCCYX, CHEST, CLAVICLE, BREAST, ABDOMEN, PELVIS, HIP, SHOULDER, ELBOW, KNEE, ANKLE, HAND, FOOT, EXTREMITY, HEAD, HEART, NECK, LEG, ARM Note: Some IODs support the Anatomic Region Sequence (0008,2218), which can provide a more comprehensive mechanism for specifying the body part being examined.
Patient Position	(0018,5100)	2C	Patient position descriptor relative to the equipment. Required for CT and MR images. See C.7.3.1.1.2. for Defined Terms and further explanation.
Smallest Pixel Value in Series	(0028,0108)	3	The minimum value of all images in this Series.
Largest Pixel Value in Series	(0028,0109)	3	The maximum value of all images in this Series.
Request Attributes Sequence	(0040,0275)	3	Sequence that contains attributes from the Imaging Service Request. The sequence may have one or more Items.
>Requested Procedure ID	(0040,1001)	1C	Identifier which identifies the Requested Procedure in the Imaging Service Request. Required if Sequence Item is present.
>Scheduled Procedure Step ID	(0040,0009)	1C	Identifier which identifies the Scheduled Procedure Step. Required if Sequence Item is present.
>Scheduled Procedure Step Description	(0040,0007)	3	Institution-generated description or classification of the Scheduled Procedure Step to be performed.
>Scheduled Action Item Code Sequence	(0040,0008)	3	Sequence describing the Scheduled Action Item(s) following a specific coding scheme. This sequence contains one or more Action Items.
>>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the type of Scheduled Action Item. Required if Sequence Item is present.
>>Coding Scheme Designator	(0008,0102)	1C	The code from Table D-2 designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Sequence Item is present.

>>Code Meaning	(0008,0104)	3	The Scheduled Procedure Step that is represented by the Code Value (0008,0100).
Performed Procedure Step ID	(0040,0253)	3	Identification of that part of a Procedure that has been carried out within this step.
Performed Procedure Step Start Date	(0040,0244)	3	Date on which the Performed Procedure Step started.
Performed Procedure Step Start Time	(0040,0245)	3	Time on which the Performed Procedure Step started.
Performed Procedure Step Description	(0040,0254)	3	Institution-generated description or classification of the Procedure Step that was performed.

Notes: 1. If the Modality Performed Procedure Step SOP Class is supported as an SCU by a Storage SCU, the SCU is strongly encouraged to support the attribute Referenced Study Component Sequence (0008,1111). This attribute references the Modality Performed Procedure Step SOP Instance, and extraction of this Attribute from an image may allow retrieval of the Modality Performed Procedure Step SOP Instance.

2. If the Modality does not conform to the Modality Performed Procedure Step SOP Class, it is still advisable to include the attributes Performed Procedure Step Start Date (0040,0244), Performed Procedure Step Start Time (0040,0245) and Performed Procedure Step Description (0040,0254) into the Image IODs.

C.7.3.1.1 General Series Attribute Descriptions

C.7.3.1.1.1 Modality

Defined Terms for the Modality (0008,0060) are:

CR = Computed Radiography
CT = Computed Tomography
MR = Magnetic Resonance
NM = Nuclear Medicine
US = Ultrasound
OT = Other
AS = Angioscopy
BI = Biomagnetic imaging
CD = Color flow Doppler
CP = Culposcopy
CS = Cystoscopy
DD = Duplex Doppler
DG = Diaphanography
DM = Digital microscopy
EC = Echocardiography
ES = Endoscopy
FA = Fluorescein angiography
FS = Fundoscopy
LP = Laparoscopy
LS = Laser surface scan
MA = Magnetic resonance angiography
MS = Magnetic resonance spectroscopy
PT = Positron emission tomography (PET)
RG = Radiographic imaging (conventional film/screen)
ST = Single-photon emission computed tomography (SPECT)
TG = Thermography
XA = X-Ray Angiography
RF = Radio Fluoroscopy
RTIMAGE = Radiotherapy Image
RTDOSE = Radiotherapy Dose
RTSTRUCT = Radiotherapy Structure Set
RTPLAN = Radiotherapy Plan
HC = Hard Copy

Retired Defined Terms for the Modality (0008,0060) are:

DS = Digital Subtraction Angiography (retired)	CF = Cinefluorography (retired)
DF = Digital fluoroscopy (retired)	VF = Videofluorography (retired)

Note: 1. The XA modality incorporates the retired modality DS.

2. The RF modality incorporates the retired modalities CF, DF, VF.

3. The modality listed in the Modality Data Element (0008,0060) may not match the name of the IOD in which it appears. For example, a SOP instance from XA IOD may list the RF modality when an RF implementation produces an XA object.

C.7.3.1.1.2 Patient Position

Patient Position (0018,5100) specifies the position of the patient relative to the imaging equipment space. This attribute is intended for annotation purposes only. It does not provide an exact mathematical relationship of the patient to the imaging equipment.

When facing the front of the imaging equipment, Head First is defined as the patient's head being positioned toward the front of the imaging equipment. Feet First is defined as the patient's feet being positioned toward the front of the imaging equipment. Prone is defined as the patient's face being positioned in a downwards (gravity) direction. Supine is defined as the patient's face being in an upwards direction. Decubitus Right is defined as the patient's right side being in a downwards direction. Decubitus Left is defined as the patient's left side being in a downwards direction.

The Defined Terms are:

HFP = Head First-Prone	HFS = Head First-Supine
HFDR = Head First-Decubitus Right	HFDL = Head First-Decubitus Left
FFDR = Feet First-Decubitus Right	FFDL = Feet First-Decubitus Left
FFP = Feet First-Prone	FFS = Feet First-Supine

C.7.4 Common Frame Of Reference Information Entity Modules

The following Frame of Reference IE Module is common to all Composite Image IODs which reference the Frame of Reference IE.

C.7.4.1 Frame Of Reference Module

Table C.7-5 specifies the Attributes necessary to uniquely identify a frame of reference which insures the spatial relationship of Images within a Series. It also allows Images across multiple Series to share the same Frame Of Reference. This Frame Of Reference (or coordinate system) shall be constant for all Images related to a specific Frame Of Reference.

When a Frame of Reference is identified, it is not important how the Patient is positioned relative to the imaging equipment or where the origin of the Frame Of Reference is located. It is important that the position of the Patient and the origin are constant in relationship to a specific Frame Of Reference.

Note: Since the criteria used to group images into a Series is application specific, it is possible for imaging applications to define multiple Series within a Study which share the same imaging space. Previous versions of the DICOM Standard specified that all images within the Series

must be spatially related. However, insufficient information was available to determine if multiple Series within a Study were spatially related.

Table C.7-5
FRAME OF REFERENCE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Frame of Reference UID	(0020,0052)	1	Uniquely identifies the frame of reference for a Series. See C.7.4.1.1.1 for further explanation.
Position Reference Indicator	(0020,1040)	2	Part of the patient's anatomy used as a reference, such as the iliac crest, orbital-medial, sternal notch, symphysis pubis, xiphoid, lower coastal margin, external auditory meatus. See C.7.4.1.1.2 for further explanation.

C.7.4.1.1 Frame Of Reference Attribute Descriptions

C.7.4.1.1.1 Frame Of Reference UID

The Frame of Reference UID (0020,0052) shall be used to uniquely identify a frame of reference for a series. Each series shall have a single Frame of Reference UID. However, multiple Series within a Study may share a Frame of Reference UID. All images in a Series which share the same Frame of Reference UID shall be spatially related to each other.

Notes: 1. Previous versions of this Standard defined a Data Element "Location" which has been retired. Frame of Reference UID provides a completely unambiguous identification of the image location reference used to indicate position.

2. A common Frame of Reference UID may be used to spatially relate localizer images with a set of axial images, however, in some cases (eg. multiple localizer images being related to a single set of axial images) a common Frame of Reference UID may not be sufficient. The Referenced Image Sequence (0008,1140) provides an unambiguous method for relating localizer images.

C.7.4.1.1.2 Position Reference Indicator

The Position Reference Indicator (0020,1040) specifies the part of the patient’s anatomy which was used as an anatomical reference point associated with a specific Frame of Reference UID. The Position Reference Indicator may or may not coincide with the origin of the fixed frame of reference related to the Frame of Reference UID.

The Position Reference Indicator shall be used only for annotation purposes and is not intended to be used as a mathematical spatial reference.

C.7.5 Common Equipment IE Modules

The following Equipment IE Module is common to all Composite Image IODs which reference the Equipment IE.

C.7.5.1 General Equipment Module

Table C.7-6 specifies the Attributes which identify and describe the piece of equipment which produced a Series of Images.

Table C.7-6
GENERAL EQUIPMENT MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Manufacturer	(0008,0070)	2	Manufacturer of the equipment that produced the digital images.
Institution Name	(0008,0080)	3	Institution where the equipment is located that produced the digital images.
Institution Address	(0008,0081)	3	Mailing address of the institution where the equipment is located that produced the digital images.
Station Name	(0008,1010)	3	User defined name identifying the machine that produced the digital images.
Institutional Department Name	(0008,1040)	3	Department in the institution where the equipment is located that produced the digital images
Manufacturer's Model Name	(0008,1090)	3	Manufacturer’s model number of the equipment that produced the digital images.
Device Serial Number	(0018,1000)	3	Manufacturer’s serial number of the equipment that produced the digital images.
Software Versions	(0018,1020)	3	Manufacturer’s designation of software version of the equipment that produced the digital images.
Spatial Resolution	(0018,1050)	3	The inherent limiting resolution in mm of the equipment for high contrast objects for the data gathering and reconstruction technique chosen. If variable across the images of the series, the value at the image center.
Date of Last Calibration	(0018,1200)	3	Date when the image acquisition device calibration was last changed in any way. Multiple entries may be used for additional calibrations at other times. See C.7.5.1.1.1 for further explanation.
Time of Last Calibration	(0018,1201)	3	Time when the image device was last changed in any way. Multiple entries may be used. See C.7.5.1.1.1 for further explanation.
Pixel Padding Value	(0028,0120)	3	Value of pixels added to non-rectangular image to pad to rectangular format. See C.7.5.1.1.2 for further explanation.

C.7.5.1.1 General Equipment Attribute Descriptions

C.7.5.1.1.1 Date Of Last Calibration, Time Of Last Calibration

Date of Last Calibration (0018,1200) and Time of Last Calibration (0018,1201) are used to convey the date and time of calibration. The Attribute Date of Last Calibration (0018,1200) may be supported alone, however, Time of Last Calibration (0018,1201) Attribute has no meaning unless Attribute Date of Last Calibration (0018,1200) is also supported. The order for each Attribute shall be from the oldest date/time to the most recent date/time. When the Attributes are both supported they shall be provided as pairs.

C.7.5.1.1.2 Pixel Padding Value

Pixel Padding Value (0028,0120) is used to pad non-rectangular images to rectangle format. The native format of some images is not rectangular. It is common for devices with this format to pad the images to the rectangular format required by the DICOM Standard with a specific pixel value that is not contained in the native image. This attribute specifies the value of this padding value.

C.7.6 Common IE Modules

The following Image IE Modules are common to all Composite Image IODs which reference the Image IE.

C.7.6.1 General Image Module

Table C.7-7 specifies the Attributes which identify and describe an image within a particular series.

Table C.7-7
GENERAL IMAGE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Image Number	(0020,0013)	2	A number that identifies this image
Patient Orientation	(0020,0020)	2C	Patient direction of the rows and columns of the image. Required if image does not require Image Orientation (0020,0037) and Image Position (0020,0032). See C.7.6.1.1.1 for further explanation.
Image Date	(0008,0023)	2C	The date the image pixel data creation started. Required if image is part of a series in which the images are temporally related.
Image Time	(0008,0033)	2C	The time the image pixel data creation started. Required if image is part of a series in which the images are temporally related.
Image Type	(0008,0008)	3	Image identification characteristics. See C.7.6.1.1.2 for Defined Terms and further explanation.
Acquisition Number	(0020,0012)	3	A number identifying the single continuous gathering of data over a period of time which resulted in this image.
Acquisition Date	(0008,0022)	3	The date the acquisition of data that resulted in this image started
Acquisition Time	(0008,0032)	3	The time the acquisition of data that resulted in this image started
Referenced Image Sequence	(0008,1140)	3	A sequence which provides reference to a set of Image SOP Class/Instance identifying other images significantly related to this image (e.g. post-localizer CT image) Encoded as sequence of items: (0008,1150) and (0008,1155)
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Image Sequence (0008,1140) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Reference Image Sequence (0008,1140) is sent.
Derivation Description	(0008,2111)	3	A text description of how this image was derived. See C.7.6.1.1.3 for further explanation.

Source Image Sequence	(0008,2112)	3	A Sequence which identifies the set of Image SOP Class/Instance pairs of the Images which were used to derive this Image. Zero or more Items may be included in this Sequence. Encoded as sequence of items: (0008,1150) and (0008,1155) See C.7.6.1.1.4 for further explanation.
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Source Image Sequence (0008,2112) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Source Image Sequence (0008,2112) is sent.
Images in Acquisition	(0020,1002)	3	Number of images that resulted from this acquisition of data
Image Comments	(0020,4000)	3	User-defined comments about the image
Lossy Image Compression	(0028,2110)	3	Specifies whether an Image has undergone lossy compression. Enumerated Values: 00 = Image has NOT been subjected to lossy compression. 01 = Image has been subjected to lossy compression. See C.7.6.1.1.5

C.7.6.1.1 General Image Attribute Descriptions

C.7.6.1.1.1 Patient Orientation

The Patient Orientation (0020,0020) relative to the image plane shall be specified by two values that designate the anatomical direction of the positive row axis (left to right) and the positive column axis (top to bottom). The first entry is the direction of the rows, given by the direction of the last pixel in the first row from the first pixel in that row. The second entry is the direction of the columns, given by the direction of the last pixel in the first column from the first pixel in that column.

Anatomical direction shall be designated by the capital letters: A (anterior), P (posterior), R (right), L (left), H (head), F (foot). Each value of the orientation attribute shall contain at least one of these characters. If refinements in the orientation descriptions are to be specified, then they shall be designated by one or two additional letters in each value. Within each value, the letters shall be ordered with the principal orientation designated in the first character.

C.7.6.1.1.2 Image Type

The Image Type (0008,0008) Attribute identifies important image identification characteristics. These characteristics are:

a. Pixel Data Characteristics

1. is the image an ORIGINAL Image; an image whose pixel values are based on original or source data
2. is the image a DERIVED Image; an image whose pixel values have been derived in some manner from the pixel value of one or more other images

b. Patient Examination Characteristics
1. is the image a PRIMARY Image; an image created as a direct result of the Patient examination
2. is the image a SECONDARY Image; an image created after the initial Patient examination

c. Modality Specific Characteristics

d. Implementation specific identifiers; other implementation specific identifiers shall be documented in an implementation's conformance statement.

The Image Type attribute is multi-valued and shall be provided in the following manner:

a. Value 1 shall identify the Pixel Data Characteristics; Enumerated Values for the Pixel Data Characteristics are:

ORIGINAL	identifies an Original Image
DERIVED	identifies a Derived Image

b. Value 2 shall identify the Patient Examination Characteristics; Enumerated Values for the Patient Examination Characteristics are:

PRIMARY	identifies a Primary Image
SECONDARY	identifies a Secondary Image

c. Value 3 shall identify any Image IOD specific specialization (optional)

d. Other Values which are implementation specific (optional)

If the pixel data of the derived Image is different from the pixel data of the source images and this difference is expected to affect professional interpretation of the image, the Derived Image shall have a UID different than all the source images.

C.7.6.1.1.3 Derivation Description

If an Image is identified to be a derived image (see C.7.6.1.1.2 Image Type), Derivation Description (0008,2111) is an optional text description of the way the image was derived. It may be used whether or not the Source Image Sequence (0008,2112) is provided. It may also be used in cases when the Derived Image pixel data is not significantly changed from one of the source images and the SOP Instance UID of the Derived Image is the same as the one used for the source image.

Note: Examples of Derived Images which would normally be expected to affect professional interpretation and would thus have a new UID include:

a. images resulting from image processing of another image (e.g. unsharp masking),

b. a multiplanar reformatted CT image,

c. a DSA image derived by subtracting pixel values of one image from another.

d. an image that has been decompressed after having been compressed with a lossy compression algorithm. To ensure that the user has the necessary information about the lossy compression, the approximate compression ratio may be included in Derivation Description (0008,2111).

An example of a Derived Image that would normally not be expected to affect professional interpretation and thus would not require a new UID is an image that has been padded with additional rows and columns for more display purposes.

C.7.6.1.1.4 Source image sequence

If an Image is identified to be a Derived image (see C.7.6.1.1.2 Image Type), Source Image Sequence (0008,2112) is an optional list of Referenced SOP Class UID (0008,1150)/ Referenced SOP Instance UID (0008,1150) pairs which identify the source images used to create the Derived image. It may be used whether or not there is a description of the way the image was derived in Derivation Description (0008,2111).

C.7.6.1.1.5 Lossy Image Compression

The Attribute Lossy Image Compression (0028,2110) conveys that the Image has undergone lossy compression. It provides a means to record that the Image has been compressed (at a point in its lifetime) with a lossy algorithm and changes have been introduced into the pixel data. Once the value has been set to “01”, it shall not be reset.

Note: If an image is compressed with a lossy algorithm, the attribute Lossy Image Compression (0028,2110) is set to “01”. Subsequently, if the image is decompressed and transferred in uncompressed format, this attribute value remains “01”.

The value of the Lossy Image Compression (0028,2110) Attribute in SOP Instances containing multiple frames in which one or more of the frames have undergone lossy compression shall be “01”.

Note: It is recommended that the applicable frames be noted in the Attribute Derivation Description (0008,2111).

If Lossy Image Compression (0028,2110) is set to “01”, Value 1 of the Attribute Image Type (0008,0008) shall be set to DERIVED, and the Image shall receive a new SOP Instance UID.

Note: 1. It is recommended that the approximate compression ratio be provided in the Attribute Derivation Description (0008,2111). Furthermore, it is recommended that Derivation Description (0008,2111) be used to indicate when pixel data changes might affect professional interpretation. (see C.7.6.1.1.3).

2. The attribute Lossy Image Compression (0028,2110) is defined as Type 3 for backward compatibility with existing IODs. It is expected to be required (i.e., defined as Type 1C) for new Image IODs and for existing IODs which undergo a major revision (e.g. a new IOD is specified).

C.7.6.2 Image Plane Module

Table C.7-8 specifies the Attributes which define the transmitted pixel array of a two dimensional image plane.

Note: In previous versions of this Standard, image position and image orientation were specified relative to a specific equipment coordinate system. This equipment coordinate system was not fully defined and a number of ambiguities existed. The equipment based coordinate system has been retired and replaced by the patient based coordinate system defined in this Module.

Table C.7-8
IMAGE PLANE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Pixel Spacing	(0028,0030)	1	Physical distance in the patient between the center of each pixel, specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing in mm.
Image Orientation (Patient)	(0020,0037)	1	The direction cosines of the first row and the first column with respect to the patient. See C.7.6.2.1.1 for further explanation.
Image Position (Patient)	(0020,0032)	1	The x, y, and z coordinates of the upper left hand corner (first pixel transmitted) of the image, in mm. See C.7.6.2.1.1 for further explanation.
Slice Thickness	(0018,0050)	2	Nominal slice thickness, in mm.
Slice Location	(0020,1041)	3	Relative position of exposure expressed in mm. C.7.6.2.1.2 for further explanation.

C.7.6.2.1 Image Plane Attribute Descriptions

C.7.6.2.1.1 Image Position And Image Orientation

The Image Position (0020,0032) specifies the x, y, and z coordinates of the upper left hand corner of the image; it is the first pixel transmitted. Image Orientation (0020,0037) specifies the direction cosines of the first row and the first column with respect to the patient. These Attributes shall be provide as a pair. Row value for the x, y, and z axes respectively followed by the Column value for the x, y, and z axes respectively.

The direction of the axes is defined fully by the patient's orientation. The x-axis is increasing to the left hand side of the patient. The y-axis is increasing to the posterior side of the patient. The z-axis is increasing toward the head of the patient.

The patient based coordinate system is a right handed system, i.e. the vector cross product of a unit vector along the positive x-axis and a unit vector along the positive y-axis is equal to a unit vector along the positive z-axis.

Note: If a patient lies parallel to the ground, face-up on the table, with his feet-to-head direction same as the front-to-back direction of the imaging equipment, the direction of the axes of this patient based coordinate system and the equipment based coordinate system in previous versions of this Standard will coincide.

C.7.6.2.1.2 Slice Location

The Slice Location (0020,1041) is defined as the relative position of exposure expressed in mm. This information is relative to an unspecified implementation specific reference point.

C.7.6.3 Image Pixel Module

Table C.7-9 specified the Attributes that describe the pixel data of the image.

Table C.7-9
IMAGE PIXEL MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Samples per Pixel	(0028,0002)	1	Number of samples (planes) in this image. See C.7.6.3.1.1 for further explanation.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. See C.7.6.3.1.2 for further explanation.
Rows	(0028,0010)	1	Number of rows in the image.
Columns	(0028,0011)	1	Number of columns in the image
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. See PS 3.5 for further explanation.
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. See PS 3.5 for further explanation.
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Each sample shall have the same high bit. See PS 3.5 for further explanation.
Pixel Representation	(0028,0103)	1	Data representation of the pixel samples. Each sample shall have the same pixel representation. Enumerated Values: 0000H = unsigned integer. 0001H = 2's complement
Pixel Data	(7FE0,0010)	1	A data stream of the pixel samples which comprise the Image. See C.7.6.3.1.4 for further explanation.
Planar Configuration	(0028,0006)	1C	Indicates whether the pixel data are sent color-by-plane or color-by-pixel. Required if Samples per Pixel (0028,0002) has a value greater than 1. See C.7.6.3.1.3 for further explanation.
Pixel Aspect Ratio	(0028,0034)	1C	Ratio of the vertical size and horizontal size of the pixels in the image specified by a pair of integer values where the first value is the vertical pixel size, and the second value is the horizontal pixel size. Required if the aspect ratio is not 1\1 and the Image Plane Module is not applicable to this Image. See C.7.6.3.1.7.
Smallest Image Pixel Value	(0028,0106)	3	The minimum actual pixel value encountered in this image.
Largest Image Pixel Value	(0028,0107)	3	The maximum actual pixel value encountered in this image.

Red Palette Color Lookup Table Descriptor	(0028,1101)	1C	Specifies the format of the Red Palette Color Lookup Table Data (0028,1201) Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR or ARGB. See C.7.6.3.1.5 for further explanation.
Green Palette Color Lookup Table Descriptor	(0028,1102)	1C	Specifies the format of the Green Palette Color Lookup Table Data (0028,1202) Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR or ARGB. See C.7.6.3.1.5 for further explanation.
Blue Palette Color Lookup Table Descriptor	(0028,1103)	1C	Specifies the format of the Blue Palette Color Lookup Table Data (0028,1203) Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR or ARGB. See C.7.6.3.1.5 for further explanation.
Red Palette Color Lookup Table Data	(0028,1201)	1C	Red Palette Color Lookup Table Data. Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR or ARGB. See C.7.6.3.1.6 for further explanation.
Green Palette Color Lookup Table Data	(0028,1202)	1C	Green Palette Color Lookup Table Data. Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR or ARGB. See C.7.6.3.1.6 for further explanation.
Blue Palette Color Lookup Table Data	(0028,1203)	1C	Blue Palette Color Lookup Table Data. Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR or ARGB. See C.7.6.3.1.6 for further explanation.

C.7.6.3.1 Image Pixel Attribute Descriptions

C.7.6.3.1.1 Samples Per Pixel

Samples per Pixel (0028,0002) is the number of separate planes in this image. One, three, and four image planes are defined. Other numbers of image planes are allowed, but their meaning is not defined by this Standard.

For monochrome (gray scale) and palette color images, the number of planes is 1. For RGB and other three vector color models, the value of this attribute is 3. For ARGB and other four vector color models, the value of this attribute is 4.

All image planes shall have the same number of Rows (0028,0010), Columns (0028,0011), Bits Allocated (0028,0100), Bits Stored (0028,0101), High Bit (0028,0102), Pixel Representation (0028,0103), and Pixel Aspect Ratio (0028,0034).

The data in each pixel may be represented as a “Composite Pixel Code”. If Samples Per Pixel is one, the Composite Pixel Code is just the “n” bit pixel sample, where “n” = Bits Allocated. If

Samples Per Pixel is greater than one, Composite Pixel Code is a “k” bit concatenation of samples, where “k” = Bits Allocated multiplied by Samples Per Pixel, and with the sample representing the vector color designated first in the Photometric Interpretation name comprising the most significant bits of the Composite Pixel Code, followed in order by the samples representing the next vector colors, with the sample representing the vector color designated last in the Photometric Interpretation name comprising the least significant bits of the Composite Pixel Code. For example, for Photometric Interpretation = “RGB”, the most significant “Bits Allocated” bits contain the Red sample, the next “Bits Allocated” bits contain the Green sample, and the least significant “Bits Allocated” bits contain the Blue sample.

C.7.6.3.1.2 Photometric Interpretation

The value of Photometric Interpretation (0028,0004) specifies the intended interpretation of the image pixel data.

The following values are defined. Other values are permitted but the meaning is not defined by this Standard.

MONOCHROME1 = Pixel data represent a single monochrome image plane. The minimum sample value is intended to be displayed as white after any VOI gray scale transformations have been performed. See PS 3.4. This value may be used only when Samples per Pixel (0028,0002) has a value of 1.

MONOCHROME2 = Pixel data represent a single monochrome image plane. The minimum sample value is intended to be displayed as black after any VOI gray scale transformations have been performed. See PS 3.4. This value may be used only when Samples per Pixel (0028,0002) has a value of 1.

PALETTE COLOR = Pixel data describe a color image with a single sample per pixel (single image plane). The pixel value is used as an index into each of the Red, Blue, and Green Palette Color Lookup Tables (0028,1101-1103&1201-1203). This value may be used only when Samples per Pixel (0028,0002) has a value of 1. When the Photometric Interpretation is Palette Color; Red, Blue, and Green Palette Color Lookup Tables shall be present.

RGB = Pixel data represent a color image described by red, green, and blue image planes. The minimum sample value for each color plane represents minimum intensity of the color. This value may be used only when Samples per Pixel (0028,0002) has a value of 3.

HSV = Pixel data represent a color image described by hue, saturation, and value image planes. The minimum sample value for each HSV plane represents a minimum value of each vector. This value may be used only when Samples per Pixel (0028,0002) has a value of 3.

ARGB = Pixel data represent a color image described by red, green, blue, and alpha image planes. The minimum sample value for each RGB plane represents minimum intensity of the color. The alpha plane is passed through Palette Color Lookup Tables. If the alpha pixel value is greater than 0, the red, green, and blue lookup table values override the red, green, and blue, pixel plane colors. This value may be used only when Samples per Pixel (0028,0002) has a value of 4.

CMYK = Pixel data represent a color image described by cyan, magenta, yellow, and black image planes. The minimum sample value for each CMYK plane represents a minimum intensity of the color. This value may be used only when Samples per Pixel (0028,0002) has a value of 4.

YBR_FULL = Pixel data represent a color image described by one luminance (Y) and two chrominance planes (C_B and C_R). This photometric interpretation may be used only when

samples per pixel (0028,0002) has a value of 3. Black is represented by Y equal to zero. The absence of color is represented by both C_B and C_R values equal to half full scale.

Note: In the case where the Bits Allocated (0028,0100) has value of 8 half full scale is 128.

In the case where Bits allocated (0028,0100) has a value of 8 then the following equations convert between RGB and YC_BC_R Photometric Interpretation.

$$Y = + .2990R + .5870G + .1140B$$

$$C_B = - .1687R - .3313G + .5000B + 128$$

$$C_R = + .5000R - .4187G - .0813B + 128$$

Note: The above is based on CCIR Recommendation 601-2 dated 1990

YBR_FULL_422 = The same as YBR_FULL except that the C_B and C_R values are sampled horizontally at half the Y rate and as a result there are half as many C_B and C_R values as Y values.

This photometric Interpretation is only allowed with Planar Configuration (0028,0006) equal to 0000. Two Y values shall be stored followed by one C_B and one C_R value. The C_B and C_R values shall be sampled at the location of the first of the two Y values. For each Row of Pixels, the first C_B and C_R samples shall be at the location of the first Y sample. The next C_B and C_R samples shall be at the location of the third Y sample etc.

Note: This subsampling is often referred to as cosited sampling.

YBR_PARTIAL_422 = The same as YBR_FULL_422 except that:

1. black corresponds to Y = 16;
2. Y is restricted to 220 levels (i.e. the maximum value is 235);
3. C_B and C_R each has a minimum value of 16;
4. C_B and C_R are restricted to 225 levels (i.e. the maximum value is 240);
5. lack of color is represented by C_B and C_R equal to 128.

In the case where Bits Allocated (0028,0100) has value of 8 then the following equations convert between RGB and YBR_PARTIAL_422 Photometric Interpretation

$$Y = + .2568R + .5041G + .0979B + 16$$

$$C_B = - .1482R - .2910G + .4392B + 128$$

$$C_R = + .4392R - .3678G - .0714B + 128$$

Note: The above is based on CCIR Recommendation 601-2 dated 1990.

C.7.6.3.1.3 Planar Configuration

Planar Configuration (0028,0006) indicates whether the color pixel data are sent color-by-plane or color-by-pixel. This Attribute shall be present if Samples per Pixel (0028,0002) has a value greater than 1. It shall not be present otherwise.

Enumerated Values:

000 = The sample values for the first pixel are followed by the sample values for the second pixel, etc. For RGB images, this means the order of the pixel values sent shall

be R1, G1, B1, R2, G2, B2, ..., etc. For HSV images, this means the order of the pixel values sent shall be H1, S1, V1, H2, S2, V2, ... etc. For ARGB images, this means the order of the pixel values sent shall be A1, R1, G1, B1, A2, R2, G2, B2, ... etc. For CMYK images, this means the order of the pixel values sent shall be C1, M1, Y1, K1, C2, M2, Y2, K2, ... etc.

001 = Each color plane shall be sent contiguously. For RGB images, this means the order of the pixel values sent is R1, R2, R3, ..., G1, G2, G3, ..., B1, B2, B3, etc. For HSV images, this means the order of the pixel values sent is H1, H2, H3, ..., S1, S2, S3, ..., V1, V2, V3, etc. For ARGB images, this means the order of the pixel values sent is A1, A2, A3, ..., R1, R2, R3, ..., G1, G2, G3, ... B1, B2, B3... etc. For CMYK images, this means the order of the pixel values sent is C1, C2, C3, ..., M1, M2, M3, ..., Y1, Y2, Y3, ..., K1, K2, K3... etc.

C.7.6.3.1.4 Pixel Data

Pixel Data (7FE0,0010) for this image. The order of pixels sent for each image plane is left to right, top to bottom , ie., the upper left pixel (labeled 1,1) is sent first followed by the remainder of row 1, followed by the first pixel of row 2 (labeled 2,1) then the remainder of row 2 and so on.

For multi-plane images see Planar Configuration (0028,0006) in this Section.

C.7.6.3.1.5 Palette Color Lookup Table Descriptor

The three values of Palette Color Lookup Table Descriptor (0028,1101-1103) describe the format of the Lookup Table Data in the corresponding Data Element (0028,1201-1203) or (0028,1221-1223).

The first value is the number of entries in the lookup table. When the number of table entries is equal to 2^{16} then this value shall be 0.

The second value is the first stored pixel value mapped. This pixel value is mapped to the first entry in the Lookup Table Data. All image pixel values less than the first entry are also mapped to the first entry in the Lookup Table Data. An image pixel value one greater than the first entry is mapped to the second entry in the Lookup Table Data. Subsequent image pixel values are mapped to the subsequent entries in the Lookup Table Data up to an image pixel value equal to number of entries + first entry - 1 which is mapped to the last entry in the Lookup Table Data. Image pixel values greater than number of entries + first entry are also mapped to the last entry in the Lookup Table Data.

The third value specifies the number of bits for each entry in the Lookup Table Data.

When the Palette Color Lookup Table Descriptor (0028,1101-1103) are used as part of the Palette Color Lookup Table Module, the third value shall be equal to 16.

Note: A value of 16 indicates the Lookup Table Data will range from (0,0,0) minimum intensity to (65535,65535,65535) maximum intensity.

C.7.6.3.1.6 Palette Color Lookup Table Data

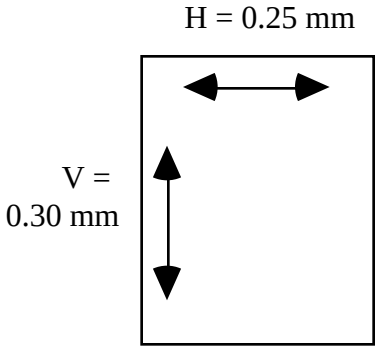
Palette Color Lookup Table Data (0028,1201-1203) contain the lookup table data corresponding to the Lookup Table Descriptor (0028,1101-1103). If padding is required to complete a full word, the padding value shall be 0.

These lookup tables shall be used only when there is a single sample per pixel (single image plane) in the image.

These lookup tables are required when the value of Photometric Interpretation (0028,0004) is Palette Color. The semantics of these lookup tables is not defined otherwise.

C.7.6.3.1.7 Pixel Aspect Ratio

The pixel aspect ratio is the ratio of the vertical size and horizontal size of the pixels in the image specified by a pair of integer values where the first value is the vertical pixel size, and the second value is the horizontal pixel size. To illustrate, consider the following example pixel size:



Dimensions of pixel

Pixel Aspect Ratio = Vertical Size \ Horizontal Size = 0.30 mm \0.25 mm. Thus the Pixel Aspect Ratio could be represented as the multivalued integer string "6\5", "60\50", or any equivalent integer ratio.

C.7.6.4 Contrast/Bolus Module

Table C.7-10 specifies the Attributes that describe the contrast /bolus used in the acquisition of the Image.

Table C.7-10
CONTRAST/BOLUS MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Contrast/Bolus Agent	(0018,0010)	2	Contrast or bolus agent
Contrast/Bolus Agent Sequence	(0018,0012)	3	Sequence that identifies the contrast agent.
>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the contrast agent. Required if Contrast/Bolus Agent Sequence (0018,0012) is sent. Values shall be taken from SNOMED/DICOM Microglossary terms of semantic type Contrast Agent when the Coding Scheme Designator (0008,0102) is 99SDM
>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Contrast/Bolus Agent Sequence (0018,0012) is sent. Defined Terms: 99SDM
>Code Meaning	(0008,0104)	3	The contrast agent that is represented by the Code Value (0008,0100).

Contrast/Bolus Route	(0018,1040)	3	Administration route of contrast agent
Contrast/Bolus Administration Route Sequence	(0018,0014)	3	Sequence that identifies the route of administration of contrast agent.
>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the contrast agent administration route. Required if Contrast/Bolus Administration Route Sequence (0018,0014) is sent. Values shall be taken from SNOMED/DICOM Microglossary terms of semantic type Drug Administration Route when the Coding Scheme Designator (0008,0102) is 99SDM.
>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Contrast/Bolus Administration Route Sequence (0018,0014) is sent. Defined Terms: 99SDM
>Code Meaning	(0008,0104)	3	The contrast agent administration route that is represented by the Code Value (0008,0100).
>Additional Drug Sequence	(0018,002A)	3	Sequence that identifies any additional drug that is administered with the contrast agent bolus.
>>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the drug. Required if Additional Drug Sequence (0018,002A) is sent. Values shall be taken from SNOMED/DICOM Microglossary terms of semantic type Interventional Drug when the Coding Scheme Designator (0008,0102) is 99SDM
>>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Additional Drug Sequence (0018,002A) is sent. Defined Terms: 99SDM
>>Code Meaning	(0008,0104)	3	The drug that is represented by the Code Value (0008,0100).
Contrast/Bolus Volume	(0018,1041)	3	Volume injected in milliliters of diluted contrast agent
Contrast/Bolus Start Time	(0018,1042)	3	Time of start of injection
Contrast/Bolus Stop Time	(0018,1043)	3	Time of end of contrast injection

Contrast/Bolus Total Dose	(0018,1044)	3	Total amount in milliliters of the undiluted contrast agent
Contrast Flow Rate(s)	(0018,1046)	3	Rate(s) of injection(s) in milliliters/sec
Contrast Flow Duration(s)	(0018,1047)	3	Duration(s) of injection(s) in seconds. Each Contrast Flow Duration value shall correspond to a value of Contrast Flow Rate (0018,1046).
Contrast/Bolus Ingredient	(0018,1048)	3	Active ingredient of agent. Defined Terms: IODINE GADOLINIUM CARBON DIOXIDE BARIUM
Contrast/Bolus Ingredient Concentration	(0018,1049)	3	Milligrams of active ingredient per milliliter of (diluted) agent

Note: 1. Flow duration is an alternate method of specifying stop time

2. Flow rate allows for stepped injections by being capable of multiple values (1,N) instances.

3. For a 100 ml injection of 76% Diatrizoate and meglumine/sodium, diluted 1:1,
the Contrast/Bolus Agent would be "76% Diatrizoate" as text
the Contrast/Bolus Volume would be 100 ml,
the Contrast/Bolus Total Dose would be 50 ml,
the Contrast/Bolus Ingredient would be "IODINE",
the Contrast/Bolus Ingredient Concentration would be 370mg/ml.

C.7.6.5 Cine Module

Table C.7-11 specifies the Attributes of a Multi-frame Cine Image.

Table C.7-11
CINE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Preferred Playback Sequencing	(0018,1244)	3	Describes the preferred playback sequencing for a multi-frame image. Enumerated Values: 0 = Looping (1,2...n,1,2,...n,1,2,....n,...) 1 = Sweeping (1,2,...n,n-1,...2,1,2,...n,...)
Frame Time	(0018,1063)	1C	Nominal time (in msec) per individual frame. See C.7.6.5.1.1 for further explanation. Required if Frame Increment Pointer (0028,0009) points to Frame Time.
Frame Time Vector	(0018,1065)	1C	An array which contains the real time increments (in msec) between frames for a Multi-frame image. See C.7.6.5.1.2 for further explanation. Required if Frame Increment Pointer (0028,0009) points to Frame Time Vector.

Start Trim	(0008,2142)	3	The frame number of the first frame of the Multi-frame image to be displayed.
Stop Trim	(0008,2143)	3	The Frame Number of the last frame of a Multi-frame image to be displayed.
Recommended Display Frame Rate	(0008,2144)	3	Recommended rate at which the frames of a Multi-frame image should be displayed in frames/second.
Cine Rate	(0018,0040)	3	Number of frames per second.
Frame Delay	(0018,1066)	3	Time (in msec) from Image Time to the start of the first frame in a Multi-frame image.
Effective Duration	(0018,0072)	3	Total time in seconds that data was actually taken for the entire Multi-frame image.
Actual Frame Duration	(0018,1242)	3	Elapsed time of data acquisition in msec per each frame.

C.7.6.5.1 Cine Attribute Descriptions

C.7.6.5.1.1 Frame Time

Frame Time (0018,1063) is the nominal time (in milliseconds) between individual frames of a Multi-frame image. If the Frame Increment Pointer points to this Attribute, Frame Time shall be used in the following manner to calculate 'the relative time' for each frame:

Frame 'Relative Time' (n) = Frame Delay + Frame Time * (n-1)

where: n = number of frame within the Multi-frame image and the first frame number is one

C.7.6.5.1.2 Frame Time Vector

Frame Time Vector (0018,1065) is an array which contains the time increments (in milliseconds) between the nth frame and the previous frame for a Multi-frame image. The first frame always has a time increment of 0. If the Frame Increment Pointer points to this Attribute, the Frame Time Vector shall be used in the following manner to calculate 'relative time' *T(n)* for frame *n*:

$$T(n) = \sum_{i=1}^{n} \Delta t_i$$

where Δt_i is the ith Frame Time Vector component.

C.7.6.6 Multi-Frame Module

Table C.7-12 specifies the Attributes of a Multi-frame pixel data Image.

Table C.7-12
MULTI-FRAME MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Number of Frames	(0028,0008)	1	Number of frames in a Multi-frame Image. See C.7.6.6.1.1 for further explanation.
Frame Increment Pointer	(0028,0009)	1	Contains the Data Element Tag of the attribute which is used as the frame increment in Multi-frame pixel data. See C.7.6.6.1.1 for further explanation.

C.7.6.6.1 Multi-Frame Attribute Descriptions

C.7.6.6.1.1 Number Of Frames And Frame Increment Pointer

A Multi-frame Image is defined as a Image whose pixel data consists of a sequential set of individual Image Pixel frames. A Multi-frame Image is transmitted as a single contiguous stream of pixels. Frame headers do not exist within the data stream.

Each individual frame shall be defined (and thus can be identified) by the Attributes in the Image Pixel Module (see C.7.6.3). All Image IE Attributes shall be related to the first frame in the Multi-frame image.

The total number of frames contained within a Multi-frame Image is conveyed in the Number of Frames (0028,0008).

The frames within a Multi-frame Image shall be conveyed as a logical sequence. The information which determines the sequential order of the frames shall be identified by the Data Element Tag or tags conveyed by the Frame Increment Pointer (0028,0009). Each specific Image IOD which supports the Multi-frame Module specializes the Frame Increment Pointer(0028,0009) to identify the Attributes which may be used as sequences.

C.7.6.7 Bi-Plane Sequence Module

Table C.7-13 describes the Attributes associated with the Image when it has the property of two planes of acquisition. This module is used to introduce a sequence of exactly two items, each item containing attributes of one image plane.

Table C.7-13
BI-PLANE SEQUENCE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Planes	(0028,0012)	1	Number of planes. Enumerated Value = 2
Bi-Plane Acquisition Sequence	(0028,5000)	1	Introduces sequence of items describing acquisition in each plane.

C.7.6.8 Bi-Plane Image Module

Table C.7-14 describes the Attributes uniquely associated with each plane of a bi-plane image.

Note: This Module is intended to be part of a sequence item associated with a single plane in a bi-plane Image Information Entity.

Table C.7-14
BI-PLANE IMAGE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Smallest Image Pixel Value in Plane	(0028,0110)	3	The minimum actual pixel value encountered in the image plane.
Largest Image Pixel Value in Plane	(0028,0111)	3	The maximum actual pixel value encountered in the image plane.

C.7.6.8.1 Bi-Plane Image Attribute Descriptions

The Smallest and Largest Image Pixel Values in Plane can be compared to the Smallest and Largest Image Pixel Values (tags (0028,0106) and (0028,0107) in the Image Pixel Module), which apply to the entire bi-plane image, and the Smallest and Largest Image Pixel Values in Series (tags (0028,0108) and (0028,0109) in the General Series Module).

C.7.6.9 Frame Pointers Module

Table C.7-15 specifies the attributes of a Frame Pointer Module.

Table C.7-15
FRAME POINTERS MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Representative Frame Number	(0028,6010)	3	The frame number selected for use as a pictorial representation (e.g. icon) of the Multi-frame Image
Frame Numbers Of Interest (FOI)	(0028,6020)	3	Frame number(s) selected as frames of interest.
Frame Of Interest Description	(0028,6022)	3	Description of each one of the Frame(s) of Interest selected in (0028,6020). If multiple Frames of Interest are selected and this Attribute is used, it shall contain the same number of values as are in Frame Numbers of Interest (0028,6020).

Notes: 1. Frame numbers begin at 1.

2. Frame of Interest Description is intended to indicate such frames as Systolic, Diastolic, Stenotic Artery.

C.7.6.10 Mask Module

Table C.7-16 specifies the Attributes that describe mask operations for a Multi-frame image.

Table C.7-16
MASK MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Mask Subtraction Sequence	(0028,6100)	1	Defines a sequence which describe mask subtraction operations for a Multi-frame Image.
>Mask Operation	(0028,6101)	1	Defined Term identifying the type of mask operation to be performed. See C.7.6.10.1 for further explanation.
>Applicable Frame Range	(0028,6102)	3	Each pair of numbers in this multi-valued attribute specify a beginning and ending frame number inclusive of a range where this particular mask operation is valid. Discontinuous ranges are represented by multiple pairs of numbers. Frames in a Multi-frame Images are specified by sequentially increasing number values beginning with 1. If this Attribute is missing in this particular sequence item, then the mask operation is applicable throughout the entire Multi-frame image, subject to certain limits as described in C.7.6.10.1.1.
>Mask Frame Numbers	(0028,6110)	1C	Specifies the frame numbers of the pixel data used to generate this mask. Frame in a Multi-frame image are specified by sequentially increasing number values beginning with 1. Required if the Mask Operation (0028,6101) is AVG_SUB.
>Contrast Frame Averaging	(0028,6112)	3	Specifies the number of contrast frames to average together before performing the mask operation. If the Attribute is missing, no averaging is performed.
>Mask Sub-pixel Shift	(0028,6114)	3	A pair of floating point numbers specifying the fractional vertical [adjacent row spacing] and horizontal [adjacent column spacing] pixel shift applied to the mask before subtracting it from the contrast frame. See Section C.7.6.10.1.2.

>TID Offset	(0028,6120)	2C	Specifies the offset to be subtracted from the current frame number in order to locate the mask frame in TID mode. If omitted, TID Offset defaults to 1. Used when Mask Operation (0028,6101) is TID.
>Mask Operations Explanations	(0028,6190)	3	Free form explanation of this particular mask operation.
Recommended Viewing Mode	(0028,1090)	2	Specifies the recommended viewing protocol(s). Defined terms: SUB = for subtraction with mask images; NAT = native viewing of image as sent. Note: If an implementation does not recognize the defined term for Recommended Viewing Mode (0028,1090) , reverting to native display mode is recommended.

Note: Frame numbers begin at 1.

C.7.6.10.1 Mask Subtraction Attribute Descriptions

C.7.6.10.1.1 Mask Operation

Mask Operation (0028,6100) specifies a type of mask operation to be performed. The Defined Terms identifying the mask operation to be performed are as follows:

NONE (No Subtraction) No mask subtraction operation is specified;

AVG_SUB (Average Subtraction) The frames specified by the Mask Frame Numbers (0028,6110) are averaged together, shifted by the amount specified in the Mask Sub-pixel Shift (0028,6114), then subtracted from the contrast frames in the range specified in the Applicable Frame Range (0028,6102) . Contrast Frame (0028,6112) number of frames starting with the current frame are averaged together before the subtraction. If the Applicable Frame Range is not present in this sequence item, the Applicable Frame Range is assumed to end at the last frame number of the image minus Contrast Frame Averaging (0028,6112) plus one;

TID (Time Interval Differencing) The mask for each frame within the Applicable Frame Range (0028,6102) is selected by subtracting TID Offset (0028,6120) from the respective frame number. If the Applicable Frame Range is not present in this sequence item, the Applicable Frame Range is assumed to be a range where TID offset subtracted from any frame number with the range results in a valid frame number within the Multi-frame image.

C.7.6.10.1.2 Mask Sub-pixel Shift

A pair of floating point numbers specifying the fractional pixel shift specifying the fractional vertical [adjacent row spacing] and horizontal [adjacent column spacing] pixel shift applied to the mask

before subtracting it from the contrast frame. The row offset results in a shift of the pixels along the column axis. The column offset results in a shift of the pixels along the row axis. A positive row offset is a shift towards the pixels of the lower row of the pixel plane. A positive column offset is a shift towards the pixels of the left hand side column of the pixel plane.

C.7.6.11 Display Shutter Module

The Display shutter is a geometric mask which may be applied on the image for presentation purposes in order to neutralize the display of any of the pixels located outside of the shutter shape. Geometry of the shutter is specified with respect to a row and column coordinate system where the origin is the upper left hand pixel. This origin is specified by the values 1,1 for row/column. A row coordinate represent a number of raw spacing (vertical) and a column coordinate represents a column spacing (horizontal). Up to three different shutter shapes may be used and superimposed.

The manner in which the display area is neutralized (black-out, gray, or other means) is beyond the scope of this Standard.

Table C.7-17
DISPLAY SHUTTER MODULE

Attribute Name	Tag	Type	Attribute Description
Shutter Shape	(0018,1600)	1	Shape(s) of the shutter defined for display. Enumerated Values: RECTANGULAR CIRCULAR POLYGONAL This multi-valued Attribute shall contain at most one of each Enumerated Value.
Shutter Left Vertical Edge	(0018,1602)	1C	Required if Shutter Shape (0018,1600) is RECTANGULAR. Location of the left edge of the rectangular shutter with respect to pixels in the image given as column.
Shutter Right Vertical Edge	(0018,1604)	1C	Required if Shutter Shape (0018,1600) is RECTANGULAR. Location of the right edge of the rectangular shutter with respect to pixels in the image given as column.
Shutter Upper Horizontal Edge	(0018,1606)	1C	Required if Shutter Shape (0018,1600) is RECTANGULAR. Location of the upper edge of the rectangular shutter with respect to pixels in the image given as row.
Shutter Lower Horizontal Edge	(0018,1608)	1C	Required if Shutter Shape (0018,1600) is RECTANGULAR. Location of the lower edge of the rectangular shutter with respect to pixels in the image given as row.
Center of Circular Shutter	(0018,1610)	1C	Required if Shutter Shape (0018,1600) is CIRCULAR. Location of the center of the circular shutter with respect to pixels in the image given as row and column.

Radius of Circular Shutter	(0018,1612)	1C	Required if Shutter Shape (0018,1600) is CIRCULAR. Radius of the circular shutter with respect to pixels in the image given as a number of pixels along the row direction.
Vertices of the Polygonal Shutter	(0018,1620)	1C	Required if Shutter Shape (0018,1600) is POLYGONAL. Multiple Values where the first set of two values are: row of the origin vertex column of the origin vertex Two or more pairs of values follow and are the row and column coordinates of the other vertices of the polygon shutter. Polygon shutters are implicitly closed from the last vertex to the origin vertex are shall be non-intersecting polygons.

The following figures illustrate the values of coordinate attributes for 1:1 aspect and 2:1 aspect ratio images with rectangular and circular display shutters applied.

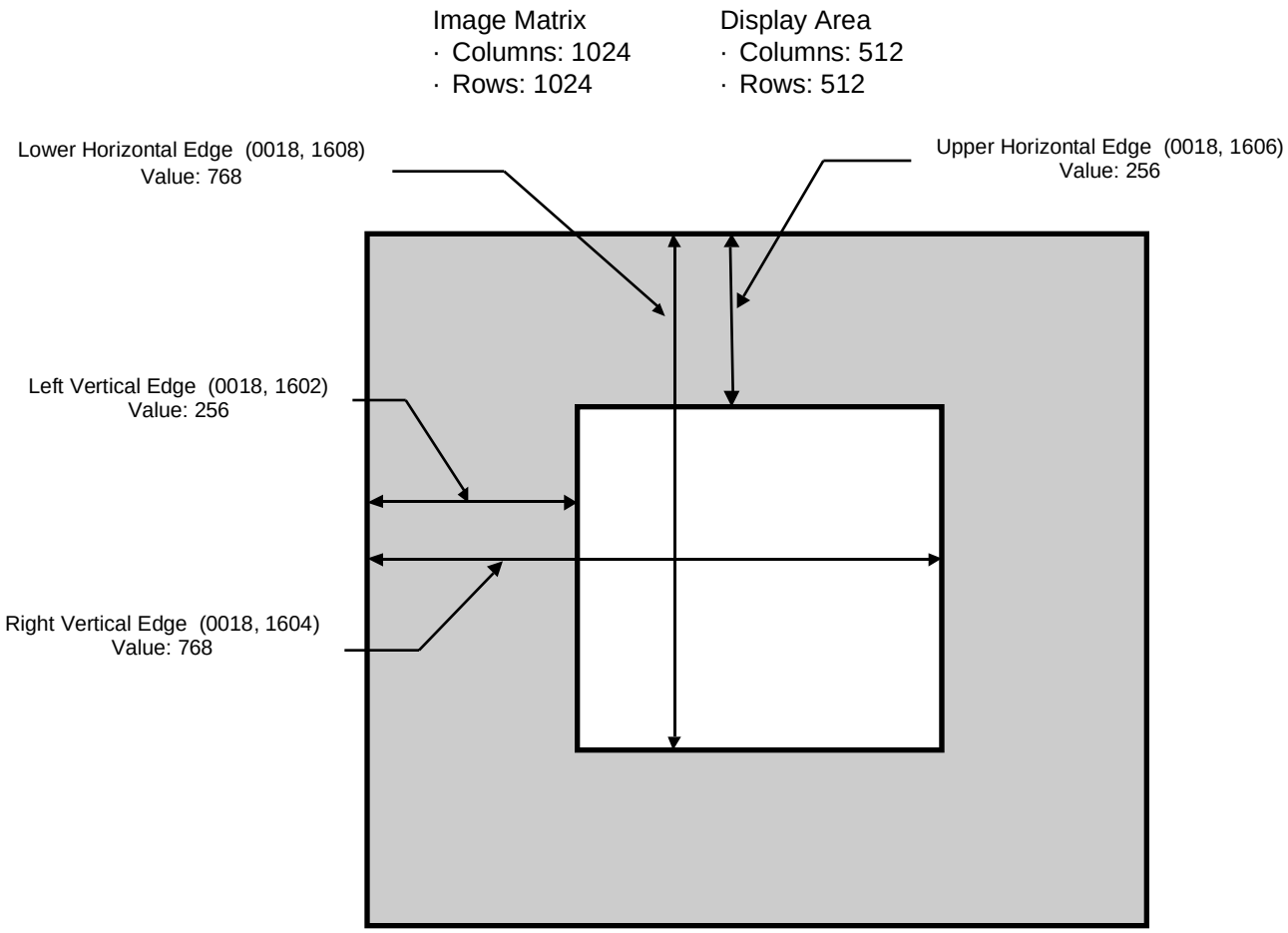


Figure C.7-1
Rectangular Display Shutter
(1:1 aspect ratio image)

Image Matrix	Display Area
· Columns: 1024	· Columns: 512
· Rows: 512	· Rows: 256

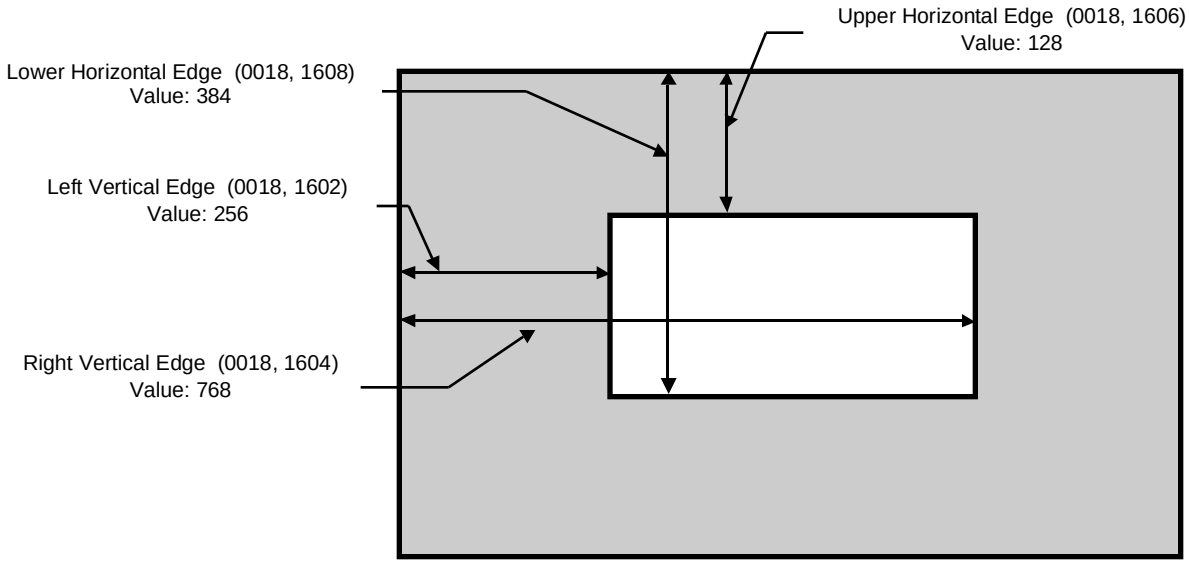


Figure C.7-2
Rectangular Display Shutter
(2:1 aspect ratio images as they would appear before interpolation for display)

Image Matrix
- Columns: 1024
- Rows: 1024

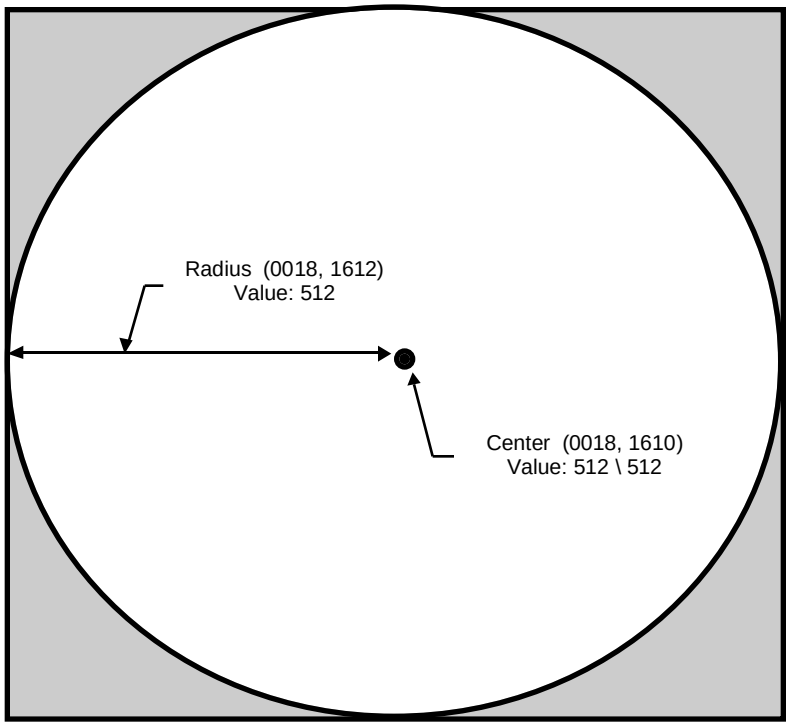


Figure C.7-3
Circular Display Shutter
(1:1 aspect ratio image)

Image Matrix
· Columns: 1024
· Rows: 512

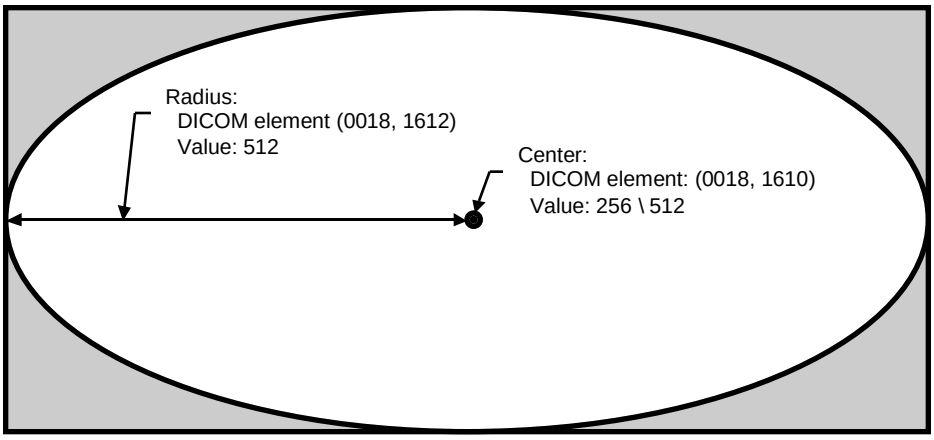


Figure C.7-4
Circular Display Shutter
(2:1 aspect ratio images as they would appear before interpolation for display)

C.7.6.12 Device

Table C.7-18 describes the Attributes of devices (e.g., catheters, markers, baskets) which are associated with a study and/or image.

Table C.7-18
DEVICE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Device Sequence	(0050,0010)	3	Introduces sequence of items describing devices used which may be visible in the image
>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the device. Required if Device Sequence (0050,0010) is present. Values shall be taken from SNOMED/DICOM Microglossary terms of semantic type Interventional Device when the Coding Scheme Designator (0008,0102) is 99SDM.
>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Device Sequence (0050,0010) is present. Defined Terms: 99SDM

>Code Meaning	(0008,0104)	3	The device that is represented by the Code Value (0008,0100). May be present if Device Sequence (0050,0010) is present.
>Device Length	(0050,0014)	3	Length in mm of device. Required as per Table in Section C.7.6.12.1.1. May be present only if Device Sequence (0050,0010) is present.
>Device Diameter	(0050,0016)	3	Unit diameter of device. Required as per Table in Section C.7.6.12.1.1. May be present only if Device Sequence (0050,0010) is present.
>Device Diameter units	(0050,0017)	2C	Required if Device Diameter (0050,0016) is present. Defined terms: FR = French GA = Gauge IN = Inch MM = Millimeter May be present only if Device Sequence (0050,0010) is present.
>Device Volume	(0050,0018)	3	Volume of device in ml. Required as per Table in Section C.7.6.12.1.1. May be present only if Device Sequence (0050,0010) is present.
>Inter-Marker Distance	(0050,0019)	3	Distance in mm between markers on calibrated device. Required as per Table in Section C.7.6.12.1.1. May be present only if Device Sequence (0050,0010) is present.
>Device Description	(0050,0020)	3	Further description in free form text describing the device. May be present only if Device Sequence (0050,0010) is present.

Note: The value 99SDM from Annex D may be used for the Coding Scheme Designator pointing to SNOMED/DICOM Microglossary terms of semantic type Interventional Device. It is expected that this value will evolve when Coding Scheme Designator UIDs are available from a registration authority.

C.7.6.12.1 Device Attribute Descriptions

C.7.6.12.1.1 Device Type and Size

Depending on the type of device specified by the Code Value (0008,0100) in an item of the Device Sequence (0050,0010), various device size attributes (e.g., Device Length (0050,0014), Device Diameter (0050,0016), Device Volume (0050,0018), Inter Marker Distance (0050,0019)) may be required to fully characterize the device.

Note: The attributes required to fully characterize the devices in the SNOMED/DICOM Microglossary Angiographic Device list are specified in that list.

C.7.6.13 Therapy

Table C.7-19 describes the Attributes of therapies (e.g. interventions during an angiographic procedure) which are associated with a study and/or image.

Table C.7-19
THERAPY MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Interventional Therapy Sequence	(0018,0036)	3	Introduces sequence of items describing interventional therapies
>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the interventional therapy. Required if Interventional Therapy Sequence (018,0036) is present. Values shall be taken from SNOMED/DICOM Microglossary terms of semantic type Interventional Procedure when the Coding Scheme Designator (0008,0102) is 99SDM.
>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Interventional Therapy Sequence (0018,0036) is present. Defined Terms: 99SDM
>Code Meaning	(0008,0104)	3	The interventional therapy that is represented by the Code Value (0008,0100). May be present if Interventional Therapy Sequence (0018,0036) is present.
>Interventional Status	(0018,0038)	2	Temporal relation to therapeutic intervention Specialized as Enumerated Values: PRE INTERMEDIATE POST NONE Required if Interventional Therapy Sequence (0018,0036) is present.
>Interventional Drug Sequence	(0018,0029)	3	Sequence that identifies the interventional drug. May be present if Interventional Therapy Sequence (0018,0036) is present.

>>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the interventional drug. Required if Interventional Drug Sequence (0018,0029) is present. Values shall be taken from SNOMED/DICOM Microglossary terms of semantic type Interventional Drug when the Coding Scheme Designator (0008,0102) is 99SDM.
>>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Interventional Drug Sequence (0018,0029) is present. Defined Terms: 99SDM
>>Code Meaning	(0008,0104)	3	The interventional drug that is represented by the Code Value (0008,0100). May be present if Interventional Drug Sequence (0018,0029) is present.
>Intervention Drug Start Time	(0018,0035)	3	Time of administration of the interventional drug. May be present if Interventional Therapy Sequence (0018,0036) is present.
>Intervention Drug Stop Time	(0018,0027)	3	Time of completion of administration of the intervention drug.
> Administration Route Code Sequence	(0054,0302)	3	Sequence that identifies the Administration Route. This sequence shall contain exactly one item.
>> Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the Administration Route. Required if Administration Route Code Sequence (0018,0027) is present. Values shall be taken from SNOMED/DICOM Microglossary terms of semantic type Drug Administration Route when the Coding Scheme Designator (0008,0102) is 99SDM.
>> Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Administration Route Code Sequence (0018,0027) is present. Defined Terms: 99SDM

>> Code Meaning	(0008,0104)	3	The Administration Route that is represented by the Code Value (0008,0100).
>Therapy Description	(0018,0039)	3	Further description in free form text describing the therapy. May be present if Interventional Therapy Sequence (0018,0036) is present.

Note: The value 99SDM from Annex D may be used for the Coding Scheme Designator pointing to SNOMED/DICOM Microglossary terms of semantic type Interventional Procedure . It is expected that this value will evolve when Coding Scheme Designator UIDs are available from a registration authority.

C.7.7 Patient Summary Module

Table C.7-20 defines Attributes that provide summary information about the Patient.

Table C.7-20
PATIENT SUMMARY MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Patient's Name	(0010,0010)	2	Patient's full name.
Patient ID	(0010,0020)	2	Primary hospital identification number or code for the patient.

C.7.8 Study Content Module

Table C.7-21 defines Attributes that provide study content information.

Table C.7-21
STUDY CONTENT MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Study ID	(0020,0010)	2	User or equipment generated Study identifier
Study Instance UID	(0020,000D)	1	Unique identifier for the Study
Referenced Series Sequence	(0008,1115)	1	Sequence of Repeating Items where each Item includes the Attributes of a Series. Zero or more Items may be included in this Sequence.
>Series Instance UID	(0020,000E)	1	Unique identifier of the Series.
>Retrieve AE Title	(0008,0054)	2C	Title of the DICOM Application Entity where the Image(s) may be retrieved on the network. This Attribute shall be present only if the Images may be retrieved at the SERIES level using a media storage. See PS 3.4.

>Storage Media File-Set ID	(0088,0130)	2C	The user or implementation specific human readable identifier that identifies the Storage Media on which the Image(s) reside. This Attribute shall be present only if the Image(s) may be retrieved at the SERIES level using a media storage.
>Storage Media File-Set UID	(0088,0140)	2C	Uniquely identifies the Storage Media on which the Image(s) reside. This Attribute shall be present only if the Image(s) may be retrieved at the SERIES level using a media storage.
>Referenced Image Sequence	(0008,1140)	1	Sequence of Repeating Items where each Item provides reference to a set of Image SOP Class/SOP Instance pairs that are contained in the Series identified by the Series Instance UID (0020,000E).
>>Referenced SOP Class UID	(0008,1150)	2	Uniquely identifies the referenced SOP Class. This Attribute is used only if Images may be retrieved as Single Image SOP Classes.
>>Reference SOP Instance UID	(0008,1155)	2	Uniquely identifies the referenced SOP Instance. This Attribute is used only if Images may be retrieved as Single Image SOP Classes.
>>Retrieve AE	(0008,0054)	2C	Title of the DICOM Application Entity where the Image(s) may be retrieved on the network. This Attribute shall be present only if not present in the Referenced Series Sequence (0008,1115) if the Images may be retrieved at the IMAGE Query/Retrieve Level. See PS 3.4.
>>Storage Media File-Set ID	(0088,0130)	2C	The user or implementation specific human readable identifier that identifies the Storage Media on which the Image(s) reside. This Attribute shall be present only if not present in the Series Sequence (0008,1115) and if the Image(s) may be retrieved at the IMAGE level using a media storage.
>>Storage Media File-Set UID	(0088,0140)	2C	Uniquely identifies the Storage Media on which the Image(s) reside. This Attribute shall be present only if not present in the Referenced Series Sequence (0008,1115) and if the Image(s) may be retrieved at the IMAGE level using a media storage.

C.7.9 Palette Color Lookup Table Module

Table C.7-22 specifies the Attributes that describe the Lookup table data for images with Palette Color photometric interpretation.

When the Palette Color Lookup Table Module is present, the conditional requirements for the use of Palette Color Lookup Table Data (0028,1201-1203) and Segmented Palette Color Lookup Table Data (0028,1221-1223), described in Table C.7.9, shall take precedence over the conditional requirements described in the Image Pixel Module (See Section C.7.6.3).

Table C.7-22
PALETTE COLOR LOOKUP MODULE

Attribute Name	Tag	Type	Attribute Description
Red Palette Color Lookup Table Descriptor	(0028,1101)	1C	Specifies the format of the Red Palette Color Lookup Table Data (0028,1201). Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR or ARGB. See C.7.6.3.1.5 for further explanation.
Green Palette Color Lookup Table Descriptor	(0028,1102)	1C	Specifies the format of the Green Palette Color Lookup Table Data (0028,1202). Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR or ARGB. See C.7.6.3.1.5 for further explanation.
Blue Palette Color Lookup Table Descriptor	(0028,1103)	1C	Specifies the format of the Blue Palette Color Lookup table Data (0028,1203). Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR or ARGB. See C.7.6.3.1.5 for further explanation.
Palette Color Lookup Table UID	(0028,1199)	3	Palette Color Lookup Table UID. See C.7.9.1 for further explanation.
Red Palette Color Lookup Table Data	(0028,1201)	1C	Red Palette Color Lookup Table Data. Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR or ARGB and segmented data is NOT used. See C.7.6.3.1.6 for further explanation.
Green Palette Color Lookup Table Data	(0028,1202)	1C	Green Palette Color Lookup Table Data. Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR or ARGB and segmented data is NOT used. See C.7.6.3.1.6 for further explanation.
Blue Palette Color Lookup Table Data	(0028,1203)	1C	Blue Palette Color Lookup Table Data. Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR or ARGB and segmented data is NOT used. See C.7.6.3.1.6 for further explanation.

Segmented Red Palette Color Lookup Table Data	(0028,1221)	1C	Segmented Red Palette Color Lookup Table Data. Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR and segmented data is used. See C.7.9.2 for further explanation.
Segmented Green Palette Color Lookup Table Data	(0028,1222)	1C	Segmented Green Palette Color Lookup Table Data. Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR and segmented data is used. See C.7.9.2 for further explanation.
Segmented Red Palette Color Lookup Table Data	(0028,1223)	1C	Segmented Blue Palette Color Lookup Table Data. Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR and segmented data is used. See C.7.9.2 for further explanation.

C.7.9.1 Palette Color Lookup Table UID

This data element uniquely identifies a palette color lookup table set (red, green, blue).

Note: This can be used to avoid reloading a palette if a system already has that palette loaded without examining all the data entries in the palette.

C.7.9.2 Segmented Palette Color Lookup Table Data

The Segmented Palette Color Lookup Table Data (0028,1221-1223) is stored as a series of segments, see Table C.7-23. When the segments are expanded into the actual lookup table data, it shall have the number of table entries specified by the first value of the Palette Color Lookup Table Descriptors (0028,1101-1103), Number of Table Entries.

These lookup tables shall be used only when segmented lookup table data use is desriable and there is a single sample per pixel (single image plane) in the image.

Table C.7-23
COMPRESSED PALETTE COLOR LOOKUP TABLE DATA

Segment 0
Segment 1
...
Segment n

There are currently three types of segments: discrete, linear, and indirect. The segments type is identified by the opcodes in Table C.7-24:

Table C.7-24
SEGMENT TYPES

Opcode	Segment type
0	Discrete
1	Linear
2	Indirect
3 & above	reserved

C.7.9.2.1 Discrete Segment Type

The discrete segment is used to represent a series of palette components which are not monotonic with respect to their predecessors or successors. The SegmentLength indicates the number of lookup table entries.

The format of the Discrete Segment Type shall be as in Table C.7-25:

Table C.7-25
DISCRETE SEGMENT TYPE

Segment Opcode = 0
Segment Length
Segment Length number of lookup table entries

C.7.9.2.2 Linear Segment Type

The linear segment represents a series of palette components whose values may be represented by a straight line.

X = palette address, Y = Value contained in the palette.

(X_0, Y_0) = end of the previous segment

$(X_0 + \text{SegmentLength}, Y_1)$ = end of this linear segment

Where: Y_1 is contained in the data portion of this segment.

During expansion, the application should “connect” the previous segment’s endpoint, (X_0, Y_0), with this segment’s endpoint, $(X_0 + \text{SegmentLength}, Y_1)$ using a straight line, by computing the values for each point between the endpoints.

Note: Because the linear segment uses the end point from the previous segment, a linear segment can not be the first segment.

The linear segment’s format shall be as as in Table C.7-26:

Table C.7-26
LINEAR SEGMENT TYPE

Segment Opcode = 1
SegmentLength
Y1

C.7.9.2.3 Indirect Segment Type

The indirect segment allows the re-use of repetitive regions within lookup table without respecifying the segment. The opcode is followed by the number of segments to copy and one offset pointer to the first segment to copy. The byte offset is relative to the beginning of the lookup table. For example, if an indirect segment wants to point to the first segment, then the offset will be zero. The offset is a 32 bit value but is stored in the segment as a least significant 16 bit value followed by a most significant 16 bit value. An indirect segment shall not point to or copy another indirect segment. This avoids the need for recursion and also avoids the possibility of infinite loops.

The indirect segment's format shall be as follows:

Table C.7-27
INDIRECT SEGMENT TYPE

Segment Opcode = 2
Number of segments to copy
Least significant 16 bits of byte offset to first segment to copy
Most significant 16 bits of byte offset to first segment to copy

C.8 MODALITY SPECIFIC MODULES

C.8.1 Computed Radiography Modules

This Section describes Computed Radiography Series and Image Modules. These Modules contain Attributes that are specific to Computed Radiography images. There is no Computed Radiography Equipment Module.

C.8.1.1 CR Series Module

Table C.8-1 contains IOD Attributes that describe a computed radiography series performed on the patient.

Table C.8-1
CR SERIES MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Body Part Examined	(0018,0015)	2	Text description of the part of the body examined. Defined Terms: SKULL CSPINE TSPINE LSPINE SSPINE COCCYX CHEST CLAVICLE BREAST ABDOMEN PELVIS HIP SHOULDER ELBOW KNEE ANKLE HAND FOOT EXTREMITY.
View Position	(0018,5101)	2	Radiographic view associated with Patient Position (0018,5100). Defined Terms: AP = Anterior/Posterior PA = Posterior/Anterior LL = Left Lateral RL = Right Lateral RLD = Right Lateral Decubitus LLD = Right Lateral Decubitus RLO = Right Lateral Oblique LLO = Left Lateral Oblique
Filter Type	(0018,1160)	3	Label for the type of filter inserted into the x-ray beam
Collimator/grid Name	(0018,1180)	3	Label describing any grid inserted.

Focal Spot	(0018,1190)	3	Size of the focal spot in mm. For devices with variable focal spot or multiple focal spots, small dimension followed by large dimension.
Plate Type	(0018,1260)	3	Label of the type of storage phosphor plates used in this series
Phosphor Type	(0018,1261)	3	Label of type of phosphor on the plates

C.8.1.2 CR Image Module

Table C.8-2 contains IOD Attributes that describe computed radiography images.

Table C.8-2
CR IMAGE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
KVP	(0018,0060)	3	Peak kilo voltage output of the x-ray generator used
Plate ID	(0018,1004)	3	The ID or serial number of the sensing plate upon which the image was acquired
Distance Source to Detector	(0018,1110)	3	Distance in mm from source to detector center
Distance Source to Patient	(0018,1111)	3	Distance in mm from source to isocenter (center of field of view)
Exposure Time	(0018,1150)	3	Time of x-ray exposure in msec
X-ray Tube Current	(0018,1151)	3	X-ray Tube Current in mA.
Exposure	(0018,1152)	3	The product of exposure time and X-ray Tube Current expressed in mAs.
Exposure in µAs	(0018,1153)	3	The product of exposure time and x-ray tube current expressed in µAs.
Imager Pixel Spacing	(0018,1164)	3	Physical distance measured at the front plane of the Image Receptor housing between the center of each pixel. Specified by a numeric pair - row spacing value (delimiter) column spacing value - in mm. In the case of CR, the front plane is defined to be the external surface of the CR plate closest to the patient and radiation source.
Generator Power	(0018,1170)	3	Power in kW to the x-ray generator.
Acquisition Device Processing Description	(0018,1400)	3	Describes device-specific processing associated with the image (e.g. Organ Description)
Acquisition Device Processing Code	(0018,1401)	3	Code representing the device-specific processing associated with the image (e.g. CR Organ Filtering code)

Cassette Orientation	(0018,1402)	3	Orientation of cassette, used to properly position the image for display. Enumerated Values: LANDSCAPE PORTRAIT
Cassette Size	(0018,1403)	3	Size of cassette. Defined Terms: 18CMX24CM 8INX10IN 24CMX30CM 10INX12IN 30CMX35CM 30CMX40CM 11INX14IN 35CMX35CM 14INX14N 35CMX43CM 14INX17N
Exposures on Plate	(0018,1404)	3	Total number of x-ray exposures that have been made on the plate identified in Plate ID (0018,1004)
Relative X-ray Exposure	(0018,1405)	3	Relative x-ray exposure on the plate. Meaning of values is implementation specific. May be used to adjust the dynamic range of the plate digitizer (scanner).
Sensitivity	(0018,6000)	3	Read out sensitivity.

C.8.2 CT Modules

This Section describes the CT Image Module. This Module contains all Attributes that are specific to CT images.

C.8.2.1 CT Image Module

The table in this Section contains IOD Attributes that describe CT images.

Table C.8-3
CT IMAGE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See C.8.2.1.1.1 for specialization.
Samples per Pixel	(0028,0002)	1	Number of samples (planes) in this image. See C.8.2.1.1.2 for specialization.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. See C.8.2.1.1.3 for specialization.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. See C.8.2.1.1.4 for specialization.
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. See C.8.2.1.1.5 for specialization.
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Each sample shall have the same high bit. See C.8.2.1.1.6 for specialization.
Rescale Intercept	(0028, 1052)	1	The value b in relationship between stored values (SV) and Hounsfield (HU). HU = m*SV+b
Rescale Slope	(0028,1053)	1	m in the equation specified in Rescale Intercept (0028,1052).
KVP	(0018,0060)	2	Peak kilo voltage output of the x-ray generator used
Acquisition Number	(0020,0012)	2	A number identifying the single continuous gathering of data over a period of time which resulted in this image
Scan Options	(0018,0022)	3	Parameters of scanning sequence.
Data Collection Diameter	(0018,0090)	3	The diameter in mm of the region over which data were collected
Reconstruction Diameter	(0018,1100)	3	Diameter in mm of the region from within which data were used in creating the reconstruction of the image. Data may exist outside this region and portions of the patient may exist outside this region.

Distance Source to Detector	(0018,1110)	3	Distance in mm from source to detector center
Distance Source to Patient	(0018,1111)	3	Distance in mm from source to isocenter (center of field of view)
Gantry/Detector Tilt	(0018,1120)	3	Nominal angle of tilt in degrees of the scanning gantry. Not intended for mathematical computations.
Table Height	(0018,1130)	3	The distance in mm of the top of the patient table to the center of rotation; below the center is positive.
Rotation Direction	(0018,1140)	3	Direction of rotation of the source when relevant, about nearest principal axis of equipment. Enumerated Values: CW = clockwise CC = counter clockwise
Exposure Time	(0018,1150)	3	Time of x-ray exposure in msec
X-ray Tube Current	(0018,1151)	3	X-ray Tube Current in mA.
Exposure	(0018,1152)	3	The product of exposure time and X-ray Tube Current expressed in mas.
Filter Type	(0018,1160)	3	Label for the type of filter inserted into the x-ray beam.
Generator Power	(0018,1170)	3	Power in kW to the x-ray generator.
Focal Spot	(0018,1190)	3	Size of the focal spot in mm. For devices with variable focal spot or multiple focal spots, small dimension followed by large dimension.
Convolution Kernel	(0018,1210)	3	A label describing the convolution kernel or algorithm used to reconstruct the data

C.8.2.1.1 CT Image Attribute Descriptions

C.8.2.1.1.1 Image Type

For CT Images, Image Type (0008,0008) is specified to be Type 1 and uses one of the following Defined Terms for Value 3:

AXIAL	identifies a CT Axial Image
LOCALIZER	identifies a CT Localizer Image

C.8.2.1.1.2 Samples Per Pixel

For CT Images, Samples per Pixel (0028,0002) shall have an Enumerated Value of 1.

C.8.2.1.1.3 Photometric Interpretation

For CT Images, Photometric Interpretation (0028,0004) shall have one of the following Enumerated Values:

MONOCHROME1

MONOCHROME2

See C.7.6.3.1.1.2 for definition of these terms.

C.8.2.1.1.4 Bits Allocated

For CT Images, Bits Allocated (0028,0100) shall have the Enumerated Value of 16.

C.8.2.1.1.5 Bits Stored

For CT Images, Bits Stored (0028,0101) shall have the Enumerated Values of 12 to 16.

C.8.2.1.1.6 High Bit

For CT Images, High Bit (0028,0102) shall have only the Enumerated Value of one less than the value sent in Bits Stored.

C.8.3 MR Modules

This Section describes the MR Image Module. This Module contains all Attributes that are specific to MR images.

C.8.3.1 MR Image Module

Table C.8-4 contains the Attributes that describe MR images.

Table C.8-4
MR IMAGE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See C.8.3.1.1.1 for specialization.
Samples per Pixel	(0028,0002)	1	Number of samples (planes) in this image. See C.8.3.1.1.2 for specialization.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. See C.8.3.1.1.3 for specialization.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. See C.8.3.1.1.4 for specialization.
Scanning Sequence	(0018,0020)	1	Description of the type of data taken. Enumerated Values: SE = Spin Echo IR = Inversion Recovery GR = Gradient Recalled EP = Echo Planar RM = Research Mode Note: Multi-valued, but not all combinations are valid (e.g. SE/GR, etc.).
Sequence Variant	(0018,0021)	1	Variant of the Scanning Sequence. Defined Terms: SK = segmented k-space MTC = magnetization transfer contrast SS = steady state TRSS = time reversed steady state SP = spoiled MP = MAG prepared OSP = oversampling phase NONE = no sequence variant

Scan Options	(0018,0022)	2	Parameters of scanning sequence. Defined Terms: PER = Phase Encode Reordering RG = Respiratory Gating CG = Cardiac Gating PPG = Peripheral Pulse Gating FC = Flow Compensation PFF = Partial Fourier - Frequency PFP = Partial Fourier - Phase SP = Spatial Presaturation FS = Fat Saturation
MR Acquisition Type	(0018,0023)	2	Identification of data encoding scheme. Enumerated Values: 2D = frequency x phase 3D = frequency x phase x phase
Repetition Time	(0018,0080)	2C	The period of time in msec between the beginning of a pulse sequence and the beginning of the succeeding (essentially identical) pulse sequence. Required except when Scanning Sequence (0018,0020) is EP and Sequence Variant (0018,0021) is not SK.
Echo Time	(0018,0081)	2	Time in ms between the middle of the excitation pulse and the peak of the echo produced (kx=0). In the case of segmented k-space, the TE(eff) is the time between the middle of the excitation pulse to the peak of the echo that is used to cover the center of k-space (i.e.-kx=0, ky=0).
Echo Train Length	(0018,0091)	2	Number of lines in k-space acquired per excitation per image.
Inversion Time	(0018,0082)	2C	Time in msec after the middle of inverting RF pulse to middle of excitation pulse to detect the amount of longitudinal magnetization. Required if Scanning Sequence (0018,0020) has values of IR.
Trigger Time	(0018,1060)	2C	Time, in msec, between peak of the R wave and the peak of the echo produced. In the case of segmented k-space, the TE(eff) is the time between the peak of the echo that is used to cover the center of k-space. Required for Scan Options (0018,0022) which include heart gating (e.g. CG, PPG, etc.)

Sequence Name	(0018,0024)	3	User defined name for the Scanning Sequence (0018,0020) and Sequence Variant (0018,0021) combination.
Angio Flag	(0018,0025)	3	Angio Image Indicator. Primary image for Angio processing. Enumerated Values: Y = Image is Angio N = Image is not Angio
Number of Averages	(0018,0083)	3	Number of times a given pulse sequence is repeated before any parameter is changed
Imaging Frequency	(0018,0084)	3	Precession frequency in MHz of the nucleus being addressed
Imaged Nucleus	(0018,0085)	3	Nucleus that is resonant at the imaging frequency. Examples: 31P, 1H
Echo Number	(0018,0086)	3	The echo number used in generating this image. In the case of segmented k-space, it is the effective Echo Number.
Magnetic Field Strength	(0018,0087)	3	Nominal field strength of MR magnet, in Tesla
Spacing Between Slices	(0018,0088)	3	Spacing between slices, in mm. The spacing is measured from the center-to-center of each slice.
Number of Phase Encoding Steps	(0018,0089)	3	Total number of lines in k-space in the 'y' direction collected during acquisition.
Percent Sampling	(0018,0093)	3	Fraction of acquisition matrix lines acquired, expressed as a percent.
Percent Phase Field of View	(0018,0094)	3	Ratio of field of view dimension in phase direction to field of view dimension in frequency direction, expressed as a percent.
Pixel Bandwidth	(0018,0095)	3	Reciprocal of the total sampling period, in hertz per pixel.
Nominal Interval	(0018,1062)	3	Average R-R interval used for the scans, in msec
Beat Rejection Flag	(0018,1080)	3	Beat length sorting has been applied. Enumerated Values: Y = yes N = No
Low R-R Value	(0018,1081)	3	R-R interval low limit for beat rejection, in msec
High R-R Value	(0018,1082)	3	R-R interval high limit for beat rejection, in msec
Intervals Acquired	(0018,1083)	3	Number of R-R intervals acquired.
Intervals Rejected	(0018,1084)	3	Number of R-R intervals rejected.
PVC Rejection	(0018,1085)	3	Description of type of PVC rejection criteria used.

Skip Beats	(0018,1086)	3	Number of beats skipped after a detected arrhythmia.
Heart Rate	(0018,1088)	3	Beats per minute.
Cardiac Number of Images	(0018,1090)	3	Number of images per cardiac cycle.
Trigger Window	(0018,1094)	3	Percent of R-R interval, based on Heart Rate (0018,1088), prescribed as a window for a valid/usable trigger.
Reconstruction Diameter	(0018,1100)	3	Diameter in mm. of the region from within which data were used in creating the reconstruction of the image. Data may exist outside this region and portions of the patient may exist outside this region.
Receiving Coil	(0018,1250)	3	Received coil used.
Transmitting Coil	(0018,1251)	3	Transmitted coil used.
Acquisition Matrix	(0018,1310)	3	Dimensions of the acquired frequency /phase data before reconstruction. Multi-valued: frequency rows\frequency columns\phase rows\phase columns.
Phase Encoding Direction	(0018,1312)	3	The axis of phase encoding with respect to the image. Enumerated Values: ROW = phase encoded in rows. COL = phase encoded in columns.
Flip Angle	(0018,1314)	3	Steady state angle in degrees to which the magnetic vector is flipped from the magnetic vector of the primary field.
SAR	(0018,1316)	3	Calculated whole body Specific Absorption Rate in watts/kilogram.
Variable Flip Angle Flag	(0018,1315)	3	Flip angle variation applied during image acquisition. Enumerated Values: Y = yes N = no
dB/dt	(0018,1318)	3	The rate of change of the gradient coil magnetic flux density with time (T/s).
Temporal Position Identifier	(0020,0100)	3	Temporal order of a dynamic or functional set of Images.
Number of Temporal Positions	(0020,0105)	3	Total number of temporal positions prescribed.
Temporal Resolution	(0020,0110)	3	Time delta between Images in a dynamic of functional set of Images.

C.8.3.1.1 MR Image Attribute Descriptions

C.8.3.1.1.1 Image Type

For MR Images, Image Type (0008,0008) is specified to be Type 1 and use one of the following Defined Terms for Value 3:

MPR	PROJECTION IMAGE	T1 MAP
T2 MAP	DIFFUSION MAP	DENSITY MAP
PHASE MAP	VELOCITY MAP	IMAGE ADDITION
PHASE SUBTRACT	MODULUS SUBTRACT	OTHER

C.8.3.1.1.2 Samples Per Pixel

For MR Images, Samples per Pixel (0028,0002) shall have an Enumerated Value of 1.

C.8.3.1.1.3 Photometric Interpretation

For MR Images, Photometric Interpretation (0028,0004) shall have one of the following Enumerated Values:

MONOCHROME1

MONOCHROME2

See C.7.6.3.1.2 for definition of these terms.

C.8.3.1.1.4 Bits Allocated

For MR Images, Bits Allocated (0028,0100) shall have the Enumerated Value of 16.

C.8.4 Nuclear Medicine Modules

This Section describes Nuclear Medicine Series, Equipment, and Image Modules. These Modules contain Attributes that are specific to the NM Image IOD.

Note: There are some cases where it may be necessary to use several SOP Instances to encode a single NM acquisition. For example, the matrix size must remain constant within a SOP instance. Multiple matrix sizes require multiple SOP instances. Similarly, multiple gated stress levels require separate SOP instances for each stress level. However, a receiving AE is not expected to recombine them.

C.8.4.1 NM Series Module (Retired)

Section C.8.4.1 was defined in a previous version of the DICOM Standard. The Section is now retired and has been moved to Annex I.1.1.1.

C.8.4.2 NM Equipment Module (Retired)

Section C.8.4.2 was defined in a previous version of the DICOM Standard. The Section is now retired and has been moved to Annex I.1.1.2.

C.8.4.3 NM Image Module (Retired)

Section C.8.4.3 was defined in a previous version of the DICOM Standard. The Section is now retired and has been moved to Annex I.1.1.3.

C.8.4.4 NM SPECT Acquisition Image Module (Retired)

Section C.8.4.4 was defined in a previous version of the DICOM Standard. The Section is now retired and has been moved to Annex I.1.1.4.

C.8.4.5 NM Multi-gated Acquisition Image Module (Retired)

Section C.8.4.5 was defined in a previous version of the DICOM Standard. The Section is now retired and has been moved to Annex I.1.1.5.

C.8.4.6 NM/PET Patient Orientation Module

Table C.8-5 specifies the Attributes that describe the NM/PET Patient Orientation.

Table C.8-5
NM/PET PATIENT ORIENTATION MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Patient Orientation Code Sequence	(0054,0410)	2	Sequence that describes the orientation of the patient with respect to gravity. See C.8.4.6.1.1 for further explanation.
> Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the patient orientation. Required if a sequence Item is present.
> Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Enumerated Value: 99SDM Required if a sequence Item is present.
> Code Meaning	(0008,0104)	3	The patient orientation that is represented by the Code Value (0008,0100).
> Patient Orientation Modifier Code Sequence	(0054,0412)	2C	Patient Orientation Modifier. Required if needed to fully specify the orientation of the patient with respect to gravity. See C.8.4.6.1.2 for further explanation.
>> Code value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the patient orientation modifier. Required if a sequence Item is present.
>> Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code value (0008,0100) onto the Code Meaning (0008,0104). Enumerated Value: 99SDM Required if a sequence Item is present.
>> Code Meaning	(0008,0104)	3	The patient orientation modifier that is represented by the Code Value (0008,0100).
Patient Gantry Relationship Code Sequence	(0054,0414)	2	Sequence which describes the orientation of the patient with respect to the gantry. See Section C.8.4.6.1.3 for further explanation.
> Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the patient orientation with respect to the gantry. Required if a sequence Item is present.

> Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Enumerated Value: 99SDM Required if a sequence Item is present.
> Code Meaning	(0008,0104)	3	The patient gantry relationship that is represented by the Code Value (0008,0100).

Note: Patient Orientation Code Sequence (0054,0410), Patient Orientation Modifier Code Sequence (0054,0412), and Patient Gantry Relationship Code Sequence (0054,0414) specify value 99SDM from Annex D for Coding Scheme Designator. It is expected that this value will evolve when Coding Scheme Designator UIDs are available from a registration authority.

C.8.4.6.1 NM/PET Patient Orientation Attribute Descriptions

C.8.4.6.1.1 Patient Orientation Code Sequence

The Patient Orientation Code Sequence (0054,0410) is used to describe the orientation of the patient with respect to gravity, and is independent of the position in the gantry. Only a single Item shall be permitted in this sequence.

The Coding Scheme Designator (0008,0102) for the Patient Orientation Code Sequence (0054,0410) shall be the SNOMED DICOM Microglossary. The Code Value (0008,0100) for the Patient Orientation Code Sequence (0054,0410) shall be the Source UID value from a SNOMED DICOM Microglossary record. This record shall have a Source value of “SNMI”, any Context value, and a Semantic Type value of “body position”.

C.8.4.6.1.2 Patient Orientation Modifier Code Sequence

The Patient Orientation Modifier Code Sequence (0054,0412) is used to modify or enhance the orientation specified by Patient Orientation Code Sequence (0054,0410). Only a single Item shall be permitted in this sequence.

The Coding Scheme Designator (0008,0102) for the Patient Orientation Modifier Code Sequence (0054,0412) shall be the SNOMED DICOM Microglossary. The Code Value (0008,0100) for the Patient Orientation Modifier Code Sequence (0054,0412) shall be the Source UID value from a SNOMED DICOM Microglossary record. This record shall have a Source value of “SNMI”, any Context value, and a Semantic Type value of “body position modifier”.

C.8.4.6.1.3 Patient Gantry Relationship Code Sequence

Patient Gantry Relationship Code Sequence (0054,0414) is used to describe the patient direction within the gantry, such as head-first or feet-first. When imaging the extremities, these directions are related to normal anatomic position.

Example: In normal anatomic position, the fingers point towards the feet.

Only a single Item shall be permitted in this sequence.

The Coding Scheme Designator (0008,0102) for the Patient Gantry Relationship Code Sequence (0054,0414) shall be the SNOMED DICOM Microglossary. The Code Value (0008,0100) for the Patient Gantry Relationship Code Sequence (0054,0414) shall be the

Source UID value from a SNOMED DICOM Microglossary record. This record shall have a Source value of “SNMI”, any Context value, and a Semantic Type value of “patient gantry relationship”.

C.8.4.7 NM Image Pixel Module

Table C.8-6 specifies the Attributes that describe the pixel data of a NM image.

Table C.8-6
NM IMAGE PIXEL MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Samples per Pixel	(0028,0002)	1	Number of samples (color planes) in this image. The value shall be 1.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. See C.8.4.7.1.1 for further explanation.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. Enumerated Values: 8, 16.
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. The value shall be the same as the value in Bits Allocated (0028,0100).
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Each sample shall have the same high bit. Shall be one less than the value in Bits Stored (0028,0101).
Pixel Spacing	(0028,0030)	2	Physical distance in the patient between the center of each pixel, specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing, in mm.

C.8.4.7.1 NM Image Pixel Attribute Descriptions

C.8.4.7.1.1 Photometric Interpretation

For NM Images, Photometric Interpretation (0028,0004) shall have one of the following Enumerated Values:

MONOCHROME2

PALETTE COLOR

See C.7.6.3.1.2 for definition of these terms.

C.8.4.8 NM Multi-frame Module

Table C.8-7 specifies the Attributes of a NM Multi-frame Image. This module is always included in a NM SOP instance, even if there is only one frame in the image.

A NM Image object is always a multi-dimensional multi-frame image. The order and organization of the frames within each image is defined by the Frame Increment Pointer (0028,0009). The Frame Increment Pointer (0028,0009) references one or more indexing vectors. An indexing vector is a

1 dimensional array with exactly one element for each frame in the image. The value of the n^{th} element in the indexing vector represents the index for the n^{th} frame, in that dimension. Indices are always numbered starting from 1.

Note: The scheme for encoding a multi-dimensional array of frames into a single image object is as follows. First, the definition of the data element called the Frame Increment Pointer is changed so that it can be multi-valued (i.e. its VM is now 1-n). Each value of the Frame Increment Pointer represents one of the dimensions of the array, with the last value representing the most rapidly changing index.

Each value of the Frame Increment Pointer is the tag of a data element which is an indexing vector. An indexing vector is a 1 dimensional array with exactly one element for each frame in the image. The value of the n^{th} element in the indexing vector represents the index for the n^{th} frame, in that dimension. For example, suppose you are encoding a Dynamic image consisting of 2 phases (containing 5 and 2 frames, respectively), from each of two detectors, using one isotope, which gives a total of 14 frames in the image. For a Dynamic image, the Frame Increment Pointer is defined as:

Frame Increment Pointer = Energy Window Vector (0054,0010) \ Detector Vector (0054,0020) \ Phase Vector (0054,0030) \ Time Slice Vector (0054,0100)

The Pixel Data (7FE0,0010) would contain the frames in the following order:

Frame	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Energy Window #	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Detector #	1	1	1	1	1	1	1	2	2	2	2	2	2	2
Phase #	1	1	1	1	1	2	2	1	1	1	1	1	2	2
Time Slice #	1	2	3	4	5	1	2	1	2	3	4	5	1	2

and the four vectors would be defined as:

Energy Window Vector = 1,1,1,1,1,1,1,1,1,1,1,1,1,1

Detector Vector = 1,1,1,1,1,1,1,2,2,2,2,2,2,2

Phase Vector = 1,1,1,1,1,2,2,1,1,1,1,1,2,2

Time Slice Vector = 1,2,3,4,5,1,2,1,2,3,4,5,1,2

The receiver can tell the relationship of all the frames from these four vectors. For instance, looking at the 11^{th} value in these four vectors tells you that the 11^{th} frame in this multi-frame object is time slice 4 of phase 1 from detector 2 and isotope 1.

The Energy Window, Detector, Phase, Rotation, R-R Interval, and Time Slot Vectors have corresponding sequence elements which contain exactly one sequence item for each of the index values in the vector. The sequence item contains a set of data elements which are specific to that group of frames, but change from one group to the next. In the above example there would be a detector sequence element, an isotope sequence element and a phase sequence element (for dynamics, no frame sequence element is needed). The detector and phase sequence elements would contain two sequence items (because there were 2 detectors and 2 phases).

Table C.8-7
NM MULTI-FRAME MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Frame Increment Pointer	(0028,0009)	1	Contains the Data Element Tags of one or more frame index vectors. See C.8.4.8.1.1 for further specialization.
Energy Window Vector	(0054,0010)	1C	An array which contains the energy window number for each frame. Required if the value of the Frame Increment Pointer (0028,0009) includes the Tag for Energy Window Vector (0054,0010). See C.8.4.8.1.2 for specialization.
Number of Energy Windows	(0054,0011)	1	Number of energy window groupings. See C.8.4.8.1.2 for specialization.
Detector Vector	(0054,0020)	1C	An array which contains the detector number for each frame. Required if the value of the Frame Increment Pointer (0028,0009) includes the Tag for Detector Vector (0054,0020). See C.8.4.8.1.3 for specialization.
Number of Detectors	(0054,0021)	1	Number of detectors. See C.8.4.8.1.3 for specialization.
Phase Vector	(0054,0030)	1C	An array which contains the phase number for each frame. Required if the value of the Frame Increment Pointer (0028,0009) includes the Tag for Phase Vector (0054,0030). See C.8.4.8.1.4 for specialization.
Number of Phases	(0054,0031)	1C	Number of phases. Required if the value of the Frame Increment Pointer (0028,0009) includes the Tag for Phase Vector (0054,0030). See C.8.4.8.1.4 for specialization.
Rotation Vector	(0054,0050)	1C	An array which contains the rotation number for each frame. Required if the value of the Frame Increment Pointer (0028,0009) includes the Tag for Rotation Vector (0054,0050). See C.8.4.8.1.5 for specialization.
Number of Rotations	(0054,0051)	1C	Number of rotations. Required if Image Type (0008,0008), Value 3 is TOMO, GATED TOMO, RECON TOMO, or RECON GATED TOMO. See C.8.4.8.1.5 for specialization.

R-R Interval Vector	(0054,0060)	1C	An array which contains the R-R interval number for each frame. Required if the value of the Frame Increment Pointer (0028,0009) includes the Tag for R-R Interval Vector (0054,0060). See C.8.4.8.1.6 for specialization.
Number of R-R Intervals	(0054,0061)	1C	Number of R-R intervals. Required if the value of the Frame Increment Pointer (0028,0009) includes the Tag for R-R Interval Vector (0054,0060). See C.8.4.8.1.6 for specialization.
Time Slot Vector	(0054,0070)	1C	An array which contains the time slot number for each frame. Required if the value of the Frame Increment Pointer (0028,0009) includes the Tag for Time Slot Vector (0054,0070). See C.8.4.8.1.7 for specialization.
Number of Time Slots	(0054,0071)	1C	Number of time slots. Required if the value of the Frame Increment Pointer (0028,0009) includes the Tag for Time Slot Vector (0054,0070). See C.8.4.8.1.7 for specialization.
Slice Vector	(0054,0080)	1C	An array which contains the spatial slice number for each frame. Required if the value of the Frame Increment Pointer (0028,0009) includes the Tag for Slice Vector (0054,0080). See C.8.4.8.1.8 for specialization.
Number of Slices	(0054,0081)	1C	Number of slices. Required if the value of the Frame Increment Pointer (0028,0009) includes the Tag for Slice Vector (0054,0080). See C.8.4.8.1.8 for specialization.
Angular View Vector	(0054,0090)	1C	An array which contains the angular view number for each frame. Required if the value of the Frame Increment Pointer (0028,0009) includes the Tag for Angular View Vector (0054,0090). See C.8.4.8.1.9 for specialization.
Time Slice Vector	(0054,0100)	1C	An array which contains the time slice number for each frame. Required if the value of the Frame Increment Pointer (0028,0009) includes the Tag for Time Slice Vector (0054,0100). See C.8.4.8.1.10 for specialization.

Note: Per the rules in PS 3.5, if a data element of Type 1C or 2C is not required, it shall not be included.

C.8.4.8.1 NM Multi-Frame Attribute Descriptions

C.8.4.8.1.1 Frame Increment Pointer

By definition, NM Images are multi-dimensional Multi-frame Images. The value of the Frame Increment Pointer (0028,0009) contains the Tag for one or more frame indexing vectors. This determines the number of dimensions of frame indices in the image, and the order in which these indices vary from one frame to the next, with the last Tag indicating the most rapidly changing index. The Enumerated Values for the Frame Increment Pointer (0028,0009) are determined by the Image Type (0008,0008), Value 3, as shown in Table C.8-8.

Table C.8-8
ENUMERATED VALUES FOR FRAME INCREMENT POINTER

Image Type (0008,0008), Value 3	Frame Increment Pointer (0028,0009)
STATIC or WHOLE BODY	0054H 0010H \ 0054H 0020H Sequencing is by Energy Window Vector (0054,0010), Detector Vector (0054,0020).
DYNAMIC	0054H 0010H \ 0054H 0020H \ 0054H 0030H \ 0054H 0100H Sequencing is by Energy Window Vector (0054,0010), Detector Vector (0054,0020), Phase Vector (0054,0030), Time Slice Vector (0054,0100)
GATED	0054H 0010H \ 0054H 0020H \ 0054H 0060H \ 0054H 0070H Sequencing is by Energy Window Vector (0054,0010), Detector Vector (0054,0020), R-R Interval Vector(0054,0060), Time Slot Vector (0054,0070)
TOMO	0054H 0010H \ 0054H 0020H \ 0054H 0050H \ 0054H 0090H Sequencing is by Energy Window Vector (0054,0010), Detector Vector (0054,0020), Rotation Vector (0054,0050), Angular View Vector (0054,0090)
GATED TOMO	0054H 0010H \ 0054H 0020H \ 0054H 0050H \ 0054H 0060H \ 0054H 0070H \ 0054H 0090H Sequencing is by Energy Window Vector (0054,0010), Detector Vector (0054,0020), Rotation Vector (0054,0050), R-R Interval Vector (0054,0060), Time Slot Vector (0054,0070), Angular View Vector (0054,0090).
RECON TOMO	0054H 0080H Sequencing is by Slice Vector (0054,0080)
RECON GATED TOMO	0054H 0060H \ 0054H 0070H \ 0054H 0080H Sequencing is by R-R Interval Vector (0054,0060), Time Slot Vector (0054,0070), Slice Vector (0054,0080)

C.8.4.8.1.2 Number of Energy Windows and Energy Window Vector

Number of Energy Windows (0054,0011) is the number of distinct energy window groupings acquired in this image. See C.8.4.10.1. When Image Type (0008,0008), Value 3, is RECON TOMO or RECON GATED TOMO, then the Number of Energy Windows (0054,0011) shall be 1.

Energy Window Vector (0054,0010) is an indexing vector. The value of the n^{th} element of this vector is the energy window number for the n^{th} frame in this image, and shall have a value from 1 to Number of Energy Windows (0054,0011).

C.8.4.8.1.3 Number of Detectors and Detector Vector

Number of Detectors (0054,0021) is the number of separate detectors which differentiate the frames in this image. When Image Type (0008,0008), Value 3, is RECON TOMO or RECON GATED TOMO, then the Number of Detectors (0054,0021) shall be 1.

Note: Number of Detectors (0054,0021) does not necessarily represent the actual number of detectors used during data acquisition.

Example 1: In a TOMO acquisition in which frames from 2 or more detectors are interleaved to form one continuous set of frames, then no distinction is made between frames on the basis of which detector created them. In this case, the Number of Detectors (0054,0021) would be 1.

Example 2: In a WHOLE BODY acquisition in which a single detector acquires anterior and posterior views in two separate passes, the Number of Detectors (0054,0021) would be 2.

Detector Vector (0054,0020) is an indexing vector. The value of the n^{th} element of this vector is the detector number of the n^{th} frame in this image, and shall have a value from 1 to Number of Detectors (0054,0021).

C.8.4.8.1.4 Number of Phases and Phase Vector

Number of Phases (0054,0031) is the number of dynamic phases, independent of the number of Detectors and Isotopes. See Section C.8.4.14 for definition of a phase.

Phase Vector (0054,0030) is an indexing vector. The value of the n^{th} element of this vector is the phase number of the n^{th} frame in this image, and shall have a value from 1 to Number of Phases (0054,0031).

C.8.4.8.1.5 Number of Rotations and Rotation Vector

Number of Rotations (0054,0051) is the number of separate rotations. See Section C.8.4.12 for definition of a rotation. When Image Type (0008,0008), Value 3, is RECON TOMO, GATED TOMO or RECON GATED TOMO, then the Number of Rotations (0054,0051) shall be 1.

Rotation Vector (0054,0050) is an indexing vector. The value of the n^{th} element of this vector is the rotation number of the n^{th} frame in this image, and shall have a value from 1 to Number of Rotations (0054,0051).

C.8.4.8.1.6 Number of R-R Intervals and R-R Interval Vector

Number of R-R Intervals (0054,0061) is the number of ranges of heartbeat durations collected. A gated acquisition may employ one R-R Interval to collect data from normal beats, a second R-R Interval to collect data from ectopic beats, and possibly others. Each R-R Interval accepts beats whose duration is greater than its Low R-R Value (0018,1081) and shorter than its High R-R Value (0018,1082). Beats which do not fall within these ranges may be accepted by another R-R Interval, or may be rejected.

The Number of R-R Intervals (0054,0061) is the total number of such ranges.

R-R Interval Vector (0054,0060) is an indexing vector. The value of the n^{th} element of this vector is the interval number of the n^{th} frame in this image, and shall have a value from 1 to Number of R-R Intervals (0054,0061).

C.8.4.8.1.7 Number of Time Slots and Time Slot Vector

Number of Time Slots (0054,0071) is the number of frames into which each gating event is divided in a gated acquisition. For example, in a cardiac gated acquisition, data from a number of heartbeats are then combined by summing together the first frames from all beats into a summed first frame, all the second frames into a summed second frame, and so on. The result has the same number of frames as the Number of Time Slots in each beat.

Time Slot Vector (0054,0070) is an indexing vector. The value of the n^{th} element of this vector is the time slot number of the n^{th} frame in this image, and shall have a value from 1 to Number of Time Slots (0054,0071).

C.8.4.8.1.8 Number of Slices and Slice Vector

Number of Slices (0054,0081) is the number of slices in each separate volume.

Note: For images with Image Type (0008,0008), Value 3, equal to RECON GATED TOMO this implies that Number of Slices (0054,0081) is the same for all R-R Intervals and Time Slots.

Slice Vector (0054,0080) is an indexing vector. The value of the n^{th} element of this vector is the slice number of the n^{th} frame in this image, and shall have a value from 1 to Number of Slices(0054,0081).

C.8.4.8.1.9 Angular View Vector

Angular View Vector (0054,0090) is an indexing vector. The value of the n^{th} element of this vector is the angular view number of the n^{th} frame in this image. If Image Type (0008,0008), Value 3, is TOMO or GATED TOMO, then the value shall be from 1 to Number of Frames in Rotation (0054,0053).

C.8.4.8.1.10 Time Slice Vector

Time Slice Vector (0054,0100) is an indexing vector. The value of the n^{th} element of this vector is the time slice number of the n^{th} frame in this image, and shall have a value from 1 to Number of Frames in Phase (0054,0033).

C.8.4.9 NM Image Module

Table C.8-9 contains the Attributes that describe Nuclear Medicine Images.

Table C.8-9
NM IMAGE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See C.8.4.9.1.1 for specialization.
Image ID	(0054,0400)	3	User or equipment generated Image identifier.
Lossy Image Compression	(0028,2110)	1C	Specifies whether an Image has undergone lossy compression. Enumerated Values: 00 = Image has NOT been subjected to lossy compression. 01 = Image has been subjected to lossy compression. See C.7.6.1.1.5 Required if Lossy Compression has been performed on the Image.
Counts Accumulated	(0018,0070)	2	Sum of all gamma events for all frames in the image. See C.8.4.9.1.2 for specialization.
Acquisition Termination Condition	(0018,0071)	3	Description of how the data collection was stopped. Defined Terms: CNTS = counts DENS = density MANU = manual OVFL = data overflow TIME = time TRIG = physiological trigger See C.8.4.9.1.3 for specialization.
Table Height	(0018,1130)	3	The height of the patient table in mm. The range and values of this element are determined by the manufacturer. Should not be included if Image Type (0008,0008), Value 3, is TOMO, GATED TOMO, RECON TOMO or RECON GATED TOMO.

Table Traverse	(0018,1131)	3	Location of the patient table (or gantry relative to the table) in mm. The range and values of this element are determined by the manufacturer. Should not be included if Image Type (0008,0008), Value 3, is TOMO, GATED TOMO, RECON TOMO or RECON GATED TOMO.
Actual Frame Duration	(0018,1242)	1C	Elapsed time for data acquisition in msec. Required if Image Type (0008,0008) Value 3 is: WHOLE BODY or STATIC. See C.8.4.9.1.4 for specialization.
Count Rate	(0018,1243)	3	Maximum count rate achieved during the acquisition in counts/sec.
Processing Function	(0018,5020)	3	Code or description of processing functions applied to the data.
Corrected Image	(0028,0051)	3	A value that indicates which, if any, corrections have been applied to the image. Corrections are applied to all frames in the image. Defined Terms: UNIF = flood corrected COR = center of rotation corrected NCO = non-circular orbit corrected DECY = decay corrected ATTN = attenuation corrected SCAT = scatter corrected DTIM = dead time corrected NRGY = energy corrected LIN = linearity corrected MOTN = motion corrected CLN = count loss normalization; Any type of normalization applied to correct for count loss in Time Slots.
Whole Body Technique	(0018,1301)	3	The type of scan performed. Used only if Image Type (0008,0008), Value 3, contains the value WHOLE BODY. Enumerated Values: 1PS = one pass 2PS = two pass PCN = patient contour following employed MSP = multiple static frames collected into a whole body frame.

Scan Velocity	(0018,1300)	2C	The speed of the camera motion over the body in mm/sec. Required if Image Type (0008,0008) Value 3 contains the value WHOLE BODY.
Scan Length	(0018,1302)	2C	Size of the imaged area in the direction of scanning motion, in mm. Required if Image Type (0008,0008) Value 3 contains the value WHOLE BODY.
Referenced Overlay Sequence	(0008,1130)	3	A sequence which provides reference to a set of SOP Class/Instance pairs which are related independent Overlays. Uniquely identifies Overlays significantly related to this Image. Encoded as sequence of items: (0008,1150) and (0008,1155). Zero or more Items may be included in this sequence.
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if a sequence Item is present.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if a sequence Item is present.
Referenced Curve Sequence	(0008,1145)	3	A sequence which provides reference to a set of SOP Class/Instance pairs which are related independent Curves. Uniquely identifies Curves significantly related to this Image. Encoded as sequence of items: (0008,1150) and (0008,1155). Zero or more Items may be included in this sequence.
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if a sequence Item is present.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if a sequence Item is present.
Trigger Source or Type	(0018,1061)	3	Text indicating trigger source. Defined Term: EKG
Anatomic Region Sequence	(0008,2218)	3	Sequence of one Item that identifies the anatomic region of interest in this image (i.e. external anatomy, surface anatomy, or general region of the body). See Section C.8.4.9.1.5.
> Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the anatomic region. Required if a sequence Item is present.

> Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Defined Term: 99SDM Required if a sequence Item is present.
> Code Meaning	(0008,0104)	3	The anatomic region that is represented by the Code Value (0008,0100).
> Anatomic Region Modifier Sequence	(0008,2220)	3	Sequence of one or more Items that modifies the anatomic region of interest in this image (i.e. prone, supine, decubitus right). See Section C.8.4.9.1.5.
>> Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the anatomic region modifier term. Required if a sequence Item is present.
>> Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Defined Term: 99SDM Required if a sequence Item is present.
>> Code Meaning	(0008,0104)	3	The anatomic region modifier term that is represented by the Code Value (0008,0100).
Primary Anatomic Structure Sequence	(0008,2228)	3	Sequence of one or more Items that identifies the primary anatomic structure of interest in this image. See Section C.8.4.9.1.6.
> Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the primary anatomic structure. Required if a sequence Item is present.
> Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Defined Term: 99SDM Required if a sequence Item is present.
> Code Meaning	(0008,0104)	3	The anatomic structure that is represented by the Code Value (0008,0100).
> Primary Anatomic Structure Modifier Sequence	(0008,2230)	3	Sequence of one or more Items that modifies the primary anatomic structure of interest in this image. See Section C.8.4.9.1.6.

>> Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the anatomic structure modifier term. Required if a sequence Item is present.
>> Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Defined Term: 99SDM Required if a sequence Item is present.
>> Code Meaning	(0008,0104)	3	The anatomic structure modifier term that is represented by the Code Value (0008,0100).

Notes: 1. Image Date (0008,0023) and Image Time (0008,0033) are included in the General Image Module, Table C.7-7, whenever the images are temporally related. For this purpose, all NM Images are considered temporally related, so that these elements are included in an NM Image.

2. Anatomic Region Sequence (0008,2218), Anatomic Region Modifier Sequence (0008,2220), Primary Anatomic Structure Sequence (0008,2228), and Primary Anatomic Structure Modifier Sequence (0008,2230) specify value 99SDM from Annex D for Coding Scheme Designator. It is expected that this value will evolve when Coding Scheme Designator UIDs are available from a registration authority.

C.8.4.9.1 NM Image Module Attribute Descriptions

C.8.4.9.1.1 Image Type

For NM images, Image Type (0008,0008) Value 3 is specified to be Type 1 and use one of the following Enumerated Values:

STATIC
DYNAMIC
GATED
WHOLE BODY
TOMO
GATED TOMO
RECON TOMO
RECON GATED TOMO

For NM images, Image Type (0008,0008) Value 4 is specified to use one of the following Enumerated Values:

EMISSION
TRANSMISSION

Note: For NM images, Image Type (0008,0008) Value 1 will be ORIGINAL for all raw data and reconstructed images. DERIVED may be appropriate for some other results images.

For NM images, Image Type (0008,0008) Value 2 will be PRIMARY.

C.8.4.9.1.2 Counts Accumulated

Counts Accumulated (0018,0070) is the total of all gamma events accumulated in all frames of this Image. This attribute applies to acquisition data, and often does not apply to processed images (DERIVED, SECONDARY).

C.8.4.9.1.3 Acquisition Termination Condition

Acquisition Termination Condition (0018,0071) is the method of acquisition termination which was actually applied to the data collection. The Defined Terms and definitions are:

CNTS	=	preset count limit was reached
DENS	=	preset count density was reached
MANU	=	acquisition was terminated manually
OVFL	=	acquisition was terminated automatically by pixel data overflow condition
TIME	=	preset time limit was reached
TRIG	=	preset number of physiological triggers was reached

C.8.4.9.1.4 Actual Frame Duration

Actual Frame Duration (0018,1242) is defined as the elapsed time in msec for a single frame of an acquisition. For some types of multi-frame images, Actual Frame Duration (0018,1242) may have a more specialized meaning as defined in the appropriate IOD Module.

C.8.4.9.1.5 Anatomic Region

The general region of the body (e.g. the anatomic region, organ, or body cavity being examined) may be identified by the Anatomic Region Sequence (0008,2218). Characteristics of the anatomic region being examined, such as its orientation relative to gravity (e.g. prone, supine, semi-erect), sub-region (e.g. medial, lateral, superior, inferior, lobe, quadrant), and laterality (e.g. right, left, both), and so on, may be refined by the Anatomic Region Modifier Sequence (0008,2220).

If the Coding Scheme Designator (0008,0102) for the Anatomic Region Code Sequence (0008,2218) is 99SDM, then the Code Value (0008,0100) for the Anatomic Region Code Sequence (0008,2218) shall be the Source UID value from a SNOMED DICOM Microglossary record. This record shall have a Source value of “SNMI”, any Context value, and a Semantic Type value of “anatomic region or structure”.

If the Coding Scheme Designator (0008,0102) for the Anatomic Region Modifier Sequence (0008,2220) is 99SDM, then the Code Value (0008,0100) for the Anatomic Region Modifier Sequence (0008,2220) shall be the Source UID value from a SNOMED DICOM Microglossary record. This record shall have a Source value of “SNMI”, any Context value, and a Semantic Type value of “anatomic region modifier”.

Note: These Data Elements allow the specification of the information encoded by the Body Part Examined (0018,0015) and Patient Position (0018,5100) Data Attributes (in the General Series Module) in a more robust, consistent way.

C.8.4.9.1.6 Primary Anatomic Structure

The specific anatomic structures of interest within the image (e.g. a particular artery within the anatomic region) is identified by the Primary Anatomic Structure Sequence (0008,2228). Characteristics of the anatomic structure, such as its location (e.g. subcapsular, peripheral, central), configuration (e.g. distended, contracted), and laterality (e.g. right, left, both), and so on, may be refined by the Primary Anatomic Structure Modifier Sequence (0008,2230).

If the Coding Scheme Designator (0008,0102) for the Primary Anatomic Structure Sequence (0008,2228) is 99SDM, then the Code Value (0008,0100) for the Primary Anatomic Structure Sequence (0008,2228) shall be the Source UID value from a SNOMED DICOM Microglossary record. This record shall have a Source value of “SNMI”, any Context value, and a Semantic Type value of “anatomic region or structure”.

If the Coding Scheme Designator (0008,0102) for the Primary Anatomic Structure Modifier Sequence (0008,2230) is 99SDM, then the Code Value (0008,0100) for the Primary Anatomic Structure Modifier Sequence (0008,2230) shall be the Source UID value from a SNOMED DICOM Microglossary record. This record shall have a Source value of “SNMI”, any Context value, and a Semantic Type value of “anatomic structure modifier”.

Note: These Data Elements are intended to replace the Anatomic Structure (0008,2208) Data Element.

C.8.4.10 NM Isotope Module

Table C.8-10 contains Attributes that describe the isotope administered for the acquisition.

Table C.8-10
NM ISOTOPE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Energy Window Information Sequence	(0054,0012)	2	Sequence of Repeating Items that describe the energy window groups used. The number of items shall be equal to Number of Energy Windows (0054,0011). The first item corresponds to frames with value of 1 in the Energy Window Vector (0054,0010), the second item with value 2, etc.
> Energy Window Name	(0054,0018)	3	A user defined name which describes this Energy Window.
>Energy Window Range Sequence	(0054,0013)	3	Sequence of Repeating Items that describes this energy window group.
>> Energy Window Lower Limit	(0054,0014)	3	The lower limit of the energy window in KeV. See C.8.4.10.1.1 for further explanation.
>> Energy Window Upper Limit	(0054,0015)	3	The upper limit of the energy window in KeV. See C.8.4.10.1.2 for further explanation.
Radiopharmaceutical Information Sequence	(0054,0016)	2	Sequence of Repeating Items that describe isotope information. One or more Items may be included in this sequence.
> Radionuclide Code Sequence	(0054,0300)	2C	Sequence that identifies the radionuclide. This sequence shall contain exactly one item. See Section C.8.4.10.1.3 for further explanation. Required if a sequence Item is present.
>> Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the radionuclide. Required if a sequence Item is present.

>> Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Enumerated Value: 99SDM Required if a sequence Item is present.
>> Code Meaning	(0008,0104)	3	The radionuclide that is represented by the Code Value (0008,0100).
> Radiopharmaceutical Route	(0018,1070)	3	Route of injection.
> Administration Route Code Sequence	(0054,0302)	3	Sequence that identifies the administration route for the radiopharmaceutical. This sequence shall contain exactly one item. See Section C.8.4.10.1.4 for further explanation
>> Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the radiopharmaceutical route. Required if a sequence Item is present.
>> Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Defined Term: 99SDM Required if a sequence Item is present.
>> Code Meaning	(0008,0104)	3	The radiopharmaceutical route that is represented by the Code Value (0008,0100).
> Radiopharmaceutical Volume	(0018,1071)	3	Volume of injection in cubic cm.
> Radiopharmaceutical Start Time	(0018,1072)	3	Time of start of injection. See C.8.4.10.1.5 for further explanation.
> Radiopharmaceutical Stop Time	(0018,1073)	3	Time of end of injection. See C.8.4.10.1.6 for further explanation.
> Radionuclide Total Dose	(0018,1074)	3	Total amount of radionuclide injected. See C.8.4.10.1.7 for further explanation.
> Calibration Data Sequence	(0054,0306)	3	Sequence that contains calibration data.
>> Energy Window Number	(0054,0308)	1C	The Item number in the Energy Window Information Sequence to which the following calibration data relates. The Items are numbered starting from 1. Required if a sequence Item is present.
>> Syringe Counts	(0018,1045)	3	Pre-injection syringe count rate in counts/sec. See C.8.4.10.1.8 for further explanation.
>> Residual Syringe Counts	(0054,0017)	3	Post-injection residue syringe count rate in counts/sec. See C.8.4.10.1.9 for further explanation.

> Radiopharmaceutical	(0018,0031)	3	Name of the radiopharmaceutical.
> Radiopharmaceutical Code Sequence	(0054,0304)	3	Sequence that identifies the radiopharmaceutical. This sequence shall contain exactly one item. See Section C.8.4.10.1.10 for further explanation.
>> Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the radiopharmaceutical. Required if a sequence Item is present.
>> Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Defined Term: 99SDM Required if a sequence Item is present.
>> Code Meaning	(0008,0104)	3	The radiopharmaceutical that is represented by the Code Value (0008,0100).
Intervention Drug Information Sequence	(0018,0026)	3	Sequence of Repeating Items that describes the intervention drugs used. Zero or more Items may be included in this sequence.
>Intervention Drug Name	(0018,0034)	3	Name of intervention drug.
>Intervention Drug Code Sequence	(0018,0029)	3	Sequence that identifies the intervention drug name. See Section C.8.4.10.1.11 for further explanation.
>> Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the intervention drug name. Required if a sequence Item is present.
>> Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Defined Term: 99SDM Required if a sequence Item is present.
>> Code Meaning	(0008,0104)	3	The intervention drug that is represented by the Code Value (0008,0100).
> Administration Route Code Sequence	(0054,0302)	3	Sequence that identifies the administration route for the intervention drug. This sequence shall contain exactly one item. See Section C.8.4.10.1.4 for further explanation

>> Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the intervention drug route. Required if a sequence Item is present.
>> Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Defined Term: 99SDM Required if a sequence Item is present.
>> Code Meaning	(0008,0104)	3	The intervention drug route that is represented by the Code Value (0008,0100).
>Intervention Drug Start Time	(0018,0035)	3	Time of administration of the intervention drug, using the same time base as for the Acquisition Start Time (0008,0032).
>Intervention Drug Stop Time	(0018,0027)	3	Time of completion of administration of the intervention drug, using the same time base as for the Acquisition Start Time (0008,0032).
>Intervention Drug Dose	(0018,0028)	3	Intervention drug dose, in mg.

Note: Radionuclide Code Sequence (0054,0300) and Administration Route Code Sequence (0054,0302) specify value 99SDM from Annex D for Coding Scheme Designator. It is expected that this value will evolve when Coding Scheme Designator UIDs are available from a registration authority.

C.8.4.10.1 NM Isotope Module Attribute Descriptions

C.8.4.10.1.1 Energy Window Lower Limit

Energy Window Lower Limit (0054,0014) is the acquisition energy window lower limit in KeV for acceptance of scintillation events into this Isotope.

C.8.4.10.1.2 Energy Window Upper Limit

Energy Window Upper Limit (0054,0015) is the acquisition energy window upper limit in KeV for acceptance of scintillation events into this Isotope.

C.8.4.10.1.3 Radionuclide Code Sequence

The Coding Scheme Designator (0008,0102) for the Radionuclide Code Sequence (0054,0300) shall be the SNOMED DICOM Microglossary. The Code Value (0008,0100) for the Radionuclide Code Sequence (0054,0300) shall be the Source UID value from a SNOMED DICOM Microglossary record. This record shall have a Source value of “SNMI”, any Context value, and a Semantic Type value of “diagnostic radionuclide”.

C.8.4.10.1.4 Administration Route Code Sequence

If the Coding Scheme Designator (0008,0102) for the Administration Route Code Sequence (0054,0302) is 99SDM, then the Code Value (0008,0100) for the Administration Route Code Sequence (0054,0302) shall be the Source UID value from a SNOMED DICOM Microglossary

record. This record shall have a Source value of “SNMI”, any Context value, and a Semantic Type value of “drug administration route”.

C.8.4.10.1.5 Radiopharmaceutical Start Time

Radiopharmaceutical Start Time (0018,1072) is the actual time of radiopharmaceutical administration to the patient for imaging purposes, using the same time base as for the Acquisition Start Time (0008,0032).

C.8.4.10.1.6 Radiopharmaceutical Stop Time

Radiopharmaceutical Stop Time (0018,1073) is the actual ending time of radiopharmaceutical administration to the patient for imaging purposes, using the same time base as for the Acquisition Start Time (0008,0032).

C.8.4.10.1.7 Radionuclide Total Dose

Radionuclide Total Dose (0018,1074) is the radiopharmaceutical dose administered to the patient measured in MegaBecquerels (Mbq) at the Radiopharmaceutical Start Time.

C.8.4.10.1.8 Syringe Counts

Syringe Counts (0018,1045) is the pre-injection syringe acquisition count rate measured in counts/sec, corrected to the Acquisition Start Time (0008,0032) if necessary.

C.8.4.10.1.9 Residual Syringe Counts

Residual Syringe Counts (0054,0017) is the syringe acquisition count rate following patient injection, measured in counts/sec, corrected to the Acquisition Start Time (0008,0032) if necessary.

C.8.4.10.1.10 Radiopharmaceutical Code Sequence

If the Coding Scheme Designator (0008,0102) for the Radiopharmaceutical Code Sequence (0054,0304) is 99SDM, then the Code Value (0008,0100) for the Radiopharmaceutical Code Sequence (0054,0304) shall be the Source UID value from a SNOMED DICOM Microglossary record. This record shall have a Source value of “SNMI”, any Context value, and a Semantic Type value of “radiopharmaceutical agent”.

C.8.4.10.1.11 Intervention Drug Code Sequence

If the Coding Scheme Designator (0008,0102) for the Intervention Drug Code Sequence (0018,0029) is 99SDM, then the Code Value (0008,0100) for the Intervention Drug Code Sequence (0018,0029) shall be the Source UID value from a SNOMED DICOM Microglossary record. This record shall have a Source value of “SNMI”, any Context value, and a Semantic Type value of “angio-interventional drug”.

C.8.4.11 NM Detector Module

Table C.8-11 contains IOD Attributes that describe Nuclear Medicine Detectors used to produce an image.

Table C.8-11
NM DETECTOR MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Detector Information Sequence	(0054,0022)	2	Sequence of Repeating Items that describe the detectors used. The number of items shall be equal to Number of Detectors (0054,0021). The first item corresponds to frames with value of 1 in the Detector Vector (0054,0020), the second item with value 2, etc.
> Collimator/Grid Name	(0018,1180)	3	Label describing the collimator used (LEAP, hires, etc.)
> Collimator Type	(0018,1181)	2C	Collimator type. Defined Terms: PARA = Parallel (default) PINH = Pinhole FANB = Fan-beam CONE = Cone-beam SLNT = Slant hole ASTG = Astigmatic DIVG = Diverging NONE = No collimator UNKN = Unknown Required if a sequence Item is present.
> Field of View Shape	(0018,1147)	3	Shape of the field of view of the Nuclear Medicine detector. Defined Terms: RECTANGLE ROUND HEXAGONAL
> Field of View Dimension(s)	(0018,1149)	3	Dimensions of the field of view, in mm. If Field of View Shape (0018,1147) is: RECTANGLE: row dimension followed by column. ROUND: diameter. HEXAGONAL: diameter of a circumscribed circle.
> Focal Distance	(0018,1182)	2C	Focal distance, in mm. A value of 0 means infinite distance for parallel collimation. See C.8.4.11.1.1 for further specialization. Required if a sequence Item is present.
> X Focus Center	(0018,1183)	3	Center of focus along a row. See C.8.4.11.1.2 for further explanation.
> Y Focus Center	(0018,1184)	3	Center of focus along a column. See C.8.4.11.1.2 for further explanation.

> Zoom Center	(0028,0032)	3	The amount of offset from (0,0) applied to each pixel in the image before application of the zoom factor, specified by a numeric pair: row value (delimiter) column value (in mm). See C.8.4.11.1.3 for further explanation.
> Zoom Factor	(0028,0031)	3	The amount of magnification applied to each pixel in the image, specified by a numeric pair: row value (delimiter) column value. See C.8.4.11.1.4 for further explanation.
> Center of Rotation Offset	(0018,1145)	3	Average center of rotation offset of Nuclear Medicine detector in mm. See C.8.4.11.1.5 for further explanation.
> Gantry/Detector Tilt	(0018,1120)	3	Angle of tilt in degrees of the detector. See C.8.4.11.1.6 for further explanation.
> Distance Source to Detector	(0018,1110)	2C	Distance in mm from transmission source to the detector face. Required if Image Type (0008,0008) Value 4 is TRANSMISSION, Value 3 is not TOMO, and a sequence Item is present.
> Start Angle	(0054,0200)	3	Position of the detector about the patient for the start of the acquisition, in degrees. Zero degrees is referenced to the origin at the patient's back. Viewing from the patient's feet, angle increases in a counter-clockwise direction (detector normal rotating from the patient's back towards the patient's left side). Should not be included if Image Type (0008,0008), Value 3, is TOMO, GATED TOMO, RECON TOMO or RECON GATED TOMO.
> Radial Position	(0018,1142)	3	Radial distance of the detector from the center of rotation, in mm. Should not be included if Image Type (0008,0008), Value 3, is TOMO, GATED TOMO, RECON TOMO or RECON GATED TOMO.
> Image Orientation (Patient)	(0020,0037)	2C	The direction cosines of the first row and the first column with respect to the patient. See C.7.6.2.1.1 for further explanation. Required if a sequence Item is present.

> Image Position (Patient)	(0020,0032)	2C	The x, y, and z coordinates of the upper left hand corner (first pixel transmitted) of the image. See C.7.6.2.1.1 for further explanation. Required if a sequence Item is present.
> View Code Sequence	(0054,0220)	3	Sequence that describes the projection of the anatomic region of interest on the image receptor. See Section C.8.4.11.1.7 for further explanation.
>> Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the view. Required if a sequence Item is present.
>> Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Defined Term: 99SDM Required if a sequence Item is present.
>> Code Meaning	(0008,0104)	3	The view that is represented by the Code Value (0008,0100).
>> View Angulation Modifier Code Sequence	(0054,0222)	2C	View Modifier. Required if needed to fully specify the View. See Section C.8.4.11.1.8 for further explanation.
>>> Code value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the view angulation modifier. Required if a sequence Item is present.
>>> Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code value (0008,0100) onto the Code Meaning (0008,0104). Defined Terms: 99SDM Required if a sequence Item is present.
>>> Code Meaning	(0008,0104)	3	The view modifier that is represented by the Code Value (0008,0100).

Note: View Code Sequence (0054,0220) and View Angulation Modifier Code Sequence (0054,0222) specify value 99SDM from Annex D for Coding Scheme Designator. It is expected that this value will evolve when Coding Scheme Designator UIDs are available from a registration authority.

C.8.4.11.1 NM Detector Attribute Descriptions

C.8.4.11.1.1 Focal Distance

Focal Distance (0018,1182) for NM Image data is the focal distance, in mm for converging or diverging collimators, measured from the front face of the collimator to the focus. Positive values

indicate converging and negative values indicate diverging collimators. A value of 0 means infinite distance for parallel collimation.

C.8.4.11.1.2 Focus Center

X Focus Center (0018,1183) and Y Focus Center (0018,1184) for NM Image data is used to define the projection of the focus for a converging or diverging collimator within the un-zoomed Field of View. It is defined in mm for row and column relative to the center of the un-zoomed Field of View.

C.8.4.11.1.3 Zoom Center

Zoom Center (0028,0032) is the offset between the un-zoomed camera field of view and field of view, measured from the center of the un-zoomed camera field of view to the center the of the zoomed field of view. The offset is measured in mm in the un-zoomed camera FOV dimensions. Positive values are to the right and down from the un-zoomed center, as viewed from the image plane. When this attribute is not given, the Zoom Center is assumed to be 0\0.

C.8.4.11.1.4 Zoom Factor

Zoom Factor (0028,0031) is the magnification factor that was used during the acquisition. When this attribute is not given, it is assumed to be 1.0\1.0.

Note: Zoom Factor (0028,0031) is informational only. Pixel Spacing (0028,0030) already takes account of this and any other changes to pixel size.

C.8.4.11.1.5 Center of Rotation Offset

Center of Rotation Offset (0018,1145) is the average amount of offset in mm between the Detector Field of View center and the physical center of rotation of the gantry for circular orbital scans. Positive values indicate the physical center is to the right of the image plane center.

C.8.4.11.1.6 Gantry/Detector Tilt

Gantry/Detector Tilt (0018,1120) for NM Image data is the angle in degrees of the detector face relative to the patient's major (Head to Feet) axis (or the table supporting the patient). Positive tilt is towards the patient’s feet.

C.8.4.11.1.7 View Code Sequence

Only a single Item shall be permitted in this sequence.

If the Coding Scheme Designator (0008,0102) for the View Code Sequence (0054,0220) is 99SDM, then the Code Value (0008,0100) for the View Code Sequence (0054,0220) shall be the Source UID value from a SNOMED DICOM Microglossary record. This record shall have a Source value of “SNMI”, any Context value, and a Semantic Type value of “imaging view”.

C.8.4.11.1.8 View Angulation Modifier Code Sequence

Only a single Item shall be permitted in this sequence.

If the Coding Scheme Designator (0008,0102) for the View Angulation Modifier Code Sequence (0054,0222) is 99SDM, then the Code Value (0008,0100) for the View Angulation Modifier Code Sequence (0054,0222) shall be the Source UID value from a SNOMED DICOM Microglossary record. This record shall have a Source value of “SNMI”, any Context value, and a Semantic Type value of “cranio-caudal angulation modifier”.

C.8.4.12 NM TOMO Acquisition Module

This Module applies to a TOMO Multi-frame Image. This module is present when the Image Type (0008,0008) Value 3, is equal to TOMO, GATED TOMO, RECON TOMO, or RECON GATED TOMO. The elements found in this module describe the acquisition of the Image.

Table C.8-12
NM TOMO ACQUISITION MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Rotation Information Sequence	(0054,0052)	2	Sequence of Repeating Items that describe TOMO rotational groups. A new rotation is defined whenever the direction of the detector motion changes, or the Table Traverse (0018,1131) changes. The number of items shall be equal to Number of Rotations (0054,0051). If Rotation Vector (0054,0050) is present, the first item corresponds to frames with value of 1 in the Rotation Vector (0054,0050), the second item with value 2, etc.
> Start Angle	(0054,0200)	1C	Position of the detector about the patient for the start of this rotation, in degrees. Zero degrees is referenced to the origin at the patient's back. Viewing from the patient's feet, angle increases in a counter-clockwise direction (detector normal rotating from the patient's back towards the patient's left side). Required if a sequence Item is present.
> Angular Step	(0018,1144)	1C	The angular scan arc step between views of the TOMO acquisition, in degrees. See C.8.4.12.1.1 for further explanation. Required if a sequence Item is present.
> Rotation Direction	(0018,1140)	1C	Direction of rotation of the detector about the patient. See Start Angle (0054,0200) for further explanation of direction. Enumerated Values: CW = clockwise (decreasing angle) CC = counter-clockwise (increasing angle). Required if a sequence Item is present.
> Scan Arc	(0018,1143)	1C	The effective angular range of the scan data in degrees. The value shall be positive. Required if a sequence Item is present.
> Actual Frame Duration	(0018,1242)	1C	Nominal acquisition time per angular position, in msec. Required if a sequence Item is present.

> Radial Position	(0018,1142)	3	Radial distance of the detector from the center of rotation, in mm. It shall have a single value which is an average value for this rotation, or it shall have one value per angular view.
> Distance Source to Detector	(0018,1110)	2C	Distance in mm from transmission source to the detector face. Required if Image Type (0008,0008), Value 4, is TRANSMISSION and a sequence Item is present.
> Number of Frames in Rotation	(0054,0053)	1C	Number of angular views in this rotation. Required if a sequence Item is present.
> Table Traverse	(0018,1131)	3	Location of the patient table (or gantry relative to the table) in mm.The range and values of this element are determined by the manufacturer.
> Table Height	(0018,1130)	3	The distance in mm of the top of the patient table to the center of rotation. Table height below the center of rotation has a positive value.
Type of Detector Motion	(0054,0202)	3	Describes the detector motion during acquisition. Enumerated Values: STEP AND SHOOT = Interrupted motion, acquire only while stationary. CONTINUOUS = Gantry motion and acquisition are simultaneous and continuous. ACQ DURING STEP = Interrupted motion, acquisition is continuous.

C.8.4.12.1 NM TOMO Acquisition Attribute Descriptions

C.8.4.12.1.1 Angular Step

Angular Step (0018,1144) is the nominal frame-to-frame incremental angle for TOMO and GATED TOMO acquisition images, defined in degrees. The Angular Step (0018,1144) shall be a positive number. Summation of Angular Step values is not defined to give accurate Angular Position or Scan Arc values. The Angular Step is the effective angular spacing between resultant frames of the Multi-framed planar image data.

C.8.4.13 NM Multi-gated Acquisition Module

Table C.8-13 contains Attributes that describe a multi-gated acquisition image performed on the patient. This refers to frames acquired while the patient is connected to a gating device.

Table C.8-13
NM MULTI-GATED ACQUISITION MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Beat Rejection Flag	(0018,1080)	3	Heart beat duration sorting has been applied. Enumerated Values: Y = yes N = no
PVC Rejection	(0018,1085)	3	Description of type of arrhythmic beat rejection criteria used.
Skip Beats	(0018,1086)	3	Number of beats skipped after a detected arrhythmia
Heart Rate	(0018,1088)	3	Average number of heart beats per minute for the collection period for these frames. This shall include all accepted beats as well as rejected beats.
Gated Information Sequence	(0054,0062)	2C	Sequence of Repeating Items that describe R-R intervals. Each gated interval is defined by an upper and lower range of heart beat durations. Required if the Frame Increment Pointer (0028,0009) contains the Tag for R-R Interval Vector (0054,0060). The number of items shall be equal to Number of R-R Intervals (0054,0061). The first item corresponds to frames with value of 1 in the R-R Interval Vector (0054,0060), the second item with value 2, etc.
> Trigger Time	(0018,1060)	3	Time interval measured in msec from the start of the R-wave to the beginning of the data taking.
> Framing Type	(0018,1064)	3	Description of type of framing performed such as forward, backward, forward/backward by percentage.
> Data Information Sequence	(0054,0063)	2C	Sequence of Repeating Items that describe gating criteria. See C.8.4.13.1.1. Required if a sequence Item is present.
>> Frame Time	(0018,1063)	1C	Nominal time per individual frame in msec. Required if a sequence Item is present.
>> Nominal Interval	(0018,1062)	3	Average duration of accepted beats, in msec.
>> Low R-R Value	(0018,1081)	3	R-R interval lower limit for beat rejection, in msec
>> High R-R Value	(0018,1082)	3	R-R interval upper limit for beat rejection, in msec

>> Intervals Acquired	(0018,1083)	3	Number of heartbeats that fall within Low R-R Value (0018,1081) and High R-R Value (0018,1082), and were therefore accepted and contribute gamma events to this R-R Interval.
>> Intervals Rejected	(0018,1084)	3	Number of heartbeats that fall outside Low R-R (0018,1081) and High R-R Value (0018,1082), and do not contribute gamma events to this R-R Interval. However, they may contribute gamma events to other R-R Intervals.
>> Time Slot Information Sequence	(0054,0072)	2C	Sequence of Repeating Items that describe Time Slot Information. Required if the Frame Increment Pointer (0028,0009) contains the Tag for Time Slot Vector (0054,0070). The number of items shall be equal to Number of Time Slots (0054,0071). The first item corresponds to frames with value of 1 in the Time Slot Vector (0054,0070), the second item with value 2, etc.
>>> Time Slot Time	(0054,0073)	3	The total amount of time, in msec, that the acquisition accumulates gamma events into this frame. See C.8.4.13.1.2.

C.8.4.13.1 NM Multi-gated Acquisition Attribute Descriptions

C.8.4.13.1.1 Data Information Sequence

Data Information Sequence (0054,0063) shall contain a single sequence item which applies to the sum of all angular views, except when Image Type (0008,0008) Value 3 is GATED TOMO. In this case it shall have either a single item which applies to the sum of all angular views, or it shall have one item for each angular view.

C.8.4.13.1.2 Time Slot Time

The Time Slot Time (0054,0073) records the effective imaging time of each Time Slot. For example, if some of the accepted beats are shorter than others then the last frames may not receive a contribution from the shorter beats. The Time Slot Time for a Time Slot is the total acquisition time for that Time Slot. It is approximately equal to the Frame Time (0018,1063) multiplied by the number of accepted beats contributing to the Time Slot.

C.8.4.14 NM Phase Module

Table C.8-14 contains Attributes that describe dynamic phases of a dynamic acquisition image performed on the patient. This module is present only when Image Type (0008,0008), Value 3, is equal to DYNAMIC. A phase is defined as a collection of frames in which the acquisition time per frame and the time delay between frames remains constant. A new phase shall be defined whenever there is a change in the time between frames, the acquisition time per frame, or the position of the patient relative to the detector.

Table C.8-14
NM PHASE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Phase Information Sequence	(0054,0032)	2C	Sequence of Repeating Items that describes each dynamic phase. Required if the Frame Increment Pointer (0028,0009) contains the Tag for Phase Vector (0054,0030). The number of items shall be equal to Number of Phases (0054,0031). The first item corresponds to frames with value of 1 in the Phase Vector (0054,0030), the second item with value 2, etc.
> Phase Delay	(0054,0036)	1C	Time paused between the last frame of the previous phase and the first frame of this phase, in msec. Required if a sequence Item is present.
> Actual Frame Duration	(0018,1242)	1C	Nominal time of acquisition per individual frame, in msec. Required if a sequence Item is present.
> Pause Between Frames	(0054,0038)	1C	Time paused between each frame of this phase (in msec). Required if a sequence Item is present.
> Number of Frames in Phase	(0054,0033)	1C	Number of frames in this phase. Required if a sequence Item is present.
>Trigger Vector	(0054,0210)	3	An array of trigger times when gating information is acquired simultaneously with the dynamic image data. See Section C.8.4.14.1.1 for further explanation.
>Number of Triggers in Phase	(0054,0211)	1C	The number of entries in the Trigger Vector (0054,0210) for this phase. Required if Trigger Vector (0054,0210) is present.

C.8.4.14.1 NM Phase Module Attributes Description

C.8.4.14.1.1 Trigger Vector

Trigger Vector (0054,0210) is an array containing a list of the inter-trigger interval times in milliseconds in the order in which they were acquired, with the first being measured from the start time of the first frame of the image data in the Phase. If this element is used, the start times are required to be the same so that a mathematical correlation can be made between trigger times and frame start times.

C.8.4.15 NM Reconstruction Module

Table C.8-15 contains Attributes that describe Nuclear Medicine reconstructed volumes. Reconstructed volumes are created by applying a transformation (reconstruction) process to the acquired TOMO frames. This module is present only when the Image Type (0008,0008), Value 3, is equal to RECON TOMO or RECON GATED TOMO**.**

Table C.8-15
NM RECONSTRUCTION MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Spacing Between Slices	(0018,0088)	2	Spacing between slices, in mm, measured from center-to-center of each slice along the normal to the first image. The sign of the Spacing Between Slices (0018,0088) determines the direction of stacking. The normal is determined by the cross product of the direction cosines of the first row and first column of the first frame, such that a positive spacing indicates slices are stacked behind the first slice and a negative spacing indicates slices are stacked in front of the first slice. See Image Orientation (0020,0037) in the NM Detector module.
Reconstruction Diameter	(0018,1100)	3	Diameter, in mm, of the region from within which the data was used in creating the reconstruction of the image. Data may exist outside this region and portions of the patient may exist outside this region.
Convolution Kernel	(0018,1210)	3	A label describing the convolution kernel or algorithm used to reconstruct the data.
Slice Thickness	(0018,0050)	2	Nominal slice thickness, in mm.
Slice Location	(0020,1041)	3	Relative position of exposure expressed in mm. See C.7.6.2.1.2 for further explanation.

C.8.5 Ultrasound Modules

This Section describes Ultrasound Frame of Reference and Image Modules. These Modules contain Attributes that are specific to Ultrasound images.

C.8.5.1 US Frame of Reference Module (Retired)

Section C.8.4.1 was defined in a previous version of the DICOM Standard. The Section is now retired and has been moved to Annex I.1.2.1.

C.8.5.2 US Region Calibration (Retired)

Section C.8.4.2 was defined in a previous version of the DICOM Standard. The Section is now retired and has been moved to Annex I.1.2.2.

C.8.5.3 US Image Module (Retired)

Section C.8.4.3 was defined in a previous version of the DICOM Standard. The Section is now retired and has been moved to Annex I.1.2.3.

C.8.5.4 US Frame of Reference Module

Table C.8-16 contains IOD Attributes that describe an ultrasound frame of reference.

Table C.8-16
US FRAME OF REFERENCE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Region Location Min x_0	(0018,6018)	1	The bounds of a rectangle specifying the location of the region, x_0,y_0,x_1,y_1. See C.8.5.4.1.1 for further explanation.
Region Location Min y_0	(0018,601A)	1	The bounds of a rectangle specifying the location of the region, x_0,y_0,x_1,y_1. See C.8.5.4.1.1 for further explanation.
Region Location Max x_1	(0018,601C)	1	The bounds of a rectangle specifying the location of the region, x_0,y_0,x_1,y_1. See C.8.5.4.1.1 for further explanation.
Region Location Max y_1	(0018,601E)	1	The bounds of a rectangle specifying the location of the region, x_0,y_0,x_1,y_1. See C.8.5.4.1.1 for further explanation.
Physical Units X Direction	(0018,6024)	1	The physical units of the dimensions of the region. See C.8.5.4.1.2 for Enumerated Values.
Physical Units Y Direction	(0018,6026)	1	The physical units of the dimensions of the region. See C.8.5.4.1.2 for Enumerated Values.
Physical Delta X	(0018,602C)	1	The physical value increments per positive X pixel increment. The units are as specified in the Physical units data element.

Physical Delta Y	(0018,602E)	1	The physical value increments per positive Y pixel increment. The units are as specified in the Physical units data element.
Reference Pixel x_0	(0018,6020)	3	This coordinate pair, x_0,y_0 defines the location of a virtual "reference" pixel. See C.8.5.4.1.3 for further explanation.
Reference Pixel y_0	(0018,6022)	3	This coordinate pair, x_0,y_0 defines the location of a virtual "reference" pixel. See C.8.5.4.1.3 for further explanation.
Ref. Pixel Physical Value X	(0018,6028)	3	The Physical Value at the reference pixel x location. The units are specified in the Physical Units field.
Ref. Pixel Physical Value Y	(0018,602A)	3	The Physical Value at the reference pixel y location. The units are specified in the Physical Units field.

C.8.5.4.1 US Frame of Reference Attribute Definitions

C.8.5.4.1.1 Region Location Min x_0, Region Location Min y_0, Region Location Max x_1 , Region Location Max y_1

The bounds of a rectangle specifying the location of the region, Region Location Min x_0 (0018,6018), Region Location Min y_0 (0018,601A), Region Location Max x_1 (0018,601C), Region Location Max y_1 (0018,601E). The upper left corner of the entire image is x=0,y=0 and the lower right corner is x=image width - 1, and y=image length - 1. Thus, a region will be specified as within these bounds. Where x_0,y_0 is the coordinate of the upper left corner of the region and x_1,y_1 is the coordinate of the lower right corner of the region.

C.8.5.4.1.2 Physical Units X Direction And Physical Units Y Direction

Physical Units X Direction (0018,6024) and Physical Units Y Direction (0018,6026) provide Enumerated Values indicating the physical units of the dimensions of the region.

Value	Meaning	Value	Meaning
0000H =	None or not applicable	0001H =	Percent
0002H =	dB	0003H =	cm
0004H =	seconds	0005H =	hertz($seconds^{-1}$)
0006H =	dB/seconds	0007H =	cm/sec
0008H =	cm^2	0009H =	cm^2/sec
000AH =	cm^3	000BH =	cm^3/sec
000CH =	degrees		

C.8.5.4.1.3 Reference Pixel x_0 and Reference Pixel y_0

This coordinate pair, Reference Pixel x_0 (0018,6020), Reference Pixel y_0 (0018,6022) defines the location of a virtual "reference" pixel. The reference pixel is used to tie the image's pixel coordinate system to the physical coordinate system. For example, the reference pixel could be defined where a depth of zero centimeters occurs in the 2D image, or it could define where the baseline (i.e.: zero frequency) resides in a spectral display. The reference pixel location is the relative offset from the region location, not necessarily the image origin. The location is not required to be within the region or even within the image boundary. For this reason, the Reference Pixel Location can be positive or negative.

Recommended locations are:

Sector - Skin line

Linear - Skin line left corner

Doppler Spectral - Baseline left

M-Mode - Skin line left

Physio - Baseline left (where baseline = 0)

C.8.5.5 US Region Calibration Module

The US Region Calibration Module has been introduced into the ultrasound IOD to provide access to the full range of data which may be present in a single US image. US images often contain multiple regions which have independent data regions, e.g. quad screen loops which may have different calibration information. The data presented in the various regions of a US image can represent a multiplicity of physical parameters, e.g., spatial distance, blood velocity, time, volume, etc., and these are often contained in the value of the pixel itself. It is therefore imperative that physical information be available for the various regions of a single region independent of each other.

C.8.5.5.1 US Region Calibration Attribute Definitions

Table C.8-17 contains IOD Attributes that describe an ultrasound region calibration.

Table C.8-17
US REGION CALIBRATION MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Sequence of Ultrasound Regions	(0018,6011)	1	Defines a sequence of Ultrasound Regions. One or more Items may be included in this Sequence.
>Region Location Min x_0	(0018,6018)	1	The bounds of a rectangle specifying the location of the region, x_0,y_0,x_1,y_1. See C.8.5.4.1.1 for further explanation.
>Region Location Min y_0	(0018,601A)	1	The bounds of a rectangle specifying the location of the region, x_0,y_0,x_1,y_1. See C.8.5.4.1.1 for further explanation.
>Region Location Max x_1	(0018,601C)	1	The bounds of a rectangle specifying the location of the region, x_0,y_0,x_1,y_1. See C.8.5.4.1.1 for further explanation.
>Region Location Max y_1	(0018,601E)	1	The bounds of a rectangle specifying the location of the region, x_0,y_0,x_1,y_1. See C.8.5.4.1.1 for further explanation.
>Physical Units X Direction	(0018,6024)	1	The physical units of the dimensions of the region. See C.8.5.4.1.2 for Enumerated Values.
>Physical Units Y Direction	(0018,6026)	1	The physical units of the dimensions of the region. See C.8.5.4.1.2 for Enumerated Values.
>Physical Delta X	(0018,602C)	1	The physical value increments per positive X pixel increment. The units are as specified in the physical units data element.
>Physical Delta Y	(0018,602E)	1	The physical value increments per positive Y pixel increment. The units are as specified in the physical units data element.
>Reference Pixel x_0	(0018,6020)	3	This coordinate pair, x_0,y_0 defines the location of a virtual "reference" pixel. See C.8.5.4.1.3 for further explanation.
>Reference Pixel y_0	(0018,6022)	3	This coordinate pair, x_0,y_0 defines the location of a virtual "reference" pixel. See C.8.5.4.1.3 for further explanation.
>Ref. Pixel Physical Value X	(0018,6028)	3	The Physical Value at the reference pixel x location. The units are specified in the Physical Units field.

>Ref. Pixel Physical Value Y	(0018,602A)	3	The Physical Value at the reference pixel y location. The units are specified in the Physical Units field.
>Region Spatial Format	(0018,6012)	1	The spatial organization of the data within the region. See C.8.5.5.1.1 for Enumerated Values.
>Region Data Type	(0018,6014)	1	The type of data within the region. See C.8.5.5.1.2 for Enumerated Values.
>Region Flags	(0018,6016)	1	Flags used for special handling of the region. See C.8.5.5.1.3 for Enumerated Values and further explanation.
>Pixel Component Organization	(0018,6044)	1C	Describes how the components of a pixel can be described. Required if pixel component calibration exists for this region. See C.8.5.5.1.4 for Enumerated Values and further explanation.
>Pixel Component Mask	(0018,6046)	1C	This value is ANDed with the composite pixel code for each pixel within the region, then shifted right by the number of contiguous least significant zeros in the mask to obtain what will be referred to as the "Shifted Masked Composite Pixel Code" (SMCPC). Required if Pixel Component Organization = Bit aligned. See C.8.5.5.1.5 for further explanation.
>Pixel Component Range Start	(0018,6048)	1C	Defines the start of the numeric range of values within the composite pixel where calibration is to be defined by the "pixel physical calibration table". To be used only when ranges are used to describe the portion of the composite pixel. Required if Pixel Component Organization = Ranges.
>Pixel Component Range Stop	(0018,604A)	1C	Defines the stop of the numeric range of values within the composite pixel where calibration is to be defined by the "pixel physical calibration table". To be used only when ranges are used to describe the portion of the composite pixel. Required if Pixel Component Organization = Ranges.

>Pixel Component Physical Units	(0018,604C)	1C	The physical units to be applied to the pixel component. Required if Pixel Component Organization exists. See C.8.5.5.1.6 for further explanation.
>Pixel Component Data Type	(0018,604E)	1C	The type of data for the pixel component. Required if Pixel Component Organization exists. See C.8.5.5.1.7 for further explanation.
>Number of Table Break Points	(0018,6050)	1C	The number of break point coordinate pairs used to describe a piece wise linear curve. Required if Pixel Component Organization equals 0 or 1. Otherwise not used. See C.8.5.5.1.8 for further explanation.
>Table of X Break Points	(0018,6052)	1C	An array of X values used to create the piece wise linear curve. Required if Pixel Component Organization equals 0 or 1. Otherwise not used. See C.8.5.5.1.9 for further explanation.
>Table of Y Break Points	(0018,6054)	1C	An array of Y values used to create the piece wise linear curve. Required if Pixel Component Organization equals 0 or 1. Otherwise not used. See C.8.5.5.1.9 for further explanation.
>Number of Table Entries	(0018,6056)	1C	The number of entries in the Table of Pixel Values. Required if the Pixel Component Organization equals 2. Otherwise not used. See C.8.5.5.1.11 for further explanation.
>Table of Pixel Values	(0018,6058)	1C	A table of Pixel Values used in conjunction with the Table of Parameter Values to provide a mapping from Pixel Value to Parameter Value. Required if the Pixel Component Organization equals 2. Otherwise not used. See C.8.5.5.1.12 for further explanation.

>Table of Parameter Values	(0018,605A)	1C	A table of Parameter Values used in conjunction with the Table of Pixel Values to provide a mapping from Pixel Value to Parameter Value. Required if the Pixel Component Organization equals 2. Otherwise not used. See C.8.5.5.1.13 for further explanation
>Tranducer Frequency	(0018,6030)	3	The manufacturer defined description of center frequency of the interrogating ultrasound energy. The units are kilohertz.
>Pulse Repetition Frequency	(0018,6032)	3	The ultrasound pulse repetition frequency, as defined by the manufacturer, used to collect data in the region. The units are in hertz.
>Doppler Correction Angle	(0018,6034)	3	The Doppler correction angle. The units are degrees.
>Steering Angle	(0018,6036)	3	The steering angle, as defined by the manufacturer, used for a steered 2D image. The units are degrees.
>Doppler Sample Volume X Position	(0018,6038)	3	The x displacement, in pixels, from the Reference pixel to the center of the Doppler sample volume.
>Doppler Sample Volume Y Position	(0018,603A)	3	The y displacement, in pixels, from the Reference pixel to the center of the Doppler sample volume.
>TM-Line Position x_0	(0018,603C)	3	The starting and ending coordinates pairs of the m-line. Where the X_0,Y_0 are the starting point and X_1,Y_1 are the end point of the tm-line. See C.8.5.5.1.10 for further explanation.
>TM-Line Position y_0	(0018,603E)	3	The starting and ending coordinates pairs of the m-line. Where the X_0,Y_0 are the starting point and X_1,Y_1 are the end point of the tm-line. See C.8.5.5.1.10 for further explanation.
>TM-Line Position x_1	(0018,6040)	3	The starting and ending coordinates pairs of the m-line. Where the X_0,Y_0 are the starting point and X_1,Y_1 are the end point of the tm-line. See C.8.5.5.1.10 for further explanation.

>TM-Line Position y_1	(0018,6042)	3	The starting and ending coordinates pairs of the m-line. Where the X_0,Y_0 are the starting point and X_1,Y_1 are the end point of the tm-line. See C.8.5.5.1.10 for further explanation.

C.8.5.5.1.1 Region Spatial Format

Enumerated Values for Region Spatial Format (0018,6012) indicate the spatial organization of the data within the region.

Value	Meaning	Value	Meaning
0000H	None or not applicable	0001H	2D(tissue or flow)
0002H	M-Mode(tissue or flow)	0003H	Spectral(CW or PW Doppler)
0004H	Wave form(physiological traces, doppler traces,....)	0005H	Graphics

C.8.5.5.1.2 Region Data Type

Enumerated Values for Region Data Type (0018,6014) indicate the type of data within the region.

Value	Meaning	Value	Meaning
0000H	None or not applicable	0001H	Tissue
0002H	Color Flow	0003H	PW Spectral Doppler
0004H	CW Spectral Doppler	0005H	Doppler Mean Trace
0006H	Doppler Mode Trace	0007H	Doppler Max Trace
0008H	Volume Trace	0009H	d(volume)/dt Trace
000AH	ECG Trace	000BH	Pulse Trace
000CH	Phonocardiogram Trace	000DH	Gray bar
000EH	Color bar	000FH	Integrated Backscatter
0010H	Area Trace	0011H	d(area)/dt
0012H	Other Physiological (Amplitude vs. Time) input		

C.8.5.5.1.3 Region Flags

Region Flags (0018,6016) are used for special handling of the region.

Enumerated Values for Bit 0 (lsb) Transparency:

1 = Transparent

0 = Opaque

If the region is transparent, then measurements may be done on regions underneath this region. This most useful for ECG overlays region overlapping with a 2D region.

Enumerated Values for Bit 1 Scaling Protection:

1 = Protected

0 = Not Protected

Ultrasound systems should set this to 1 if the image is scaled automatically by the ultrasound system. If the image is frame-grabbed and scaling is not available then it should be set to 0. If the region is protected, the region can not be manually rescaled. That is the data defined by the region calibration Module can not be overridden by a reader of that image.

Enumerated Values for Bit 2 Doppler Scale Type:

1 = Frequency

0 = Velocity

Valid for PW and CW regions only. Indicates which type of doppler scale is used.

Bit 3-31 Reserved for future use, shall be set to zero.

C.8.5.5.1.4 Pixel Component Organization

Pixel Component Organization (0018,6044) provides an Enumerated Value describing how the components of a pixel can be described. The absence of this data element means that pixel component calibration does not exist for this region. Where:

0 = Bit aligned positions

1 = Ranges

2 = Table look up

Other values reserved for future use.

C.8.5.5.1.5 Pixel Component Mask

Pixel Component Mask (0018,6046) is ANDed with the Composite Pixel Code (see Section C.7.6.3.1.1) for each pixel within the region, then shifted right by the number of contiguous least significant zeros in the mask to obtain what will be referred to as the "Shifted Masked Composite Pixel Code".

The mask will most likely (but not necessarily) contain a block of contiguous ones, surrounded by leading and trailing zeros. The purpose of this mask is to keep only those bits within the composite pixel code which pertain to the region. It is to be used only when Pixel Organization is bit aligned positions.

C.8.5.5.1.6 Pixel Component Physical Units

For Pixel Component Physical Units (0018,604C), the Enumerated Values describing the physical units to be applied to the pixel component are:

Value	Meaning	Value	Meaning
0000H	None or not applicable	0001H	Percent
0002H	dB	0003H	cm
0004H	seconds	0005H	hertz($seconds^{-1}$)
0006H	dB/seconds	0007H	cm/sec
0008H	cm^2	0009H	cm^2/sec
000AH	cm^3	000BH	cm^3/sec
000CH	degrees		

C.8.5.5.1.7 Pixel Component Data Type

For Pixel Component Data Type (0018,604E), the Enumerated Values indicating the type of data for the pixel component are:

Value	Meaning	Value	Meaning
0000H	None or not applicable	0001H	Tissue
0002H	Spectral doppler	0003H	Color Flow Velocity
0004H	Color Flow Variance	0005H	Color Flow Intensity
0006H	Gray bar	0007H	Color bar
0008H	Integrated Backscatter	0009H	Computed Border

C.8.5.5.1.8 Number of Table Break Points

The Number of Table Break Points (0018,6050) gives the number of entries in each of two tables: the Table of X Break Points (0018,6052) and Table of Y Break Points (0018,6054). These tables are used to designate a curve mapping the value of a pixel component to its actual physical value, as described in Section C.8.5.5.1.9.

C.8.5.5.1.9 Table of X Break Points and Table of Y Break Points

Table of X Break Points (0018,6052) and Table of Y Break Points (0018,6054) are individual arrays of coordinates which interpreted together are used to create a piecewise linear curve. Each X value from the Table of X Break Points is matched with the corresponding Y value from the Table of Y Break Points yielding an (X,Y) coordinate. The set of (X,Y) coordinates describes a piecewise linear curve mapping the value of a pixel component to its actual physical value (in units defined in Pixel Component Physical Units data element (0018,604C)).

The X direction on the curve has no units, and represents actual pixel component values. If the Pixel Component Organization (0018,6044) is "Bit aligned positions", and the width of the Pixel Component Mask is *n* bits then the X coordinates are in the range 0 through 2^n -1. If the Pixel Component Organization is *Ranges*, then the X coordinates are in the range 0 through $2^{\text{number of bits in the composite pixel}} - 1$.

Note: The X value is NOT relative to the Pixel Component Range Start (0018,6048). Not all possible X values in the range need be covered by the curve.

For any pixel component value in the range of the curve described by this table, the corresponding Y value is the actual physical value for that pixel, in units specified in the Pixel Component Physical Units data element (0018,604C). If the pixel component value is NOT within the range of specified X values for the curve, then no pixel calibration is defined by this region. It may be possible for pixel calibration to be defined by other spatial regions underneath this one, if Region Flags (0018,6016) indicates this region is *Transparent*.

C.8.5.5.1.10 TM-Line Position X_0 , TM-Line Position Y_0, TM-Line Position X_1 ,TM-Line Position Y_1

The TM-Line Position X_0 (0018,603C) and TM-Line Position Y_0 (0018,603E) are the coordinates of the starting point and TM-Line Position X_1 (0018,6040), TM-Line Position Y_1 (0018,6042) are the coordinates of the end point of the TM-line. The coordinate is defined as the displacement, in pixels, from the Reference pixel. Typically used for M-mode line and CW doppler.

C.8.5.5.1.11 Number of Table Entries

The Number of Table Entries (0018,6056) gives the number of entries in the Table of Pixel Values. The number of entries in the Table of Parameter Values is also equal to this number. Pixel Value and Parameter Value tables are used to assign Parameter values to pixels. A pixel is calibrated by finding an entry in the Pixel Value Table that matches its Composite Pixel Code (see Section C.7.6.3.1.1). The offset of this entry is used as an index into the Parameter Value Table. The Parameter value entry at this offset gives the Parameter Value of the Pixel.

Note: If a Composite Pixel Code has no matching value in the Pixel Value Table then there is no unambiguous way to determine the corresponding Parameter Value. A method may exist to determine a valid Parameter Value but the specification of such a method is outside the scope of the DICOM standard. No assumption should be made that linear interpolation will produce a valid result.

C.8.5.5.1.12 Table of Pixel Values

This is a table of unique Pixel Codes (0018,6058). The number of entries in the table is given by Number of Table Entries (0018,6056).

C.8.5.5.1.13 Table of Parameter Values

This is a table of parameter values (0018,605A). The number of table entries is given by Number of Table Entries and the physical units are given by Pixel Component Physical Units (0018,604C). Values may repeat when a parameter value is associated with more than one Composite Pixel Code value.

C.8.5.6 US Image Module

Table C.8-18 specifies the Attributes that describe ultrasound images.

Table C.8-18
US IMAGE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Samples Per Pixel	(0028,0002)	1	Number of samples (planes) in this image. See C.8.5.6.1.12 for specialization
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. See C.8.5.6.1.2 for specialization.
Bits Allocated	(0028,0100)	1	Specifies the intended interpretation of the pixel data. See C.8.5.6.1.13 for specialization.
Bits Stored	(0028,0101)	1	Number of bits allocated for each pixel sample. See C.8.5.6.1.14 for specialization.
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. See C.8.5.6.1.15 for specialization.
Planar Configuration	(0028,0006)	1C	Indicates whether the pixel data are sent color-by-plane or color-by-pixel. Required if Samples per Pixel (0028,0002) has a value greater than 1. See C.8.5.6.1.16 for specialization.

Pixel Representation	(0028,0103)	1	Data representation of pixel samples. See C.8.5.6.1.3 for specialization.
Frame Increment Pointer	(0028,0009)	1C	Contains the Data Element Tag of the attribute which is used as the frame increment in Multi-frame pixel data (see C.7.6.6). Required if Number of Frames is sent. See C.8.5.6.1.4 for specialization.
Image Type	(0008,0008)	2	Image identification characteristics. See C.8.5.6.1.1 for specialization.
Lossy Image Compression	(0028,2110)	1C	Specifies whether an Image has undergone lossy compression. Enumerated Values: 00 = Image has NOT been subjected to lossy compression. 01 = Image has been subjected to lossy compression. See C.7.6.1.1.5 Required if Lossy Compression has been performed on the Image.
Number of Stages	(0008,2124)	2C	Number of Stages in this protocol. Required if image was acquired in a Stage protocol.
Number of Views in Stage	(0008,212A)	2C	Number of views in this Stage. Required if image was acquired in a Stage protocol.
Ultrasound Color Data Present	(0028,0014)	3	This element indicates if any ultrasound color data is present in an image. Enumerated Values: 00 = Ultrasound color data not present in image 01 = Ultrasound color data is present in image. See C.8.5.6.10
Referenced Overlay Sequence	(0008,1130)	3	A Sequence which provides reference to a set of SOP Class/Instance pairs which are related independent Overlays. Uniquely identifies Overlays significantly related to this Image. Zero or more Items may be included in this Sequence. Encoded as sequence of items: (0008,1150) and (0008,1155)
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Overlay Sequence (0008,1130) is sent.

>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Reference Overlay Sequence (0008,1130) is sent.
Referenced Curve Sequence	(0008,1145)	3	A sequence which provides reference to a set of SOP Class/Instance pairs which are related independent Curves. Uniquely identifies Curves significantly related to this Image. Encoded as sequence of items: (0008,1150) and (0008,1155)
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Curve Sequence (0008,1145) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Reference Curve Sequence (0008,1145) is sent.
Stage Name	(0008,2120)	3	A Stage is a particular time slice of a protocol in which a set of images are collected. The names can be free form text. Recommended text for Stress Echo stage names are: PRE-EXERCISE, POST-EXERCISE, PEAK-EXERCISE, RECOVERY, BASELINE, LOW DOSE, PEAK DOSE
Stage Number	(0008,2122)	3	A number that identifies the Stage. Stage Number starts at one.
View Number	(0008,2128)	3	A number that identifies the View. View Number starts at one.
Number of Event Timers	(0008,2129)	3	The number of event timers used at the time of acquisition of a Multi-frame image.
Event Elapsed Time(s)	(0008,2130)	3	An array of values associated with each event timer. Units in milliseconds.
Event Timer Name(s)	(0008,2132)	3	Name that identifies the event timer.
Anatomic Region Sequence	(0008,2218)	3	Sequence of one Item that identifies the anatomic region of interest in this image (i.e. external anatomy, surface anatomy, or general region of the body). See Section C.8.5.6.1.17.
>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the anatomic region. Required if a sequence item is present.

>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if a sequence item is present. Defined Term: 99SDM
>Code Meaning	(0008,0104)	3	The anatomic region that is represented by the Code Value (0008,0100).
>Anatomic Region Modifier Sequence	(0008,2220)	3	Sequence of one or more Items that modifies the anatomic region of interest in this image (i.e. prone, supine, decubitus right). See Section C.8.5.6.1.17.
>>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the anatomic region modifier term. Required if a sequence item is present.
>>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if a sequence item is present. Defined Term: 99SDM
>>Code Meaning	(0008,0104)	3	The anatomic region modifier term that is represented by the Code Value (0008,0100).
Primary Anatomic Structure Sequence	(0008,2228)	3	Sequence of one or more Items that identifies the primary anatomic structure of interest in this image. See Section C.8.5.6.1.18
>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the primary anatomic structure. Required if a sequence item is present.
>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if a sequence item is present. Defined Term: 99SDM
>Code Meaning	(0008,0104)	3	The anatomic structure that is represented by the Code Value (0008,0100).
>Primary Anatomic Structure Modifier Sequence	(0008,2230)	3	Sequence of one or more Items that modifies the primary anatomic structure of interest in this image. See Section C.8.5.6.1.18

>>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the anatomic structure modifier term. Required if a sequence item is present.
>>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if a sequence item is present. Defined Term: 99SDM
>>Code Meaning	(0008,0104)	3	The anatomic structure modifier term that is represented by the Code Value (0008,0100).
Transducer Position Sequence	(0008,2240)	3	Sequence of one or more Items that identifies the transducer position used in this image. See Section C.8.5.6.1.19.
>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the primary transducer position. Required if a sequence item is present.
>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if a sequence item is present. Defined Term: 99SDM
>Code Meaning	(0008,0104)	3	The transducer position that is represented by the Code Value (0008,0100).
> Transducer Position Modifier Sequence	(0008,2242)	3	Sequence of one or more Items that modifies the primary transducer position of interest in this image. See Section C.8.5.6.1.19.
>>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the transducer position modifier term. Required if a sequence item is present.
>>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if a sequence item is present. Defined Term: 99SDM
>>Code Meaning	(0008,0104)	3	The transducer position modifier term that is represented by the Code Value (0008,0100).

Transducer Orientation Sequence	(0008,2244)	3	Sequence of one or more Items that identifies the Transducer Orientation used in this image. See Section C.8.5.6.1.20.
>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the primary Transducer Orientation. Required if a sequence item is present.
>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if a sequence item is present. Defined Term: 99SDM
>Code Meaning	(0008,0104)	3	The transducer orientation that is represented by the Code Value (0008,0100).
> Transducer Orientation Modifier Sequence	(0008,2246)	3	Sequence of one or more Items that modifies the primary Transducer Orientation of interest in this image. See Section C.8.5.6.1.20
>>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the transducer orientation modifier term. Required if a sequence item is present.
>>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if a sequence item is present. Defined Term: 99SDM
>>Code Meaning	(0008,0104)	3	The transducer orientation structure modifier term that is represented by the Code Value (0008,0100).
Trigger Time	(0018,1060)	3	Time interval measured in msec from the start of the R-wave to the beginning of data taking
Nominal Interval	(0018,1062)	3	Average R-R interval used for these data, in msec
Beat Rejection Flag	(0018,1080)	3	Beat length sorting has been applied. Enumerated Values: Y = yes N = no
Low R-R Value	(0018,1081)	3	R-R interval low limit for beat rejection, in msec

High R-R Value	(0018,1082)	3	R-R interval high limit for beat rejection, in msec
Heart Rate	(0018,1088)	3	Beats per minute.
Output Power	(0018,5000)	3	Manufacturer defined character string description of ultrasound output level(s) used in generating a given image. Data may be expressed in dB, %, W/cm^2, etc.
Transducer Data	(0018,5010)	3	Manufacturer defined code or description of ultrasound transducer used.
Transducer Type	(0018,6031)	3	Defined Terms: SECTOR_PHASED SECTOR_MECH SECTOR_ANNULAR LINEAR CURVED LINEAR SINGLE CRYSTAL SPLIT XTAL CWD IV_PHASED IV_ROT XTAL IV_ROT MIRROR ENDOCAV_PA ENDOCAV_MECH ENDOCAV_CLA ENDOCAV_AA ENDOCAV_LINEAR VECTOR_PHASED
Focus Depth	(0018,5012)	3	The depth, from the transducer face, of the manufacturer defined beam focus used for the image, in cm.
Preprocessing Function	(0018,5020)	3	Manufacturer defined description of processing of echo information. Data may include code or description of gain (initial, overall, TGC, dynamic range, etc.), preprocessing, postprocessing, Doppler processing parameters, e.g. cutoff filters, etc., as used in generating a given image.
Mechanical Index	(0018,5022)	3	See C.8.5.6.1.8 for Description.
Bone Thermal Index,	(0018,5024)	3	See C.8.5.6.1.8 for Description.
Cranial Thermal Index	(0018,5026)	3	See C.8.5.6.1.8 for Description.
Soft Tissue Thermal Index	(0018,5027)	3	See C.8.5.6.1.8 for Description.
Soft Tissue-focus Thermal Index	(0018,5028)	3	See C.8.5.6.1.8 for Description.
Soft Tissue-surface Thermal Index	(0018,5029)	3	See C.8.5.6.1.8 for Description.
Depth of Scan Field	(0018,5050)	3	The depth, in mm, from the transducer face to the deepest point included in the displayed image– the field of view.

Image Transformation Matrix	(0018,5210)	3	Transformation Matrix, as described in C.8.5.6.1.9. Used for spatially related images where the relationship includes rotations.
Image Translation Vector	(0018,5212)	3	Translation Vector as described in C.8.5.6.1.9. Used for spatially related images where the relationship includes translations.
Overlay Subtype	(60xx,0045)	3	Defined term which identifies the intended purpose of the ROI Overlay Type. See C.8.5.6.1.11 for specialization.

C.8.5.6.1 US Image Attribute Descriptions

C.8.5.6.1.1 Image Type

For US Images, Image Type (0008,0008) is specified to be Type 2. The Defined Terms for Value 3 are:

ABDOMINAL	BREAST	CHEST
ENDOCAVITARY	ENDORECTAL	ENDOVAGINAL
EPICARDIAL	FETAL HEART	GYNECOLOGY
INTRACARDIAC	INTRAOPERATIVE	INTRAVASCULAR
MUSCULOSKELETAL	NEONATAL HEAD	OBSTETRICAL
OPHTHALMIC	PEDIATRIC	PELVIC
RETROPERITONEAL	SCROTAL	SMALL PARTS
TEE	THYROID	TRANSCRANIAL
TTE	US BIOPSY	VASCULAR

Value 4 is constructed as a modality bit map to allow for a description of multi-modality displays. In using this bit map, the sum of the values of the various modalities will unambiguously determine the constituent modalities.

0001 = 2D Imaging	0002 = M-Mode	0004 = CW Doppler
0008 = PW Doppler	0010 = Color Doppler	0020 = Color M-Mode
0040 = 3D Rendering		

Notes: 1. All Values are hexadecimal encoded as a CS. See PS 3.5.

2. For example, Color Flow with CW spectral Doppler would have a value 4 = 0015. Note that no assumption should be made in Color Doppler or Color M-Mode regarding underlying B or M-Mode, respectively.

C.8.5.6.1.2 Photometric Interpretation

For US Images, Photometric Interpretation (0028,0004) is specified to use the following Defined Terms:

MONOCHROME2	PALETTE COLOR	RGB

ARGB (retired) YBR_FULL YBR_FULL_422
YBR_PARTIAL_422

Note: It is recommended that future implementations should not use ARGB photometric interpretation.

C.8.5.6.1.3 Pixel Representation

For US Images, Pixel Representation (0028,0103) is specified to use the following Enumerated Value:

0000H = unsigned integer

C.8.5.6.1.4 Frame Increment Pointer

For US Multi-frame images, the Attribute Frame Increment Pointer (0028,0009) of the Multi-frame Module (see Section C.7.6.6) is specified by the following Defined Terms:

00180063 = sequencing by Frame Time (0018,1063)

00181065 = sequencing by Frame Time Vector (0018,1065)

C.8.5.6.1.5 Retired

C.8.5.6.1.6 Retired

C.8.5.6.1.7 Retired

C.8.5.6.1.8 Mechanical Index, Bone Thermal Index, Cranial Thermal Index, Soft Tissue Thermal Index

The thermal and/or mechanical indices, when made available by a manufacturer, are defined according to the *Standard for Real-Time Display of Thermal and Mechanical Acoustic Output Indices on Diagnostic Ultrasound Equipment*, a voluntary performance standard jointly published by AIUM and NEMA.

C.8.5.6.1.9 Image Transformation Matrix and Image Translation Vector

In spatially related US images it is necessary to be able to convert data from the (x', y', z') coordinate system of the echo plane into the (x, y, z) coordinate system of the frame of reference. It is assumed that the echo-plane is a right handed, orthogonal Cartesian coordinate system, with its origin at the Reference Pixel as defined in the US Frame Of Reference Module, such that +x' is directed to the right, +y' is directed toward the top of the screen, and +z' is directed out of the screen toward the viewer. From this definition $z' \equiv 0$ everywhere on the echo plane. (x, y, z) is a similar right-handed system. The origin of (x', y', z') lies at the point (x_0, y_0, z_0) in the (x, y, z) system ($\mathbf{x_0}$ in vector notation). Once the appropriate translation has been applied, the two coordinate systems are related by a 3x3 rotation matrix **A**, such that a point **r'** in (x', y', z') may be converted to **r** in ((x, y, z) by a matrix multiplication and translation:

$$\mathbf{r} = \mathbf{A}\mathbf{r}' + \mathbf{x_0}.$$

These two operations may be combined in a single matrix multiplication by appending the translation vector to the rotation matrix:

$$\begin{bmatrix} a_{11} & a_{12} & a_{13} & x_0 \\ a_{21} & a_{22} & a_{23} & y_0 \\ a_{31} & a_{32} & a_{33} & z_0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

Eq C.8-1

Where each a_{ij} represents the cosine of the angle between the ith unit vector of the (x', y', z') system and the jth unit vector of the (x, y, z) system, or i· j. These nine rotation components are not independent, but rather are constrained by the orthonormality condition to

$$\sum_{i=1}^{3} a_{ij} a_{ik} = \delta_{jk}$$

where δ_{jk} is the Kronecker delta function, 0 for j≠k, and 1 for j=k.

Taking advantage of the fact that z' ≡ 0, Eq. C.8-1 can be reduced to:

$$\begin{bmatrix} a_{11} & a_{12} & 0 & x_0 \\ a_{21} & a_{22} & 0 & y_0 \\ a_{31} & a_{32} & 0 & z_0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x' \\ y' \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} x \\ y \\ z \\ \end{bmatrix}$$

Eq C.8-2

The Image Transformation Matrix (0018,5210)shall consist of the direction cosines in the following order:

$$a_{11}, a_{21}, a_{31}, a_{12}, a_{22}, a_{32}.$$

The Image Translation Vector (0018,5212) shall consist of the translation elements from Eq C.8-2 in the following order:

$$x_0, y_0, z_0.$$

The frame of reference (x, y, z) shall be defined by the first image in a spatially related series. Subsequent rotations of θ about x (fan), y (propeller) or z (panorama) shall have the following Image Transformation Matrices:

FAN: $\begin{bmatrix} 1 & 0 \\ 0 & \cos\theta \\ 0 & \sin\theta \end{bmatrix}$ PROP: $\begin{bmatrix} \cos\theta & 0 \\ 0 & 1 \\ -\sin\theta & 0 \end{bmatrix}$ PAN: $\begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \\ 0 & 0 \end{bmatrix}$

The convention used for rotation shall be positive when it appears counterclockwise when looking from the +x axis of rotation to the origin.

C.8.5.6.1.10 Ultrasound Color Data Present

Note: This data element can be used to indicate if an image contains any Ultrasound color data.

For example: Some Ultrasound images may have a Photometric Interpretation equal to RGB but the image will have no color information if R=G=B for all pixels.

For consistency within a particular implementation Monochrome Ultrasound images may be coded using a color photometric interpretation. In that case inclusion of this data element can significantly speed up processing. Since all components are known to be equal only one need

be handled. The enhancements can be significant when compressed Transfer Syntaxes are used.

C.8.5.6.1.11 Overlay Subtype

For US Images, Overlay Subtype (60xx,0045) shall use the following Defined Terms:

ACTIVE 2D/BMODE IMAGE AREA = identification of the active area of a 2D/B-mode image.

C.8.5.6.1.12 Samples Per Pixel

For US Images, Samples Per Pixel (0028,0002) is specified to use the following values for specific Photometric Interpretations:

Table C.8-19
US SAMPLES PER PIXEL

Photometric Interpretation	Samples Per Pixel Value
MONOCHROME2	0001H
RGB	0003H
YBR_FULL	0003H
YBR_FULL_422	0003H
YBR_PARTIAL_422	0003H
PALETTE COLOR	0001H

C.8.5.6.1.13 Bits Allocated

For US Images, Bits Allocated (0028,0100) is specified to use the following values for specific Photometric Interpretations:

Table C.8-20
US BITS ALLOCATED

Photometric Interpretation	Bits Allocated Value
MONOCHROME2	0008H
RGB	0008H
YBR_FULL	0008H
YBR_FULL_422	0008H
YBR_PARTIAL_422	0008H
PALETTE COLOR	0008H - 8 bit palette, or 0010H - 16 bit palette

C.8.5.6.1.14 Bits Stored

For US Images, Bits Stored (0028,0101) is specified to use the following values for specific Photometric Interpretations:

Table C.8-21
US BITS STORED

Photometric Interpretation	Bits Stored Value
MONOCHROME2	0008H
RGB	0008H
YBR_FULL	0008H
YBR_FULL_422	0008H
YBR_PARTIAL_422	0008H
PALETTE COLOR	0008H - 8 bit palette, or 0010H - 16 bit palette

C.8.5.6.1.15 High Bit

For US Images, High Bit (0028,0102) is specified to use the following values for specific Photometric Interpretations:

Table C.8-22
US HIGH BIT

Photometric Interpretation	High Bit Value
MONOCHROME2	0007H
RGB	0007H
YBR_FULL	0007H
YBR_FULL_422	0007H
YBR_PARTIAL_422	0007H
PALETTE COLOR	0007H - 8 bit palette, or 000FH - 16 bit palette

C.8.5.6.1.16 Planar Configuration

For US Images, Planar Configuration (0028,0006) is specified to use the following values for specific Photometric Interpretations:

Table C.8-23
US PLANAR CONFIGURATION

Photometric Interpretation	Planar Configuration Value
RGB	0000H - color-by-pixel, or 0001H - color-by-plane
YBR_FULL	0001H
YBR_FULL_422	0000H
YBR_PARTIAL_422	0000H

C.8.5.6.1.17 Anatomic Region Sequence

The general region of the body (e.g. the anatomic region, organ, or body cavity being examined) may be identified by the Anatomic Region Sequence (0008,2218). Characteristics of the anatomic region being examined, such as its orientation relative to gravity (e.g. prone, supine, semi-erect), sub-region (e.g. medial, lateral, superior, inferior, lobe, quadrant), and laterality (e.g. right, left, both), and so on, may be refined by the Anatomic Region Modifier Sequence (0008,2220).

If the Coding Scheme Designator (0008,0102) for the Anatomic Region Sequence (0008,2218) is 99SDM, then the Code Value (0008,0100) for the Anatomic Region Sequence (0008,2218) shall be the Source UID value from a SNOMED DICOM Microglossary record. This record shall have Source value of “SNMI”, any Context value, and a Semantic Type value of “anatomic region or structure”.

If the Coding Scheme Designator (0008,0102) for the Anatomic Region Modifier Sequence (0008,2220) is 99SDM, then the Code Value (0008,0100) for the Anatomic Region Modifier Sequence (0008,2220) shall be the Source UID value from a SNOMED DICOM Microglossary record. This record shall have Source value of “SNMI”, any Context value, and a Semantic Type value of “anatomic region modifier”.

Note: 1) These Data Elements allow the specification of the information encoded by the Body Part Examined (0018,0015) and Patient Position (0018,5100) Data Attributes (in the General Series Module) in a more robust, consistent way.

2) Anatomic Region Sequence (0008,2218) and Anatomic Region Modifier Sequence (0008,2220) specify value 99SDM from Annex D for Coding Scheme Designator. It is expected that this value will evolve when Coding Scheme Designator UIDs are available from a registration authority.

C.8.5.6.1.18 Primary Anatomic Structure Sequence

The specific anatomic structures of interest within the image (e.g. a particular artery within the anatomic region) is identified by the Primary Anatomic Structure Sequence (0008,2228). Characteristics of the anatomic structure, such as its location (e.g. subcapsular, peripheral, central), configuration (e.g. distended, contracted), and laterality (e.g. right, left, both), and so on, may be refined by the Primary Anatomic Structure Modifier Sequence (0008,2230).

If the Coding Scheme Designator (0008,0102) for the Primary Anatomic Structure Sequence (0008,2228) is 99SDM, then the Code Value (0008,0100) for the Primary Anatomic Structure Sequence (0008,2228) shall be the Source UID value from a SNOMED DICOM Microglossary record. This record shall have Source value of “SNMI”, any Context value, and a Semantic Type value of “anatomic region or structure”.

If the Coding Scheme Designator (0008,0102) for the Primary Anatomic Structure Modifier Sequence (0008,2230) is 99SDM, then the Code Value (0008,0100) for the Primary Anatomic Structure Modifier Sequence (0008,2230) shall be the Source UID value from a SNOMED DICOM Microglossary record. This record shall have Source value of “SNMI”, any Context value, and a Semantic Type value of “anatomic structure modifier”.

Note: 1) These Data Elements are intended to replace the Anatomic Structure (0008,2208) Data Element.

2) Primary Anatomic Structure Sequence (0008,2228) and Primary Anatomic Structure Modifier Sequence (0008,2230) specify value 99SDM from Annex D for Coding Scheme Designator. It is expected that this value will evolve when Coding Scheme Designator UIDs are available from a registration authority.

C.8.5.6.1.19 Transducer Position Sequence

If the Coding Scheme Designator (0008,0102) for the Transducer Position Sequence (0008,2240) is 99SDM, then the Code Value (0008,0100) for the Transducer Position Sequence (0008,2240) shall be the Source UID value from a SNOMED DICOM Microglossary record. This record shall have Source value of “SNMI”, any Context value, and a Semantic Type value of “transducer position”.

If the Coding Scheme Designator (0008,0102) for the Transducer Position Modifier Sequence (0008,2242) is 99SDM, then the Code Value (0008,0100) for the Transducer Position Modifier Sequence (0008,2242) shall be the Source UID value from a SNOMED DICOM Microglossary record. This record shall have Source value of “SNMI”, any Context value, and a Semantic Type value of “transducer position modifier”.

Note: 1) These Data Elements are intended to replace the Transducer Position (0008,2200) Data Element.

2) Transducer Position Sequence (0008,2240), Transducer Position Modifier Code Sequence (0008,2242) specify value 99SDM from Annex D for Coding Scheme Designator. It is expected that this value will evolve when Coding Scheme Designator UIDs are available from a registration authority.

C.8.5.6.1.20 Transducer Orientation Sequence

If the Coding Scheme Designator (0008,0102) for the Transducer Orientation Sequence (0008,2244) is 99SDM, then the Code Value (0008,0100) for the Transducer Orientation Sequence (0008,2244) shall be the Source UID value from a SNOMED DICOM Microglossary record. This record shall have Source value of “SNMI”, any Context value, and a Semantic Type value of “transducer orientation”.

If the Coding Scheme Designator (0008,0102) for the Transducer Orientation Modifier Sequence (0008,2246) is 99SDM, then the Code Value (0008,0100) for the Transducer Orientation Modifier Sequence (0008,2246) shall be the Source UID value from a SNOMED DICOM Microglossary record. This record shall have Source value of “SNMI”, any Context value, and a Semantic Type value of “transducer orientation modifier”.

Note: 1) These Data Elements are intended to replace the Transducer Orientation(0008,2204) Data Element.

2) Transducer Orientation Sequence (0008,2244), Transducer Orientation Modifier Code Sequence (0008,2246) specify value 99SDM from Annex D for Coding Scheme Designator. It is expected that this value will evolve when Coding Scheme Designator UIDs are available from a registration authority.

C.8.6 Secondary Capture Modules

C.8.6.1 SC Equipment Module

This Module describes equipment used to convert images into a DICOM format.

Table C.8-24
SC IMAGE EQUIPMENT MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Conversion Type	(0008,0064)	1	Describes the kind of image conversion. Defined Terms : DV = Digitized Video DI = Digital Interface DF = Digitized Film WSD = Workstation
Modality	(0008,0060)	3	Source equipment for the image. See C.7.3.1.1.1 for Enumerated Values.
Secondary Capture Device ID	(0018,1010)	3	User defined identification of the device that converted the image
Secondary Capture Device Manufacturer	(0018,1016)	3	Manufacturer of the Secondary Capture Device
Secondary Capture Device Manufacturer's Model Name	(0018,1018)	3	Manufacturer's model number of the Secondary Capture Device
Secondary Capture Device Software Version	(0018,1019)	3	Manufacturer's designation of software version of the Secondary Capture Device
Video Image Format Acquired	(0018,1022)	3	Original format of the captured video image (e.g. NTSC, PAL, Videomed-H)
Digital Image Format Acquired	(0018,1023)	3	Additional information about digital interface used to acquire the image

Notes: 1. The Attributes specified in the General equipment Module (see Table C.7-6) describe the equipment which created the image being captured. The Attributes of the SC Image Equipment Module define the equipment that captured the image. The following table illustrate typical scenarios for different conversion types:

Conversion Type (0008,0064)	General Equipment	Secondary Capture Equipment
Digitized Video (DV)	The equipment generating the video signal.	The equipment digitizing the video signal.
Digital Interface (DI)	The equipment on the sending side of the digital interface.	The equipment on the receiving side of the digital interface.
Digitized Film (DF)	The equipment which created the film.	The equipment digitizing the film.
Workstation (WSD)	Application dependent, but often the equipment which placed the image on the workstation screen, or created the modified image.	The equipment which captured the image from the screen, or which placed the modified image into a DICOM SOP Instance.

2. The Attribute Modality (0008,0060) specified in the General Series Module (see Table C.7-4) has been specialized by this Module and is defined as a Type 3 Attribute.

C.8.6.2 SC Image Module

Table C.8-25 contains IOD Attributes that describe Secondary Capture Images.

Table C.8-25
SC IMAGE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Date of Secondary Capture	(0018,1012)	3	The date the Secondary Capture Image was captured.
Time of Secondary Capture	(0018,1014)	3	The time the Secondary Capture Image was captured.

Note: The Attributes specified in the General Image Module (see Table C.7-7) describe this image (ie. the secondary capture image). For example, Image Number (0020,0013) is the image number of the secondary capture image. Source Image Sequence (0008,2112) may reference the DICOM image from which this image was generated.

C.8.7 X-Ray Modules

This Section describes Modules used in one or more X-Ray IODs. These Modules contain Attributes that are specific to X-Ray images.

C.8.7.1 X-Ray Image Module

Table C.8-26
X-RAY IMAGE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Frame Increment Pointer	(0028,0009)	1C	Required if Multi-Frame Image. Contains the Data Element Tag of the attribute which is used as the Frame increment in Multi-frame image pixel data (See C.7.6.6). Specialized for X-Ray as Enumerated Value: 00181063H = Frame Time (0018,1063); 00181065H = Frame Time Vector (0018,1065).
Lossy Image Compression	(0028,2110)	1C	Specifies whether an Image has undergone lossy compression. Enumerated Values: 00 = Image has NOT been subjected to lossy compression. 01 = Image has been subjected to lossy compression. See C.7.6.1.1.5 Required if Lossy Compression has been performed on the Image.
Image Type	(0008,0008)	1	Image identification characteristics. See C.8.7.1.1.1 for specialization.
Pixel Intensity Relationship	(0028,1040)	1	The relationship between the Pixel sample values and the X-Ray beam intensity. See Section C.8.7.1.1.2.
Samples per Pixel	(0028,0002)	1	Number of samples (color planes) in this image shall have a value of 1.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. Only MONOCHROME2 may be used.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. See Section C.8.7.1.1.6.
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. See Section C.8.7.1.1.7.

High Bit	(0028,0102)	1	Most significant bit for pixel sample data. See Section C.8.7.1.1.8.
Pixel Representation	(0028, 0103)	1	Data representation of the pixel samples. Shall have the value: 0000H = Unsigned Integer.
Scan Options	(0018,0022)	3	Parameters of scanning sequence. See Section C. 8.7.1.1.4.
Anatomic Region Sequence	(0008,2218)	3	Sequence of one Item that identifies the anatomic region of interest in this image (i.e. external anatomy, surface anatomy, or general region of the body). This anatomic region is placed on the table for examination. See C.8.7.1.1.10.
>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the anatomic region. Required if Anatomic Region Sequence (0008,2218) is sent.
>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Anatomic Region Sequence (0008,2218) is sent. Defined Term: 99SDM
>Code Meaning	(0008,0104)	3	The anatomic region that is represented by the Code Value (0008,0100). May be present only if Anatomic Region Sequence (0008,2218) is sent.
>Anatomic Region Modifier Sequence	(0008,2220)	3	Sequence of one or more Items that modifies the anatomic region of interest in this image (i.e. prone, supine, decubitus right). May be present only if Anatomic Region Sequence (0008,2218) is sent. See C.8.7.1.1.10.
>>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the anatomic region modifier term. Required if Anatomic Region Modifier Sequence (0008,2220) is sent.

>>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Anatomic Region Modifier Sequence (0008,2220) is sent. Defined Term: 99SDM
>>Code Meaning	(0008,0104)	3	The anatomic region modifier term that is represented by the Code Value (0008,0100). . May be present only if Anatomic Region Modifier Sequence (0008,2220) is sent.
Primary Anatomic Structure Sequence	(0008,2228)	3	Sequence of one or more Items that identifies the primary anatomic structure of interest in this image. See C.8.7.1.1.11.
>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the primary anatomic structure. Required if Primary Anatomic Structure Sequence (0008,2228) is sent.
>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Primary Anatomic Structure Sequence (0008,2228) is sent. Defined Term: 99SDM
>Code Meaning	(0008,0104)	3	The anatomic structure that is represented by the Code Value (0008,0100). May be present only if Primary Anatomic Structure Sequence (0008,2228) is sent.
>Primary Anatomic Structure Modifier Sequence	(0008,2230)	3	Sequence of one or more Items that modifies the primary anatomic structure of interest in this image. May be present only if Primary Anatomic Structure Sequence (0008,2228) is sent. See C.8.7.1.1.11.
>>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the anatomic structure modifier term. Required if Primary Anatomic Structure Modifier Sequence (0008,2230) is sent.

>>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Primary Anatomic Structure Modifier Sequence (0008,2230) is sent. Defined Term: 99SDM
>>Code Meaning	(0008,0104)	3	The anatomic structure modifier term that is represented by the Code Value (0008,0100). May be present only if Primary Anatomic Structure Modifier Sequence (0008,2230) is sent.
R Wave Pointer	(0028,6040)	3	Marks the location(s) of the R Wave in the cardiac cycles by referencing frame numbers; frame numbers begin with 1.
Reference Image Sequence	(0008,1140)	1C	A sequence which provides reference to a set of Image SOP Class/Instance identifying other images significantly related to this image. Shall be used to relate each plane to the corresponding plane if Image Type (0008,0008) Value 3 is BIPLANE A or BIPLANE B. Encoded as a sequence of items: (0008,1150) and (0008,1155). When relating to the corresponding plane of a Biplane acquisition, only a single item shall be present.
> Reference SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Image Sequence (0008,1140) is present.
> Reference SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Image Sequence (0008,1140) is present.
Derivation Description	(0008,2111)	3	A text description of how this image was derived. See C.8.7.1.1.5 for further explanation.
Acquisition Device Processing Description	(0018,1400)	3	Indicates any visual processing performed on the images prior to exchange. See Section C.8.7.1.1.3.
Calibration Image	(0050,0004)	3	Indicates whether a reference object (phantom) of known size is present in the image and was used for calibration. Enumerated Values: YES NO Device is identified using the Device module. See C.7.6.12.

C.8.7.1.1 X-Ray Image Attribute Descriptions

C.8.7.1.1.1 Image Type

The Image Type attribute identifies important image characteristics in a multiple valued data element. For X-Ray, Image Type is specialized as follows:

a. Value 1 shall identify the Pixel Data Characteristics in accordance with Section C.7.6.1.1.2; Enumerated Values are: ORIGINAL and DERIVED;

b. Value 2 shall identify the Patient Examination Characteristics in accordance with Section C.7.6.1.1.2; Enumerated Values are: PRIMARY and SECONDARY.

Note: X-Ray images generally use PRIMARY value for images captured from patient exposure.

c. Value 3 shall identify the image set in terms of the imaging planes. Enumerated Values are:

SINGLE PLANE	Image is a single plane acquisition;
BIPLANE A	Image is the first plane (e.g., Frontal) of a Bi-plane acquisition, collected in a single plane IOD (i.e., the Bi-Plane Sequence Module is not included in the IOD);
BIPLANE B	Image is the second plane (e.g., Lateral) of a Bi-plane acquisition, collected in a single plane IOD (i.e., the Bi-Plane Sequence Module is not included in the IOD);
BIPLANE	Image is both planes of a Bi-plane acquisition (frame data from the A and B planes alternate), collected in a double plane IOD (i.e., the Bi-Plane Sequence Module is included in the IOD).

d. Other Values are implementation specific (optional).

C.8.7.1.1.2 Pixel Intensity Relationship

Pixel Intensity Relationship (0028,1040) shall identify the relationship of the pixel values to the X-Ray beam intensity. Defined terms are:

LIN	Approximately proportional to X-Ray beam intensity;
LOG	Non-linear " Log Function"; A Modality LUT shall be included with the image to allow it to be scaled back to its proportional value to X-Ray beam intensity;
DISP	Ready to be displayed; A Modality LUT may be included with the image to allow it to be scaled back to its proportional value to X-Ray beam intensity. The Attribute Acquisition Device Processing Description may be used to provide some indication on the pre-processing performed to create the ready to be displayed image.

C.8.7.1.1.3 Acquisition Device Processing Description

Acquisition Device Processing Description (0018,1400) provides some indication in human readable text of the digital processing on the images before exchange. Examples of this processing are: edge enhanced, subtracted, time filtered, gamma corrected, convolved (spatially filtered).

C.8.7.1.1.4 Scan Options

The Scan Options attribute identifies any acquisition technique which was used during the acquisition of the image. Defined Terms are:

EKG	EKG Event Trigger
PHY	Physiological Event Trigger
TOMO	Tomography
CHASE	Bolus Chasing
STEP	Stepping
ROTA	Rotation

C.8.7.1.1.5 Derivation Description

If an Image is identified to be a Derived image (see C.8.9.1.1.1 Image Type), Derivation Description (0008,2111) is an optional and implementation specific text description of the way the image was derived from an original image. As applied to X-Ray images, it may be used to describe derivation operations such as edge enhancement, temporal filtering, digital subtraction, or other linear and non-linear transformations.

C.8.7.1.1.6 Bits Allocated

For X-Ray Images, Bits Allocated (0028,0100) shall have the Enumerated Value of 8 or 16.

C.8.7.1.1.7 Bits Stored

For X-Ray Images, Bits Stored (0028,0101) shall have the Enumerated Values of 8, 10, 12, or 16.

C.8.7.1.1.8 High Bit

For X-Ray Images, High Bit (0028,0102) shall have the Enumerated Value of one less than the value in Bit Stored.

C.8.7.1.1.9 Synchronization of Frame and Curve Times

If a Curve is present and of type ECG, pressure, physiological, respiration, time activity curve, the origin of the coordinate start time (50xx, 0112) shall be the time of frame 1.

C.8.7.1.1.10 Anatomic Region

The general region of the body (e.g. the anatomic region, organ, or body cavity being examined) may be identified by the Anatomic Region Sequence (0008,2218). Characteristics of the anatomic region being examined, such as its orientation relative to gravity (e.g. prone, supine, semi-erect), sub-region (e.g. medial, lateral, superior, inferior, lobe, quadrant), and laterality (e.g. right, left, both), and so on, may be refined by the Anatomic Region Modifier Sequence (0008,2220). These sequences utilize coding triplet encoding to reference anatomic and modifier terms from a Coding Scheme (e.g. SNOMED).

Code Values (0008,0100) for the Anatomic Region Sequence (0008,2218) shall be selected from the SNOMED/DICOM Microglossary terms of semantic type Anatomic Region or Structure Topography module when the Coding Scheme Designator (0008,0102) is 99SDM.

Code Values (0008,0100) for the Anatomic Region Modifier Sequence (0008,2220) shall be selected from the SNOMED/DICOM Microglossary terms of semantic type Anatomic Region Modifier General Linkage/Modifiers module when the Coding Scheme Designator (0008,0102) is 99SDM.

Note: These Data Elements allow the specification of the information encoded by the Body Part Examined (0018,0015) and Patient Position (0018,5100) Data Attributes (in the General Series Module) in a more robust, consistent way.

C.8.7.1.1.11 Primary Anatomic Structure

The specific anatomic structures of interest within the image (e.g. a particular artery within the anatomic region) is identified by the Primary Anatomic Structure Sequence (0008,2228). Characteristics of the anatomic structure, such as its location (e.g. subcapsular, peripheral, central), configuration (e.g. distended, contracted), and laterality (e.g. right, left, both), and so on, may be refined by the Primary Anatomic Structure Modifier Sequence (0008,2230). These sequences utilize triplet encoding to reference anatomic and modifier terms from a Coding Scheme (e.g. SNOMED).

Code Values (0008,0100) for the Primary Anatomic Structure Sequence (0008,2228) shall be selected from the SNOMED/DICOM Microglossary terms of semantic type Anatomic Region or Structure Topography module when the Coding Scheme Designator (0008,0102) is 99SDM.

Code Values (0008,0100) for the Primary Anatomic Structure Modifier Sequence (0008,2230) shall be selected from the SNOMED/DICOM terms of semantic type Anatomic Structure Modifier Microglossary General Linkage/Modifiers module when the Coding Scheme Designator (0008,0102) is 99SDM.

Note: These Data Elements are intended to replace the Anatomic Structure (0008,2208) Data Element.

C.8.7.2 X-Ray Acquisition ModuleC.8-27

X-RAY ACQUISITION MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
KVP	(0018,0060)	2	Peak kilo voltage output of the X-Ray generator used.
Radiation Setting	(0018,1155)	1	Identify the general level of X-Ray dose exposure. Enumerated values are: SC = low dose exposure generally corresponding to fluoroscopic settings (e.g. preparation for diagnostic quality image acquisition); GR = high dose for diagnostic quality image acquisition (also called digital spot or cine);
X-Ray Tube Current	(0018,1151)	2C	X-Ray Tube Current in mA. Required if Exposure (0018,1152) is not present.
Exposure Time	(0018,1150)	2C	Duration of X-Ray exposure in msec. See 8.7.2.1.1. Required if Exposure (0018,1152) is not present.
Exposure	(0018,1152)	2C	The product of exposure time and X-Ray Tube Current expressed in mAs. Required if either Exposure Time (0018,1150) or X-Ray Tube Current (0018,1151) are not present.
Grid	(0018,1166)	3	Identify the grid. Defined Terms are: IN = A Grid is positioned; NONE = No Grid is used.
Average Pulse Width	(0018,1154)	3	Average width of X-Ray pulse in msec.
Radiation Mode	(0018,115A)	3	Specifies X-Ray radiation mode. Defined Terms: CONTINUOUS PULSED
Type of Filters	(0018,1161)	3	Type of filter(s) inserted into the X-Ray beam (e.g. wedges).
Intensifier Size	(0018,1162)	3	Diameter of X-Ray intensifier in mm
Field of View Shape	(0018,1147)	3	Shape of the Image Intensifier Field of View. See C.8.7.2.1.2. Defined Terms are: ROUND RECTANGLE
Field of View Dimension(s)	(0018,1149)	3	Dimensions of the Image Intensifier Field of View in mm. If Rectangle, row dimension followed by column; if Round, diameter.

Imager Pixel Spacing	(0018,1164)	3	Physical distance measured at the front plane of the Image Receptor housing between the center of each pixel specified by a numeric pair - row spacing value(delimiter) column spacing value in mm.
Focal Spot	(0018,1190)	3	Nominal focal spot size in mm used to acquire this image.
Image Area Dose Product	(0018,115E)	3	X-Ray dose, measured in dGy*cm*cm, to which the patient was exposed for the acquisition of this image plus any non-digitally recorded fluoroscopy which may have been performed to prepare for the acquisition of this image. Note: The sum of the Image Area Dose Product of all images of a Series or a Study may not result in the actual area dose product to which the patient was exposed.

C.8.7.2.1 X-Ray Acquisition Attribute Descriptions

C.8.7.2.1.1 Exposure Time

Exposure time is the cumulative time the patient received X-Ray exposure during this image (Multi-frame image acquisition). Calculation is pulse width * number of frames.

C.8.7.2.1.2 Field of View

The Field of View Attribute describes the shape and dimensions of the Image Intensifier Field of View (zoom mode). This could be further restricted by the Collimator. See Section C.8.7.3.

C.8.7.3 X-Ray Collimator

An X-Ray Collimator is a device placed close to the X-Ray Source to restrict the span of the X-Ray beam. It is often made of lead shutters. Figure C.8-1 presents in a graphical form its relationship with the Field Of View Dimensions (0018,1149) and the Intensifier Size (0018,1162) defined in Section C.8.7.2.

Geometry of the collimator is specified with respect to a row and column coordinate system where the origin is the upper left hand pixel. This origin is specified by the values 1,1 for row/column. A row coordinate represent a number of raw spacing (vertical) and a column coordinate represents a column spacing (horizontal). Up to three different collimator shapes may be used and superimposed.

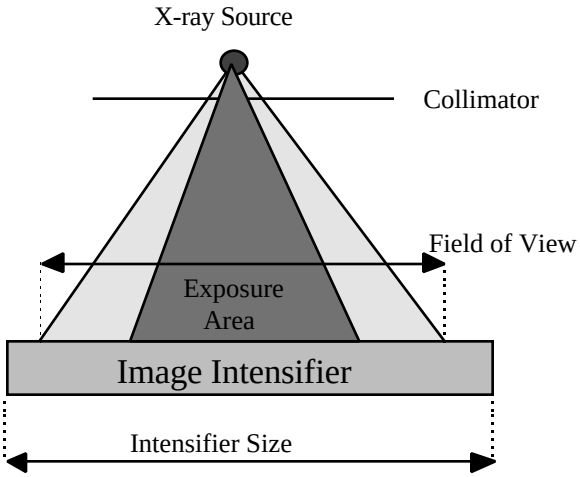


Figure C.8-1
Relationships of X-Ray Collimator

Table C.8-28
X-RAY COLLIMATOR MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Collimator Shape	(0018,1700)	1	Shape(s) of the collimator. Enumerated Values: RECTANGULAR CIRCULAR POLYGONAL This multi-valued Attribute shall contain at most one of each Enumerated Value.
Collimator Left Vertical Edge	(0018,1702)	1C	Required if Collimator Shape (0018,1700) is RECTANGULAR. Location of the left edge of the rectangular collimator with respect to pixels in the image given as column.

Collimator Right Vertical Edge	(0018,1704)	1C	Required if Collimator Shape (0018,1700) is RECTANGULAR. Location of the right edge of the rectangular collimator with respect to pixels in the image given as column.
Collimator Upper Horizontal Edge	(0018,1706)	1C	Required if Collimator Shape (0018,1700) is RECTANGULAR. Location of the upper edge of the rectangular collimator with respect to pixels in the image given as row.
Collimator Lower Horizontal Edge	(0018,1708)	1C	Required if Collimator Shape (0018,1700) is RECTANGULAR. Location of the lower edge of the rectangular collimator with respect to pixels in the image given as row.
Center of Circular Collimator	(0018,1710)	1C	Required if Collimator Shape (0018,1700) is CIRCULAR. Location of the center of the circular collimator with respect to pixels in the image given as row and column.
Radius of Circular Collimator	(0018,1712)	1C	Required if Collimator Shape (0018,1700) is CIRCULAR. Radius of the circular collimator with respect to pixels in the image given as a number of pixels along the row direction.
Vertices of the Polygonal Collimator	(0018,1720)	1C	Required if Collimator Shape (0018,1700) is POLYGONAL. Multiple Values where the first set of two values are: row of the origin vertex; column of the origin vertex. Two or more pairs of values follow and are the row and column coordinates of the other vertices of the polygon collimator. Polygon collimators are implicitly closed from the last vertex to the origin vertex are shall be non-intersecting polygons.

C.8.7.4 X-Ray Table Module

Table C.8-29 contains Attributes that describe X-Ray images acquired with movement of the patient imaging table.

Table C.8-29
X-RAY TABLE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Table Motion	(0018,1134)	2	Defined terms: STATIC DYNAMIC

Table Vertical Increment	(0018,1135)	2C	Incremental change in Vertical position of the table relative to first frame of Multi-frame image given in mm. Required if Table Motion is DYNAMIC.
Table Longitudinal Increment	(0018,1137)	2C	Incremental change in Longitudinal position of the table relative to first frame of Multi-frame image in mm. Table motion towards LAO is positive. Required if Table Motion is DYNAMIC.
Table Lateral Increment	(0018,1136)	2C	Incremental change in Lateral position of the table relative to first frame of Multi-frame image given in mm. Table motion towards CRA is positive. Required if Table Motion is DYNAMIC.
Table Angle	(0018,1138)	3	Angle of table plane in degrees relative to horizontal plane [Gravity plane]. Positive values indicate that the head of the table is upwards.

C.8.7.4.1 X-Ray Table Attribute Descriptions

C.8.7.4.1.1 Table Motion Increments

The table moves the Patient with respect to the imaging chain. This is being tracked as a motion of the imaging chain with respect to a coordinate system attached to the patient (assumption is that the patient does not move with respect to the table). The coordinate system origin is fixed with respect to the patient at the time of the first frame. The X-axis is increasing to the left hand side of the patient. The y-axis is increasing to the posterior side of the patient. The Z-axis is increasing toward the head of the patient. The X and Z axis as drawn in Figure C.8-2 are parallel to the Patient Plane.

Note: Table motion causes the apparent locus of imaging to move in the opposite direction. For instance, with table motion towards LAO, the area of the patient imaged moves toward RAO.

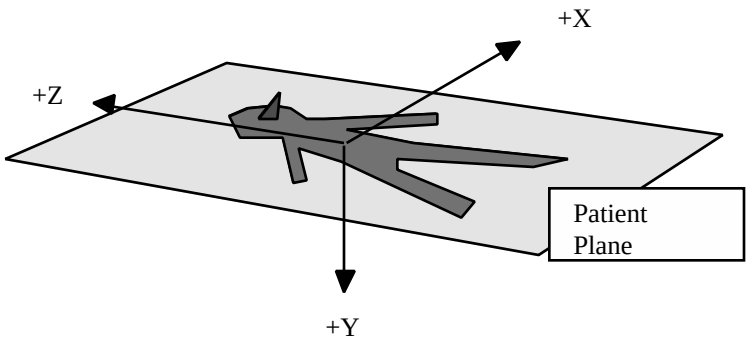


Figure C.8-2
Table Motion Vector Coordinates

C.8.7.5 XA Positioner Module

Table C.8-30 contains IOD Attributes that describe a c-arm positioner typically used in acquiring X-Ray Angiographic Images. The coordinate system used to track the positioner is defined in reference to the patient. The definition of coordinates with respect to the equipment is not supported. Furthermore, this module does not describe the movement of the Patient.

Note: The scope of the XA IOD is to address images produced on acquisition equipment equipped with an X-Ray source and an image Receptor positioned by what is general called a c-arm For clinical areas other than Angiography which are using a c-arm to position the X-Ray source and image receptor (e.g. Interventional Procedures and Myelography and Biopsy/Localization), the X-Ray Angiography Image Object should be also used. Although the object is optimized for c-arm systems, it may also be used by other systems which support a similar coordinate system, such as some RF systems.

Table C.8-30
XA POSITIONER MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Distance Source to Patient	(0018,1111)	3	Distance in mm from source to isocenter (center of field of view).
Distance Source to Detector	(0018,1110)	3	Distance in mm from source to detector center.
Estimated Radiographic Magnification Factor	(0018,1114)	3	Ratio of Source Image Distance (SID) over Source Object Distance (SOD).
Positioner Motion	(0018,1500)	2C	Used to describe the activity of the imaging devices. Defined terms: DYNAMIC, STATIC. Required if Multi-frame data. See C.8.7.5.1.1.
Positioner Primary Angle	(0018,1510)	2	Position of the X-Ray Image Intensifier about the patient from the RAO to LAO direction where movement from RAO to vertical is positive. See C.8.7.5.1.2.
Positioner Secondary Angle	(0018,1511)	2	Position of the X-Ray Image Intensifier about the patient from the CAU to CRA direction where movement from CAU to vertical is positive. See C.8.7.5.1.2
Positioner Primary Angle Increment	(0018,1520)	2C	Incremental change in primary positioner angle for each frame. See C.8.7.5.1.3. Required if Positioner Motion is DYNAMIC.
Positioner Secondary Angle Increment	(0018,1521)	2C	Incremental change in secondary positioner angle for each frame. See C.8.7.5.1.3. Required if Positioner Motion is DYNAMIC.

Detector Primary Angle	(0018,1530)	3	Angle of the X-Ray beam in the row direction in degrees relative to the normal to the detector plane. Positive values indicate that the X-Ray beam is tilted towards higher numbered columns. Negative values indicate that the X-Ray beam is tilted towards lower numbered columns. See C.8.7.5.1.4.
Detector Secondary Angle	(0018,1531)	3	Angle of the X-Ray beam in the column direction in degrees relative to the normal to the detector plane. Positive values indicate that the X-Ray beam is tilted towards lower numbered rows. Negative values indicate that the X-Ray beam is tilted towards higher numbered rows. See C.8.7.5.1.4.

C.8.7.5.1 XA Positioner Attribute Descriptions

C.8.7.5.1.1 Positioner Motion

Positioner Motion attribute is STATIC if the imaging table moves during a multi-frame acquisition, but the X-Ray positioner do not move.

Note: If the positioner undergoes translation (non-rotational movement) during the acquisition, then that motion shall be described by an opposite table motion (See Section C.8.7.4).

C.8.7.5.1.2 Positioner Primary and Secondary Angles

The definitions of Positioner Angles shall be with respect to the patient as illustrated in Figures C.8-3 and C.8-4 Zero degree is referenced to the origin perpendicular to the patient's chest. The Positioner Primary Angle definition is like longitude (in the equatorial plan); the Positioner Secondary Angle definition is like latitude (in the sagittal plane). The Positioner Angle attributes apply to the first frame of a multi-frame image. The valid range of Primary Positioner Angle is -180 to +180 degrees and the Secondary Positioner Angle range is -90 to + 90 degrees.

The Patient Plane is defined by the isocenter of the imaging device and slices through the patient such that it is perpendicular to the sagittal plane of the body. The Primary Axis of rotation is defined at the intersection of the Patient Plane and of the Sagittal Plane. The Positioner Primary Angle is defined in the transaxial plane at the isocenter with zero degrees in the direction perpendicular to the patient's chest and + 90 degrees at the Patient left hand side (LAO) and -90 at the Patient right hand side (RAO). The valid range of Primary Positioner Angle is -180 to +180 degrees.

The Secondary Axis is in the Patient Plane and is perpendicular to the Primary Axis at the isocenter. The Positioner Secondary Angle is defined in the Sagittal Plane at the isocenter with zero degrees in the direction perpendicular to the patient's chest. +90 degrees corresponds to the cranial direction. The Secondary Positioner Angle range is -90 to + 90 degrees.

At a 0 angle for both the Primary Angle (0018,1510) and Secondary Angle (0018,1511), the patient faces the Image Intensifier.

The Positioner Primary Angle (0018,1510) and Secondary Angle (0018,1511) apply to the first frame of a multi-frame image.

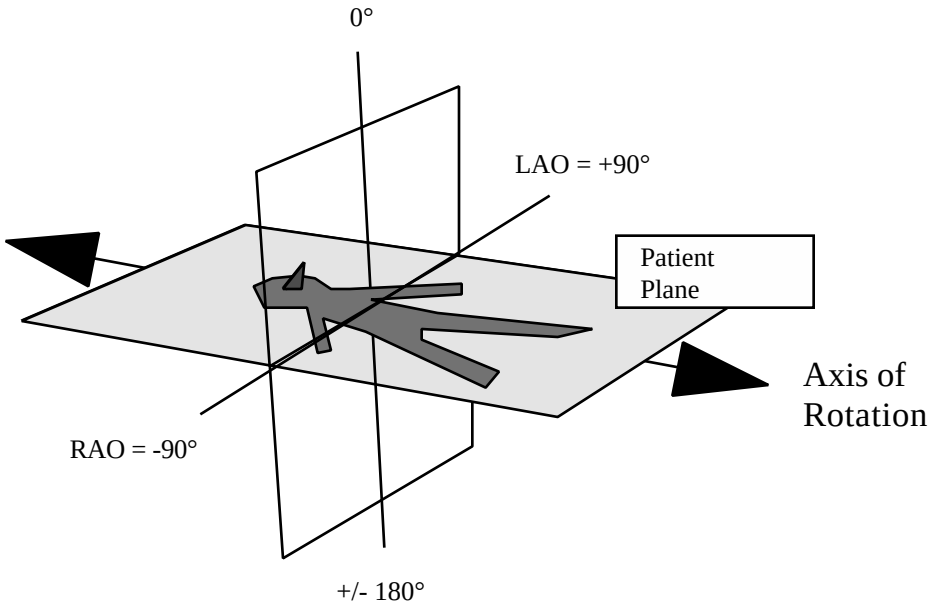


Figure C.8-3
Positioner Primary Angle

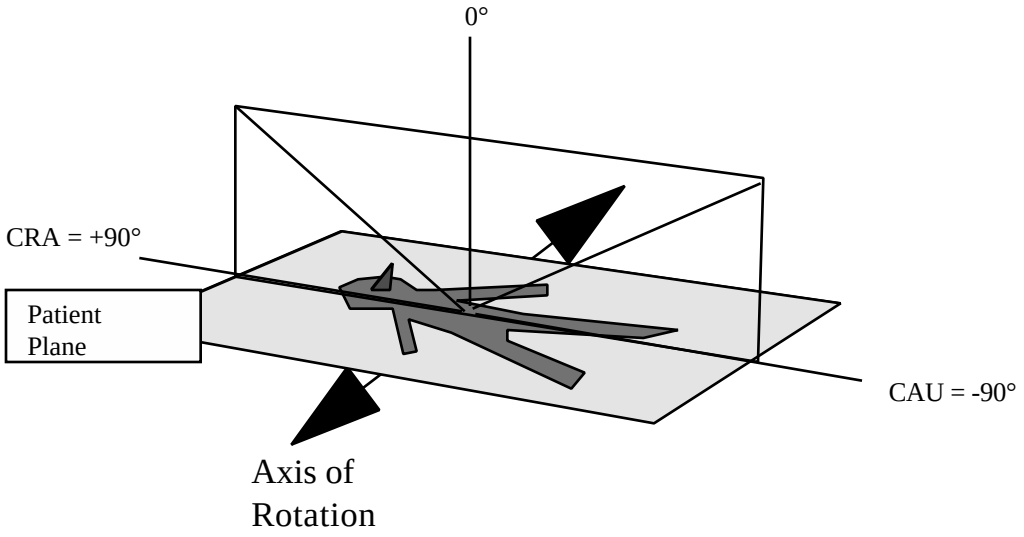


Figure C.8-4
Positioner Secondary Angle

C.8.7.5.1.3 Positioner Angle Increments

If the positioner angles change during acquisition of a multi-frame image, the Positioner Angle Increment attributes describe the angular change per frame.

If the change in positioner angle is nominally constant for each frame, these fields may contain a single value of the average angular change per frame. Alternatively, the fields may contain a vector of offsets from the (initial) Positioner Angle attributes, with one value for each frame in the multi-frame image. The number of values in the Positioner Angle Increment attributes must be one, or must be equal to the Number of Frames attribute (0028,0008) in the Multi-Frame Module (see Section C.7.6.6).

Note: It is permissible to generate a vector of the absolute positioner angles in the Positioner Angle Increment attributes, and set the Positioner Primary and Secondary Angle attributes to value 0.

C.8.7.5.1.4 Detector Primary and Secondary Angles

Detector Angles are defined in a fashion similar to the positioner angles, except that the angle of the central x-ray beam vector is relative to the detector plane rather than the patient plane. The central x-ray beam vector is defined as the vector from the x-ray source through the isocenter to the detector plane. Zero degree is referenced to the normal to the detector plane pointing away from the x-ray source. The Detector Angle attributes apply to the first frame of a multi-frame image. The valid range of the Detector Angles is -90 to + 90 degrees.

The Primary Axis of rotation is defined along the line in the column direction of the detector plane which intersects the central x-ray beam vector. The Detector Primary Angle is defined in the plane perpendicular to the Primary Axis of rotation at the point where the central x-ray beam vector intersects the detector plane, with zero degrees in the direction normal to the detector plane and -90 degrees at the left hand side of the image (i.e., toward column 1) and +90 at the right hand side of the image (i.e., toward the highest numbered column). The valid range of Primary Detector Angle is -90 to +90 degrees.

The Secondary Axis is in the detector plane and is perpendicular to the Primary Axis at the intersection of the beam vector with the detector plane (i.e., it is along the row direction). The Detector Secondary Angle is defined in the plane perpendicular to the Secondary Axis at the point where the central x-ray beam vector intersects the detector plane, with zero degrees in the direction normal to the detector plane. +90 degrees corresponds to the direction toward the top of the image. The Secondary Detector Angle range is -90 to + 90 degrees.

C.8.7.6 XRF Positioner Module

Table C.8-31
XRF POSITIONER MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Distance Source to Detector	(0018,1110)	3	Distance in mm from source to detector center.
Distance Source to Patient	(0018,1111)	3	Distance in mm from source to isocenter (center of field of view).
Estimated Radiographic Magnification Factor	(0018,1114)	3	Ratio of SID (Source Image Distance) over SOD (Source Object Distance).

Column Angulation	(0018,1450)	3	Angle of the X-Ray beam in degree relative to an orthogonal axis to the detector plane. Positive values indicate that the tilt is towards the head of the table. Note: The detector plane is assumed to be parallel to the table plane.

C.8.7.7 XRF Tomography Acquisition Module

This Module describes the attributes of a Tomography RF acquisition (translation of X-Ray source during the acquisition of a single frame image).

Table C.8-32
XRF TOMOGRAPHY ACQUISITION MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Tomo Layer Height	(0018,1460)	1	Distance in mm between the table surface and the sharp image plane.
Tomo Angle	(0018,1470)	3	Angle span in degrees of rotation of X-Ray Source during X-Ray acquisition.
Tomo Time	(0018,1480)	3	Time in seconds the source has taken to rotate the Tomo Angle during X-Ray acquisition.

C.8.8 Radiotherapy Modules

This Section describes Radiotherapy-specific modules.

Modules defined here make reference to “IEC” coordinate systems and standards. These standards are defined in IEC Standard 1217, “Radiotherapy Equipment - Coordinates, Movements and Scales” (Reference CEI/IEC 1217: 1996).

Many of the dosimetry concepts referred to in this document can be found in ICRU Report 50, Prescribing, Recording, and Reporting Photon Beam Therapy, International Commission on Radiation Units and Measurements, 1993.

C.8.8.1 RT Series Module

There exist significant differences in the manner in which RT objects as compared to diagnostic objects. An RT object can be one of several types, and a series of a given object type may be created over a temporal span of several weeks. The RT Series Module has been created to satisfy the requirements of the standard DICOM Query/Retrieve model while including only those attributes relevant to the identification and selection of radiotherapy objects.

Table C.8-33 - RT SERIES MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data. Enumerated Values: RTIMAGE = RT Image RTDOSE = RT Dose RTSTRUCT = RT Structure Set RTPLAN = RT Plan See C.8.8.1.1.
Series Instance UID	(0020,000E)	1	Unique identifier of the series.
Series Number	(0020,0011)	2	A number that identifies this series.
Series Description	(0008,103E)	3	User provided description of the series.
Referenced Study Component Sequence	(0008,1111)	3	Uniquely identifies the Study Component SOP Instances to which the series is related. One or more items may be included in this sequence.
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Study Component (0008,1111) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Study Component (0008,1111) is sent.

C.8.8.1.1 Modality

The Enumerated Value for Modality (0008,0060) shall determined by the IOD:

RTIMAGE if RT Image IOD,

RTDOSE if RT Dose IOD,

RTSTRUCT if RT Structure Set IOD,

RTPLAN if RT Plan IOD.

Note: DICOM specifies that a given series shall contain objects of only one Modality, and shall be created by a single device (described in the General Equipment Module). However, in general there may be many series defined for a given modality/device pair. Note that a radiotherapy series is generally created over an extended time interval (unlike in radiology, where all images in an image series are generally created together).

C.8.8.2 RT Image Module

Table C.8-34 contains attributes that describe RT-specific characteristics of a projection image. The image described by these attributes must be a radiotherapy image acquired or calculated using a conical imaging geometry.

Table C.8-34—RT IMAGE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Samples per Pixel	(0028,0002)	1	Number of samples (planes) in this image. See C.8.8.2.6.1 for specialization.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. See C.8.8.2.6.2 for specialization.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. See C.8.8.2.6.3 for specialization.
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. See C.8.8.2.6.4 for specialization.
High Bit	(0028,0102)	1	Most significant bit for each pixel sample. Each sample shall have the same high bit. See C.8.2.6.5 for specialization.
Pixel Representation	(0028,0103)	1	Data representation of the pixel samples. Each sample shall have the same pixel representation. See C.8.8.2.6.6 for specialization.
RT Image Label	(3002,0002)	1	User-defined label for RT Image.
RT Image Name	(3002,0003)	3	User-defined name for RT Image.
RT Image Description	(3002,0004)	3	User-defined description of RT Image.
Operators' Name	(0008,1070)	2	Name of operator(s) acquiring or creating RT Image.

Image Type	(0008,0008)	1	Image identification characteristics (see Section C.7.6.1.1.2). RT Images shall use one of the following Defined Terms for Value 3: DRR = digitally reconstructed radiograph PORTAL = digital portal image or portal film image SIMULATOR = conventional simulator image RADIOGRAPH = radiographic image BLANK = image pixels set to background value
Conversion Type	(0008,0064)	2	Describes the kind of image conversion. Defined Terms: DV = Digitized Video DI = Digital Interface DF = Digitized Film WSD = Workstation
Reported Values Origin	(3002,000A)	2C	Describes the origin of the parameter values reported in the image. Required if Value 3 of Image Type (0008,0008) is SIMULATOR or PORTAL. Enumerated Values: OPERATOR = manually entered by operator PLAN = planned parameter values ACTUAL = electronically recorded
RT Image Plane	(3002,000C)	1	Describes whether or not image plane is normal to beam axis. Enumerated Values: NORMAL = image plane normal to beam axis NON_NORMAL = image plane non-normal to beam axis
X-Ray Image Receptor Angle	(3002,000E)	2	X-Ray Image Receptor Angle i.e. orientation of IEC X-RAY IMAGE RECEPTOR coordinate system with respect to IEC GANTRY coordinate system (degrees). See C.8.8.2.2.
RT Image Orientation	(3002,0010)	2C	The direction cosines of the first row and the first column with respect to the IEC X-RAY IMAGE RECEPTOR coordinate system. Required if RT Image Plane (3002,000C) is NON_NORMAL.

Image Plane Pixel Spacing	(3002,0011)	2	Physical distance (in mm) between the center of each image pixel, specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing. See C.8.8.2.3.
RT Image Position	(3002,0012)	2	The x and y coordinates (in mm) of the upper left hand corner (first pixel transmitted) of the image, in the IEC X-RAY IMAGE RECEPTOR coordinate system.
Radiation Machine Name	(3002,0020)	2	User-defined name identifying radiation machine used in acquiring or computing image (i.e. name of conventional simulator, electron accelerator, X-ray device, or machine modeled when calculating DRR).
Primary Dosimeter Unit	(300A,00B3)	2	Measurement unit of machine dosimeter. Enumerated Values: MU = Monitor Unit MINUTE = minute
Radiation Machine SAD	(3002,0022)	2	Radiation source to Gantry rotation axis distance of radiation machine used in acquiring or computing image (mm).
Radiation Machine SSD	(3002,0024)	3	Source to patient surface distance (in mm) of radiation machine used in acquiring or computing image.
RT Image SID	(3002,0026)	2	Distance from radiation machine source to image plane (in mm) along radiation beam axis. See C.8.8.2.3.
Source to Reference Object Distance	(3002,0028)	3	Source to reference object distance (in mm), as used for magnification calculation of RADIOGRAPH and SIMULATOR images.
Referenced RT Plan Sequence	(300C,0002)	3	Introduces sequence of one Class/Instance pair describing RT Plan associated with image. Only a single item shall be permitted in this sequence.
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced RT Plan Sequence (300C,0002) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced RT Plan Sequence (300C,0002) is sent.
Referenced Beam Number	(300C,0006)	3	Uniquely identifies the corresponding N-segment treatment beam specified by Beam Number (300A,00C0) within Beam Sequence in RT Beams Module within the RT Plan referenced in Referenced RT Plan Sequence (300C,0002).

Referenced Fraction Group Number	(300C,0022)	3	Identifier of Fraction Group within RT Plan referenced in Referenced RT Plan Sequence (300C,0002).
Fraction Number	(3002,0029)	3	Fraction Number of fraction during which image was acquired, within Fraction Group referenced by Referenced Fraction Group Number (300C,0022) within RT Plan referenced in Referenced RT Plan Sequence (300C,0002).
Start Cumulative Meterset Weight	(300C,0008)	3	Cumulative Meterset Weight within Beam referenced by Referenced Beam Number (300C,0006) at which image acquisition starts.
End Cumulative Meterset Weight	(300C,0009)	3	Cumulative Meterset Weight within Beam referenced by Referenced Beam Number (300C,0006) at which image acquisition ends.
Exposure Sequence	(3002,0030)	3	Introduces sequence of Exposure parameter sets, corresponding to exposures used in generating the image. One or more items may be included in this sequence. See C.8.8.2.4.
>Referenced Frame Number	(0008,1160)	1C	Identifies corresponding image frame in multi-frame image. Required if Exposure Sequence (3002,0030) is sent, there is more than one item in Exposure Sequence (3002,0030), and image is a multi-frame image.
>KVP	(0018,0060)	2C	Peak kilo voltage output (kV) of X-ray generator used to acquire image. Required if Value 3 of Image Type (0008,0008) is PORTAL, SIMULATOR or RADIOGRAPH and Exposure Sequence (3002,0030) is sent.
>X-Ray Tube Current	(0018,1151)	2C	Imaging device X-ray Tube Current (mA). Required if Value 3 of Image Type (0008,0008) is SIMULATOR or RADIOGRAPH and Exposure Sequence (3002,0030) is sent.
>Exposure Time	(0018,1150)	2C	Time of X-ray exposure (msec). Required if Value 3 of Image Type (0008,0008) is SIMULATOR or RADIOGRAPH and Exposure Sequence (3002,0030) is sent.

>Meterset Exposure	(3002,0032)	2C	Treatment machine Meterset duration over which image has been acquired, specified in Monitor units (MU) or minutes as defined by Primary Dosimeter Unit (300A,00B3). Required if Value 3 of Image Type (0008,0008) is PORTAL and Exposure Sequence (3002,0030) is sent.
>Beam Limiting Device Sequence	(300A,00B6)	3	Introduces sequence of beam limiting device (collimator) jaw or leaf (element) positions for given exposure. One or more items may be included in this sequence.
>>RT Beam Limiting Device Type	(300A,00B8)	1C	Type of beam limiting device (collimator). Required if Beam Limiting Device Sequence (300A,00B6) is sent. Enumerated Values: X = symmetric jaw pair in IEC X direction Y = symmetric jaw pair in IEC Y direction ASYMX = asymmetric jaw pair in IEC X direction ASYMY = asymmetric pair in IEC Y direction MLCX = multileaf (multi-element) jaw pair in IEC X direction MLCY = multileaf (multi-element) jaw pair in IEC Y direction
>>Source to Beam Limiting Device Distance	(300A,00BA)	3	Radiation source to beam limiting device (collimator) distance (mm).
>>Number of Leaf/Jaw Pairs	(300A,00BC)	1C	Number of leaf (element) or jaw pairs (equal to 1 for standard beam limiting device jaws). Required if Beam Limiting Device Sequence (300A,00B6) is sent.
>>Leaf Position Boundaries	(300A,00BE)	2C	Boundaries (in mm) of beam limiting device (collimator) leaves (elements) in IEC BEAM LIMITING DEVICE coordinate axis appropriate to RT Beam Limiting Device Type (300A,00B8), i.e. X-axis for MLCY, Y-axis for MLCX. Contains N+1 values, where N is the Number of Leaf/Jaw Pairs (300A,00BC), starting from Leaf (Element) Pair 1. Required if RT Beam Limiting Device Type (300A,00B8) is MLCX or MLCY.

>>Leaf/Jaw Positions	(300A,011C)	1C	Positions of beam limiting device (collimator) leaf or jaw (element) pairs (in mm) in IEC BEAM LIMITING DEVICE coordinate axis appropriate to RT Beam Limiting Device Type (300A,00B8), e.g. X-axis for MLCX, Y-axis for MLCY). Contains 2N values, where N is the Number of Leaf/Jaw Pairs (300A,00BC), in IEC leaf (element) subscript order 101, 102, ... 1N, 201, 202, ... 2N. Required if Beam Limiting Device Sequence (300A,00B6) is sent.
>Applicator Sequence	(300A,0107)	3	Introduces sequence of Applicators associated with Beam. Only a single item shall be permitted in this sequence.
>>Applicator ID	(300A,0108)	1C	User or machine supplied identifier for Applicator. Required if Applicator Sequence (300A,0107) is sent.
>>Applicator Type	(300A,0109)	1C	Type of Applicator. Required if Applicator Sequence (300A,0107) is sent. Defined Terms: ELECTRON_SQUARE = square electron applicator ELECTRON_RECT = rectangular electron applicator ELECTRON_CIRC = circular electron applicator ELECTRON_SHORT = short electron applicator ELECTRON_OPEN = open (dummy) electron applicator INTRAOPERATIVE = intraoperative (custom) applicator STEREOTACTIC = stereotactic applicator
>>Applicator Description	(300A,010A)	3	User-defined description for Applicator.
>Number of Blocks	(300A,00F0)	1C	Number of shielding blocks associated with Beam. Required if Exposure Sequence (3002,0030) is sent.
>Block Sequence	(300A,00F4)	2C	Introduces sequence of blocks associated with Beam. Required if Number of Blocks (300A,00F0) is non-zero. One or more items may be included in this sequence.
>>Block Tray ID	(300A,00F5)	3	User-supplied identifier for block tray.
>>Source to Block Tray Distance	(300A,00F6)	2C	Radiation Source to attachment edge of block tray assembly (mm). Required if Block Sequence (300A,00F4) is sent.

>>Block Type	(300A,00F8)	1C	Type of block. Required if Block Sequence (300A,00F4) is sent. Enumerated Values: SHIELDING = blocking material is inside contour APERTURE = blocking material is outside contour
>>Block Divergence	(300A,00FA)	2C	Indicates presence or otherwise of geometrical divergence. Required if Block Sequence (300A,00F4) is sent. Enumerated Values: PRESENT = block edges are shaped for beam divergence ABSENT = block edges are not shaped for beam divergence
>>Block Number	(300A,00FC)	1C	Identification Number of the Block. The value of Block Number (300A,00FC) shall be unique within the Beam in which it is created. Required if Block Sequence (300A,00F4) is sent.
>>Block Name	(300A,00FE)	3	User-defined name for block.
>>Material ID	(300A,00E1)	2C	User-supplied identifier for material used to manufacture Block. Required if Block Sequence (300A,00F4) is sent.
>>Block Thickness	(300A,0100)	3	Physical thickness of block (in mm) parallel to radiation beam axis.
>>Block Number of Points	(300A,0104)	2C	Number of (x,y) pairs defining the block edge. Required if Block Sequence (300A,00F4) is sent.
>>Block Data	(300A,0106)	2C	A data stream of (x,y) pairs which comprise the block edge. The number of pairs shall be equal to Block Number of Points (300A,0104), and the vertices shall be interpreted as a closed polygon. Coordinates are projected onto the machine isocentric plane in the IEC BEAM LIMITING DEVICE coordinate system (mm). Required if Block Sequence (300A,00F4) is sent.
Gantry Angle	(300A,011E)	3	Treatment machine gantry angle, i.e. orientation of IEC GANTRY coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees).

Beam Limiting Device Angle	(300A,0120)	3	Treatment machine beam limiting device (collimator) angle, i.e. orientation of IEC BEAM LIMITING DEVICE coordinate system with respect to IEC GANTRY coordinate system (degrees).
Patient Support Angle	(300A,0122)	3	Patient Support angle, i.e. orientation of IEC PATIENT SUPPORT coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees).
Table Top Eccentric Axis Distance	(300A,0124)	3	Distance (positive) from the IEC PATIENT SUPPORT vertical axis to the IEC TABLE TOP ECCENTRIC vertical axis (mm).
Table Top Eccentric Angle	(300A,0125)	3	Table Top (non-isocentric) angle, i.e. orientation of IEC TABLE TOP ECCENTRIC coordinate system with respect to IEC PATIENT SUPPORT system (degrees).
Table Top Vertical Position	(300A,0128)	3	Table Top Vertical position in IEC TABLE TOP coordinate system (mm).
Table Top Longitudinal Position	(300A,0129)	3	Table Top Longitudinal position in IEC TABLE TOP coordinate system (mm).
Table Top Lateral Position	(300A,012A)	3	Table Top Lateral position in IEC TABLE TOP coordinate system (mm).

Note: The numeric beam data parameters recorded with the RT Image correspond to the parameters as they were known at the time the image was created or taken. The parameters may or may not correspond to an actual RT Plan instance that is created for a patient. If the Reported Values Origin (3002,000A) has an enumerated value of OPERATOR or ACTUAL and there is an RT Plan reference present, the numeric beam data parameters may or may not be the same in the two objects.

C.8.8.2.1 Multi-frame image data

In either multiple exposure multi-frame images or cine images, only the attributes inside of the Exposure Sequence (3002,0030) shall differ between frames. For example, attributes such as beam limiting device (collimator) leaf (element) positions and block information may change, whereas attributes such as gantry and beam limiting device (collimator) angle shall not change.

C.8.8.2.2 X-Ray Image Receptor Angle

The X-Ray Image Receptor Angle (3002,000E) specifies the rotation of the image receptor device in the IEC X-RAY IMAGE RECEPTOR PLANE. A positive angle corresponds to a counter-clockwise rotation of the X-Ray Image Receptor as viewed from the radiation source in the IEC GANTRY coordinate system. The normal (non-rotated) value for this parameter is zero degrees.

C.8.8.2.3 Image Plane Pixel Spacing and RT Image SID

The Image Plane Pixel Spacing (3002,0011) attribute shall always be defined on the image plane, i.e. at the radiation machine source to image plane distance specified by RT Image SID (3002,0026). For images where the source-image distance is undefined or unknown (e.g. DRR

images), RT Image SID (3002,0026) shall equal Radiation Machine SAD (3002,0022) and Image Plane Pixel Spacing (3002,0011) shall be defined on this common plane.

C.8.8.2.4 Exposure Sequence

The Exposure Sequence (3002,0030) allows specification of imaging parameters and aperture definitions for single exposure images (single item sequence) or multiple exposures (multiple item sequence). A multiple exposure image can be expressed as a multi-frame image containing either a single frame, or more than one frame. Referenced Frame Number (0008,1160) shall be specified for each Exposure Sequence item for multiple exposure images expressed using more than one frame.

C.8.8.2.5 Single frame and multi-frame images

If the Multi-frame Module is present and the Cine Module is not present then the Frame Increment Pointer (0028,0009) shall have the Enumerated Value of 00200013 (Image Number). If the Multi-frame Module and Cine Module are both present then the Frame Increment Pointer (0028,0009) shall have an Enumerated Value of either 00181063 (Frame Time) or 00181065 (Frame Time Vector).

C.8.8.2.6 Image Pixel Module Attributes

C.8.8.2.6.1 Samples per Pixel

For RT Images, Samples per Pixel (0028,0002) shall have the Enumerated Value of 0001H.

C.8.8.2.6.2 Photometric Interpretation

For RT Images, Photometric Interpretation (0028,0004) shall have the Enumerated Value of MONOCHROME2.

C.8.8.2.6.3 Bits Allocated

For RT Images, Bits Allocated (0028,0100) shall have an Enumerated Value of 8 or 16.

C.8.8.2.6.4 Bits Stored

For RT Images, Bits Stored (0028,0101) shall have an Enumerated Value of:

8	when Bits Allocated (0028,0100) is 8
12-16	when Bits Allocated (0028,0100) is 16

C.8.8.2.6.5 High Bit

For RT Images, High Bit (0028,0102) shall have the Enumerated Value of one less than the value sent in Bits Stored (0028,0101).

C.8.8.2.6.6 Pixel Representation

For RT Images, Pixel Representation (0028,0103) shall have the Enumerated Value of 0000H (unsigned integer).

C.8.8.3 RT Dose Module

The RT Dose module is used to convey 2D or 3D radiation dose data generated from treatment planning systems or similar devices. The attributes defined within the module support dose for a single radiation beam (potentially comprised of multiple segments, as delivered in a dynamic treatment) or a group of beams comprising either a fraction group (see C.8.8.13) or a complete treatment plan (potentially the sum of multiple fraction groups).

The RT Dose module provides the mechanism to transmit a 3D array of dose data as a set of 2D dose planes which may or may not be related to CT or MR image planes. This mechanism works via the DICOM Multi-Frame module which is required if multi-frame pixel data are sent.

Table C.8-35—RT DOSE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Samples per Pixel	(0028,0002)	1C	Number of samples (planes) in this image. See C.8.3.4.1 for specialization. Required if Pixel Data (7FE0,0010) is present.
Photometric Interpretation	(0028,0004)	1C	Specifies the intended interpretation of the pixel data. See C.8.3.4.2 for specialization. Required if Pixel Data (7FE0,0010) is present.
Bits Allocated	(0028,0100)	1C	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. See C.8.3.4.3 for specialization. Required Pixel Data (7FE0,0010) is present.
Bits Stored	(0028,0101)	1C	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. See C.8.3.4.4 for specialization. Required if Pixel Data (7FE0,0010) is present.
High Bit	(0028,0102)	1C	Most significant bit for each pixel sample. Each sample shall have the same high bit. See C.8.3.4.5 for specialization. Required if Pixel Data (7FE0,0010) is present.
Pixel Representation	(0028,0103)	1C	Data representation of the pixel samples. Each sample shall have the same pixel representation. See C.8.3.4.6 for specialization. Required Pixel Data (7FE0,0010) is present.
Dose Units	(3004,0002)	1	Units used to describe dose. Enumerated Values: GY = Gray RELATIVE = dose relative to implicit reference value
Dose Type	(3004,0004)	1	Type of dose. Defined Terms: PHYSICAL = physical dose EFFECTIVE = physical dose after correction for biological effect using user-defined modeling technique ERROR = difference between desired and planned dose
Dose Comment	(3004,0006)	3	User-defined comments for dose data.

Normalization Point	(3004,0008)	3	Coordinates (x, y, z) of normalization point in the patient based coordinate system described in C.7.6.2.1.1 (mm). See C.8.8.3.1.
Dose Summation Type	(3004,000A)	1	Type of dose summation. Defined Terms: PLAN = dose calculated for entire RT Plan FRACTION = dose calculated for a single Fraction Group within RT Plan BEAM = dose calculated for one or more Beams within RT Plan BRACHY = dose calculated for one or more Brachy Application Setups within RT Plan
Referenced RT Plan Sequence	(300C,0002)	1C	Introduces sequence of one Class/Instance pair describing RT Plan associated with dose. Required if Dose Summation Type (3004,000A) is PLAN, FRACTION, BEAM, or BRACHY. Only a single item shall be permitted in this sequence. See Note 1.
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced RT Plan Sequence (300C,0002) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced RT Plan Sequence (300C,0002) is sent.
>Referenced Fraction Group Sequence	(300C,0020)	1C	Introduces sequence of one Fraction Group containing beams or brachy application setups contributing to dose. Required if Dose Summation Type (3004,000A) is FRACTION, BEAM, or BRACHY. Only a single item shall be permitted in this sequence. See Note 1.
>>Referenced Fraction Group Number	(300C,0022)	1C	Uniquely identifies Fraction Group specified by Fraction Group Number (300A,0071) in Fraction Group Sequence of RT Fraction Scheme Module within RT Plan referenced in Referenced RT Plan Sequence (300C,0002). Required if Referenced Fraction Group Sequence (300C,0020) is sent.
>>Referenced Beam Sequence	(300C,0004)	1C	Introduces sequence of Beams in current Fraction Group contributing to dose. Required if Dose Summation Type (3004,000A) is BEAM. One or more items may be included in this sequence.

>>>Referenced Beam Number	(300C,0006)	1C	Uniquely identifies Beam specified by Beam Number (300A,00C0) in Beam Sequence of RT Beams Module within RT Plan referenced in Referenced RT Plan Sequence (300C,0002). Required if Referenced Beam Sequence (300A,0004) is sent.
>>Referenced Brachy Application Setup Sequence	(300C,000A)	1C	Introduces sequence of Brachy Application Setups in current Fraction Group contributing to dose. Required if Dose Summation Type (3004,000A) is BRACHY. One or more items may be included in this sequence.
>>>Referenced Brachy Application Setup Number	(300C,000C)	1C	Uniquely identifies Brachy Application Setup specified by Brachy Application Setup Number (300A,0234) in Brachy Application Setup Sequence (300A,0230) of RT Brachy Application Setups Module within RT Plan referenced in Referenced RT Plan Sequence (300C,0002). Required if Referenced Brachy Application Setup Sequence (300C,000A) is sent.
Grid Frame Offset Vector	(3004,000C)	1C	An array which contains the z coordinates (in mm) of the image frames in a multi-frame dose. Required if multi-frame pixel data are present and Frame Increment Pointer (0028,0009) points to Grid Frame Offset Vector (3004,000C). See C.8.8.3.2.
Dose Grid Scaling	(3004,000E)	1	Dimensionless scaling factor converting dose data into dose units specified in Dose Units (3004,0002).

Note: In order to prevent misrepresentation of dose summation components, if the Dose Summation Type (3004,000A) is PLAN then only a single instance of RT Plan is referenced (i.e. component fraction groups are not referenced). Similarly, if the Dose Summation Type (3004,000A) is FRACTION then only a single instance of RT Plan and a single Fraction Group are referenced (i.e. component beams or brachy application setups are not referenced).

C.8.8.3.1 Normalization Point

The Normalization Point (3004,0008) aids in the interpretation and subsequent use of the transmitted data. If used, it shall be a point receiving dose contributions from all referenced components of the dose summation.

C.8.8.3.2 Grid Frame Offset Vector

Grid Frame Offset Vector (3004,000C) shall be provided if a dose distribution is sent as a multi-frame image. This attribute contains an array of *n* elements indicating the plane location of the data. This attribute is conditional since the RT Dose module may be included even if pixel doses are not being transmitted, or the image may be a single-frame image. If the Multi-frame Module is present, Frame Increment Pointer (0028,0009) shall have the Enumerated Value of 3004000C (Grid Frame Offset Vector).

C.8.8.3.3 Dose Units

Dose Units are specified in both the RT Dose and RT Dose ROI modules. The attribute Dose Type present in the RT Dose module shall apply to all doses present in the RT Dose IOD.

C.8.8.3.4 Image Pixel Module Attributes

C.8.8.3.4.1 Samples per Pixel

For RT Doses, Samples per Pixel (0028,0002) shall have the Enumerated Value of 1.

C.8.8.3.4.2 Photometric Interpretation

For RT Doses, Photometric Interpretation (0028,0004) shall have the Enumerated Value of MONOCHROME2.

C.8.8.3.4.3 Bits Allocated

For RT Doses, Bits Allocated (0028,0100) shall have an Enumerated Value of 16 or 32.

C.8.8.3.4.4 Bits Stored

For RT Doses, Bits Stored (0028,0101) shall have an Enumerated Value equal to Bits Allocated (0028,0100).

C.8.8.3.4.5 High Bit

For RT Doses, High Bit (0028,0102) shall have the Enumerated Value of one less than the value sent in Bits Stored (0028,0101).

C.8.8.3.4.6 Pixel Representation

For RT Doses, Pixel Representation (0028,0103) shall have the Enumerated Value of 0000H (unsigned integer).

C.8.8.4 RT DVH Module

The RT DVH module provides for the inclusion of differential or cumulative dose volume histogram data. The data contained within this module may supplement dose data in the RT Dose and/or RT Dose ROI modules, or it may be present in the absence of other dose data.

Table C.8-36—RT DVH MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Referenced Structure Set Sequence	(300C,0060)	1	Introduces sequence of one class/instance pair describing Structure Set containing structures which are used to calculate Dose-Volume Histograms (DVHs). Only a single item shall be permitted in this sequence. See C.8.8.4.1.
>Referenced SOP Class UID	(0008,1150)	1	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	1	Uniquely identifies the referenced SOP Instance.
DVH Normalization Point	(3004,0040)	3	Coordinates (x, y, z) of common DVH normalization point in the patient based coordinate system described in C.7.6.2.1.1 (mm).

DVH Normalization Dose Value	(3004,0042)	3	Dose Value at DVH Normalization Point (3004,0040) used as reference for individual DVHs when Dose Units (3004,0002) is RELATIVE.
DVH Sequence	(3004,0050)	1	Introduces sequence of DVHs. One or more items may be included in this sequence.
>DVH Referenced ROI Sequence	(3004,0060)	1	Introduces sequence of referenced ROIs used to calculate DVH.
>>Referenced ROI Number	(3006,0084)	1	Uniquely identifies ROI used to calculate DVH specified by ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) in Structure Set Module within RT Structure Set referenced by referenced RT Plan in Referenced RT Plan Sequence (300C,0002) in RT Dose Module.
>>DVH ROI Contribution Type	(3004,0062)	1	Specifies whether volume within ROI is included or excluded in DVH. See C.8.8.4.2. Enumerated Values: INCLUDED, EXCLUDED.
>DVH Type	(3004,0001)	1	Type of DVH. Enumerated Values: DIFFERENTIAL = differential dose-volume histogram CUMULATIVE = cumulative dose-volume histogram
>Dose Units	(3004,0002)	1	Dose axis units. Enumerated Values: GY = Gray RELATIVE = dose relative to reference value specified in DVH Normalization Dose Value (3004,0042)
>Dose Type	(3004,0004)	1	Type of dose. Defined Terms: PHYSICAL = physical dose EFFECTIVE = physical dose after correction for biological effect using user-defined modeling technique ERROR = difference between desired and planned dose
>DVH Dose Scaling	(3004,0052)	1	Dimensionless scaling factor converting dose values found in DVH Data (3004,0058) into dose units specified in Dose Units (3004,0002).

>DVH Volume Units	(3004,0054)	1	Volume axis units. Defined Terms: CM3 = cubic centimeters PERCENT = percent
>DVH Number of Bins	(3004,0056)	1	Number of bins n used to store DVH Data (3004,0058).
>DVH Data	(3004,0058)	1	A data stream describing the dose bin widths D_n and associated volumes V_n in the order D_1V_1, D_2V_2, ... D_nV_n.
>DVH Minimum Dose	(3004,0070)	3	Minimum calculated dose to ROI(s) described by DVH Referenced ROI Sequence (3004,0060).
>DVH Maximum Dose	(3004,0072)	3	Maximum calculated dose to ROI(s) described by DVH Referenced ROI Sequence (3004,0060).
>DVH Mean Dose	(3004,0074)	3	Mean calculated dose to ROI(s) described by DVH Referenced ROI Sequence (3004,0060).

C.8.8.4.1 Referenced Structure Set Sequence

The Referenced Structure Set Sequence (300C,0060) is required for direct cross-reference of the dose bin data with the corresponding ROI(s) from which they were derived. ROIs referenced by the DVH Referenced ROI Sequence (3004,0050) shall only contain contours with a Contour Geometric Type (3006,0042) of POINT or CLOSED_PLANAR.

C.8.8.4.2 DVH ROI Contribution Type

The volume used to calculate the DVH shall be the geometric union of ROIs where DVH ROI Contribution Type (3004,0062) is INCLUDED, minus the geometric union of ROIs where DVH ROI Contribution Type (3004,0062) is EXCLUDED.

C.8.8.5 Structure Set Module

A structure set defines a set of areas of significance. Each area can be associated with a Frame of Reference and zero or more images. Information which can be transferred with each region of interest (ROI) includes geometrical and display parameters, and generation technique.

Table C.8-37—STRUCTURE SET MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Structure Set Label	(3006,0002)	1	User-defined label for Structure Set.
Structure Set Name	(3006,0004)	3	User-defined name for Structure Set.
Structure Set Description	(3006,0006)	3	User-defined description for Structure Set.
Structure Set Date	(3006,0008)	2	Date at which Structure Set was last modified.
Structure Set Time	(3006,0009)	2	Time at which Structure Set was last modified.

Referenced Frame of Reference Sequence	(3006,0010)	3	Introduces sequence of items describing Frames of Reference in which the ROIs are defined. One or more items may be included in this sequence. See C.8.8.5.1.
>Frame of Reference UID	(0020,0052)	1C	Uniquely identifies Frame of Reference within Structure Set. Required if Referenced Frame of Reference Sequence (3006,0010) is sent.
>Frame of Reference Relationship Sequence	(3006,00C0)	3	Introduces sequence of transforms that relate other Frames of Reference to this Frame of Reference.
>>Related Frame of Reference UID	(3006,00C2)	1C	Frame of Reference Coordinate System to be transformed to the current Frame of Reference. Required if Frame of Reference Relationship Sequence (3006,00C0) is sent.
>>Frame of Reference Transformation Type	(3006,00C4)	1C	Type of Transformation. Required if Frame of Reference Relationship Sequence (3006,00C0) is sent. Defined Terms: HOMOGENEOUS
>>Frame of Reference Transformation Matrix	(3006,00C6)	1C	Four-by-four transformation Matrix from Related Frame of Reference to current Frame of Reference. Matrix elements shall be listed in row-major order. Required if Frame of Reference Relationship Sequence (3006,00C0) is sent. See C.8.8.5.2.
>>Frame of Reference Transformation Comment	(3006,00C8)	3	Comment regarding the transformation between the related and current Frames of Reference.
>RT Referenced Study Sequence	(3006,0012)	3	Introduces sequence of Studies containing series to be referenced. One or more items may be included in this sequence.
>>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if RT Referenced Study Sequence (3006,0012) is sent.
>>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if RT Referenced Study Sequence (3006,0012) is sent.
>>RT Referenced Series Sequence	(3006,0014)	1C	Introduces sequence of items describing series of images within the referenced study which are used in defining the Structure Set. Required if RT Referenced Study Sequence (3006,0012) is sent. One or more items may be included in this sequence.

>>>Series Instance UID	(0020,000E)	1C	Unique identifier for the series containing the images. Required if RT Referenced Series Sequence (3006,0014) is sent.
>>>Contour Image Sequence	(3006,0016)	1C	Introduces sequence of items describing images in a given series used in defining the Structure Set (typically CT or MR images). Required if RT Referenced Series Sequence (3006,0014) is sent. One or more items may be included in this sequence.
>>>>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced image SOP Class. Required if Contour Image Sequence (3006,0016) is sent.
>>>>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced image SOP Instance. Required if Contour Image Sequence (3006,0016) is sent.
>>>>Referenced Frame Number	(0008,1160)	3	Identifies image frame if a multi-frame image is referenced.
Structure Set ROI Sequence	(3006,0020)	3	Introduces sequence of ROIs for current Structure Set. One or more items may be included in this sequence.
>ROI Number	(3006,0022)	1C	Identification number of the ROI. The value of ROI Number (3006,0022) shall be unique within the Structure Set in which it is created. Required if Structure Set ROI Sequence (3006,0020) is sent.
>Referenced Frame of Reference UID	(3006,0024)	1C	Uniquely identifies Frame of Reference in which ROI is defined, specified by Frame of Reference UID (0020,0052) in Referenced Frame of Reference Sequence (3006,0010). Required if Structure Set ROI Sequence (3006,0020) is sent.
>ROI Name	(3006,0026)	2C	User-defined name for ROI. Required if Structure Set ROI Sequence (3006,0020) is sent.
>ROI Description	(3006,0028)	3	User-defined description for ROI.
>ROI Volume	(3006,002C)	3	Volume of ROI (cubic centimeters).
>ROI Generation Algorithm	(3006,0036)	2C	Type of algorithm used to generate ROI. Required if Structure Set ROI Sequence (3006,0020) is sent. Defined Terms: AUTOMATIC = calculated ROI SEMIAUTOMATIC = ROI calculated with user assistance MANUAL = user-entered ROI

>ROI Generation Description	(3006,0038)	3	User-defined description of technique used to generate ROI.

C.8.8.5.1 Frames of Reference

The Referenced Frame of Reference Sequence (3006,0010) describes a set of frames of reference in which some or all of the ROIs are expressed. Since the Referenced Frame of Reference UID (3006,0024) is required for each ROI, each frame of reference used to express the coordinates of an ROI shall be listed in the Referenced Frame of Reference Sequence (3006,0010) once and only once.

Notes: 1.As an example, a set of ROIs defined using a single image series would list the image series in a single Referenced Frame of Reference Sequence (3006,0010) item, providing the UID for this referenced frame of reference (obtained from the source images), and listing all pertinent images in the Contour Image Sequence (3006,0016).

2. As an example, a set of ROIs containing ROIs referencing more than one frame of reference would list the referenced images in two or more different Referenced Frame of Reference Sequence (3006,0010) items, providing in each case the UID for this referenced frame of reference (obtained from the source images), and listing all pertinent images in the Contour Image Sequence (3006,0016). Each ROI would then reference the appropriate Frame of Reference UID (0020,0052).

C.8.8.5.2 Frame of Reference Transformation Matrix

In a rigid body system, two coordinate systems can be related using a single 4 x 4 transformation matrix to describe any rotations and/or translations necessary to transform coordinates from the related coordinate system (frame of reference) to the primary system. The equation performing the transform from a point (X',Y',Z') in the related coordinate system to a point (X,Y,Z) in the current coordinate system can be shown as follows, where for homogeneous transforms $M_{41} = M_{42} = M_{43} = 0$ and $M_{44} = 1$:

$$\begin{bmatrix} X \\ Y \\ Z \\ 1 \end{bmatrix} = \begin{bmatrix} M_{11} & M_{12} & M_{13} & M_{14} \\ M_{21} & M_{22} & M_{23} & M_{24} \\ M_{31} & M_{32} & M_{33} & M_{34} \\ M_{41} & M_{42} & M_{43} & M_{44} \end{bmatrix} \times \begin{bmatrix} X' \\ Y' \\ Z' \\ 1 \end{bmatrix}$$

C.8.8.6 ROI Contour Module

In general, a ROI can be defined by either a sequence of overlays or a sequence of contours. This module, if present, is used to define the ROI as a set of contours. Each ROI contains a sequence of one or more contours, where a contour is either a single point (for a point ROI) or more than one point (representing an open or closed polygon).

Table C.8-38—ROI CONTOUR MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
ROI Contour Sequence	(3006,0039)	1	Introduces sequence of Contour Sequences defining ROIs. One or more items may be included in this sequence.
>Referenced ROI Number	(3006,0084)	1	Uniquely identifies the referenced ROI described in the Structure Set ROI Sequence (3006,0020).
>ROI Display Color	(3006,002A)	3	RGB triplet color representation for ROI, specified using the range 0-255.
>Contour Sequence	(3006,0040)	3	Introduces sequence of Contours defining ROI. One or more items may be included in this sequence.
>>Contour Image Sequence	(3006,0016)	3	Introduces sequence of images containing the contour. One or more items may be included in this sequence.
>>>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced image SOP Class of the image containing the Contour, if it exists. Required if Contour Image Sequence (3006,0016) is sent.
>>>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced image SOP Instance of the image containing the Contour, if it exists. Required if Contour Image Sequence (3006,0016) is sent.
>>>Referenced Frame Number	(0008,1160)	1C	Identifies image frame if a multi-frame image is referenced. Required if referenced image is a multi-frame image.
>>Contour Geometric Type	(3006,0042)	1C	Geometric type of contour. Required if Contour Sequence (3006,0040) is sent. See C.8.8.6.1. Enumerated Values: POINT = single point OPEN_PLANAR = open contour containing coplanar points OPEN_NONPLANAR = open contour containing non-coplanar points CLOSED_PLANAR = closed contour (polygon) containing coplanar points

>>Contour Slab Thickness	(3006,0044)	3	Thickness of slab (in mm) represented by contour, where the Contour Data (3006,0050) defines a plane in the center of the slab, offset by the Contour Offset Vector (3006,0045) if it is present. See C.8.8.6.2.
>>Contour Offset Vector	(3006,0045)	3	Vector (x,y,z) in the the patient based coordinate system described in C.7.6.2.1.1 which is normal to plane of Contour Data (3006,0050), describing direction and magnitude of the offset (in mm) of each point of the central plane of a contour slab from the corresponding original point of Contour Data (3006,0050). See C.8.8.6.2.
>>Number of Contour Points	(3006,0046)	1C	Number of points (triplets) in Contour Data (3006,0050). Required if Contour Sequence (3006,0040) is sent.
>>Contour Data	(3006,0050)	1C	Sequence of (x,y,z) triplets defining a contour in the patient based coordinate system described in C.7.6.2.1.1 (mm). Required if Contour Sequence (3006,0040) is sent. See C.8.8.6.1.

C.8.8.6.1 Contour Geometric Type

A contour can be one of the following geometric types:

- A Contour Geometric Type (3006,0042) of POINT indicates that the contour is a single point, defining a specific location of significance.

- A Contour Geometric Type (3006,0042) of OPEN_PLANAR indicates that the last vertex shall *not* be connected to the first point, and that all points in Contour Data (3006,0050) shall be coplanar.

- A Contour Geometric Type (3006,0042) of OPEN_NONPLANAR indicates that the last vertex shall *not* be connected to the first point, and that the points in Contour Data (3006,0050) may be non-coplanar. Contours having a Geometric Type (3006,0042) of OPEN_NONPLANAR can be used to represent objects best described by a single, possibly non-coplanar curve, such as a brachytherapy applicator.

- A Contour Geometric Type (3006,0042) of CLOSED_PLANAR indicates that the last point shall be connected to the first point, where the first point is not repeated in the Contour Data (3006,0050). All points in Contour Data (3006,0050) shall be coplanar.

C.8.8.6.2 Contour Slab Thickness

A set of Contour slabs may define a multi-slab Volume of Interest. Contour Slab Thickness (3006,0044) shall specify the thickness of a slab, the central plane of which shall be defined by the set of points offset from Contour Data (3006,0050) by the value of Contour Offset Vector (3006,0045). One contour slab may contain one to many sets of Contour Data (3006,0050) that

may define regions of one complex Volume of Interest. If no valid value of Contour Slab Thickness (3006,0044) is sent, then the offset value shall be (0,0,0) and the original Contour Data (3006,0050) shall define the central plane of the Contour slab.

C.8.8.7 RT Dose ROI Module

RT Dose ROI provides ancillary dose-related information to the ROI data defined within the Structure Set and ROI Contour modules, which may be included in the RT Dose IOD composite object. These modules in combination provide for the definition of dose data in the form of *isodose curves* or named or unnamed dose points. Isodose curves in radiation oncology are simply contours identifying a set of points with the same dose value.

Table C.8-39—RT DOSE ROI MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
RT Dose ROI Sequence	(3004,0010)	1	Introduces sequence of items specifying dose levels for isodose curves or dose points described in the ROI module. One or more items may be included in this sequence. See C.8.8.7.1.
>Referenced ROI Number	(3006,0084)	1	Uniquely identifies the referenced ROI within the current RT Dose. See Note 1 and C.8.8.7.2.
>Dose Units	(3004,0002)	1	Units used for ROI Dose. Enumerated Values: GY = Gray RELATIVE = dose relative to implicit reference value
>Dose Value	(3004,0012)	1	Dose value for ROI, in units defined by Dose Units (3004,0002). See C.8.8.7.3.

Notes: 1. The Structure Set ROI Sequence (3006,0020) defining the dose point and surfaces is defined in the Structure Set module. The ROI Number (3006,0022) attribute is unique within the Structure Set ROI Sequence, and is referenced from the RT Dose ROI module using Referenced ROI Number (3006,0084).

2. The RT Dose ROI module defines the attributes that describe references to ROIs contained within the associated Structure Set and RT ROI Contour modules. Note that the RT Dose module table specifies that either all or none of the modules Structures Set, ROI Contour, and RT Dose ROI must be present in the RT Dose IOD.

C.8.8.7.1 Contour Geometric Type of Referenced ROI

ROIs referenced in the RT Dose ROI Module shall have a Contour Geometric Type (3006,0042) of POINT, OPEN_PLANAR or CLOSED_PLANAR.

C.8.8.7.2 Referenced ROI Number

There shall be a one-to-one correspondence between Referenced ROI Number (3006,0084) and the sequence of ROIs defined in the Structure Set and ROI Contour modules. The RT Dose ROI module shall only contain references to structures which are dose-related (i.e. dose points and isodose curves).

C.8.8.7.3 Dose Value

Dose Value (3004,0012) shall be the dose value corresponding to the referenced isodose curve, named dose point, or unnamed dose point.

C.8.8.8 RT ROI Observations Module

The RT ROI Observations module specifies the identification and interpretation of an ROI specified in the Structure Set and ROI Contour modules.

Table C.8-40—RT ROI OBSERVATIONS MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
RT ROI Observations Sequence	(3006,0080)	1	Introduces sequence of observations related to ROIs defined in the ROI Module. One or more items may be included in this sequence.
>Observation Number	(3006,0082)	1	Identification number of the Observation. The value of Observation Number (3006,0082) shall be unique within the RT ROI Observations Sequence (3006,0080).
>Referenced ROI Number	(3006,0084)	1	Uniquely identifies the referenced ROI described in the Structure Set ROI Sequence (3006,0020).
>ROI Observation Label	(3006,0085)	3	User-defined label for ROI Observation.
>ROI Observation Description	(3006,0088)	3	User-defined description for ROI Observation.
>RT Related ROI Sequence	(3006,0030)	3	Introduces sequence of significantly related ROIs, e.g. CTVs contained within a PTV. One or more items may be included in this sequence.
>>Referenced ROI Number	(3006,0084)	1C	Uniquely identifies the related ROI described in the Structure Set ROI Sequence (3006,0020). Required if RT Related ROI Sequence (3006,0030) is sent.
>>RT ROI Relationship	(3006,0033)	3	Relationship of referenced ROI with respect to referencing ROI. Defined Terms: SAME = ROIs represent the same entity ENCLOSED = referenced ROI completely encloses referencing ROI ENCLOSING = referencing ROI completely encloses referenced ROI
>RT ROI Identification Code Sequence	(3006,0086)	3	Introduces sequence containing Code used to identify ROI. If this sequence is included, only one item shall be present. Baseline Context ID Number = 96. See Section 5.3 for further explanation.

>>Code Value	(0008,0100)	1C	Identifier within Coding Scheme which identifies ROI. Required if RT ROI Identification Code Sequence (3006,0086) is sent. See Section 5.3 for further explanation.
>>Coding Scheme Designator	(0008,0102)	1C	Uniquely identifies the table (Coding Scheme) where the Code Value (0008,0100) is linked to its Code Meaning (0008,0104). Required if RT ROI Identification Code Sequence (3006,0086) is sent. See Section 5.3 for further explanation.
>>Code Meaning	(0008,0104)	3	Human-readable text interpretation of Code Value (0008,0100). See Section 5.3 for further explanation.
>Related RT ROI Observations Sequence	(3006,00A0)	3	Introduces sequence of related ROI Observations. One or more items may be included in this sequence.
>>Observation Number	(3006,0082)	1C	Uniquely identifies a related ROI Observation. Required if Related RT ROI Observations Sequence (3006,00A0) is sent.

>RT ROI Interpreted Type	(3006,00A4)	2	Type of ROI. See C.8.8.8.1. Defined Terms: EXTERNAL = external patient contour PTV = Planning Target Volume (as defined in ICRU50) CTV = Clinical Target Volume (as defined in ICRU50) GTV = Gross Tumor Volume (as defined in ICRU50) TREATED_VOLUME = Treated Volume (as defined in ICRU50) IRRAD_VOLUME = Irradiated Volume (as defined in ICRU50) BOLUS = patient bolus to be used for external beam therapy AVOIDANCE = region in which dose is to be minimized ORGAN = patient organ MARKER = patient marker REGISTRATION = registration ROI ISOCENTER = treatment isocenter to be used for external beam therapy CONTRAST_AGENT = volume into which a contrast agent has been injected CAVITY = patient anatomical cavity BRACHY_CHANNEL = brachytherapy channel BRACHY_ACCESSORY = brachytherapy accessory device BRACHY_SRC_APP = brachytherapy source applicator BRACHY_CHNL_SHLD = brachytherapy channel shield
>ROI Interpreter	(3006,00A6)	2	Name of person performing the interpretation.
>Material ID	(300A,00E1)	3	User-supplied identifier for ROI material.
>ROI Physical Properties Sequence	(3006,00B0)	3	Introduces sequence describing physical properties associated with current ROI interpretation. One or more items may be included in this sequence.

>>ROI Physical Property	(3006,00B2)	1C	Physical property specified by ROI Physical Property Value (3006,00B4). Required if ROI Physical Properties Sequence (3006,00B0) is sent. Defined Terms: REL_MASS_DENSITY = mass density relative to water REL_ELEC_DENSITY = electron density relative to water EFFECTIVE_Z = effective atomic number EFF_Z_PER_A = effective ratio of atomic number to mass (AMU^{-1})
>>ROI Physical Property Value	(3006,00B4)	1C	User-assigned value for physical property. Required if ROI Physical Properties Sequence (3006,00B0) is sent.

C.8.8.8.1 RT ROI Interpreted Type

RT ROI Interpreted Type (3006,00A4) shall describe the class of ROI (e.g. CTV, PTV). Individual instances of each class of structure (e.g. CTV1, CTV2) can be distinguished using ROI Observation Label (3006,0085).

C.8.8.9 RT General Plan Module

Table C.8-41—RT GENERAL PLAN MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
RT Plan Label	(300A,0002)	1	User-defined label for treatment plan.
RT Plan Name	(300A,0003)	3	User-defined name for treatment plan.
RT Plan Description	(300A,0004)	3	User-defined description of treatment plan.
Operators' Name	(0008,1070)	2	Name of operator(s) creating treatment plan.
RT Plan Date	(300A,0006)	2	Date treatment plan was last modified.
RT Plan Time	(300A,0007)	2	Time treatment plan was last modified.
Treatment Protocols	(300A,0009)	3	Planned treatment protocols.
Treatment Intent	(300A,000A)	3	Intent of this course of treatment. Defined Terms: CURATIVE PALLIATIVE PROPHYLACTIC
Treatment Sites	(300A,000B)	3	Planned treatment sites.

RT Plan Geometry	(300A,000C)	1	Describes whether RT Plan is based on patient or treatment device geometry. See C.8.8.9.1. Defined Terms: PATIENT = RT Structure Set exists TREATMENT_DEVICE = RT Structure Set does not exist
Referenced Structure Set Sequence	(300C,0060)	1C	Introduces sequence of one Class/Instance pair describing instance of RT Structure Set on which the RT Plan is based. Only a single item shall be permitted in this sequence. Required if RT Plan Geometry (300A,000C) is PATIENT.
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Structure Set Sequence (300C,0060) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Structure Set Sequence (300C,0060) is sent.
Referenced Dose Sequence	(300C,0080)	3	Introduces sequence of related SOP Class/Instance pairs describing related instances of RT Dose (for grids and named/unnamed point doses). One or more items may be included in this sequence. See Note 1.
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced RT Dose Sequence (300C,0080) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced RT Dose Sequence (300C,0080) is sent.
Referenced RT Plan Sequence	(300C,0002)	3	Introduces sequence of related SOP Class/Instance pairs describing related instances of RT Plan. One or more items may be included in this sequence.
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced RT Plan Sequence (300C,0002) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced RT Plan Sequence (300C,0002) is sent.

>RT Plan Relationship	(300A,0055)	1C	Relationship of referenced plan with respect to current plan. Required if Referenced RT Plan Sequence (300C,0002) is sent. Defined Terms: PRIOR = plan delivered prior to current treatment ALTERNATIVE = alternative plan prepared for current treatment PREDECESSOR = plan used in derivation of current plan

Note: An RT Dose IOD referenced within the Referenced Dose Sequence (300C,0080) can be used for storing grid-based (pixel) data, individual dose points (with optional dose point names), isodose curves, and DVH's.

C.8.8.9.1 Referenced Structure Set Sequence

An RT Plan Geometry (300A,000C) of PATIENT shall signify that an RT Structure Set has been defined upon which the plan geometry is based, and this RT Structure Set shall be specified in the Referenced Structure Set Sequence (300C,0060). An RT Plan Geometry (300A,000C) of TREATMENT_DEVICE shall indicate that no patient geometry is available, and that the RT Plan is being defined with respect to the IEC FIXED Coordinate System.

C.8.8.10 RT Prescription Module

Table C.8-42—RT PRESCRIPTION MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Prescription Description	(300A,000E)	3	User-defined description of treatment prescription.
Dose Reference Sequence	(300A,0010)	3	Introduces sequence of Dose References. One or more items may be included in this sequence.
>Dose Reference Number	(300A,0012)	1C	Identification number of the Dose Reference. The value of Dose Reference Number (300A,0012) shall be unique within the RT Plan in which it is created. Required if Dose Reference Sequence (300A,0012) is sent.

>Dose Reference Structure Type	(300A,0014)	1C	Structure type of Dose Reference. Required if Dose Reference Sequence (300A,0010) is sent. Defined Terms: POINT = dose reference point specified as ROI VOLUME = dose reference volume specified as ROI COORDINATES = point specified by Dose Reference Point Coordinates (300A,0018) SITE = dose reference clinical site
>Dose Reference Description	(300A,0016)	3	User-defined description of Dose Reference.
>Referenced ROI Number	(3006,0084)	1C	Uniquely identifies ROI representing the dose reference specified by ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) in Structure Set Module within RT Structure Set in Referenced Structure Set Sequence (300C,0060) in RT General Plan Module. Required if Dose Reference Structure Type (300A,0014) is POINT or VOLUME and Dose Reference Sequence (300A,0010) is sent.
>Dose Reference Point Coordinates	(300A,0018)	1C	Coordinates (x,y,z) of Reference Point in the patient based coordinate system described in C.7.6.2.1.1 (mm). Required if Dose Reference Structure Type (300A,0014) is COORDINATES and Dose Reference Sequence (300A,0010) is sent.
>Nominal Prior Dose	(300A,001A)	3	Dose (in Gy) from prior treatment to this Dose Reference (e.g. from a previous course of treatment).
>Dose Reference Type	(300A,0020)	1C	Type of Dose Reference. Required if Dose Reference Sequence (300A,0010) is sent. Defined Terms: TARGET = treatment target (corresponding to GTV, PTV, or CTV in ICRU50) ORGAN_AT_RISK = Organ at Risk (as defined in ICRU50)
>Constraint Weight	(300A,0021)	3	Relative importance of satisfying constraint, where high values represent more important constraints.
>Delivery Warning Dose	(300A,0022)	3	The dose (in Gy) which when reached or exceeded should cause some action to be taken.

>Delivery Maximum Dose	(300A,0023)	3	The maximum dose (in Gy) which can be delivered to the dose reference.
>Target Minimum Dose	(300A,0025)	3	Minimum permitted dose (in Gy) to Dose Reference if Dose Reference Type (300A,0020) is TARGET.
>Target Prescription Dose	(300A,0026)	3	Prescribed dose (in Gy) to Dose Reference if Dose Reference Type (300A,0020) is TARGET.
>Target Maximum Dose	(300A,0027)	3	Maximum permitted dose (in Gy) to Dose Reference if Dose Reference Type (300A,0020) is TARGET.
>Target Underdose Volume Fraction	(300A,0028)	3	Maximum permitted fraction (in percent) of Target to receive less than the Target Prescription Dose if Dose Reference Type (300A,0020) is TARGET and Dose Reference Structure Type (300A,0014) is VOLUME. See C.8.8.10.1.
>Organ at Risk Full-volume Dose	(300A,002A)	3	Maximum dose (in Gy) to entire Dose Reference if Dose Reference Type (300A,0020) is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) is VOLUME.
>Organ at Risk Limit Dose	(300A,002B)	3	Maximum permitted dose (in Gy) to any part of Dose Reference if Dose Reference Type (300A,0020) is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) is VOLUME.
>Organ at Risk Maximum Dose	(300A,002C)	3	Maximum dose (in Gy) to non-overdosed part of Dose Reference if Dose Reference Type (300A,0020) is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) is VOLUME.
>Organ at Risk Overdose Volume Fraction	(300A,002D)	3	Maximum permitted fraction (in percent) of the Organ at Risk to receive more than the Organ at Risk Maximum Dose if Dose Reference Type (300A,0020) is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) is VOLUME.

C.8.8.10.1 Target Underdose Volume Fraction

If the Target Underdose Volume Fraction (300A,0028) is not present, it shall be interpreted as zero.

C.8.8.11 RT Tolerance Tables Module

Table C.8-43—RT TOLERANCE TABLES MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Tolerance Table Sequence	(300A,0040)	3	Introduces sequence of tolerance tables to be used for delivery of treatment plan. One or more items may be included in this sequence. See Note 1.
>Tolerance Table Number	(300A,0042)	1C	Identification number of the Tolerance Table. The value of Tolerance Table Number (300A,0042) shall be unique within the RT Plan in which it is created. Required if Tolerance Table Sequence (300A,0040) is sent.
>Tolerance Table Label	(300A,0043)	3	User-defined label for Tolerance Table.
>Gantry Angle Tolerance	(300A,0044)	3	Maximum permitted difference (in degrees) between planned and delivered Gantry Angle.
>Beam Limiting Device Angle Tolerance	(300A,0046)	3	Maximum permitted difference (in degrees) between planned and delivered Beam Limiting Device Angle.
>Beam Limiting Device Tolerance Sequence	(300A,0048)	3	Introduces sequence of beam limiting device (collimator) tolerances. One or more items may be included in this sequence.
>>RT Beam Limiting Device Type	(300A,00B8)	1C	Type of beam limiting device (collimator). Required if Beam Limiting Device Tolerance Sequence (300A,0040) is sent. Enumerated Values: X = symmetric jaw pair in IEC X direction Y = symmetric jaw pair in IEC Y direction ASYMX = asymmetric jaw pair in IEC X direction ASYMY = asymmetric pair in IEC Y direction MLCX = multileaf (multi-element) jaw pair in IEC X direction MLCY = multileaf (multi-element) jaw pair in IEC Y direction
>>Beam Limiting Device Position Tolerance	(300A,004A)	1C	Maximum permitted difference (in mm) between planned and delivered leaf (element) or jaw positions for current beam limiting device (collimator). Required if Beam Limiting Device Tolerance Sequence (300A,0040) is sent.

>Patient Support Angle Tolerance	(300A,004C)	3	Maximum permitted difference (in degrees) between planned and delivered Patient Support Angle.
>Table Top Eccentric Angle Tolerance	(300A,004E)	3	Maximum permitted difference (in degrees) between planned and delivered Table Top Eccentric Angle.
>Table Top Vertical Position Tolerance	(300A,0051)	3	Maximum permitted difference (in mm) between planned and delivered Table Top Vertical Position.
>Table Top Longitudinal Position Tolerance	(300A,0052)	3	Maximum permitted difference (in mm) between planned and delivered Table Top Longitudinal Position.
>Table Top Lateral Position Tolerance	(300A,0053)	3	Maximum permitted difference (in mm) between planned and delivered Table Top Lateral Position.

Note: Tolerance Tables may be used to compare planned with delivered machine parameters. If the absolute difference between the planned and delivered values exceeds the Tolerance Table value, treatment may be inhibited or the operator may be warned.

C.8.8.12 RT Patient Setup Module

The RT Patient Setup Module contains information describing the positioning of the patient with respect to the treatment machine, along with any fixation devices used. It also describes the shielding devices applied to the patient. The module contains a sequence of patient setup descriptions, each of which may be referenced by one of more beams or brachy application setups.

Table C.8-44—RT PATIENT SETUP MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Patient Setup Sequence	(300A,0180)	1	Introduces sequence of patient setup data for current plan. One or more items may be included in this sequence.
>Patient Setup Number	(300A,0182)	1	Identification number of the Patient Setup. The value of Patient Setup Number (300A,0182) shall be unique within the RT Plan in which it is created.
>Patient Position	(0018,5100)	1C	Patient position descriptor relative to the equipment. Required if Patient Additional Position (300A,0184) is not present. See Section C.7.3.1.1.2 for Defined Terms and further explanation.
>Patient Additional Position	(300A,0184)	1C	User-defined additional description of patient position. Required if Patient Position (0018,5100) is not present.
>Fixation Device Sequence	(300A,0190)	3	Introduces sequence of Fixation Devices used in Patient Setup. One or more items may be included in this sequence.

>>Fixation Device Type	(300A,0192)	1C	Type of Fixation Device used during in Patient Setup. Required if Fixation Device Sequence (300A,0190) is sent. Defined Terms: BITEBLOCK HEADFRAME MASK MOLD CAST HEADREST BREAST_BOARD
>>Fixation Device Label	(300A,0194)	2C	User-defined label identifier for Fixation Device. Required if Fixation Device Sequence (300A,0190) is sent.
>>Fixation Device Description	(300A,0196)	3	User-defined description of Fixation Device.
>>Fixation Device Position	(300A,0198)	3	Position/Notch number of Fixation Device.
>Shielding Device Sequence	(300A,01A0)	3	Introduces sequence of Shielding Devices used in Patient Setup. One or more items may be included in this sequence.
>>Shielding Device Type	(300A,01A2)	1C	Type of Shielding Device used in Patient Setup. Required if Shielding Device Sequence (300A,01A0) is sent. Defined Terms: GUM EYE GONAD
>>Shielding Device Label	(300A,01A4)	2C	User-defined label for Shielding Device. Required if Shielding Device Sequence (300A,01A0) is sent.
>>Shielding Device Description	(300A,01A6)	3	User-defined description of Shielding Device.
>>Shielding Device Position	(300A,01A8)	3	Position/Notch number of Shielding Device.
>Setup Technique	(300A,01B0)	3	Setup Technique used in Patient Setup. Defined Terms: ISOCENTRIC FIXED_SSD TBI BREAST_BRIDGE SKIN_APPOSITION
>Setup Technique Description	(300A,01B2)	3	User-defined description of Setup Technique.

>Setup Device Sequence	(300A,01B4)	3	Introduces sequence of devices used for patient alignment in Patient Setup. One or more items may be included in this sequence.
>>Setup Device Type	(300A,01B6)	1C	Type of Setup Device used for Patient alignment. Required if Setup Device Sequence (300A,01B4) is sent. Defined Terms: LASER_POINTER DISTANCE_METER TABLE_HEIGHT MECHANICAL_PTR ARC
>>Setup Device Label	(300A,01B8)	2C	User-defined label for Setup Device used for patient alignment. Required if Setup Device Sequence (300A,01B4) is sent.
>>Setup Device Description	(300A,01BA)	3	User-defined description for Setup Device used for patient alignment.
>>Setup Device Parameter	(300A,01BC)	2C	Setup Parameter for Setup Device in appropriate IEC 1217 coordinate system. Units shall be mm for distances and angles for degrees. Required if Setup Device Sequence (300A,011B4) is sent.
>>Setup Reference Description	(300A,01D0)	3	User-defined description of Setup Reference used for patient alignment.
>Table Top Vertical Setup Displacement	(300A,01D2)	3	Vertical Displacement in IEC TABLE TOP coordinate system (in mm) relative to initial Setup Position, i.e. vertical offset between patient positioning performed using setup and treatment position.
>Table Top Longitudinal Setup Displacement	(300A,01D4)	3	Longitudinal Displacement in IEC TABLE TOP coordinate system (in mm) relative to initial Setup Position, i.e. longitudinal offset between patient positioning performed using setup and treatment position.
>Table Top Lateral Setup Displacement	(300A,01D6)	3	Lateral Displacement in IEC TABLE TOP coordinate system (in mm) relative to initial Setup Position, i.e. lateral offset between patient positioning performed using setup and treatment position.

C.8.8.13 RT Fraction Scheme Module

The RT Fraction Scheme module contains attributes that describe a single or multiple scheme of dose descriptions. Each sequence item contains dose specification information, fractionation patterns, and either beam or brachytherapy application setup specifications. The design of the RT

Fraction Scheme module allows a beam or brachytherapy application setup to be used in multiple fraction schemes.

Table C.8-45—RT FRACTION SCHEME MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Fraction Group Sequence	(300A,0070)	1	Introduces sequence of Fraction Groups in current Fraction Scheme. One or more items may be included in this sequence.
>Fraction Group Number	(300A,0071)	1	Identification number of the Fraction Group. The value of Fraction Group Number (300A,0071) shall be unique within the RT Plan in which it is created.
>Referenced Patient Setup Number	(300C,006A)	3	Uniquely identifies Patient Setup specified by Patient Setup Number (300A,0182) within Patient Setup Sequence (300A,0180) in RT Patient Setup Module.
>Referenced Dose Sequence	(300C,0080)	3	Introduces sequence of related SOP Class/Instance pairs describing related instances of RT Dose (for grids, isodose curves and named/unnamed point doses). One or more items may be included in this sequence. See Note 1.
>>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Dose Sequence (300C,0080) is sent.
>>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Dose Sequence (300C,0080) is sent.
>Referenced Dose Reference Sequence	(300C,0050)	3	Introduces sequence of Dose References for the current Fraction Group. One or more items may be included in this sequence.
>>Referenced Dose Reference Number	(300C,0051)	1C	Uniquely identifies Dose Reference specified by Dose Reference Number (300A,0012) within Dose Reference Sequence (300A,0010) in RT Prescription Module. Required if Referenced Dose Reference Sequence (300C,0050) is sent.
>>Constraint Weight	(300A,0021)	3	Relative importance of satisfying constraint, where high values represent more important constraints.
>>Delivery Warning Dose	(300A,0022)	3	The dose (in Gy) which when reached or exceeded should cause some action to be taken.
>>Delivery Maximum Dose	(300A,0023)	3	The maximum dose (in Gy) which can be delivered to the dose reference.

>>Target Minimum Dose	(300A,0025)	3	Minimum permitted dose (in Gy) to Dose Reference if Dose Reference Type (300A,0020) of referenced Dose Reference is TARGET.
>>Target Prescription Dose	(300A,0026)	3	Prescribed dose (in Gy) to Dose Reference if Dose Reference Type (300A,0020) of referenced Dose Reference is TARGET.
>>Target Maximum Dose	(300A,0027)	3	Maximum permitted dose (in Gy) to Dose Reference if Dose Reference Type (300A,0020) of referenced Dose Reference is TARGET.
>>Target Underdose Volume Fraction	(300A,0028)	3	Maximum permitted fraction (in percent) of Target to receive less than the Target Prescription Dose (300A,0027) if Dose Reference Type (300A,0020) of referenced Dose Reference is TARGET and Dose Reference Structure Type (300A,0014) of referenced Dose Reference is VOLUME.
>>Organ at Risk Full-volume Dose	(300A,002A)	3	Maximum dose (in Gy) to entire Dose Reference if Dose Reference Type (300A,0020) of referenced Dose Reference is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) of referenced Dose Reference is VOLUME.
>>Organ at Risk Limit Dose	(300A,002B)	3	Maximum permitted dose (in Gy) to any part of Dose Reference if Dose Reference Type (300A,0020) of referenced Dose Reference is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) of referenced Dose Reference is VOLUME.
>>Organ at Risk Maximum Dose	(300A,002C)	3	Maximum dose (in Gy) to non-overdosed part of Dose Reference if Dose Reference Type (300A,0020) of referenced Dose Reference is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) of referenced Dose Reference is VOLUME.
>>Organ at Risk Overdose Volume Fraction	(300A,002D)	3	Maximum permitted fraction (in percent) of Organ at Risk to receive more than the Organ at Risk Maximum Dose if Dose Reference Type (300A,0020) of referenced Dose Reference is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) of referenced Dose Reference is VOLUME.
>Number of Fractions Planned	(300A,0078)	2	Total number of treatments (Fractions) prescribed for current Fraction Group.

>Number of Fractions Per Day	(300A,0079)	3	Total number of treatments (Fractions) prescribed per day for current Fraction Group. See Note 2.
>Repeat Fraction Cycle Length	(300A,007A)	3	Number of weeks needed to describe treatment pattern. See Note 2.
>Fraction Pattern	(300A,007B)	3	String of 0's (no treatment) and 1's (treatment) describing treatment pattern. Length of string is 7 _ Number of Fractions Per Day _ Repeat Cycle Length. Pattern shall start on a Monday. See Note 2.
>Number of Beams	(300A,0080)	1	Number of Beams in current Fraction Group. If Number of Beams is greater then zero, Number of Brachy Application Setups (300A,00A0) shall equal zero.
>Referenced Beam Sequence	(300C,0004)	1C	Introduces sequence of treatment beams in current Fraction Group. Required if Number of Beams (300A,0080) is greater than zero. One or more items may be included in this sequence.
>>Referenced Beam Number	(300C,0006)	1C	Uniquely identifies Beam specified by Beam Number (300A,00C0) within Beam Sequence (300A,00B0) in RT Beams Module. Required if Referenced Beam Sequence (300C,0004) is sent.
>>Beam Dose Specification Point	(300A,0082)	3	Coordinates (x,y,z) of point at which Beam Dose is specified in the patient based coordinate system described in C.7.6.2.1.1 (mm). See Note 3.
>>Beam Dose	(300A,0084)	3	Dose (in Gy) at Beam Dose Specification Point (300A,0082) due to current Beam.
>>Beam Meterset	(300A,0086)	3	Machine setting to be delivered for current Beam, specified in Monitor Units (MU) or minutes as defined by Primary Dosimeter Unit (300A,00B3) (in RT Beams Module) for referenced Beam. See Note 4.
>Number of Brachy Application Setups	(300A,00A0)	1	Number of Brachy Application Setups in current Fraction Group. If Number of Brachy Application Setups is greater then zero, Number of Beams (300A,0080) shall equal zero.
>Referenced Brachy Application Setup Sequence	(300C,000A)	1C	Introduces sequence of treatment Brachy Application Setups in current Fraction Group. Required if Number of Brachy Application Setups (300A,00A0) is greater than zero. One or more items may be included in this sequence.

>>Referenced Brachy Application Setup Number	(300C,000C)	1C	Uniquely identifies Brachy Application Setup specified by Brachy Application Setup Number (300A,0234) within Brachy Application Setup Sequence (300A,0230) in RT Brachy Application Setups Module. Required if Referenced Brachy Application Setup Sequence (300C,000A) is sent.
>>Brachy Application Setup Dose Specification Point	(300A,00A2)	3	Coordinates (x,y,z) of point in the patient based coordinate system described in C.7.6.2.1.1 at which Brachy Application Setup Dose (300A,00A4) is specified (mm).
>>Brachy Application Setup Dose	(300A,00A4)	3	Dose (in Gy) at Brachy Application Setup Dose Specification Point (300A,00A2) due to current Brachy Application Setup.

Notes: 1. An RT Dose IOD referenced within the Referenced Dose Sequence (300C,0080) can be used for storing grid-based (pixel) data, isodose curves, and/or individual dose points (with optional dose point names) for the current Fraction Group.

2. The fractionation pattern does not indicate the actual start of treatment. If treatment does not commence as outlined in the pattern, it is the application's responsibility to make any necessary adjustments.

Examples of Fractionation Pattern Schemes:

a) 1 fraction group, 1 fraction per day (Monday to Friday):

Number of Fractions per Day = 1, Repeat Fraction Cycle Length = 1, Fraction Pattern = 1111100

b) 2 fraction groups, 1 fraction per day, first fraction group Monday, Wednesday, and Friday, second fraction group Tuesday and Thursday:

Fraction Group 1: Number of Fractions Per Day = 1, Repeat Fraction Cycle Length = 1, Fraction Pattern = 1010100

Fraction Group 2: Number of Fractions Per Day = 1, Repeat Fraction Cycle Length = 1, Fraction Pattern = 0101000

c) 2 fraction groups, 1 fraction per day, alternating fraction groups every day of treatment (Monday to Friday):

Fraction Group 1: Number of Fractions Per Day = 1, Repeat Fraction Cycle Length = 2, Fraction Pattern = 10101000101000

Fraction Group 2: Number of Fractions Per Day = 1, Repeat Fraction Cycle Length = 2, Fraction Pattern = 01010001010100

d) 1 fraction group, 2 fractions per day (Monday to Friday):

Fraction Group 1: Number of Fractions Per Day = 2, Repeat Fraction Cycle Length = 1, Fraction Pattern = 11111111110000

e) 2 fraction groups, 2 fractions per day, alternating fraction groups every treatment (Monday to Friday):

Fraction Group 1: Number of Fractions Per Day = 1, Repeat Fraction Cycle Length = 2, Fraction Pattern = 10101010100000

Fraction Group 2: Number of Fractions Per Day = 1, Repeat Fraction Cycle Length = 2, Fraction Pattern = 01010101010000

3. The Beam Dose Specification Point (300A,0082) and Brachy Application Setup Dose Specification Point (300A,00A2) contain the coordinates of the single point used for dose normalization. This point is distinct from the Referenced Dose Reference Sequence (300C,0050) in the RT Beams module and the Brachy Referenced Dose Reference Sequence (300A,0055) in the RT Brachy Application Setups module, which are used for plan evaluation and dose tracking.

4. The Meterset at a given Control Point (see RT Beams Module) is equal to the Beam Meterset (300A,0086) multiplied by the Cumulative Meterset Weight (300A,0134) for the Control Point, divided by the Final Cumulative Meterset Weight (300A,010E).

C.8.8.14 RT Beams Module

The RT Beams Module contains information defining equipment parameters for delivery of external radiation beams.

Table C.8-46—RT BEAMS MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Beam Sequence	(300A,00B0)	1	Introduces sequence of treatment beams for current RT Plan. One or more items may be included in this sequence.
>Beam Number	(300A,00C0)	1	Identification number of the Beam. The value of Beam Number (300A,00C0) shall be unique within the RT Plan in which it is created.
>Beam Name	(300A,00C2)	3	User-defined name for Beam.
>Beam Description	(300A,00C3)	3	User-defined description for Beam.
>Beam Type	(300A,00C4)	1	Motion characteristic of Beam. Enumerated Values: STATIC = all beam parameters remain unchanged during delivery DYNAMIC = one or more beam parameters changes during delivery
>Radiation Type	(300A,00C6)	2	Particle type of Beam. Defined Terms: PHOTON ELECTRON NEUTRON PROTON
>Treatment Machine Name	(300A,00B2)	2	User-defined name identifying treatment machine to be used for beam delivery. See Note 1.

>Manufacturer	(0008,0070)	3	Manufacturer of the equipment to be used for beam delivery.
>Institution Name	(0008,0080)	3	Institution where the equipment is located that is to be used for beam delivery.
>Institution Address	(0008,0081)	3	Mailing address of the institution where the equipment is located that is to be used for beam delivery.
>Institutional Department Name	(0008,1040)	3	Department in the institution where the equipment is located that is to be used for beam delivery.
>Manufacturer's Model Name	(0008,1090)	3	Manufacturer's model name of the equipment that is to be used for beam delivery.
>Device Serial Number	(0018,1000)	3	Manufacturer's serial number of the equipment that is to be used for beam delivery.
>Primary Dosimeter Unit	(300A,00B3)	3	Measurement unit of machine dosimeter. See C.8.8.14.1. Enumerated Values: MU = Monitor Unit MINUTE = minute
>Referenced Tolerance Table Number	(300C,00A0)	3	Uniquely identifies Tolerance Table specified by Tolerance Table Number (300A,0042) within Tolerance Table Sequence in RT Tolerance Tables Module. These tolerances are to be used for verification of treatment machine settings.
>Source-Axis Distance	(300A,00B4)	3	Radiation source to Gantry rotation axis distance of the equipment that is to be used for beam delivery (mm).
>Beam Limiting Device Sequence	(300A,00B6)	1	Introduces sequence of beam limiting device (collimator) jaw or leaf (element) sets. One or more items may be included in this sequence.
>>RT Beam Limiting Device Type	(300A,00B8)	1	Type of beam limiting device (collimator). Enumerated Values: X = symmetric jaw pair in IEC X direction Y = symmetric jaw pair in IEC Y direction ASYMX = asymmetric jaw pair in IEC X direction ASYMY = asymmetric pair in IEC Y direction MLCX = multileaf (multi-element) jaw pair in IEC X direction MLCY = multileaf (multi-element) jaw pair in IEC Y direction

>>Source to Beam Limiting Device Distance	(300A,00BA)	3	Radiation source to beam limiting device (collimator) distance of the equipment that is to be used for beam delivery (mm).
>>Number of Leaf/Jaw Pairs	(300A,00BC)	1	Number of leaf (element) or jaw pairs (equal to 1 for standard beam limiting device jaws).
>>Leaf Position Boundaries	(300A,00BE)	2C	Boundaries of beam limiting device (collimator) leaves (in mm) in IEC BEAM LIMITING DEVICE coordinate axis appropriate to RT Beam Limiting Device Type (300A,00B8), i.e. X-axis for MLCY, Y-axis for MLCX. Contains N+1 values, where N is the Number of Leaf/Jaw Pairs (300A,00BC), starting from Leaf (Element) Pair 1. Required if Beam Limiting Device Sequence (300A,00B6) is sent and RT Beam Limiting Device Type (300A,00B8) is MLCX or MLCY. See Note 2.
>Referenced Patient Setup Number	(300C,006A)	3	Uniquely identifies Patient Setup to be used for current beam, specified by Patient Setup Number (300A,0182) within Patient Setup Sequence of RT Patient Setup Module.
>Referenced Reference Image Sequence	(300C,0042)	3	Introduces sequence of reference images used for validation of current beam. One or more items may be included in this sequence.
>>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Reference Image Sequence (300C,0042) is sent.
>>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Reference Image Sequence (300C,0042) is sent.
>>Reference Image Number	(300A,00C8)	1C	Uniquely identifies Reference Image within Referenced Reference Image Sequence (300A,0042). Required if Referenced Reference Image Sequence (300A,0042) is sent.
>>Start Cumulative Meterset Weight	(300C,0008)	3	Cumulative Meterset Weight within current Beam at which image acquisition starts.
>>End Cumulative Meterset Weight	(300C,0009)	3	Cumulative Meterset Weight within current Beam at which image acquisition ends.
>Planned Verification Image Sequence	(300A,00CA)	3	Introduces sequence of planned verification images to be acquired during current beam. One or more items may be included in this sequence. See C.8.8.14.2.

>>Start Cumulative Meterset Weight	(300C,0008)	3	Cumulative Meterset Weight within current Beam at which image acquisition will start.
>>Meterset Exposure	(3002,0032)	3	Meterset duration over which image is to be acquired, specified in Monitor units (MU) or minutes as defined by Primary Dosimeter Unit (300A,00B3).
>>End Cumulative Meterset Weight	(300C,0009)	3	Cumulative Meterset Weight within current Beam at which image acquisition will end.
>>RT Image Plane	(3002,000C)	3	Describes whether or not image plane is normal to beam axis. Enumerated Values: NORMAL = image plane normal to beam axis NON_NORMAL = image plane non-normal to beam axis
>>X-Ray Image Receptor Angle	(3002,000E)	3	X-Ray Image Receptor Angle i.e. orientation of IEC X-RAY IMAGE RECEPTOR coordinate system with respect to IEC GANTRY coordinate system (degrees). See C.8.8.14.3.
>>RT Image Orientation	(3002,0010)	3	The direction cosines of the first row and the first column with respect to the IEC X-RAY IMAGE RECEPTOR coordinate system.
>>RT Image Position	(3002,0012)	3	The x and y coordinates (in mm) of the upper left hand corner (first pixel transmitted) of the image, in the IEC X-RAY IMAGE RECEPTOR coordinate system.
>>RT Image SID	(3002,0026)	3	Radiation machine source to image plane distance (mm).
>>Imaging Device-Specific Acquisition Parameters	(300A,00CC)	3	User-specified device-specific parameters which describe how the imager will acquire the image.
>>Referenced Reference Image Number	(300C,0007)	3	Uniquely identifies Reference Image to which planned verification image is related, specified by Reference Image Number (300A,00C8) within Referenced Reference Image Sequence (300A,0042).

>Treatment Delivery Type	(300A,00CE)	3	Delivery Type of treatment. Defined Terms: TREATMENT = normal patient treatment OPEN_PORTFILM = portal image acquisition with open field TRMT_PORTFILM = portal image acquisition with treatment port CONTINUATION = continuation of interrupted treatment
>Referenced Dose Sequence	(300C,0080)	3	Introduces sequence of related SOP Class/Instance pairs describing related instances of RT Dose (for grids, isodose curves, and named/unnamed point doses). One or more items may be included in this sequence.
>>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Dose Sequence (300C,0080) is sent.
>>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Dose Sequence (300C,0080) is sent.
>Number of Wedges	(300A,00D0)	1	Number of wedges associated with current Beam.
>Wedge Sequence	(300A,00D1)	1C	Introduces sequence of treatment wedges. Required if Number of Wedges (300A,00D0) is non-zero. One or more items may be included in this sequence.
>>Wedge Number	(300A,00D2)	1C	Identification number of the Wedge. The value of Wedge Number (300A,00D2) shall be unique within the Beam in which it is created. Required if Wedge Sequence (300A,00D1) is sent.
>>Wedge Type	(300A,00D3)	2C	Type of wedge (if any) defined for Beam. Required if Wedge Sequence (300A,00D1) is sent. Defined Terms: STANDARD = standard (static) wedge DYNAMIC = moving beam limiting device (collimator) jaw simulating wedge MOTORIZED = single wedge which can be removed from beam remotely
>>Wedge ID	(300A,00D4)	3	User-supplied identifier for Wedge.
>>Wedge Angle	(300A,00D5)	2C	Nominal wedge angle (degrees). Required if Wedge Sequence (300A,00D1) is sent.

>>Wedge Factor	(300A,00D6)	2C	Nominal wedge factor under machine calibration conditions at the beam energy specified by the Nominal Beam Energy (300A,0114) of the first Control Point of the Control Point Sequence (300A,0111). Required if Wedge Sequence (300A,00D1) is sent.
>>Wedge Orientation	(300A,00D8)	2C	Orientation of wedge, i.e. orientation of IEC WEDGE FILTER coordinate system with respect to IEC BEAM LIMITING DEVICE coordinate system (degrees). Required if Wedge Sequence (300A,00D1) is sent.
>>Source to Wedge Tray Distance	(300A,00DA)	3	Radiation source to wedge tray attachment edge distance (in mm) for current wedge.
>Number of Compensators	(300A,00E0)	1	Number of compensators associated with current Beam.
>Total Compensator Tray Factor	(300A,00E2)	3	Compensator Tray transmission factor (between 0 and 1), at the beam energy specified by the Nominal Beam Energy (300A,0114) of the first Control Point of the Control Point Sequence (300A,0111).
>Compensator Sequence	(300A,00E3)	1C	Introduces sequence of treatment compensators. Required if Number of Compensators (300A,00E0) is non-zero. One or more items may be included in this sequence.
>>Compensator Number	(300A,00E4)	1C	Identification number of the Compensator. The value of Compensator Number (300A,00E4) shall be unique within the Beam in which it is created. Required if Number of Compensators (300A,00E0) is non-zero.
>>Material ID	(300A,00E1)	2C	User-supplied identifier for material used to manufacture Compensator. Required if Number of Compensators (300A,00E0) is non-zero.
>>Compensator ID	(300A,00E5)	3	User-supplied identifier for compensator.
>>Source to Compensator Tray Distance	(300A,00E6)	2C	Radiation source to compensator tray attachment edge distance (in mm) for current compensator. Required if Compensator Sequence (300A,00E3) is sent.
>>Compensator Rows	(300A,00E7)	1C	Number of rows in the compensator. Required if Compensator Sequence (300A,00E3) is sent.
>>Compensator Columns	(300A,00E8)	1C	Number of columns in the compensator. Required if Compensator Sequence (300A,00E3) is sent.

>>Compensator Pixel Spacing	(300A,00E9)	1C	Physical distance (in mm) between the center of each pixel projected onto machine isocentric plane. Specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing. Required if Compensator Sequence (300A,00E3) is sent.
>>Compensator Position	(300A,00EA)	1C	The x and y coordinates of the upper left hand corner (first pixel transmitted) of the compensator, projected onto the machine isocentric plane in the IEC BEAM LIMITING DEVICE coordinate system (mm). Required if Compensator Sequence (300A,00E3) is sent.
>>Compensator Transmission Data	(300A,00EB)	1C	A data stream of the pixel samples which comprise the compensator, expressed as broad-beam transmission values (between 0 and 1) along a ray line passing through the pixel, at the beam energy specified by the Nominal Beam Energy (300A,0114) of the first Control Point of the Control Point Sequence (300A,0111). The order of pixels sent is left to right, top to bottom (upper left pixel, followed by the remainder of row 1, followed by the remainder of the columns). Required if Compensator Sequence (300A,00E3) is sent and Material ID (300A,00E1) is zero-length.
>>Compensator Thickness Data	(300A,00EC)	1C	A data stream of the pixel samples which comprise the compensator, expressed as thicknesses (in mm) parallel to radiation beam axis. The order of pixels sent is left to right, top to bottom (upper left pixel, followed by the remainder of row 1, followed by the remainder of the columns). Required if Compensator Sequence (300A,00E3) is sent and Material ID (300A,00E1) is non-zero length.
>Number of Boli	(300A,00ED)	1	Number of boli associated with current Beam.
>Referenced Bolus Sequence	(300C,00B0)	1C	Introduces sequence of boli associated with Beam. Required if Number of Boli (300A,00ED) is non-zero. One or more items may be included in this sequence.

>>Referenced ROI Number	(3006,0084)	1C	Uniquely identifies ROI representing the Bolus specified by ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) in Structure Set Module within RT Structure Set in Referenced Structure Set Sequence (300C,0060) in RT General Plan Module. Required if Referenced Bolus Sequence (300A,00B0) is sent.
>Number of Blocks	(300A,00F0)	1	Number of shielding blocks associated with Beam.
>Total Block Tray Factor	(300A,00F2)	3	Total block tray transmission for all block trays (between 0 and 1) at the beam energy specified by the Nominal Beam Energy (300A,0114) of the first Control Point of the Control Point Sequence (300A,0111).
>Block Sequence	(300A,00F4)	1C	Introduces sequence of blocks associated with Beam. Required if Number of Blocks (300A,00F0) is non-zero. One or more items may be included in this sequence.
>>Block Tray ID	(300A,00F5)	3	User-supplied identifier for block tray.
>>Source to Block Tray Distance	(300A,00F6)	2C	Radiation Source to attachment edge of block tray assembly (mm). Required if Block Sequence (300A,00F4) is sent.
>>Block Type	(300A,00F8)	1C	Type of block. Required if Block Sequence (300A,00F4) is sent. See C.8.8.14.4. Enumerated Values: SHIELDING = blocking material is inside contour APERTURE = blocking material is outside contour
>>Block Divergence	(300A,00FA)	2C	Indicates presence or otherwise of geometrical divergence. Required if Block Sequence (300A,00F4) is sent. Enumerated Values: PRESENT = block edges are shaped for beam divergence ABSENT = block edges are not shaped for beam divergence
>>Block Number	(300A,00FC)	1C	Identification number of the Block. The value of Block Number (300A,00FC) shall be unique within the Beam in which it is created. Required if Block Sequence (300A,00F4) is sent.
>>Block Name	(300A,00FE)	3	User-defined name for block.

>>Material ID	(300A,00E1)	2C	User-supplied identifier for material used to manufacture Block. Required if Block Sequence (300A,00F4) is sent.
>>Block Thickness	(300A,0100)	2C	Physical thickness of block (in mm) parallel to radiation beam axis. Required if Block Sequence (300A,00F4) is sent and Material ID (300A,00E1) is non-zero length. See C.8.8.14.4.
>>Block Transmission	(300A,0102)	2C	Transmission through the block (between 0 and 1) at the beam energy specified by the Nominal Beam Energy (300A,0114) of the first Control Point of the Control Point Sequence (300A,0111). Required if Block Sequence (300A,00F4) is sent and Material ID (300A,00E1) is zero length. See C.8.8.14.4.
>>Block Number of Points	(300A,0104)	2C	Number of (x,y) pairs defining the block edge. Required if Block Sequence (300A,00F4) is sent.
>>Block Data	(300A,0106)	2C	A data stream of (x,y) pairs which comprise the block edge. The number of pairs shall be equal to Block Number of Points (300A,0104), and the vertices shall be interpreted as a closed polygon. Coordinates are projected onto the machine isocentric plane in the IEC BEAM LIMITING DEVICE coordinate system (mm). Required if Block Sequence (300A,00F4) is sent. See Note 3.
>Applicator Sequence	(300A,0107)	3	Introduces sequence of Applicators associated with Beam. Only a single item shall be permitted in this sequence.
>>Applicator ID	(300A,0108)	1C	User or machine supplied identifier for Applicator. Required if Applicator Sequence (300A,0107) is sent.

>>Applicator Type	(300A,0109)	1C	Type of Applicator. Required if Applicator Sequence (300A,0107) is sent. Defined Terms: ELECTRON_SQUARE = square electron applicator ELECTRON_RECT = rectangular electron applicator ELECTRON_CIRC = circular electron applicator ELECTRON_SHORT = short electron applicator ELECTRON_OPEN = open (dummy) electron applicator INTRAOPERATIVE = intraoperative (custom) applicator STEREOTACTIC = stereotactic applicator
>>Applicator Description	(300A,010A)	3	User-defined description for Applicator.
>Final Cumulative Meterset Weight	(300A,010E)	1C	Value of Cumulative Meterset Weight (300A,0134) for final Control Point in Control Point Sequence (300A,0111). Required if Cumulative Meterset Weight is non-null in Control Points specified within Control Point Sequence (300A,0111). See C.8.8.14.1.
>Number of Control Points	(300A,0110)	1	Number of control points in Beam.
>Control Point Sequence	(300A,0111)	1	Introduces sequence of machine configurations describing treatment beam. Two or more items may be included in this sequence. See C.8.8.14.5 and C.8.8.14.6.
>>Control Point Index	(300A,0112)	1C	Index of current Control Point, starting at 0 for first Control Point. Required if Control Point Sequence (300A, 0111) is sent.
>>Cumulative Meterset Weight	(300A,0134)	2C	Cumulative weight to current control point. Cumulative Meterset Weight for the first item in Control Point Sequence shall always be zero. Cumulative Meterset Weight for the final item in Control Point Sequence shall always be equal to Final Cumulative Meterset Weight. Required if Control Point Sequence (300A,0111) is sent. See C.8.8.14.1.
>>Referenced Dose Reference Sequence	(300C,0050)	3	Introduces a sequence of Dose References for current Beam. One or more items may be included in this sequence.

>>>Referenced Dose Reference Number	(300C,0051)	1C	Uniquely identifies Dose Reference specified by Dose Reference Number (300A,0012) in Dose Reference Sequence (300A,0010) in RT Prescription Module. Required if Referenced Dose Reference Sequence (300C,0050) is sent.
>>>Cumulative Dose Reference Coefficient	(300A,010C)	2C	Coefficient used to calculate cumulative dose contribution from this Beam to the referenced Dose Reference at the current Control Point. Required if Referenced Dose Reference Sequence (300C,0050) is sent. See C.8.8.14.7.
>>Nominal Beam Energy	(300A,0114)	3	Nominal Beam Energy at control point (MV/MeV).
>>Dose Rate Set	(300A,0115)	3	Dose Rate to be set on treatment machine for segment beginning at current control point (e.g. MU/min).
>>Wedge Position Sequence	(300A,0116)	3	Introduces sequence of Wedge positions for current control point. One or more items may be included in this sequence.
>>>Referenced Wedge Number	(300C,00C0)	1C	Uniquely references Wedge described by Wedge Number (300A,00D2) in Wedge Sequence (300A,00D1). Required if Wedge Position Sequence (300A,0116) is sent.
>>>Wedge Position	(300A,0118)	1C	Position of Wedge at current Control Point. Required if Wedge Position Sequence (300A,0116) is sent. Enumerated Values: IN OUT
>>Beam Limiting Device Position Sequence	(300A,011A)	1C	Introduces sequence of beam limiting device (collimator) jaw or leaf (element) positions. Required for first item of Control Point Sequence, or if Beam Limiting Device changes during Beam. One or more items may be included in this sequence.

>>>RT Beam Limiting Device Type	(300A,00B8)	1C	Type of beam limiting device (collimator). The value of this attribute shall correspond to RT Beam Limiting Device Type (300A,00B8) defined in an item of Beam Limiting Device Sequence (300A,00B6). Required if Beam Limiting Device Position Sequence (300A,0116) is sent. Enumerated Values: X = symmetric jaw pair in IEC X direction Y = symmetric jaw pair in IEC Y direction ASYMX = asymmetric jaw pair in IEC X direction ASYMY = asymmetric pair in IEC Y direction MLCX = multileaf (multi-element) jaw pair in IEC X direction MLCY = multileaf (multi-element) jaw pair in IEC Y direction
>>>Leaf/Jaw Positions	(300A,011C)	1C	Positions of beam limiting device (collimator) leaf (element) or jaw pairs (in mm) in IEC BEAM LIMITING DEVICE coordinate axis appropriate to RT Beam Limiting Device Type (300A,00B8), e.g. X-axis for MLCX, Y-axis for MLCY. Contains 2N values, where N is the Number of Leaf/Jaw Pairs (300A,00BC) in Beam Limiting Device Sequence (300A,00B6). Values shall be listed in IEC leaf (element) subscript order 101, 102, ... 1N, 201, 202, ... 2N. Required if Beam Limiting Device Position Sequence (300A,0116) is sent. See Note 2.
>>Gantry Angle	(300A,011E)	1C	Gantry angle of radiation source, i.e. orientation of IEC GANTRY coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees). Required for first item of Control Point Sequence, or if Gantry Angle changes during Beam.
>>Gantry Rotation Direction	(300A,011F)	1C	Direction of Gantry Rotation when viewing gantry from isocenter, for segment following Control Point. Required for first item of Control Point Sequence, or if Gantry Rotation Direction changes during Beam. See C.8.8.14.8. Enumerated Values: CW = clockwise CC = counter-clockwise NONE = no rotation

>>Beam Limiting Device Angle	(300A,0120)	1C	Beam Limiting Device angle, i.e. orientation of IEC BEAM LIMITING DEVICE coordinate system with respect to IEC GANTRY coordinate system (degrees). Required for first item of Control Point Sequence, or if Beam Limiting Device Angle changes during Beam.
>>Beam Limiting Device Rotation Direction	(300A,0121)	1C	Direction of Beam Limiting Device Rotation when viewing beam limiting device (collimator) from radiation source, for segment following Control Point. Required for first item of Control Point Sequence, or if Beam Limiting Device Rotation Direction changes during Beam. See C.8.8.14.8. Enumerated Values: CW = clockwise CC = counter-clockwise NONE = no rotation
>>Patient Support Angle	(300A,0122)	1C	Patient Support angle, i.e. orientation of IEC PATIENT SUPPORT (turntable) coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees). Required for first item of Control Point Sequence, or if Patient Support Angle changes during Beam.
>>Patient Support Rotation Direction	(300A,0123)	1C	Direction of Patient Support Rotation when viewing table from above, for segment following Control Point. Required for first item of Control Point Sequence, or if Patient Support Rotation Direction changes during Beam. See C.8.8.14.8. Enumerated Values: CW = clockwise CC = counter-clockwise NONE = no rotation
>>Table Top Eccentric Axis Distance	(300A,0124)	3	Distance (positive) from the IEC PATIENT SUPPORT vertical axis to the IEC TABLE TOP ECCENTRIC vertical axis (mm).
>>Table Top Eccentric Angle	(300A,0125)	1C	Table Top (non-isocentric) angle, i.e. orientation of IEC TABLE TOP ECCENTRIC coordinate system with respect to IEC PATIENT SUPPORT coordinate system (degrees). Required for first item of Control Point Sequence, or if Table Top Eccentric Angle changes during Beam.

>>Table Top Eccentric Rotation Direction	(300A,0126)	1C	Direction of Table Top Eccentric Rotation when viewing table from above, for segment following Control Point. Required for first item of Control Point Sequence, or if Table Top Eccentric Rotation Direction changes during Beam. See C.8.8.14.8. Enumerated Values: CW = clockwise CC = counter-clockwise NONE = no rotation
>>Table Top Vertical Position	(300A,0128)	2C	Table Top Vertical position in IEC TABLE TOP coordinate system (mm). Required for first item of Control Point Sequence, or if Table Top Vertical Position changes during Beam. See C.8.8.14.6.
>>Table Top Longitudinal Position	(300A,0129)	2C	Table Top Longitudinal position in IEC TABLE TOP coordinate system (mm). Required for first item of Control Point Sequence, or if Table Top Longitudinal Position changes during Beam. See C.8.8.14.6.
>>Table Top Lateral Position	(300A,012A)	2C	Table Top Lateral position in IEC TABLE TOP coordinate system (mm). Required for first item of Control Point Sequence, or if Table Top Lateral Position changes during Beam. See C.8.8.14.6.
>>Isocenter Position	(300A,012C)	2C	Isocenter coordinates (x,y,z) in the patient based coordinate system described in C.7.6.2.1.1 (mm). Required for first item of Segment Control Point Sequence, or if Segment Isocenter Position changes during Beam.
>>Surface Entry Point	(300A,012E)	3	Patient surface entry point coordinates (x,y,z) in the patient based coordinate system described in C.7.6.2.1.1 (mm).
>>Source to Surface Distance	(300A,0130)	3	Source to Patient Surface distance (mm).

Notes: 1. The DICOM standard does not support the transmission of treatment unit modeling information such as depth doses and beam profiles.

2. Implementors should take note that Leaf Position Boundaries (300A,00BE) are the positions of the mechanical boundaries (projected to the isocentric plane) between beam limiting device (collimator) leaves, fixed for a given beam limiting device (collimator). Leaf/Jaw Positions (300A,011C) are values specific to a given beam control point, specifying the beam limiting device (collimator) leaf (element) openings.

3. Block coordinates may not be transmitted when such data is not available from the transmitting system. However, the receiving system may not have internal mechanisms to use or store such data. For example, a plan sent from an treatment planning system to a Record and Verify (R&V) system will contain the block data for blocked beams. Subsequent transfer of

beam data from the R&V system may omit this data since the R&V system may not have stored it.

C.8.8.14.1 Meterset calculations

The Meterset at a given Control Point is equal to the Beam Meterset (300A,0086) specified in the Referenced Beam Sequence (300A,0004) of the RT Fraction Scheme Module, multiplied by the Cumulative Meterset Weight (300A,0134) for the Control Point, divided by the Final Cumulative Meterset Weight (300A,010E). The Meterset is specified in units defined by Primary Dosimeter Unit (300A,00B3). If the calculation for Meterset results in a meterset value which is not an exact multiple of the primary meterset resolution, then the result shall be rounded to the nearest allowed meterset value (i.e. less than a half resolution unit shall be rounded down to the nearest resolution unit, and equal or greater than half a resolution unit shall be rounded up to the nearest resolution unit).

Note also that if Final Cumulative Meterset Weight (300A,010E) is equal to 100, then Cumulative Meterset Weight (300A,0134) becomes equivalent to the percentage of Beam Meterset (300A,0086) delivered at each control point. If Final Cumulative Meterset Weight (300A,010E) is equal to Beam Meterset (300A,0086), then the Cumulative Meterset Weight (300A,0134) at each control point becomes equal to the cumulative Meterset delivered at that control point.

C.8.8.14.2 Planned Verification Image Sequence

The Planned Verification Image Sequence (300A,00CA) contains attributes which describe the planned verification images to be acquired during current beam. The Start Cumulative Meterset Weight (300C,0008) specifies the Cumulative Meterset Weight at which image acquisition is to begin. If Meterset Exposure (3002,0032) is present in a sequence item and End Cumulative Meterset Weight (300C,0009) is not present then a single image shall be acquired using the meterset duration specified in Meterset Exposure (3002,0032). If End Cumulative Meterset Weight (300C,0009) is present in a sequence item and Meterset Exposure (3002,0032) is not present then a single image shall be acquired over the beam delivery from Start Cumulative Meterset Weight (300C,0008) to End Cumulative Meterset Weight (300C,0009). If both Meterset Exposure (3002,0032) and End Cumulative Meterset Weight (300C,0009) are present in a sequence item then images shall be acquired every Meterset Exposure (3002,0032) from Start Cumulative Meterset Weight (300C,0008) to End Cumulative Meterset Weight (300C,0009). No images shall extend past End Cumulative Meterset Weight (300C,0009).

C.8.8.14.3 X-Ray Image Receptor Angle

The X-Ray Image Receptor Angle (3002,000E) specifies the rotation of the image receptor device in the IEC X-RAY IMAGE RECEPTOR PLANE. A positive angle corresponds to a counter-clockwise rotation of the X-Ray Image Receptor as viewed from the radiation source in the IEC GANTRY coordinate system. The normal (non-rotated) value for this parameter is zero degrees.

C.8.8.14.4 Multiple aperture blocks

All blocks with Block Type (300A,00F8) of APERTURE for a given beam shall have equal values of Block Transmission (300A,0102) and/or Block Thickness (300A,0100) if they are specified. The composite aperture shall be evaluated as the union of the individual apertures within a single Block. Shielding block transmission(s) shall be applied multiplicatively after the (composite) aperture has been evaluated.

C.8.8.14.5 Control Point Sequence

The DICOM RT Beams Module uses a single beam model to handle static, arc, and dynamic delivery of external beam radiation by a medical accelerator or gamma beam therapy equipment (cobalt unit). All applicable parameters shall be specified at Control Point 0, with the exception of

couch positions (see C.8.8.14.6). All parameters which change at any control point of a given beam shall be specified explicitly at all control points (including those preceding the change). No assumptions are made about the behavior of machine parameters between specified control points, and communicating devices shall agree on this behavior outside the current standard. Some examples of beam specification using control points are as follows:

a) Static delivery:

Control Point 0: All applicable treatment parameters defined, Cumulative Meterset Weight = 0

Control Point 1: Cumulative Meterset Weight = 1, no other parameters defined

b) Arc delivery:

Control Point 0: All applicable treatment parameters defined, Cumulative Meterset Weight = 0, Gantry Rotation Direction = *rotation direction*, Gantry Angle = *initial angle*

Control Point 1: Cumulative Meterset Weight = 1, Gantry Rotation Direction = NONE, Gantry Angle = *final angle*

c) Dynamic delivery of two equally weighted segments:

Control Point 0: All applicable treatment parameters defined, Cumulative Meterset Weight = 0

Control Point 1: All changing treatment parameters defined (including those which do not change at this control point), Cumulative Meterset Weight = 0.5

Control Point 2: All changing treatment parameters defined (including those which do not change at this control point), Cumulative Meterset Weight = 1

d) Dynamic Delivery of two unequally weighted segments with a step change in table angle:

Control Point 0: All applicable treatment parameters defined, Patient Support Angle = *initial angle*, Patient Support Rotation Direction = NONE, Cumulative Meterset Weight = 0

Control Point 1: Cumulative Meterset Weight = 0.3, Patient Support Angle = *initial angle*, Patient Support Rotation Direction = *rotation direction*, no other parameters defined

Control Point 2: Cumulative Meterset Weight = 0.3, Patient Support Angle = *new angle*, Patient Support Rotation Direction = NONE, no other parameters defined

Control Point 3: Cumulative Meterset Weight = 1, Patient Support Angle = *new angle*, Patient Support Rotation Direction = NONE, no other parameters defined

C.8.8.14.6 Absolute and relative machine coordinates

All treatment machine parameters except couch translations are specified in absolute machine coordinates as defined by IEC 1217. For the Table Top Vertical Position (300A,0128), Table Top Longitudinal Position (300A,0129), and Table Top Lateral Position (300A,012A), if the first Control Point contains a value of non-zero length, all subsequent Control Point position values are absolute values in their respective coordinate system. If the first Control Point contains a zero-length value, all subsequent Control Point position values are specified relative to the (unknown) initial value.

C.8.8.14.7 Cumulative Dose Reference Coefficient

The Cumulative Dose Reference Coefficient (300A,010C) is the value by which Beam Dose (300A,0084) is multiplied to obtain the dose to the referenced dose reference site at the current control point (and after previous control points have been successfully administered). The Cumulative Dose Reference Coefficient (300A,010C) is by definition zero for the initial control point. The Cumulative Dose Reference Coefficient (300A,010C) of the final control point multiplied by Beam Dose (300A,0084) results in the final dose to the referenced dose reference

site for the current beam. Dose calculation for dose reference sites other than points is not well defined.

C.8.8.14.8 Machine rotations

For the machine rotation angles Gantry Angle (300A,011E), Beam Limiting Device Angle (300A,0120), Patient Support Angle (300A,0122) , and Table Top Eccentric Angle (300A,0125), rotation direction is specified as clockwise (CW), counter-clockwise (CC), or NONE. The maximum permitted rotation between two Control Points is 360 degrees. Examples:

a) Gantry Angle moves from 5 degrees to 5 degrees, Gantry Rotation Direction = NONE:

No movement.

b) Gantry Angle moves from 5 degrees to 5 degrees, Gantry Rotation Direction = CW:

Full clockwise rotation (360 degrees).

c) Table Angle moves from 170 degrees to 160 degrees, Table Rotation Direction = CC:

Counter-clockwise rotation by 350 degrees (note direction of increasing table angle as defined by IEC 1217).

C.8.8.15 RT Brachy Application Setups Module

The RT Brachy Application Setups Module describes the application of a brachytherapy radiotherapy treatment. It contains one or more sources, each associated with one or more Channels. A Channel is a device by which a source is placed in its intended treatment position or positions. A Channel may consist of a Source Applicator plus a Transfer Tube, a Source Applicator alone, a rigid or flexible linear source, or a seed. A number of Channels (for example applicators, sources or seeds) are generally arranged in an Application Setup which may be considered a “logical” device. It is important not to confuse Application Setup with Applicator. The model used here has been primarily built around the concept of remote afterloading, but extended to support other brachytherapy applications such as manual applicators and molds, seeds, and sources. Additional devices which are not Channels are described as Brachy Accessory Devices. Examples of Accessory Devices include shields, which modify the dose distribution from all sources in the treatment. However, Channel shields modify the dose only for the source(s) in that Channel.

The data in the module are arranged as follows:

Treatment Machine Sequence	*;treatment machine information (single item)*
Source Sequence	*;library of sources used in brachy application*
Application Setup Sequence	*;one or more applicators, sources, seeds etc*
Brachy Accessory Device Sequence	*;application level shields etc*
Channel Sequence	*;applicator, line source(s), seed(s) etc*
Channel Shield Sequence	*;channel-specific shields*
Brachy Control Point Sequence	*;mechanism to support individual source dwell times*

Table C.8-47—RT BRACHY APPLICATION SETUPS MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Brachy Treatment Technique	(300A,0200)	1	Type of brachytherapy treatment technique. Enumerated Values: INTRALUMENARY INTRACAVITARY INTERSTITIAL CONTACT INTRAVASCULAR PERMANENT See C.8.8.15.1.
Brachy Treatment Type	(300A,0202)	1	Type of brachytherapy treatment. Defined Terms: MANUAL = manually positioned HDR = High dose rate MDR = Medium dose rate LDR = Low dose rate PDR = Pulsed dose rate
Treatment Machine Sequence	(300A,0206)	1	Introduces single item sequence describing treatment machine to be used for treatment delivery. Only one item may be included in this sequence.
>Treatment Machine Name	(300A,00B2)	2	User-defined name identifying treatment machine to be used for treatment delivery.
>Manufacturer	(0008,0070)	3	Manufacturer of the equipment to be used for treatment delivery.
>Institution Name	(0008,0080)	3	Institution where the equipment is located that is to be used for treatment delivery.
>Institution Address	(0008,0081)	3	Mailing address of the institution where the equipment is located that is to be used for treatment delivery.
>Institutional Department Name	(0008,1040)	3	Department in the institution where the equipment is located that is to be used for treatment delivery.
>Manufacturer's Model Name	(0008,1090)	3	Manufacturer's model name of the equipment that is to be used for treatment delivery.
>Device Serial Number	(0018,1000)	3	Manufacturer's serial number of the equipment that is to be used for treatment delivery.
Source Sequence	(300A,0210)	1	Introduces sequence of Sources to be used within Application Setups. One or more items may be included in this sequence.

>Source Number	(300A,0212)	1	Identification number of the Source. The value of Source Number (300A,0212) shall be unique within the RT Plan in which it is created.
>Source Type	(300A,0214)	1	Type of Source. Defined Terms: POINT LINE CYLINDER SPHERE
>Source Manufacturer	(300A,0216)	3	Manufacturer of Source.
>Active Source Diameter	(300A,0218)	3	Diameter of active Source (mm).
>Active Source Length	(300A,021A)	3	Length of active Source (mm).
>Material ID	(300A,00E1)	3	User-supplied identifier for encapsulation material of active Source.
>Source Encapsulation Nominal Thickness	(300A,0222)	3	Nominal thickness of wall of encapsulation (mm).
>Source Encapsulation Nominal Transmission	(300A,0224)	3	Nominal transmission through wall of encapsulation (between 0 and 1).
>Source Isotope Name	(300A,0226)	1	Name of Isotope.
>Source Isotope Half Life	(300A,0228)	1	Half-life of Isotope (days).
>Reference Air Kerma Rate	(300A,022A)	1	Air Kerma Rate in air of Isotope specified at Air Kerma Rate Reference Date (300A,022C) and Air Kerma Rate Reference Time (300A,022E) (in $\mu Gy\ h^{-1}$ at 1 m).
>Air Kerma Rate Reference Date	(300A,022C)	1	Reference date of Reference Air Kerma Rate (300A,022A) of Isotope.
>Air Kerma Rate Reference Time	(300A,022E)	1	Reference time of Air Kerma Rate (300A,022A) of Isotope.
Application Setup Sequence	(300A,0230)	1	Introduces sequence of Application Setups for current RT Plan. One or more items may be included in this sequence.

>Application Setup Type	(300A,0232)	1	Type of Application Setup. Defined Terms: FLETCHER_SUIT DELCLOS BLOEDORN JOSLIN_FLYNN CHANDIGARH MANCHESTER HENSCHKE NASOPHARYNGEAL OESOPHAGEAL ENDOBRONCHIAL SYED_NEBLETT ENDORECTAL PERINEAL
>Application Setup Number	(300A,0234)	1	Identification number of the Application Setup. The value of Application Setup Number (300A,0234) shall be unique within the RT Plan in which it is created.
>Application Setup Name	(300A,0236)	3	User-defined name for Application Setup.
>Application Setup Manufacturer	(300A,0238)	3	Manufacturer of Application Setup.
>Template Number	(300A,0240)	3	Identification number of the Template. The value of Template Number (300A,0240) shall be unique within the Application Setup in which it is created.
>Template Type	(300A,0242)	3	User-defined type for Template Device.
>Template Name	(300A,0244)	3	User-defined name for Template Device.
>Referenced Reference Image Sequence	(300C,0042)	3	Introduces sequence of reference images used for validation of current Application Setup. One or more items may be included in this sequence.
>>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Reference Image Sequence (300C,0042) is sent.
>>Referenced SOP Class Instance	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Reference Image Sequence (300C,0042) is sent.
>Total Reference Air Kerma	(300A,0250)	1	Total Reference Air Kerma for current Application Setup, i.e. the product of Air Kerma Rate of all Sources in all Channels with their respective Channel Times (µGy at 1 m).

>Brachy Accessory Device Sequence	(300A,0260)	3	Introduces sequence of Brachy Accessory Devices associated with current Application Setup. One or more items may be included in this sequence.
>>Brachy Accessory Device Number	(300A,0262)	2C	Identification number of the Brachy Accessory Device. The value of Brachy Accessory Device Number (300A,0262) shall be unique within the Application Setup in which it is created. Required if Brachy Accessory Device Sequence (300A,0260) is sent.
>>Brachy Accessory Device ID	(300A,0263)	2C	User or machine supplied identifier for Brachy Accessory Device. Required if Brachy Accessory Device Sequence (300A,0260) is sent.
>>Brachy Accessory Device Type	(300A,0264)	1C	Type of Brachy Accessory Device. Required if Brachy Accessory Device Sequence (300A,0260) is sent. Defined Terms: SHIELD DILATATION MOLD PLAQUE FLAB
>>Brachy Accessory Device Name	(300A,0266)	3	User-defined name for Brachy Accessory Device.
>>Material ID	(300A,00E1)	3	User-supplied identifier for material of Brachy Accessory Device. See Note.
>> Brachy Accessory Device Nominal Thickness	(300A,026A)	3	Nominal thickness of Brachy Accessory Device (mm).
>> Brachy Accessory Device Nominal Transmission	(300A,026C)	3	Nominal Transmission through Brachy Accessory Device (between 0 and 1).
>>Referenced ROI Number	(3006,0084)	2C	Uniquely identifies ROI representing the Brachy Accessory specified by ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) in Structure Set Module within RT Structure Set referenced by Referenced RT Structure Set Sequence (300C,0060) in RT General Plan Module. Required if Brachy Accessory Device Sequence (300A,0260) is sent. See C.8.8.15.2.
>Channel Sequence	(300A,0280)	1	Introduces sequence of Channels for current Application Setup. One or more items may be included in this sequence.

>>Channel Number	(300A,0282)	1	Identification number of the Channel. The value of Channel Number (300A,0282) shall be unique within the Application Setup in which it is created.
>>Channel Length	(300A,0284)	2	Length of Channel (mm). See C.8.8.15.3.
>>Channel Total Time	(300A,0286)	1	Total amount of time between first and final Control Points of the Brachy Control Point Sequence (300A,02D0) for current Channel (sec). Channel Total Time calculation is based upon the Reference Air Kerma Rate (300A,022A) of the Referenced Source Number (300C,000E).
>>Source Movement Type	(300A,0288)	1	Type of Source movement. See C.8.8.15.4. Defined Terms: STEPWISE FIXED OSCILLATING UNIDIRECTIONAL
>>Number of Pulses	(300A,028A)	1C	Number of Pulses per fraction for current Channel. Required if Brachy Treatment Type (300A,0202) is PDR.
>>Pulse Repetition Interval	(300A,028C)	1C	Pulse repetition interval (sec) for current Channel. Required if Brachy Treatment Type (300A,0202) is PDR.
>>Source Applicator Number	(300A,0290)	3	Identification number of the Source Applicator. The value of Source Applicator Number (300A,0290) shall be unique within the Channel in which it is created.
>>Source Applicator ID	(300A,0291)	2C	User or machine supplied identifier for Source Applicator. Required if Source Applicator Number (300A,0290) is sent.
>>Source Applicator Type	(300A,0292)	1C	Type of Source Applicator. Required if Source Applicator Number (300A,0290) is sent. Defined Terms: FLEXIBLE RIGID
>>Source Applicator Name	(300A,0294)	3	User-defined name for Source Applicator.
>>Source Applicator Length	(300A,0296)	1C	Length of Source Applicator (mm), defined as the distance between the connector of the applicator and the distal-most position of the source. Required if Source Applicator Number (300A,0290) is sent.
>>Source Applicator Manufacturer	(300A,0298)	3	Manufacturer of Source Applicator.
>>Material ID	(300A,00E1)	3	User-supplied identifier for material of Source Applicator wall. See Note.

>> Source Applicator Wall Nominal Thickness	(300A,029C)	3	Nominal Thickness of Source Applicator wall (mm).
>> Source Applicator Wall Nominal Transmission	(300A,029E)	3	Nominal Transmission through Source Applicator wall (between 0 and 1).
>>Source Applicator Step Size	(300A,02A0)	1C	Distance of path along channel (in mm) between adjacent (potential) dwell positions. Required if Source Movement Type (300A,0288) is STEPWISE.
>>Referenced ROI Number	(3006,0084)	2C	Uniquely identifies ROI representing the Source Applicator specified by ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) in Structure Set Module within RT Structure Set referenced by Referenced RT Structure Set Sequence (300C,0060) in RT General Plan Module. Required if Source Applicator Number (300A,0290) is sent. See C.8.8.15.2.
>>Transfer Tube Number	(300A,02A2)	2	Identification number of the Transfer Tube. The value of Transfer Tube Number (300A,02A2) shall be unique within the Channel in which it is created.
>>Transfer Tube Length	(300A,02A4)	2C	Length of Transfer Tube of current afterloading Channel (mm). Required if value Transfer Tube Number (300A,02A2) is non-null.
>>Channel Shield Sequence	(300A,02B0)	3	Introduces sequence of Channel Shields associated with current Channel. One or more items may be included in this sequence. See C.8.8.15.5.
>>>Channel Shield Number	(300A,02B2)	1C	Identification number of the Channel Shield. The value of Channel Shield Number (300A,02B2) shall be unique within the Channel in which it is created. Required if Channel Shield Sequence (300A,02B0) is sent.
>>>Channel Shield ID	(300A,02B3)	2C	User or machine supplied identifier for Channel Shield. Required if Channel Shield Sequence (300A,02B0) is sent.
>>>Channel Shield Name	(300A,02B4)	3	User-defined name for Channel Shield.
>>>Material ID	(300A,00E1)	3	User-supplied identifier for material of Channel Shield. See Note.
>>>Channel Shield Nominal Thickness	(300A,02B8)	3	Nominal Thickness of Channel Shield (mm).
>>>Channel Shield Nominal Transmission	(300A,02BA)	3	Nominal Transmission of Channel Shield (between 0 and 1).

>>>Referenced ROI Number	(3006,0084)	2C	Uniquely identifies ROI representing the Channel Shield specified by ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) in Structure Set Module within RT Structure Set referenced by Referenced RT Structure Set Sequence (300C,0060) in RT General Plan Module. Required if Channel Shield Sequence (300A,02B0) is sent. See C.8.8.15.2.
>>Referenced Source Number	(300C,000E)	1	Uniquely identifies the referenced Source within the Source Sequence (300A,0210) for current Application Setup.
>>Number of Control Points	(300A,0110)	1	Number of control points in Channel. For an N-segment Channel there will be 2N (stepwise movement) or N+1 (continuous movement) control points.
>>Final Cumulative Time Weight	(300A,02C8)	1C	Value of Cumulative Time Weight (300A,02D6) for final Control Point in Brachy Control Point Sequence (300A,02D0). Required if Cumulative Time Weight (300A,02D6) is non-null in Control Points specified within Brachy Control Point Sequence (300A,02D0). See C.8.8.15.6.
>>Brachy Control Point Sequence	(300A,02D0)	1	Introduces sequence of machine configurations describing this Channel. Two or more items may be included in this sequence. See C.8.8.15.7.
>>>Control Point Index	(300A,0112)	1	Index of current Control Point, starting at 0 for first Control Point.
>>>Cumulative Time Weight	(300A,02D6)	2	Cumulative time weight to current Control Point (where the weighting is proportional to time values delivered). Cumulative Time Weight for first item in Brachy Control Point Sequence (300A,02D0) is always zero. See C.8.8.15.6 and C.8.8.15.8.
>>>Control Point Relative Position	(300A,02D2)	1	Distance between current Control Point Position and the distal-most possible Source position in current Channel (mm). See C.8.8.15.9.
>>>Control Point 3D Position	(300A,02D4)	3	Coordinates (x, y, z) of Control Point in the patient based coordinate system described in C.7.6.2.1.1 (mm). See C.8.8.15.10.
>>>Brachy Referenced Dose Reference Sequence	(300C,0055)	3	Introduces a sequence of Dose References for current Channel. One or more items may be included in this sequence.

>>>>Referenced Dose Reference Number	(300C,0051)	1C	Uniquely identifies Dose Reference described in Dose Reference Sequence. (300A,0010) within RT Prescription Module of current RT Plan. Required if Brachy Referenced Dose Reference Sequence (300C,0055) is sent.
>>>>Cumulative Dose Reference Coefficient	(300A,010C)	1C	Coefficient used to calculate cumulative dose contribution from this Source to the referenced Dose Reference at the current Control Point. Required if Brachy Referenced Dose Reference Sequence (300C,0055) is sent. See C.8.8.15.11.

Note: Material ID (300A,00E1) may also be specified within a referenced ROI, if an ROI is used to describe the object.

C.8.8.15.1 Permanent Implants

In permanent implant techniques the value for Channel Total Time (300A,0286) shall be mean life time of the isotope. The Brachy Control Point Sequence (300A,02D0) shall consist of two items: the first having Cumulative Time Weight (300A,02D6) = 0 and the second having Cumulative Time Weight (300A,02D6) = Final Cumulative Time Weight (300A,02C8).

C.8.8.15.2 Referenced ROI Number

The Structure Set ROI shall be used in the Brachy Application Setups Module to describe the 3D coordinates of Accessory Devices, Applicators and Channel Shields, but not individual source positions (see C.8.8.15.9 and C.8.8.15.10).

C.8.8.15.3 Channel Length

If specified, the Channel Length (300A,0284) shall be the sum of the Source Applicator Length (300A,0296) and Transfer Tube Length (300A,02A4).

C.8.8.15.4 Oscillating source movement

In brachytherapy treatment techniques involving oscillating source movement (i.e. when Source Movement Type (300A,0288) is OSCILLATING), the Brachy Control Point Sequence (300A,02D0) shall consist of two items. The first Control Point shall have Cumulative Time Weight (300A,02D6) = 0, and Control Point Relative Position (300A,02D2) equal to one end point of the oscillation. The second Control Point shall have Cumulative Time Weight (300A,02D6) = Final Cumulative Time Weight (300A,02C8), and Control Point Relative Position (300A,02D2) equal to the other end point of the oscillation. Transit time shall not be modeled explicitly for oscillating techniques.

C.8.8.15.5 Channel shields

The effect of Channel Shields on dose contributions shall be specific to the Channel for which they are specified. There shall be no effect of these shields on the dose contributions from any other Channels.

C.8.8.15.6 Time calculations

The treatment time at a given Control Point is equal to the Channel Total Time (300A,0286), multiplied by the Cumulative Time Weight (300A,02D6) for the Control Point, divided by the Final Cumulative Time Weight (300A,02C8). If the calculation for treatment time results in a time value

which is not an exact multiple of the timer resolution, then the result shall be rounded to the nearest allowed timer value (i.e. less than a half resolution unit shall be rounded down to the nearest resolution unit, and equal or greater than half a resolution unit shall be rounded up to the nearest resolution unit).

Note also that if Final Cumulative Time Weight (300A,02C8) is equal to 100, then Cumulative Time Weight (300A,02D6) becomes equivalent to the percentage of Channel Total Time (300A,0286) delivered at each control point. If Final Cumulative Time Weight (300A,02C8) is equal to Channel Total Time (300A,0286), then the Cumulative Time Weight (300A,02D6) at each control point becomes equal to the cumulative treatment time delivered at that control point.

If Treatment Type (300A,0202) is PDR, then the Channel Total Time (3008,0286) shall specify the duration of a single pulse.

C.8.8.15.7 Brachy Control Point Sequence

The Control Points shall be arranged such that the first Control Point for a particular Channel describes the first dwell position and the final Control Point for the Channel describes the final dwell position. If Brachy Treatment Type (300A,0202) is PDR, the Brachy Control Point Sequence (300A,02D0) shall specify the sequence of machine configurations for a single pulse. Similarly, if Source Movement Type (300A,0288) is OSCILLATING, the Brachy Control Point Sequence (300A,02D0) shall specify the sequence of machine configurations for a single period.

Some examples of Brachytherapy specification using control points are as follows:

a) Stepwise motion; Four equally weighted dwell positions; Step size = 10; Final Cumulative Time Weight = 100:

Control Point 0:	Control Point Relative Position = 30, Cumulative Time Weight = 0
Control Point 1:	Control Point Relative Position = 30, Cumulative Time Weight = 25
Control Point 2:	Control Point Relative Position = 20, Cumulative Time Weight = 25
Control Point 3:	Control Point Relative Position = 20, Cumulative Time Weight = 50
Control Point 4:	Control Point Relative Position = 10, Cumulative Time Weight = 50
Control Point 5:	Control Point Relative Position = 10, Cumulative Time Weight = 75
Control Point 6:	Control Point Relative Position = 0, Cumulative Time Weight = 75
Control Point 7:	Control Point Relative Position = 0, Cumulative Time Weight = 100

b) Fixed (manually placed) sources; Final Cumulative Time Weight = 100:

Control Point 0:	Control Point Relative Position = 0, Control Point 3D Position = (x,y,z), Cumulative Time Weight = 0
Control Point 1:	Control Point Relative Position = 0, Control Point 3D Position = (x,y,z), Cumulative Time Weight = 100

c) Oscillating movement; Final Cumulative Time Weight = 100:

Control Point 0:	Control Point Relative Position = 100, Cumulative Time Weight = 0
Control Point 1:	Control Point Relative Position = 0, Cumulative Time Weight = 100

d) Unidirectional movement; Final Cumulative Time Weight = 100:

Control Point 0:	Control Point Relative Position = 0, Cumulative Time Weight = 0
Control Point 1:	Control Point Relative Position = 100, Cumulative Time Weight = 100

e) Stepwise motion with consideration of source transit times between dwell positions; Three equally weighted dwell positions; Step size = 10; Final Cumulative Time Weight = 79:

Control Point 0:	Control Point Relative Position = 30, Cumulative Time Weight = 0
Control Point 1:	Control Point Relative Position = 30, Cumulative Time Weight = 25
Control Point 2:	Control Point Relative Position = 20, Cumulative Time Weight = 27
Control Point 3:	Control Point Relative Position = 20, Cumulative Time Weight = 52
Control Point 4:	Control Point Relative Position = 10, Cumulative Time Weight = 54
Control Point 5:	Control Point Relative Position = 10, Cumulative Time Weight = 79

f) Stepwise motion with consideration of source transit times between dwell positions and to first and from last dwell position; Three equally weighted dwell positions; Step size = 10; Final Cumulative Time Weight = 383:

Control Point 0:	Control Point Relative Position = 1200, Cumulative Time Weight = 0
Control Point 1:	Control Point Relative Position = 30, Cumulative Time Weight = 150
Control Point 2:	Control Point Relative Position = 30, Cumulative Time Weight = 175
Control Point 3:	Control Point Relative Position = 20, Cumulative Time Weight = 177
Control Point 4:	Control Point Relative Position = 20, Cumulative Time Weight = 202
Control Point 5:	Control Point Relative Position = 10, Cumulative Time Weight = 204
Control Point 6:	Control Point Relative Position = 10, Cumulative Time Weight = 229
Control Point 7:	Control Point Relative Position = 1200, Cumulative Time Weight = 383

C.8.8.15.8 Source transit time

The Source transit times between dwell positions of a remote afterloader may be considered by specifying a non-zero increment in the Cumulative Time Weight (300A,02D6) when the Source moves between Control Points. In this case the Channel Total Time (300A,0286) shall include the overall Source transit time for the Channel.

C.8.8.15.9 Control Point Relative Position

Control Point Relative Position (300A,02D2) shall describe where a given source in a channel is located with respect to the end of the channel. This position shall correspond to the end of the afterloader applicator, *not* the “safe position”.

C.8.8.15.10 Control Point 3D Position

Control Point 3D Position (300A,02D4) shall describe the absolute 3D coordinates of a source. This position shall correspond to the *center* of a source in an applicator during a remote or manually controlled afterloading treatment.

C.8.8.15.11 Cumulative Dose Reference Coefficient

The Cumulative Dose Reference Coefficient (300A,010C) is the value by which Brachy Application Setup Dose (300A,00A4) is multiplied to obtain the dose to the referenced dose reference site at the current control point (and after previous control points have been successfully administered). The Cumulative Dose Reference Coefficient (300A,010C) is by definition zero for the initial control point. The Cumulative Dose Reference Coefficient (300A,010C) of the final control point multiplied by Brachy Application Setup Dose (300A,00A4)

results in the final dose to the referenced dose reference site for the current channel. Dose calculation for dose reference sites other than points is not well defined.

If Treatment Type (300A,0202) is PDR, then the Cumulative Dose Reference Coefficient (3008,010C) shall specify the dose delivered to the dose reference during a single pulse. The total dose delivered to the dose reference shall then be expressed by Cumulative Dose Reference Coefficient (3008,010C) multiplied by Number of Pulses (300A,028A) multiplied by Brachy Application Setup Dose (300A,00A4).

C.8.8.16 Approval Module

Table C.8-48—APPROVAL MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Approval Status	(300E,0002)	1	Approval status at the time the SOP Instance was created. Enumerated Values: APPROVED = Reviewer recorded that object met an implied criterion UNAPPROVED = No review of object has been recorded REJECTED = Reviewer recorded that object failed to meet an implied criterion
Review Date	(300E,0004)	2C	Date on which object was reviewed. Required if Approval Status (300E,0002) is APPROVED or REJECTED.
Review Time	(300E,0005)	2C	Time at which object was reviewed. Required if Approval Status (300E,0002) is APPROVED or REJECTED.
Reviewer Name	(300E,0008)	2C	Name of person who reviewed object. Required if Approval Status (300E,0002) is APPROVED or REJECTED.

C.8.9 PET Information Module Definitions

This Section describes Positron Emission Tomography series and image Modules. These Modules contain Attributes that are specific to Positron Emission Tomography images.

C.8.9.1 PET Series Module

Table C.8-49 contains IOD Attributes that describe a PET Series.

Table C.8-49 - PET SERIES MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Series Date	(0008,0021)	1	Date the Series started. See C.8.9.1.1.2 for specialization.
Series Time	(0008,0031)	1	Time the Series started. See C.8.9.1.1.2 for specialization.
Units	(0054,1001)	1	Pixel value units. See C.8.9.1.1.3 for explanation. Defined terms: CNTS, NONE, CM2, PCNT, CPS, BQML, MGMINML, UMOLMINML, MLMING, MLG, 1CM, UMOLML, PROPCNTS, PROPCPS, MLMINML, MLML, GML, STDDEV
Counts Source	(0054,1002)	1	The primary source of counts. The primary source leads to the underlying image Units (0054,1001), as opposed to secondary sources which are used during reconstruction correction. Enumerated Values: EMISSION TRANSMISSION
Series Type	(0054,1000)	1	A multi-valued indicator of the type of Series. See C.8.9.1.1.4 for explanation. Value 1 Enumerated Values: STATIC DYNAMIC GATED WHOLE BODY Value 2 Enumerated Values: IMAGE REPROJECTION
Reprojection Method	(0054,1004)	2C	Method for projecting volumetric data onto planar projection. Required if Series Type (0054,1000), Value 2 is REPROJECTION. Defined terms: SUM MAX PIXEL
Number of R-R Intervals	(0054,0061)	1C	The maximum number of R-R Intervals that may exist in this Series. Required if Series Type (0054,1000), Value 1 is GATED.

Number of Time Slots	(0054,0071)	1C	The maximum number of Time Slots that may exist in this Series. Required if Series Type (0054,1000), Value 1 is GATED.
Number of Time Slices	(0054,0101)	1C	The maximum number of Time Slices that may exist in this Series. Required if Series Type (0054,1000), Value 1 is DYNAMIC.
Number of Slices	(0054,0081)	1	The maximum number of Slices that may exist in this Series.
Corrected Image	(0028,0051)	2	A value that indicates which, if any, corrections have been applied to the images in this series. Defined terms: DECY=decay corrected ATTN=attenuation corrected SCAT=scatter corrected DTIM=dead time corrected MOTN=gantry motion corrected (e.g. wobble, clamshell) PMOT=patient motion corrected CLN=count loss normalization (correction for count loss in gated Time Slots). RAN=randoms corrected RADL=non-uniform radial sampling corrected DCAL=sensitivity calibrated using dose calibrator NORM=detector normalization
Randoms Correction Method	(0054,1100)	3	Type of randoms correction processing. Defined terms: NONE = no randoms correction DLYD = delayed event subtraction SING = singles estimation
Attenuation Correction Method	(0054,1101)	3	A textual description of the attenuation correction processing. e.g. measured vs. calculated, transmission source type (ring, line, point), assumed patient geometry (polygon, ellipse, segmented, attenuation coefficient, skull thickness), post-injection transmission, smoothing.
Scatter Correction Method	(0054,1105)	3	A textual description of the scatter correction processing. e.g. convolution-subtraction, dual energy window, model-based, use of attenuation data.

Decay Correction	(0054,1102)	1	The real-world event to which images in this Series were decay corrected. See C.8.9.1.1.5 for explanation. Defined terms: NONE = no decay correction START= acquisition start time ADMIN = radiopharmaceutical administration time
Reconstruction Diameter	(0018,1100)	3	Diameter, in mm, of the region within which the data was used in creating the reconstruction of the image. Data may exist outside this region and portions of the patient may exist outside this region.
Convolution Kernel	(0018,1210)	3	Textual description of the convolution kernel(s) used to reconstruct the data (e.g. name, cutoff, radial/axial/angular, mathematical form, DC handling)
Reconstruction Method	(0054,1103)	3	Textual description of reconstruction processing, e.g. 2D filtered backprojection, 2D iterative, 3D PROMIS, 3D FAVOR, 3D iterative.
Detector Lines of Response Used	(0054,1104)	3	Textual description of which detector lines of response were used, mashed, or otherwise processed during tomographic reconstruction.
Acquisition Start Condition	(0018,0073)	3	Description of how the data collection was started. Defined terms: DENS = density (counts/sec) RDD = relative density difference (change in counts/sec) MANU = manual TIME = time AUTO = automatic, when ready TRIG = physiological trigger See C.8.9.1.1.6 for explanation.
Acquisition Start Condition Data	(0018,0074)	3	Count density, change in count density, or physiological triggers causing data collection to start.

Acquisition Termination Condition	(0018,0071)	3	Description of how the data collection for the series was stopped. Defined terms: CNTS = counts DENS = density (counts/sec) RDD = relative density difference (change in counts/sec) MANU = manual OVFL = data overflow TIME = time TRIG = physiological trigger See C.8.4.9.1.3 for explanation.
Acquisition Termination Condition Data	(0018,0075)	3	Number of counts, count density, change in count density, or physiological triggers causing the termination.
Field of View Shape	(0018,1147)	3	Shape of the field of view of the PET camera. Defined Terms: CYLINDRICAL RING HEXAGONAL MULTIPLE PLANAR
Field of View Dimensions	(0018,1149)	3	Dimensions of the field of view, in mm. Transverse detector diameter followed by axial width.
Gantry/Detector Tilt	(0018,1120)	3	Angle of tilt in degrees of the gantry. See C.8.9.1.1.7 for explanation.
Gantry/Detector Slew	(0018,1121)	3	Angle of slew in degrees of the gantry. Positive slew is moving the gantry on the patient's left toward the patient's superior, when the patient is supine.
Type of Detector Motion	(0054,0202)	3	Describes the detector motion during acquisition. Defined Terms: NONE = stationary gantry STEP AND SHOOT = Interrupted motion, acquire only while stationary CONTINUOUS = Gantry motion and acquisition are simultaneous and continuous WOBBLE = wobble motion CLAMSHELL = clamshell motion
Collimator Type	(0018,1181)	2	Collimator Type. Defined Terms: NONE = no collimator RING = transverse septa
Collimator/Grid Name	(0018,1180)	3	Label describing the collimator used.
Axial Acceptance	(0054,1200)	3	Maximum axial angle accepted, in degrees.
Axial Mash	(0054,1201)	3	Number of adjacent axial lines of response mashed together. See C.8.9.1.1.8 for explanation.

Transverse Mash	(0054,1202)	3	Number of adjacent transverse lines of response mashed together. See C.8.9.1.1.9 for explanation.
Detector Element Size	(0054,1203)	3	Size of an individual detector element, in mm. Transverse dimension followed by axial dimension. For a discrete crystal, this is the crystal size. For a continuous detector, this is the pixel bin size.
Coincidence Window Width	(0054,1210)	3	The width of the coincidence timing window, in nsec. The maximum time difference accepted between two single events.
Energy Window Range Sequence	(0054,0013)	3	Sequence of Repeating Items that describes the energy windows used for this Series. This sequence may contain zero or more items. See C.8.9.1.1.10 for explanation.
>Energy Window Lower Limit	(0054,0014)	3	The lower limit of the energy window, in KeV.
>Energy Window Upper Limit	(0054,0015)	3	The upper limit of the energy window, in KeV.
Secondary Counts Type	(0054,1220)	3	Array defining the type of additional counts accumulated during acquisition. Defined terms: DLYD=delayed events SCAT=scattered events in secondary window SING=singles DTIM=events lost due to deadtime

C.8.9.1.1 PET Series Attribute Descriptions

Note: The meaning of a General Series in DICOM is determined by the attributes in the General Series Module and by the Source Entities (Patient, Study, Frame of Reference, Equipment) that originate the Series. The Source Entities are the single-valued entities of the 1->n relationship, where the Series is the multi-valued entity. Therefore, a Series is a group of images that: are from the same patient and study; are from the same Equipment; and, are from the same spatial Frame of Reference.

The PET Image IOD further refines a PET Series IE by the attributes in the PET Series Module, the PET Isotope Module, and the PET Multi-gated Acquisition Module. These are the attributes that shall not change from Image to Image. Therefore, in addition to the criteria above for a General Series (same patient, study, frame of reference, equipment), the attributes in the PET Series IE define a PET series as a group of images that: are from the same temporal frame of reference; have the same fundamental meaning (e.g. same units: either activity density, metabolism, or attenuation); are derived from the same activity source (emission or transmission); are from the same isotope and radiopharmaceutical; were derived from the same reconstruction processing; and, originated from the same acquisition setup and parameters.

C.8.9.1.1.1 Specialization of Image Plane Module and Image Pixel Module Attributes

For PET Series, the following Image Pixel Module attributes shall not vary from Image to Image :

Photometric Interpretation (0028,0004)
Rows (0028,0010)
Columns (0028,0011)
Bits Allocated (0028,0100)
Bits Stored (0028,0101)
Pixel Representation (0028,0103)

For PET Series, the following Image Plane Module attributes shall not vary from Image to Image :

Pixel Spacing (0028,0030)

For PET Series where Series Type (0054,1000), Value 2 is IMAGE, the following Image Plane Module attributes shall not vary from Image to Image :

Image Orientation (0020,0037)

Note: This means that for a Series Type (0054,1000) Value 2 of IMAGE, all images in the PET Series lie on parallel planes. The images, however, may have non-uniform spacing along the normals to the planes.

For PET Series where Series Type (0054,1000), Value 2 is REPROJECTION, the Image Orientation (0020,0037) attribute shall vary such that the images rotate about a single axis. Geometrically, the normal to each image plane is defined by the cross product of its row and column vectors. Each reprojection image has one Center Normal that passes through the center of the image. Reprojection images within a PET Series shall have their Center Normals be co-planar and pass through a single point.

C.8.9.1.1.2 Series Date, Series Time

For PET Series, Series Date (0008,0021) and Series Time (0008,0031) are specified to be Type 1. The Series Date (0008,0021) and Series Time (0008,0031) are used as the reference time for all PET Image attributes that are temporally related, including activity measurements. The Series Date (0008,0021) and Series Time (0008,0031) are not tied to any real-world event (e.g. acquisition start, radiopharmaceutical administration) and their real-world meaning are implementation dependent.

C.8.9.1.1.3 Units

The pixel value units of the Pixel Data (7FE0,0010). Defined Terms:

CNTS = counts
NONE = unitless
CM2 = centimeter**2
PCNT = percent
CPS = counts/second
BQML = Becquerels/milliliter
MGMINML = milligram/minute/milliliter
UMOLMINML = micromole/minute/milliliter
MLMING = milliliter/minute/gram
MLG = milliliter/gram
1CM = 1/centimeter
UMOLML = micromole/milliliter
PROPCNTS = proportional to counts
PROPCPS = proportional to counts/sec
MLMINML = milliliter/minute/milliliter
MLML = milliliter/milliliter

GML = grams/milliliter
STDDEV = standard deviations

C.8.9.1.1.4 Series Type

The Series Type (0054,1000), Value 1 is used to identify the spatial location and temporal nature of the images within a PET Series. The Enumerated Values and their definitions are:

STATIC = a group of images at varying spatial locations at the same time
DYNAMIC = a group of images at a set of spatial locations (e.g. slices) at varying time slices, with all spatial locations acquired at all time slices
GATED = a group of images at the same spatial location, same starting and ending time, but acquired in different time slots of (possibly) different R-R intervals
WHOLE BODY = same as STATIC, except covering multiple axial fields of view (and therefore acquired at a different time).

Notes: 1. Using this definition and the comments in C.8.9.1.1.1, here are some examples of PET series and the encoding of Series Type (0054,1000) Value 1.

Static acquisition: a group of n transverse images at varying superior<->inferior locations, all acquired between the same starting and ending time. Series Type = STATIC.

Dynamic acquisition: a group of n*m transverse images at n superior<->inferior locations, acquired with m different starting and ending times. Series Type = DYNAMIC.

Gated acquisition: a group of n*m*p transverse images at n superior<->inferior locations, all acquired between the same starting and ending time, acquired in m different R-R Intervals (as determined by Low R-R Value (0018,1081) and High R-R Value (0018,1082)), and acquired in p time slots of a given R-R Interval (as determined by Trigger Time (0054,1000)). Series Type = GATED.

Whole body acquisition: a group of n transverse images at varying superior<->inferior locations covering a significant fraction of the entire body. Series Type = WHOLE BODY.

Multiple axial fields of view: a group of n transverse images at varying superior<->inferior locations. Series Type = WHOLE BODY.

Interleaved: group of 2*n transverse images acquired at overlapped AFOVs to increase axial sampling. Series Type = WHOLE BODY.

Sagittal (Coronal, Oblique): sagittal (coronal, oblique) re-sliced images derived by reformatting transverse images. The Series Type is STATIC, DYNAMIC, GATED, or WHOLE BODY depending on source Series Type.

Arithmetic: images derived by an arithmetic operation on operand images. The Series Type is STATIC, DYNAMIC, GATED, or WHOLE BODY depending on source Series Type.

Metabolic: images derived by a metabolic model. The Series Type is STATIC, DYNAMIC, GATED, or WHOLE BODY depending on source Series Type.

2. Using this definition, here are some images that are not stored in the same PET Series:

Two images from the same scan that were reconstructed differently.

Emission and transmission images for the same Patient and Study, even if acquired simultaneously (because emission and transmission images have different reconstruction processing).

Two images of same patient, one after NH3 injection and one after FDG injection.

Two images: an original image created from reconstructed scan data and its derived image based on a metabolic model.

The Series Type (0054,1000), Value 2 is used to identify the volumetric meaning of the images within a PET Series. The Enumerated Values and their definitions are:

IMAGE = a tomographic image slice

REPROJECTION = a projection image derived from forward projection through slices of tomographic images, using the algorithm defined in Reprojection Method (0054,1004).

C.8.9.1.1.5 Decay Correction

The Decay Correction (0054,1102) is the real-world event to which images in this Series were decay corrected. If decay correction is applied, all images in the Series shall be decay corrected to the same time. The Defined Terms and definitions are:

NONE = no decay correction
START= acquisition start time, Acquisition Time (0008,0032)
ADMIN = radiopharmaceutical administration time, Radiopharmaceutical Start Time (0018,1072)

The time to which images have been decay corrected can be derived from Decay Factor (0054,1321), Frame Reference Time (0054,1300), Radionuclide Half Life (0018,1075), Series Date (0008,0021), and Series Time (0008,0031).

C.8.9.1.1.6 Acquisition Start Condition

Acquisition Start Condition (0018,0073) is the method of starting acquisition data collection. The Defined Terms and definitions are:

DENS = preset count density (counts/sec) was reached
RDD = preset relative count density difference (change in counts/sec) was reached
MANU = acquisition was started manually
TIME = preset time limit was reached
AUTO = start automatically, when ready
TRIG = preset number of physiological triggers was reached

C.8.9.1.1.7 Gantry/Detector Tilt

Gantry/Detector Tilt (0018,1120) for PET Image data is the angle in degrees of the gantry relative to the patient's major (Head to Feet) axis (or the table supporting the patient). Positive tilt is moving the top of the gantry towards the patient's feet.

C.8.9.1.1.8 Axial Mash

Axial Mash (0054,1201) is multi-valued and is defined as the number of unique axial Lines of Response (LOR) that were mashed together (center of the axial field of view only). Value 1 is the number of LORs mashed for an odd slice. Value 2 is the number of LORs mashed for an even slice. For discrete crystal scanners, each unique LOR corresponds to a pair of crystals. For continuous detectors whose bin size is variable, the number of LORs mashed is determined by the actual bin size divided by the Detector Element Size (0054,1203), Value 2. The value of Axial Mash (0054,1201) is the same regardless of whether the mashing was done during acquisition or reconstruction.

Note: As an example on a discrete crystal scanner, if a ring difference of -2,0,+2 are binned as an odd slice and a ring difference of -1,+1 are binned as an even slice, then the Axial Mash (0054,1201) is equal to 3\2 .

C.8.9.1.1.9 Transverse Mash

Transverse Mash (0054,1202) is defined as the number of unique transverse Lines of Response (LOR) that were mashed together. For discrete crystal scanners, each unique LOR corresponds to a pair of crystals. For continuous detectors whose bin size is variable, the number of LORs

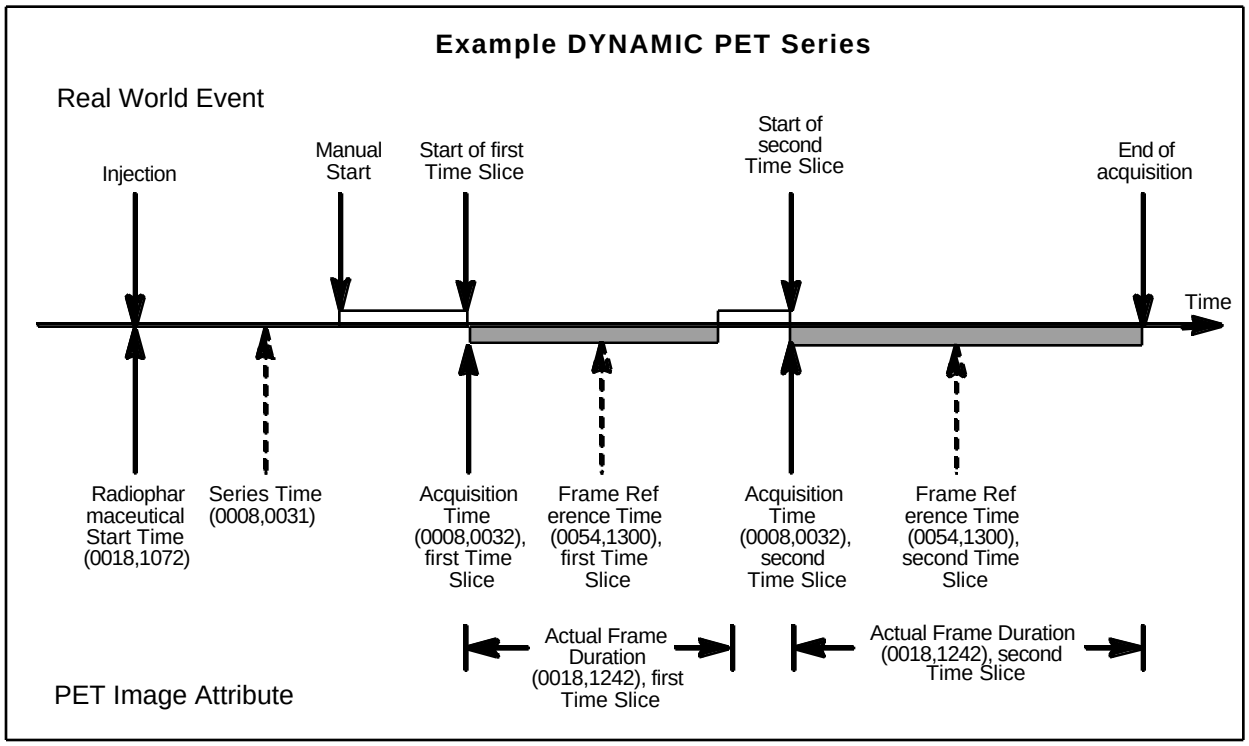
mashed is determined by the actual bin size divided by the Detector Element Size (0054,1203), Value 1. The value of Transverse Mash (0054,1202) is the same regardless of whether the mashing was done during acquisition or reconstruction.

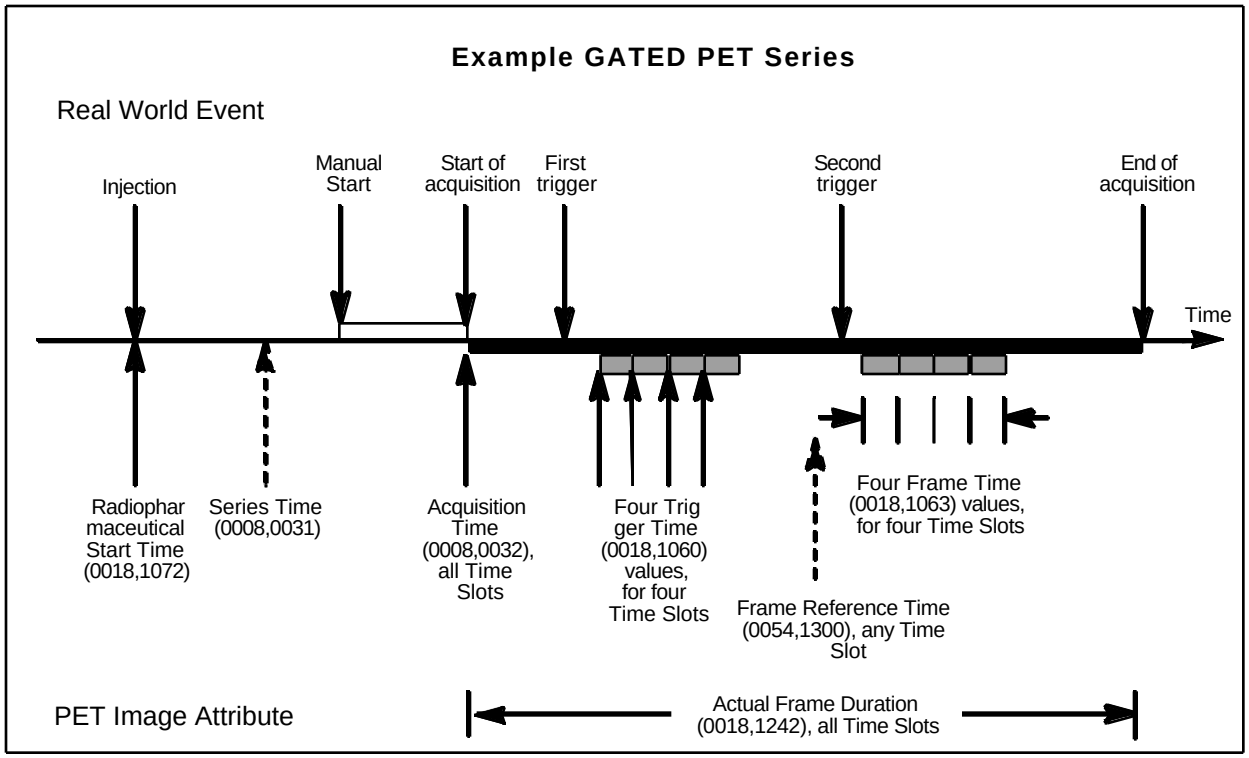
C.8.9.1.1.10 Energy Window Range Sequence

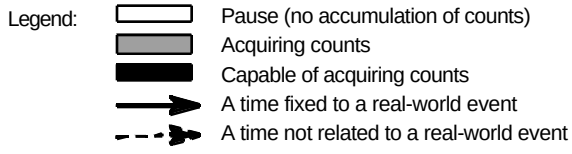
Multiple energy windows are allowed in order to allow coincidence events based on additional Energy Windows (e.g. Compton events scattered in the detector). All energy windows are assumed to contribute to all images in the PET Series.

C.8.9.1.1.11 Temporal Relationships of Images in PET Series

The following diagram shows the temporal relationships of images within a PET Series.


Example DYNAMIC PET Series
Real World Event
Injection
Manual Start
Start of first Time Slice
Start of second Time Slice
End of acquisition
Time
Radiopharmaceutical Start Time (0018,1072)
Series Time (0008,0031)
Acquisition Time (0008,0032), first Time Slice
Frame Reference Time (0054,1300), first Time Slice
Acquisition Time (0008,0032), second Time Slice
Frame Reference Time (0054,1300), second Time Slice
Actual Frame Duration (0018,1242), first Time Slice
Actual Frame Duration (0018,1242), second Time Slice
PET Image Attribute


Example GATED PET Series
Real World Event
Injection
Manual Start
Start of acquisition
First trigger
Second trigger
End of acquisition
Time
Radiopharmaceutical Start Time (0018,1072)
Series Time (0008,0031)
Acquisition Time (0008,0032), all Time Slots
Four Trigger Time (0018,1060) values, for four Time Slots
Four Frame Time (0018,1063) values, for four Time Slots
Frame Reference Time (0054,1300), any Time Slot
PET Image Attribute
Actual Frame Duration (0018,1242), all Time Slots


Legend:
Pause (no accumulation of counts)
Acquiring counts
Capable of acquiring counts
A time fixed to a real-world event
A time not related to a real-world event

C.8.9.2 PET Isotope Module

Table C.8-50 contains IOD Attributes that describe a PET Isotope.

Table C.8-50 - PET ISOTOPE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Radiopharmaceutical Information Sequence	(0054,0016)	2	Sequence of Repeating Items that describe isotope information. This sequence may contain one or more items.
>Radionuclide Code Sequence	(0054,0300)	2	Sequence that identifies the radionuclide. This sequence shall contain exactly one item. See Section C.8.4.10.1.3 for explanation.
>>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the radionuclide. Required if Radionuclide Code Sequence (0054,0300) is sent.
>>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Radionuclide Code Sequence (0054,0300) is sent. Defined Terms: 99SDM
>>Code Meaning	(0008,0104)	3	The radionuclide that is represented by the Code Value (0008,0100).
>Radiopharmaceutical Route	(0018,1070)	3	Route of administration.
>Administration Route Code Sequence	(0054,0302)	3	Sequence that identifies the administration route of the radiopharmaceutical. This sequence shall contain exactly one item. See Section C.8.4.10.1.4 for explanation.
>>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the radiopharmaceutical route. Required if Administration Route Code Sequence (0054,0302) is sent.
>>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Administration Route Code Sequence (0054,0302) is sent. Defined Terms: 99SDM
>>Code Meaning	(0008,0104)	3	The radiopharmaceutical route that is represented by the Code Value (0008,0100).
>Radiopharmaceutical Volume	(0018,1071)	3	Volume of administered radiopharmaceutical in cubic cm.

>Radiopharmaceutical Start Time	(0018,1072)	3	Time of start of administration. The actual time of radiopharmaceutical administration to the patient for imaging purposes, using the same time base as Series Time (0008,0031).
>Radiopharmaceutical Stop Time	(0018,1073)	3	Time of end of administration. The actual ending time of radiopharmaceutical administration to the patient for imaging purposes, using the same time base as Series Time (0008,0031).
>Radionuclide Total Dose	(0018,1074)	3	The radiopharmaceutical dose administered to the patient measured in Becquerels (Bq) at the Radiopharmaceutical Start Time (0018,1072).
>Radionuclide Half Life	(0018,1075)	3	The radionuclide half life, in seconds, that was used in the correction of this image.
>Radionuclide Positron Fraction	(0018,1076)	3	The radionuclide positron fraction (fraction of decays that are by positron emission) that was used in the correction of this image.
>Radiopharmaceutical Specific Activity	(0018,1077)	3	The activity per unit mass of the radiopharmaceutical, in Bq/micromole, at the Radiopharmaceutical Start Time (0018,1072).
>Radiopharmaceutical	(0018,0031)	3	Name of the radiopharmaceutical.
>Radiopharmaceutical Code Sequence	(0054,0304)	3	Sequence that identifies the radiopharmaceutical. This sequence shall contain exactly one item.
>>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the radiopharmaceutical. Required if Radiopharmaceutical Code Sequence (0054,0304) is sent.
>>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Radiopharmaceutical Code Sequence (0054,0304) is sent. Defined Terms: 99SDM
>>Code Meaning	(0008,0104)	3	The radiopharmaceutical that is represented by the Code Value (0008,0100).
Intervention Drug Information Sequence	(0018,0026)	3	Sequence of Repeating Items that describes the intervention drugs used. Zero or more items may be included in this sequence.

>Intervention Drug Name	(0018,0034)	3	Name of the intervention drug.
>Intervention Drug Code Sequence	(0018,0029)	3	Sequence that identifies the intervention drug name.
>>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the intervention drug name. Required if Intervention Drug Code Sequence (0018,0029) is sent.
>>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Intervention Drug Code Sequence (0018,0029) is sent. Defined Terms: 99SDM
>>Code Meaning	(0008,0104)	3	The intervention drug that is represented by the Code Value (0008,0100).
>Intervention Drug Start Time	(0018,0035)	3	Time of administration of the intervention drug, using the same time base as for the Series Time (0008,0031).
>Intervention Drug Stop Time	(0018,0027)	3	Time of completion of administration of the intervention drug, using the same time base as for the Series Time (0008,0031).
>Intervention Drug Dose	(0018,0028)	3	Intervention drug dose, in mg.

Note: Radionuclide Code Sequence (0054,0300) and Radiopharmaceutical Route Code Sequence (0054,0302) specify value 99SDM from Annex D for Coding Scheme Designator. It is expected that this value will evolve when Coding Scheme Designator UIDs are available from a registration authority.

C.8.9.3 PET Multi-gated Acquisition Module

Table C.8-51 contains IOD Attributes that describe a PET Multi-gated Acquisition.

Table C.8-51 - PET MULTI-GATED ACQUISITION MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Beat Rejection Flag	(0018,1080)	2	Heart beat duration sorting has been applied. Enumerated values: Y = yes N = no
Trigger Source or Type	(0018,1061)	3	Text indicating trigger source. Defined terms: EKG
PVC Rejection	(0018,1085)	3	Description of the type of PVC rejection criteria used.
Skip Beats	(0018,1086)	3	Number of beats skipped after a detected arrhythmia.

Heart Rate	(0018,1088)	3	Average number of heart beats per minute for the collection period for this image. This shall include all accepted beats as well as rejected beats.
Framing Type	(0018,1064)	3	Description of type of framing performed. Defined Terms: FORW = forward BACK = backward PCNT = forward/backward by percentage

C.8.9.4 PET Image Module

Table C.8-52 contains IOD Attributes that describe PET images.

Table C.8-52- PET IMAGE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See C.8.9.4.1.1 for specialization.
Samples per Pixel	(0028,0002)	1	Number of samples (planes) in this image. This value shall be 1.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. See C.8.9.4.1.2 for specialization.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. Enumerated values: 16.
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. The value shall be the same as the value in Bits Allocated (0028,0100).
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Each sample shall have the same high bit. Shall be one less than the value in Bits Stored (0028,0101).
Rescale Intercept	(0028,1052)	1	The value b in relationship between stored values (SV) and pixel value units (U) defined in Units (0054,1001): U = m*SV+b. The Rescale Intercept is always zero for PET images.
Rescale Slope	(0028,1053)	1	m in the equation specified in Rescale Intercept (0028,1052).
Frame Reference Time	(0054,1300)	1	The time that the pixel values in the image occurred. Frame Reference Time is the offset, in msec, from the Series reference time. See explanation in C.8.9.4.1.5.
Trigger Time	(0018,1060)	1C	Time interval, in msec, from the start of the trigger to the beginning of data acquisition for this image. Required if Series Type (0054,1000), Value 1 is GATED.
Frame Time	(0018,1063)	1C	Nominal duration per individual frame, in msec. Required if Series Type (0054,1000), Value 1 is GATED. See C.8.9.4.1.3 for explanation.
Low R-R Value	(0018,1081)	1C	R-R interval lower limit for beat rejection, in msec. Required if Series Type (0054,1000), Value 1 is GATED and Beat Rejection Flag (0018,1080) is Y.

High R-R Value	(0018,1082)	1C	R-R interval upper limit for beat rejection, in msec. Required if Series Type (0054,1000), Value 1 is GATED and Beat Rejection Flag (0018,1080) is Y.
Lossy Image Compression	(0028,2110)	1C	Specifies whether an Image has undergone lossy compression. Enumerated values: 00 = Image has NOT been subjected to lossy compression. 01 = Image has been subjected to lossy compression. See C.7.6.1.1.5. Required if Lossy Compression has been performed on the image.
Image Index	(0054,1330)	1	An index identifying the position of this image within a PET Series. See C.8.9.4.1.9 for explanation.
Acquisition Date	(0008,0022)	2	The date the acquisition of data that resulted in this image started. See C.8.9.4.1.4 for specialization.
Acquisition Time	(0008,0032)	2	The time the acquisition of data that resulted in this image started. See C.8.9.4.1.4 for specialization.
Actual Frame Duration	(0018,1242)	2	Elapsed time of the data acquisition for this image, in msec. See C.8.9.4.1.6 for explanation.
Nominal Interval	(0018,1062)	3	Average duration of accepted beats, in msec, of the R-R interval.
Intervals Acquired	(0018,1083)	3	Number of heartbeats that fall within Low R-R Value (0018,1081) and High R-R Value (0018,1082), and were therefore accepted and contribute coincidence events to this R-R Interval.
Intervals Rejected	(0018,1084)	3	Number of heartbeats that fall outside Low R-R Value (0018,1081) and High R-R Value (0018,1082), and do not contribute coincidence events to this R-R Interval. However, they may contribute coincidence events to other R-R Intervals.
Primary (Prompts) Counts Accumulated	(0054,1310)	3	The sum of events that occur in the primary event channel. The counts include Trues +Scatter+ Randoms if Randoms Correction Method (0054,1100) is NONE; otherwise the counts are Trues +Scatter.
Secondary Counts Accumulated	(0054,1311)	3	Sum of counts accumulated in secondary channels. See C.8.9.4.1.7 for explanation.

Slice Sensitivity Factor	(0054,1320)	3	The slice-to-slice sensitivity correction factor that was used to correct this image. The value shall be one if no slice sensitivity correction was applied.
Decay Factor	(0054,1321)	1C	The decay factor that was used to scale this image. Required if Decay Correction (0054,1102) is other than NONE. If decay correction is applied, all images in the Series shall be decay corrected to the same time.
Dose Calibration Factor	(0054,1322)	3	Factor that was used to scale this image from counts/sec to Bq/ml using a dose calibrator. The value shall be one if no dose calibration was applied. See C.8.9.4.1.8 for explanation.
Scatter Fraction Factor	(0054,1323)	3	An estimate of the fraction of acquired counts that were due to scatter and were corrected in this image. The value shall be zero if no scatter correction was applied.
Dead Time Factor	(0054,1324)	3	The average dead time correction factor that was applied to this image. The value shall be one if no dead time correction was applied.
Referenced Overlay Sequence	(0008,1130)	3	A sequence which provides reference to a set of SOP Class/Instance pairs which are related independent Overlays. Uniquely identifies Overlays significantly related to this Image. Encoded as a sequence of items: (0008,1150) and (0008,1155). Zero or more Items may be included in this sequence.
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Overlay Sequence (0008,1130) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Overlay Sequence (0008,1130) is sent.
Referenced Curve Sequence	(0008,1145)	3	A sequence which provides reference to a set of SOP Class/Instance pairs which are related independent Curves. Uniquely identifies Curves significantly related to this Image. Encoded as a sequence of items: (0008,1150) and (0008,1155). Zero or more Items may be included in this sequence.
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Curve Sequence (0008,1145) is sent.

>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Curve Sequence (0008,1145) is sent.
Anatomic Region Sequence	(0008,2218)	3	Sequence of one Item that identifies the anatomic region of interest in this image (i.e. external anatomy, surface anatomy, or general region of the body). See Section C.8.4.9.1.5.
>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the anatomic region. Required if Anatomic Region Sequence (0008,2218) is sent.
>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Anatomic Region Sequence (0008,2218) is sent. Defined Terms: 99SDM
>Code Meaning	(0008,0104)	3	The anatomic region that is represented by the Code Value (0008,0100).
>Anatomic Region Modifier Sequence	(0008,2220)	3	Sequence of one or more Items that modify the anatomic region of interest in this image (i.e. prone, supine, decubitus right). See Section C.8.4.9.1.5.
>>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the anatomic region modifier term. Required if Anatomic Region Modifier Sequence (0008,2220) is sent.
>>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Anatomic Region Modifier Sequence (0008,2220) is sent. Defined Terms: 99SDM
>>Code Meaning	(0008,0104)	3	The anatomic region modifier term that is represented by the Code Value (0008,0100).
Primary Anatomic Structure Sequence	(0008,2228)	3	Sequence of one or more Items that identifies the primary anatomic structure of interest in this image. See Section C.8.4.9.1.6.

>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the primary anatomic structure. Required if Primary Anatomic Structure Sequence (0008,2228) is sent.
>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Primary Anatomic Structure Sequence (0008,2228) is sent. Defined Terms: 99SDM
>Code Meaning	(0008,0104)	3	The anatomic structure that is represented by the Code Value (0008,0100).
>Primary Anatomic Structure Modifier Sequence	(0008,2230)	3	Sequence of one or more Items that modify the primary anatomic structure of interest in this image. See Section C.8.4.9.1.6.
>>Code Value	(0008,0100)	1C	The code value (defined by the coding scheme) that represents the primary anatomic structure modifier term. Required if Primary Anatomic Structure Modifier Sequence (0008,2230) is sent.
>>Coding Scheme Designator	(0008,0102)	1C	The code from Annex D designating the coding scheme which maps the Code Value (0008,0100) onto the Code Meaning (0008,0104). Required if Primary Anatomic Structure Modifier Sequence (0008,2230) is sent. Defined Terms: 99SDM
>>Code Meaning	(0008,0104)	3	The anatomic structure modifier term that is represented by the Code Value (0008,0100).

Note: Anatomic Region Sequence (0008,2218), Anatomic Region Modifier Sequence (0008,2220), Primary Anatomic Structure Sequence (0008,2228), and Primary Anatomic Structure Modifier Sequence (0008,2230) specify value 99SDM from Annex D for Coding Scheme Designator. It is expected that this value will evolve when Coding Scheme Designator UIDs are available from a registration authority.

C.8.9.4.1 PET Image Module Attribute Descriptions

C.8.9.4.1.1 Image Type

For PET Images, Image Type (0008,0008) is specified to be Type 1.

Note: For PET images, Image Type (0008,0008) Value 1 will be ORIGINAL for reconstructed images. DERIVED may be appropriate for some other results images. For PET images, Image Type (0008,0008) Value 2 will be PRIMARY.

C.8.9.4.1.2 Photometric Interpretation

For PET images, Photometric Interpretation (0028,0004) shall have one of the following Enumerated Values:

MONOCHROME2

See C.7.6.3.1.2 for definition of this term.

C.8.9.4.1.3 Frame Time

The Frame Time (0018,1063) is the explicit duration of the gated frame when Framing Type (0018,1064) is equal to FORW or BACK. Frame Time (0018,1063) is the nominal duration of the gated frame when Framing Type (0018,1064) is equal to PCNT.

C.8.9.4.1.4 Acquisition Date, Acquisition Time

For PET Images, Acquisition Date (0008,0022) and Acquisition Time (0008,0032) are specified to be Type 2. The Acquisition Date (0008,0022) and Acquisition Time (0008,0032) use the same time base as Series Time (0008,0031).

For Series Type (0054,1000) Value 1 equal to STATIC, WHOLE BODY, or DYNAMIC, the Acquisition Time (0008,0032) is the real-world beginning of the accumulation of events into this Image. For STATIC, WHOLE BODY, or DYNAMIC Series, the Acquisition Time (0008,0032) may vary from Image to Image within a PET Series.

For Series Type (0054,1000) Value 1 equal to GATED, the Acquisition Time (0008,0032) is the real-world beginning of the *capability* of accumulating events into this Image. (The *actual* accumulation of events has only occurred during an R-R Interval.) For GATED Series, the Acquisition Time (0008,0032) shall not vary from Image to Image within a PET Series.

C.8.9.4.1.5 Frame Reference Time

Frame Reference Time (0054,1300) is the time that the pixel values in the Image occurred. Frame Reference Time is defined as the time offset, in msec, from the Series Reference Time, where the Series Reference Time is defined by the combination of Series Date (0008,0021) and Series Time (0008,0031).

Note: Frame Reference Time (0054,1300) is implementation dependent and may or may not be tied to any real-world event. To illustrate the meaning of Frame Reference Time (0054,1300), the following are some examples of possible implementations:

Example 1: For a long-lived radionuclide and a non-time-varying radiopharmaceutical distribution, an implementation sets the Frame Reference Time (0054,1300) to the midpoint of the Actual Frame Duration (0018,1242).

Example 2: For a short-lived radionuclide and a non-time-varying radiopharmaceutical distribution, an implementation sets the Frame Reference Time (0054,1300) to the time at which the average activity occurs for a decaying radionuclide, T_{ave} . If image acquisition started at the Series Reference Time and the image has not been decay corrected, then T_{ave} will be:

$$T_{ave} = \frac{1}{\lambda} \ln \frac{\lambda T}{1 - e^{-\lambda T}}$$

where: lambda = decay constant = $(\ln 2)/T_{1/2}$
$T_{1/2}$ = Radionuclide Half Life (0018,1075)
T = Actual Frame Duration (0018,1242)

Note that T_{ave} will be sooner than the midpoint of the Actual Frame Duration (0018,1242).

Example 3: For a short-lived radionuclide and a time-varying radiopharmaceutical distribution, an implementation with supplementary data (e.g. scanner count rates or blood sample data) sets the Frame Reference Time (0054,1300) to a derived time determined to be its best estimate of the time that the pixel values occurred.

C.8.9.4.1.6 Actual Frame Duration

The accumulation of counts for a PET Image shall occur entirely between:

(1) the acquisition starting time (as specified by Acquisition Date (0008,0022) and Acquisition Time (0008,0032)), and

(2) the acquisition ending time, which is equal to the acquisition starting time in (1) plus the Actual Frame Duration (0018,1242).

If the Series Type (0054,1000), Value 1 is GATED, then the actual accumulation of counts has only occurred during an R-R Interval.

C.8.9.4.1.7 Secondary Counts Accumulated

Secondary Counts Accumulated (0054,1311) is multi-valued and, if supplied, has Values corresponding to the Secondary Counts Type (0054,1220). The number and order of the Values in Secondary Counts Accumulated (0054,1311) shall be the same as Secondary Counts Type (0054,1220).

C.8.9.4.1.8 Dose Calibration Factor

The Dose Calibration Factor (0054,1322) is the factor that was used to scale this image from counts/sec to Bq/ml using an external dose calibrator. The value shall be one if no dose calibration was applied. The application of a dose calibration correction is specified by Corrected Image (0028,0051) equal to DCAL.

Note: Dose Calibration Factor (0054,1322) is not equal to the inverse of the sensitivity (kcps/Bq/ml) of the scanner, which is usually measured for a given radiopharmaceutical distribution and excluding the effects of attenuation.

C.8.9.4.1.9 Image Index

Image Index (0054,1330) is an index identifying the position of this image within a PET Series.

Note: The scheme for encoding Image Index (0054,1330) is as follows. Images within a PET Series can be viewed as a multi-dimensional array whose possible dimensions include R-R Intervals, Time Slots, Time Slices, and Slices. The dimensions of the array are defined by the Series Type (0054,1000) Value 1. Each dimension of the array has an index that identifies the position of this image in the array. The indices are: R-R Interval Index, Time Slot Index, Time Slice Index, Slice Index. The indices are calculated as follows:

Index	Range of Index	Order of Images along that Dimension
R-R Interval Index	1 to Number of R-R Intervals (0054,0061)	Increasing Low R-R Value (0018,1081)

Time Slot Index	1 to Number of Time Slots (0054,0071)	Increasing Trigger Time (0018,1060)
Time Slice Index	1 to Number of Time Slices (0054,0101)	Increasing Frame Reference Time (0054,1300)
Slice Index	1 to Number of Slices (0054,0081)	If Series Type (0054,1000) Value 2 is IMAGE: Order is in increasing position along the normal, where the normal is determined by the cross product of the direction cosines of the row and column of the image. See Image Orientation (0020,0037) in the Image Plane Module. If Series Type (0054,1000) Value 2 is REPROJECTION: Order is in increasing or decreasing angle of the normal, where the normal is determined by the cross product of the direction cosines of the row and column of the image. See Image Orientation (0020,0037) in the Image Plane Module. (Note that reprojection images rotate about only a single axis as described in C.8.9.1.1.1. Therefore, all normals are co-planar and make a single angle with respect to each other.)

Using these index values the position of this image within the multi-dimensional array (the Image Index (0054,1330)) is calculated as follows:

Series Type (0054,1000), Value 1	**Dimensions of Array (Last dimension is most rapidly changing)**	**Encoding of Image Index (0054,1330)**
STATIC	Slice	Slice Index
WHOLE BODY	Slice	Slice Index
DYNAMIC	Time Slice \ Slice	((Time Slice Index - 1) * (Number of Slices (0054,0081))) + Slice Index
GATED	R-R Interval \ Time Slot \ Slice	((R-R Interval Index - 1) * (Number of Time Slots (0054,0071)) * (Number of Slices (0054,0081))) + ((Time Slot Index - 1) * (Number of Slices (0054,0081))) + Slice Index

C.8.9.5 PET Curve Module

Table C.8-53 contains IOD Attributes that describe a PET Curve.

Table C.8-53 - PET CURVE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Curve Dimensions	(50xx,0005)	1	Number of dimensions for these data. The dimensions may be any number from 1 to n. See C.8.9.5.1.2 for specialization.
Type of Data	(50xx,0020)	1	Type of data in this curve. See C.8.9.5.1.3 for specialization of Defined Terms.
Curve Data	(50xx,3000)	1	Curve data. See C.10.2.1.4 and C.8.9.5.1.4 for further explanation.
Axis Units	(50xx,0030)	1	Units of measure for the axes. See C.8.9.5.1.5 for specialization of Defined Terms.
Dead Time Correction Flag	(0054,1401)	1C	Dead time correction has been applied to Curve Data (50xx,3000). Required if Type of Data (50xx,0020) is BLDSMPL. Enumerated Values: Y = yes N = no
Counts Included	(0054,1400)	2C	Type of counts included in this count rate data. Enumerated Values: TRUES SCATTER RANDOMS SINGLES Required if Axis Units (50xx,0030) contains CPS or CNTS.
Processing Function	(0018,5020)	3	A textual description of the processing that has been applied to this curve. (e.g. smoothing, time interpolation)

C.8.9.5.1 PET Curve Attribute Descriptions

C.8.9.5.1.1 Specialization of Curve Module Attributes

For PET Curves, all Curve Data (50xx,3000) values that are temporal are defined as time offsets from the Series Reference Time, where the Series Reference Time is defined by the combination of Series Date (0008,0021) and Series Time (0008,0031).

Note: Because the PET Curve is related to a single PET Series, all Curve Data (50xx,3000) points must be decay corrected (or not) to the same real-world event as defined in Decay Correction (0054,1102).

C.8.9.5.1.2 Curve Dimensions

If the Type of Data (50xx,0020) is SYSRATE, then the Curve Dimensions (50xx,0005) shall equal 2.

If the Type of Data (50xx,0020) is SLICERATE, then the Curve Dimensions (50xx,0005) shall equal 3.

If the Type of Data (50xx,0020) is BLDSMPL, then the Curve Dimensions (50xx,0005) shall equal 2.

If the Type of Data (50xx,0020) is CPM, then the Curve Dimensions (50xx,0005) shall equal 3.

C.8.9.5.1.3 Type of Data

A description of the Type of Data (50xx,0020) in this Curve. Defined Terms:

SYSRATE = system count rate
SLICERATE = slice count rate
BLDSMPL = blood samples
CPM = cardiac polar map

Note: Cardiac Polar Maps will be supported under the Standalone PET Curve IOD. This does not preclude the transmission of Cardiac Polar Maps in Secondary Capture images when preservation of quantitative information is not required.

C.8.9.5.1.4 Curve Data

If Type of Data (50xx,0020) is SYSRATE, then Curve Data (50xx,3000) is specified as x1\y1\x2\y2\... where:

xn = time since Series Date (0008,0021) and Series Time (0008,0031)
yn = system count rate at time xn.

If Type of Data (50xx,0020) is SLICERATE, then Curve Data (50xx,3000) is specified as x1\y1\z1\x2\y2\z2\... where:

xn = time since Series Date (0008,0021) and Series Time (0008,0031)
yn = position of slice
zn = slice count rate of slice yn at time xn

Values of yn shall be increasing from patient inferior to superior.

If Type of Data (50xx,0020) is BLDSMPL, then Curve Data (50xx,3000) is specified as x1\y1\x2\y2\... where:

xn = time since Series Date (0008,0021) and Series Time (0008,0031)
yn = blood activity at time xn.

If the Type of Data (50xx,0020) is BLDSMPL, then Axis Units (50xx,0030) Value 1 shall be MILS or SEC, and Axis Units (50xx,0030) Value 2 shall be BQML or CPS.

If Type of Data (50xx,0020) is CPM, then Curve Data (50xx,3000) is specified as x1\y1\z1\x2\y2\z2\... where:

xn = distance from apex along long axis of heart
yn = start angle of sector
zn = value for sector in appropriate units.

Sector boundaries (yn) are measured in degrees clockwise relative to the antero-lateral wall. The end angle for a sector is the start angle of next largest yn value for the same xn. The end angle for the last sector is the start angle of the smallest yn for the same xn.

C.8.9.5.1.5 Axis Units

Axis Units (50xx,0030) are the units of measure for the axes. One value for each dimension. The order for the units is the same as the dimensions for the curve data in Curve Data (50xx,3000).

Defined Terms:

SEC = seconds
CNTS = counts
MM = millimeters
NONE = unitless
CM = centimeters
CM2 = cm**2
DEG = degrees
MILS = milliseconds
PCNT = percent
CPS = counts/second
BQML = Becquerels/milliliter
MGMINML = milligram/minute/milliliter
UMOLMINML = micromole/minute/milliliter
MLMING = milliliter/minute/gram
MLG = milliliter/gram
1CM = 1/centimeter
UMOLML = micromole/milliliter
PROPCNTS = proportional to counts
PROPCPS = proportional to counts/sec
MLMINML = milliliter/minute/milliliter
MLML = milliliter/milliliter
GML = grams/milliliter
STDDEV = standard deviations

If the Type of Data (50xx,0020) is SYSRATE, then Axis Units (50xx,0030) Value 1 shall be MILS or SEC, and Axis Units (50xx,0030) Value 2 shall be CPS.

If the Type of Data (50xx,0020) is SLICERATE, then Axis Units (50xx,0030) Value 1 shall be MILS or SEC, Axis Units (50xx,0030) Value 2 shall be MM or CM, and Axis Units (50xx,0030) Value 3 shall be CPS. Values of Axis Units (50xx,0030) Value 2 shall be increasing from patient inferior to superior.

If the Type of Data (50xx,0020) is BLDSMPL, then Axis Units (50xx,0030) Value 1 shall be MILS or SEC, and Axis Units (50xx,0030) Value 2 shall be BQML or CPS.

If the Type of Data (50xx,0020) is CPM, then Axis Units (50xx,0030) Value 1 shall be MM or CM, Axis Units (50xx,0030) Value 2 shall be DEG, and Axis Units (50xx,0030) Value 3 shall be one of:

CNTS, NONE, CM2, PCNT, CPS, BQML, MGMINML, UMOLMINML, MLMING, MLG, 1CM, UMOLML, PROPCNTS, PROPCPS, MLMINML, MLML, GML, STDDEV

C.8.10 Hardcopy Modules

C.8.10.1 Hardcopy Equipment Module

This Module describes equipment used to create Hardcopy Grayscale and Color Image IODs.

Table C.8-54
HARDCOPY EQUIPMENT MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that created this Hardcopy Image. Enumerated Value: HC
Hardcopy Creation Device ID	(0018,1011)	3	User defined identification of the device that created this Hardcopy Image.
Hardcopy Device Manufacturer	(0018,1017)	3	Manufacturer of the device that created this Hardcopy Image.
Hardcopy Device Software Versions	(0018,101A)	3	Manufacturer's designation of the software of the device that created this Hardcopy Image.
Hardcopy Device Manufacturer's Model Name	(0018,101B)	3	Manufacturer's model number of the device that created this Hardcopy Image.

Note: The Attributes specified in the General Equipment Module (See Table C.7-6) describe the equipment which created the image that was the source for this Hardcopy Image. The Attributes of the Hardcopy Equipment Module define the equipment that created the Hardcopy Image.

C.8.10.2 Hardcopy Grayscale Image Module

This Module describes a printable 8 or 12 bit grayscale image. The Hardcopy Grayscale Image Pixel Module is a specialization of the Image Pixel Module defined in C.7.6.3 of this part.

Table C.8-55
HARDCOPY GRAYSCALE IMAGE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Samples Per Pixel	(0028,0002)	1	See C.7.6.3 for description of Image Pixel Module; Enumerated Value: 1
Photometric Interpretation	(0028,0004)	1	See C.7.6.3 for description of Image Pixel Module; Enumerated Values: MONOCHROME1 MONOCHROME2
Rows	(0028,0010)	1	See C.7.6.3 for description of Image Pixel Module.
Columns	(0028,0011)	1	See C.7.6.3 for description of Image Pixel Module.
Pixel Aspect Ratio	(0028,0034)	1C	See C.7.6.3 for description of Image Pixel Module. Required if the aspect ratio is not 1\1.
Bits Allocated	(0028,0100)	1	See C.7.6.3 for description of Image Pixel Module. Enumerated Values: 8 (if Bits Stored = 8) 16 (if Bits Stored =12)

Bits Stored	(0028,0101)	1	See C.7.6.3 for description of Image Pixel Module. Enumerated Values: 8, 12
High Bit	(0028,0102)	1	See C.7.6.3 for description of Image Pixel Module. The value shall be Bits Stored (0028,0101) - 1.
Pixel Representation	(0028,0103)	1	See C.7.6.3 for description of Image Pixel Module. Enumerated Value: 0000H (unsigned integer)
Pixel Data	(7FE0,0010)	1	See C.7.6.3 for description of Image Pixel Module.

C.8.10.3 Hardcopy Color Image Module

This Module describes a printable 8 bit RGB Color image. The Hardcopy Color Image Pixel Module is a specialization of the Image Pixel Module defined in C.7.6.3 of this part.

Table C.8-56
HARDCOPY COLOR IMAGE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Samples Per Pixel	(0028,0002)	1	See C.7.6.3 for description of Image Pixel Module; Enumerated Value: 3
Photometric Interpretation	(0028,0004)	1	See C.7.6.3 for description of Image Pixel Module; Enumerated Value: RGB
Planar Configuration	(0028,0006)	1	See C.7.6.3 for description of Image Pixel Module; Enumerated Value: 0001H (frame interleave)
Rows	(0028,0010)	1	See C.7.6.3 for description of Image Pixel Module.
Columns	(0028,0011)	1	See C.7.6.3 for description of Image Pixel Module.
Pixel Aspect Ratio	(0028,0034)	1C	See C.7.6.3 for description of Image Pixel Module. Required if the aspect ratio is not 1\1.
Bits Allocated	(0028,0100)	1	See C.7.6.3 for description of Image Pixel Module; Enumerated Value: 8
Bits Stored	(0028,0101)	1	See C.7.6.3 for description of Image Pixel Module; Enumerated Value: 8
High Bit	(0028,0102)	1	See C.7.6.3 for description of Image Pixel Module; Enumerated Value: 7
Pixel Representation	(0028,0103)	1	See C.7.6.3 for description of Image Pixel Module; Enumerated Value: 0000H (unsigned integer)

Pixel Data	(7FE0,0010)	1	See C.7.6.3 for description of Image Pixel Module

C.9 OVERLAYS

C.9.1 Overlay identification module

Table C.9-1 contains Attributes that identify an independent Overlay; i.e. an Overlay which is handled as an independent Information Entity.

Table C.9-1
OVERLAY IDENTIFICATION MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Overlay Number	(0020,0022)	2	A number that identifies this Overlay.
Overlay Date	(0008,0024)	3	The date the Overlay was created.
Overlay Time	(0008,0034)	3	The time the Overlay was created.
Referenced Image Sequence	(0008,1140)	3	A Sequence which provides reference to a set of Image SOP Class/Instance pairs. Uniquely identifies the images significantly related to this overlay. One or more Items may be included in this Sequence. Encoded as sequence of items: (0008,1150) and (0008,1155).
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Image Sequence (0008,1140) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Reference Image Sequence (0008,1140) is sent.

C.9.2 Overlay plane module

Table C.9-2 contains Attributes that describe characteristics of an Overlay Plane.

An Overlay Plane describes graphics or bit-mapped text that is associated with an Image or has its own existence within a Series. It may also describe a Region of Interest in an Image.

Each Overlay Plane is one bit deep. Sixteen separate Overlay Planes may be associated with an Image or exist as Standalone Overlays in a Series.

Overlay pixel data are stored either in Overlay Data (60xx,3000) or embedded in the image pixel data in Image Pixel Data (7FE0,0010). See PS 3.5 for a description of overlay pixel data imbedded with image pixel data. See the Section Repeating Groups in PS 3.5 for a description of permitted values of 60xx.

Attributes describing display of grayscale and color overlays were defined in a previous version of the DICOM Standard. These have now been retired and have been moved to Annex I.2.

Table C.9-2
OVERLAY PLANE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Overlay Rows	(60xx,0010)	1	Number of Rows in Overlay.
Overlay Columns	(60xx,0011)	1	Number of Columns in Overlay.

Overlay Type	(60xx,0040)	1	Indicates whether this overlay represents a region of interest or other graphics. Enumerated Values: G = Graphics R = ROI.
Overlay Origin	(60xx,0050)	1	Location of first overlay point with respect to pixels in the image, given as row\column. The upper left pixel of the image has the coordinate 1\1. Column values greater than 1 indicate the overlay plane origin is to the right of the image origin. Row values greater than 1 indicate the overlay plane origin is below the image origin. Values less than 1 indicate the overlay plane origin is above or to the left of the image origin. Note: Values of 0\0 indicate that the overlay pixels start 1 row above and one column to the left of the image pixels.
Overlay Bits Allocated	(60xx,0100)	1	Number of Bits Allocated in the Overlay. If the overlay data are embedded in the Image Pixel Data (7FE0,0010), the value of this Attribute shall be the same as Bits Allocated (0028,0100).
Overlay Bit Position	(60xx,0102)	1	Bit in which Overlay is stored. See PS 3.5 for further explanation.
Overlay Data	(60xx,3000)	1C	Overlay pixel data. The order of pixels sent for each overlay is left to right, top to bottom, i.e., the upper left pixel is sent first followed by the remainder of the first row , followed by the first pixel of the 2nd row, then the remainder of the 2nd row and so on. Overlay data shall be contained in this Attribute or imbedded with the image pixel data in Group 7FE0. Required if overlay data are in this Group. See C.9.2.1.1 for further explanation.
Overlay Description	(60xx,0022)	3	User-defined comments about the overlay.
Overlay Subtype	(60xx,0045)	3	Defined term which identifies the intended purpose of the ROI Overlay Type.
Overlay Label	(60xx,1500)	3	A user defined text string which may be used to label or name this overlay.

ROI Area	(60xx,1301)	3	Number of pixels in ROI area. See C.9.2.1.2 for further explanation.
ROI Mean	(60xx,1302)	3	ROI Mean. See C.9.2.1.2 for further explanation.
ROI Standard Deviation	(60xx,1303)	3	ROI standard deviation. See C.9.2.1.2 for further explanation.

C.9.2.1 Overlay Attribute Descriptions

C.9.2.1.1 Overlay type

There are two specific types of overlays. The type is specified in this Attribute.

A Region of Interest (ROI) is a specific use of an Overlay. The overlay bits corresponding to all the pixels included in the ROI shall be set to 1. All other bits are set to 0. This is used to specify an area of the image of particular interest.

A Graphics overlay may express reference marks, graphic annotation, or bit mapped text, etc. A Graphics overlay may be used to mark the boundary of a ROI. If this is the case and the ROI statistical parameters are used, they will only refer to the pixels under the boundaries, not those in the included regions.

The overlay bits corresponding to all the pixels included in the Graphics shall be set to 1. All other bits are set to 0.

C.9.2.1.2 ROI area, ROI mean, and ROI standard deviation

These Attributes contain the statistical parameters of the ROI. The values of these parameters are for the overlay pixel values set to 1.

C.9.3 Multi-frame Overlay Module

Table C.9-3 specifies the Attributes of a Multi-frame overlay.

Table C.9-3
MULTI-FRAME OVERLAY MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Number of Frames in Overlay	(60xx,0015)	1	Number of Frames in Overlay. Required if Overlay data contains multiple frames.
Image Frame Origin	(60xx,0051)	3	Frame number of Multi-frame Image to which this overlay applies; frames are numbered from 1.

C.9.3.1 Multi-Frame Overlay Attribute Descriptions

C.9.3.1.1 Number of frames in overlay

A Multi-frame Overlay is defined as an Overlay whose overlay data consists of a sequential set of individual Overlay frames. A Multi-frame Overlay is transmitted as a single contiguous stream of overlay data. Frame delimiters are not contained within the data stream.

Each individual frame shall be defined (and thus can be identified) by the Attributes in the Overlay Plane Module (see C.9.2).

The total number of frames contained within a Multi-frame Overlay is conveyed in the Number of Frames in Overlay (60xx,0015).

The frames within a Multi-frame Overlay shall be conveyed as a logical sequence. If Multi-frame Overlays are related to a Multi-frame Image, the order of the Overlay Frames are one to one with the order of the Image frames. Otherwise, no attribute is used to indicate the sequencing of the Overlay Frames. If Image Frame Origin (60xx,0051) is present, the Overlay frames are applied one to one to the Image frames, beginning at the indicated frame number**.** Otherwise, no attribute is used to indicated the sequencing of the Overlay Frames.

The Number of Frames in Overlay (60xx,0015) plus the Image Frame Origin (60xx,0051) minus 1 shall be less than or equal to the total number of frames in the Multi-frame Image.

If the Overlay data are embedded in the pixel data, then the Image Frame Origin (60xx,0051) must be 1 and the Number of Frames in Overlay (60xx,0015) must equal the number of frames in the Multi-frame Image.

C.9.4 Bi-Plane Overlay Module

Table C.9.4-1 describes the Attributes associated with an overlay when it is associated with a bi-plane image.

Table C.9.4-1
BI-PLANE OVERLAY MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Overlay Planes	(60xx,0012)	1	Number of planes.
Overlay Plane Origin	(60xx,0052)	2C	Plane to which overlay applies. Required if Overlay is one plane in a bi-plane image. If no value is present, overlay is applied to both frames.

C.9.4.1 Bi-Plane Overlay Attribute Descriptions

An overlay associated with a bi-plane image may itself be either a single plane or bi-plane, as indicated by the Overlay Planes attribute (value of 1 or 2). If the overlay is a single plane, it is applied to the modality image plane specified in the Overlay Plane Origin attribute. If the overlay is bi-plane (Overlay Planes attribute value of 2), each overlay plane shall be applied to the corresponding modality image plane using the Origin attribute of the Overlay Plane Module (see Section C.9.2) and Image Frame Origin attribute of Multi-frame Overlay Module (See Section C.9.3).

C.10 CURVE

C.10.1 Curve identification module

The table in this Section contains Attributes that identify an independent Curve; i.e. a Curve which is handled as a separate information entity.

Table C.10-1
CURVE IDENTIFICATION MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Curve Number	(0020,0024)	2	A number that identifies this Curve.
Curve Date	(0008,0025)	3	The date the Curve was created.
Curve Time	(0008,0035)	3	The time the Curve was created.
Referenced Image Sequence	(0008,1140)	3	A Sequence which provides reference to a set of Image SOP Class/Instance pairs. Uniquely identifies the images significantly related to this Curve. One or more Items may be included in this Sequence. Encoded as sequence of items: (0008,1150) and (0008,1155).
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Image Sequence (0008,1140) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Reference Image Sequence (0008,1140) is sent.
Referenced Overlay Sequence	(0008,1130)	3	A Sequence which provides reference to a set of SOP Class/Instance pairs which are related independent Overlays. Uniquely identifies Overlays significantly related to this Curve. Zero or more Items may be included in this Sequence. Encoded as sequence of items: (0008,1150) and (0008,1155)
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Overlay Sequence (0008,1130) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Reference Overlay Sequence (0008,1130) is sent.
Referenced Curve Sequence	(0008,1145)	3	A Sequence which provides reference to a set of Curve SOP Class/Instance pairs. Uniquely identifies the curves significantly related to this curve. Zero or more Items may be included in this Sequence. Encoded as sequence of items: (0008,1150) and (0008,1155)
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Curve Sequence (0008,1145) is sent.

>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Curve Sequence (0008,1145) is sent.

C.10.2 Curve module

This Module defines Attributes of Curves. A Curve may or may not be related to an Image and/or a Curve.

Table C.10-2
CURVE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Curve Dimensions	(50xx,0005)	1	Number of dimensions for these data. The dimensions may be any number from 1 to n.
Number of Points	(50xx,0010)	1	Number of data points in this Curve
Type of Data	(50xx,0020)	1	Type of data in this curve. See C.10.2.1.1 for Defined Terms.
Data Value Representation	(50xx,0103)	1	Data representation of the curve data points. See C.10.2.2 for Enumerated Values and further explanation.
Curve Data	(50xx,3000)	1	Curve data. See C.10.2.1.4 for further explanation.
Curve Description	(50xx,0022)	3	User-defined comments about the Curve
Axis Units	(50xx,0030)	3	Units of measure for the axes. See C.10.2.1.3 for Defined Terms.
Axis Labels	(50xx,0040)	3	Text labels for each axis. One label for each axis.
Minimum Coordinate Value	(50xx,0104)	3	The minimum value in the set of data. One value for each dimension.
Maximum Coordinate Value	(50xx,0105)	3	The maximum value in the set of data. One value for each dimension.
Curve Range	(50xx,0106)	3	A minimum-maximum pair for each dimension for defining the range of the curve representation, in the same units as Axis Units.
Curve Data Descriptor	(50xx,0110)	1C	Specifies the format of the Curve Data. Required if any dimensions of the data are described by interval spacing. See C.10.2.1.5 for further explanation.

Coordinate Start Value	(50xx,0112)	1C	The starting point of a one dimensional data list. Required if Curve Data Descriptor is used. One value for each dimension. The Value Representation is given in Data Value Representation (50xx,0103).
Coordinate Step Value	(50xx,0114)	1C	The interval spacing between two successive points. Required if Curve Data Descriptor is used. One value for each dimension. The Value Representation is given in Data Value Representation (50xx,0103).
Curve Label	(50xx,2500)	3	A user defined text string which may be used to label or name this curve.
Referenced Overlay Sequence	(50xx,2600)	3	A Sequence which provides reference to a set of related overlays used to generate this curve.
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Overlay Sequence (50xx,2600) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Overlay Sequence (50xx,2600) is sent.
>Referenced Overlay Group	(50xx,2610)	1C	The Group number of the related overlay. Required if Referenced Overlay Sequence (50xx,2600) is sent.

C.10.2.1 CURVE ATTRIBUTE DESCRIPTIONS

C.10.2.1.1 Type of data

A description of the Type of Data (50xx,0020) in this curve.

Defined Terms:

TAC = time activity curve
HIST = histogram
TABL = table of values
POLY = poly line
PRESSURE = pressure data
PHYSIO = physio data
PROF = image profile
ROI = polygraphic region of interest
FILT = filter kernel
ECG = ecg data
FLOW = flow data
RESP = Respiration trace

C.10.2.1.2 Data value representation

The Data Value Representation (50xx,0103) of the data in the curve. All dimensions shall have the same value representation.

Enumerated Values:

0000H = unsigned short (US)

0001H = signed short (SS)
0002H = floating point single (FL)
0003H = floating point double (FD)
0004H = signed long (SL)

C.10.2.1.3 Axis units

Axis Units (50xx,0030) are the units of measure for the axes. One value for each dimension. The order for the units is the same order as the dimensions for the curve data in Curve Data (50xx,3000).

Defined Terms:

SEC = Seconds	CNTS = Counts	MM = millimeters
PIXL = Pixels	NONE = Unitless	BPM = beats/min
CM = centimeters	CMS = centimeters/second	CM2 = cm**2
CM2S = cm**2/second	CM3 = cm**3	CM3S = cm**3/second
CMS2 = cm/second**2	DB = dB	DBS = dB/second
DEG = degrees	GM = gram	GMM2 = gram/meter**2
HZ = Hertz	IN = inch	KG = kg
LMIN = liters/minute	LMINM2 = liters/minute/meter**2	M2 = meters **2
MS2 = meters/sec**2	MLM2 = milliliters/meter**2	MILS = milliseconds
MILV = millivolts	MMHG = mmHg	PCNT = percent
LB = pound		

C.10.2.1.4 Curve data

Curve Data (50xx,3000) points in the curve, each dimension for the first point, followed by dimensions for second point, etc. For a two dimensional curve: X1,Y1,X2,Y2, etc. The Value Representation of all components of the N-tuple must be the same. The Value Representation is given in Data Value Representation (50xx,0103).

A region of interest (ROI) is defined as an N-tuple list of end points which form a closed polygraph. A two-dimensional ROI is represented as a list of value pairs; a three dimensional ROI as a list of value triplets, etc. A region of interest would normally be represented in pixel units, with the Curve Range values matching the pixel matrix of the images with which the ROI is associated. Alternatively, it is possible to define a unitized region of interest which can be applied to any size image.

A poly line is defined as an n-tuple list of end points which form a general trace not forming a closed polygraph. It is used to represent any graphic which does not fall within the normal understanding of a curve plot or region of interest. The poly line can be used to define any graphic trace.

C.10.2.1.5 Curve data descriptor, coordinate start value, coordinate step value

The Curve Data for dimension(s) containing evenly distributed data can be eliminated by using a method that defines the Coordinate Start Value and Coordinate Step Value (interval). The one dimensional data list is then calculated rather than being enumerated.

For the Curve Data Descriptor (50xx,0110) an Enumerated Value describing how each component of the N-tuple curve is described, either by points or interval spacing. One value for each dimension. Where:

0000H = Dimension component described using interval spacing

0001H = Dimension component described using values

Using interval spacing:

Dimension component(s) described by interval spacing use Attributes of Coordinate Start Value (50xx,0112), Coordinate Step Value (50xx,0114) and Number of Points (50xx,0010). The 1-dimensional data list is calculated by using a start point of Coordinate Start Value and adding the interval (Coordinate Step Value) to obtain each data point until the Number of Points is satisfied. The data points of this dimension will be absent from Curve Data (50xx,3000).

Using values:

Dimension component(s) of the N-tuple curve are listed as data points in curve Data (50xx,3000). Data is absent from the tuple where the dimension data is defined by using the interval spacing method.

The absence of this data element means that the curve is described using points for the complete N-tuple. The interval spacing method is not used.

C.10.3 Audio module

This Module defines Attributes that describe characteristics of audio curves.

Table C.10-3
AUDIO MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Audio Type	(50xx,2000)	1	Indicates the type of Audio Sample Data. Enumerated Values: 0000H = none 0001H = Doppler Audio 0002H = Voice Audio 0003H = Phono Audio
Audio Sample Format	(50xx,2002)	1	Format of the Audio Sample Data. Enumerated Values: 0000H = 16 bit 2's complement Stored LSB first, interleaved per channel: channel 0 sample 0, channel 1 sample 0, channel 0 sample 1, channel 1 sample 1 0001H = 8 bit 2's complement, interleaved per channel: channel 0 sample 0, channel 1 sample 0, channel 0 sample 1, channel 1 sample 1
Number of Channels	(50xx,2004)	1	Number of Audio Channels. Enumerated Values: 0000H = mono 0001H = stereo

Number of Samples	(50xx,2006)	1	The number of audio samples for one channel. Each channel will have this many samples.
Sample Rate	(50xx,2008)	1	Number of samples per second at which audio data was acquired. The temporal axis is linear. Note: Log compression is not supported.
Total Time	(50xx,200A)	1	Length of real time that the audio data covers (in microseconds).
Audio Sample Data	(50xx,200C)	1	Audio sample data values. The amplitude representation of the audio sample data is linear. Note: Log compression is not supported.
Referenced Image Sequence	(0008,1140)	3	A Sequence which provides reference to a set of Image SOP Class/Instance pairs to which this audio applies. One or more Items may be included in this Sequence. Encoded as sequence of items: (0008,1150) and (0008,1155).
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Image Sequence (0008,1140) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Image Sequence (0008,1140) is sent.
Audio Comments	(50xx,200E)	3	User defined comments about the audio.

C.10.3.1 AUDIO SYNCHRONIZATION

The approach being taken is to provide for audio in an elementary, basic way. Audio is typically used for voice commentary of what is found during an examination, and perhaps in a diagnosis, similar to written notes. Audio is also used to record physiological information such as Doppler audio.

The only link between audio and image time bases is alignment between audio time zero and image time zero, on a frame boundary. The time bases for each are distinct and separate.

Synchronization of audio to single frame images is not necessary, since an image is "stationary." The Audio Module need only reference the image to which it applies, using the element Referenced Image Sequence (0008,1140).

Synchronization of audio to Multi-frame loops is accomplished by referencing the loop to which the audio applies, similar to single frame images. Audio starts at time zero of the loop and continues for Attribute Total Time (50xx,200A) number of microseconds, using the time base specified in the Audio Module.

Other than synchronizing the audio at time zero of the image loop, there is no other synchronization between image and audio time bases. The audio may partially span, fully span, or overspan the duration of the image loop. This is beyond the scope of this Standard.

If audio does not start at frame zero, then the appropriate offset may be added by padding the Audio Sample Data with null values to achieve the necessary offset.

C.11 LOOK UP TABLES

C.11.1 Modality LUT module

Table C.11-1 specifies the Attributes that describe the Modality LUT.

Table C.11-1
MODALITY LUT MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Modality LUT Sequence	(0028,3000)	3	Defines a sequence of Modality LUTs.
>LUT Descriptor	(0028,3002)	1C	Specifies the format of the LUT Data in this Sequence. See C.11.1.1 for further explanation. Required if the Modality LUT Sequence (0028,3000) is sent.
>LUT Explanation	(0028,3003)	3	Free form text explanation of the meaning of the LUT.
>Modality LUT Type	(0028,3004)	1C	Specifies the output values of this Modality LUT. See C.11.1.1 for further explanation. Required if the Modality LUT Sequence (0028,3000) is sent.
>LUT Data	(0028,3006)	1C	LUT Data in this Sequence. Required if the Modality LUT Sequence (0028,3000) is sent.
Rescale Intercept	(0028,1052)	1C	The value b in relationship between stored values (SV) and the output units specified in Rescale Type (0028,1054). Output units = m*SV + b. Required if Modality LUT Sequence (0028,3000) is not present.
Rescale Slope	(0028,1053)	1C	m in the equation specified by Rescale Intercept (0028,1052). Required if Rescale Intercept is present.
Rescale Type	(0028,1054)	1C	Specifies the output units of Rescale Slope (0028,1053) and Rescale Intercept (0028,1052). Required if Rescale Intercept is present.

C.11.1.1 LUT Attribute Descriptions

C.11.1.1.1 LUT descriptor

The three values of the LUT Descriptor (0028,3002) describe the format of the LUT Data in the corresponding Data Element (0028,3006).

The first value is the number of entries in the lookup table.

The second value is the first stored pixel value mapped. This pixel value is mapped to the first entry in the LUT. All image pixel values less than the first entry are also mapped to the first entry in the LUT Data. An image pixel value one greater than the first entry is mapped to the second entry in the LUT Data. Subsequent image pixel values are mapped to the subsequent entries in the LUT Data up to an image pixel value equal to number of entries + first entry - 1 which is mapped to the last entry in the LUT Data. Image pixel values greater than number of entries + first entry are also mapped to the last entry in the LUT Data.

The third value specifies the number of bits for each entry in the LUT Data. It shall take the value 8 or 16. The LUT Data shall be stored in a format equivalent to 8 or 16 bits allocated and high bit equal 1-bits allocated.

The third value conveys the range of LUT entry values. It shall take the value 8 or 16, corresponding with the LUT entry value range of 256 or 65536.

Note: The third value is not required for describing the LUT data and is only included for informational usage and for maintaining compatibility with ACR-NEMA 2.0.

The LUT Data contains the LUT entry values.

C.11.1.1.2 Modality LUT type

Specifies the units of the output of the Modality LUT.

Defined Terms:

OD = The number in the LUT represents thousands of optical density. That is, a value of 2140 represents an optical density of 2.140.

US = Unspecified

Other values are permitted, but are not defined by the DICOM Standard.

C.11.2 VOI LUT module

Table C.11-2 specifies the Attributes that describe the VOI LUT.

Table C.11-2
VOI LUT MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
VOI LUT Sequence	(0028,3010)	3	Defines a sequence of VOI LUTs.
>LUT Descriptor	(0028,3002)	1C	Specifies the format of the LUT Data in this Sequence. See C.11.1.1 for further explanation. Required if the VOI LUT Sequence (0028,3010) is sent.
>LUT Explanation	(0028,3003)	3	Free form text explanation of the meaning of the LUT.
>LUT Data	(0028,3006)	1C	LUT Data in this Sequence. Required if the VOI LUT Sequence (0028,3010) is sent.
Window Center	(0028,1050)	3	Window Center for display. See C.11.2.1.1 for further explanation.

Window Width	(0028,1051)	1C	Window Width for display. See C.11.2.1.1 for further explanation. Required if Window Center (0028,1050) is sent.
Window Center & Width Explanation	(0028,1055)	3	Free form explanation of the meaning of the Window Center and Width. Multiple values correspond to multiple Window Center and Width values.

C.11.2.1 LUT Attribute Descriptions

C.11.2.1.1 Window center and window width

Window Center (0028,1050) and Window Width (0028,1051) specifies a linear conversion from stored pixel values to values to be displayed. Window Center contains the pixel value that is the center of the window. Window Width contains the width of the window.

These Attributes shall be used only for Images with Photometric Interpretation (0028,0004) values of MONOCHROME1 and MONOCHROME2. They have no meaning for other Images.

If multiple values are present, both Attributes shall have the same number of values and shall be considered as pairs. Multiple values indicate that multiple viewing should be presented.

This transformation of pixel values shall be applied after any Modality LUT.

If any VOI LUT Table is included or referenced by an Image, a Window Width and Window Center or the VOI LUT Table, but not both, it shall be applied to the Image for display. Inclusion of both indicates that multiple viewing should be presented.

C.11.3 LUT identification module

Table C.11-3 contains Attributes that identify a LUT IOD.

Table C.11-3
LUT Identification Module Attributes

Attribute Name	Tag	Type	Attribute Description
LUT Number	(0020,0026)	2	A number that identifies this LUT.
Referenced Image Sequence	(0008,1140)	3	A Sequence which provides reference to a set of Image SOP Class/Instance pairs to which this Look Up Table applies. One or more Items may be included in this Sequence. Encoded as sequence of items: (0008,1150) and (0008,1155).
>Referenced SOP Class UID	(0008,1150)	1C	Required if Referenced Image Sequence (0008,1140) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Required if Reference Image Sequence (0008,1140) is sent.

C.11.4 Presentation LUT Module

Table C.11-4
Presentation LUT Module

Attribute name	Tag	Description
Presentation LUT Sequence	(2050,0010)	Defines a sequence of Presentation LUTs. Only a single item shall be included in this sequence.
>LUT Descriptor	(0028,3002)	Specifies the format of the LUT Data in this Sequence.
>LUT Explanation	(0028,3003)	Free form text explanation of the meaning of the LUT.
>LUT Data	(0028,3006)	LUT Data in this Sequence.
Presentation LUT Shape	(2050,0020)	Specifies pre-defined Presentation LUT shapes. Enumerated Values : IDENTITY = input to the Presentation LUT is in P-Values, no further translation is necessary. LIN OD = input to Presentation LUT is in linear optical density over the range of Min Density (2010,0120) and Max Density (2010,1030). Note: LIN OD is only defined for hardcopy devices and is not applicable to softcopy devices.

C.12 GENERAL MODULES

The SOP Common Module shall be mandatory for all DICOM IODs.

C.12.1 SOP Common Module

Table C.12-1 defines the Attributes which are required for proper functioning and identification of the associated SOP Instances. They do not specify any semantics about the Real-World Object represented by the IOD.

Table C.12-1
SOP COMMON MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
SOP Class UID	(0008,0016)	See C.12.1.1.1	Uniquely identifies the SOP Class. See PS 3.4.
SOP Instance UID	(0008,0018)	See C.12.1.1.1	Uniquely identifies the SOP Instance. See PS 3.4.
Specific Character Set	(0008,0005)	1C	Character Set that expands or replaces the Basic Graphic Set. Required if an expanded or replacement character set is used. See C.12.1.1.2 for Defined Terms.
Instance Creation Date	(0008,0012)	3	Date the SOP Instance was created.
Instance Creation Time	(0008,0013)	3	Time the SOP Instance was created.
Instance Creator UID	(0008,0014)	3	Uniquely identifies device which created the SOP Instance.

C.12.1.1 SOP Common Attribute Descriptions

C.12.1.1.1 SOP Class UID, SOP Instance UID

The SOP Class UID and SOP Instance UID Attributes are defined for all DICOM IODs. However, they are only encoded in Composite IODs with the Type equal to 1. When encoded they shall be equal to their respective Attributes in the DIMSE Services and the File Meta Information header (see PS 3.10 Media Storage).

C.12.1.1.2 Specific Character Set

Specific Character Set (0008,0005) identifies the Character Set that expands or replaces the Basic Graphic Set (ISO 646) for values of Data Elements that have Value Representation of SH, LO, ST, PN or LT. See PS 3.5.

If the Attribute Specific Character Set (0008,0005) is not present or has only a single value, Code Extension techniques are not used. Defined terms for the Attribute Specific Character Set (0008,0005), when single valued, are International Registration Number as per ISO 2375 (e.g., IR 100 for Latin alphabet No. 1). See Table C.12-2.

Table C.12-2
DEFINED TERMS FOR SINGLE-BYTE CHARACTER SETS WITHOUT CODE EXTENSIONS

Character Set Description	Defined Term	ISO registration number	Number of characters	Code element	Character Set
Default repertoire	none	ISO-IR 6	94	G0	ISO 646:
Latin alphabet No. 1	ISO_IR 100	ISO-IR 100	96	G1	Supplementary set
		ISO-IR 6	94	G0	ISO 646:
Latin alphabet No. 2	ISO_IR 101	ISO-IR 101	96	G1	Supplementary set
		ISO-IR 6	94	G0	ISO 646:
Latin alphabet No. 3	ISO_IR 109	ISO-IR 109	96	G1	Supplementary set
		ISO-IR 6	94	G0	ISO 646:
Latin alphabet No. 4	ISO_IR 110	ISO-IR 110	96	G1	Supplementary set
		ISO-IR 6	94	G0	ISO 646:
Cyrillic	ISO_IR 144	ISO-IR 144	96	G1	Supplementary set
		ISO-IR 6	94	G0	ISO 646:
Arabic	ISO_IR 127	ISO-IR 127	96	G1	Supplementary set
		ISO-IR 6	94	G0	ISO 646:
Greek	ISO_IR 126	ISO-IR 126	96	G1	Supplementary set
		ISO-IR 6	94	G0	ISO 646:
Hebrew	ISO_IR 138	ISO-IR 138	96	G1	Supplementary set
		ISO-IR 6	94	G0	ISO 646:
Latin alphabet No. 5	ISO_IR 148	ISO-IR 148	96	G1	supplementary set
		ISO-IR 6	94	G0	ISO 646:
Japanese	ISO_IR 13	ISO-IR 13	94	G1	JIS X 0201: Katakana
		ISO-IR 14	94	G0	JIS X 0201: Romaji

Note: To use the single-byte code table of JIS X0201, the value of attribute Specific Character Set (0008,0005), value 1 should be ISO_IR 13. This means that ISO-IR 13 is designated as the G1 code element which is invoked in the GR area. It should be understood that, in addition, ISO-IR 14 is designated as the G0 code element and this is invoked in the GL area.

If the attribute Specific Character Set (0008,0005) has more than one value, Code Extension techniques are used and Escape Sequences may be encountered in all character sets. In order to indicate the presence of Code Extension, the Defined Terms for the repertoires have the prefix “ISO 2022”, e.g., ISO 2022 IR 100 for the Latin Alphabet No. 1. See Table 12-3 and Table 12-4. Table 12-3 describes single-byte character sets for value 1 to value n of the attribute Specific Character Set (0008,0005), and Table 12-4 describes multi-byte character sets for value 2 to value n of the attribute Specific Character Set (0008,0005).

Note: A prefix other than “ISO 2022” may be needed in the future if other Code Extension techniques are adopted.

Table C.12-3
DEFINED TERMS FOR SINGLE-BYTE CHARACTER SETS WITH CODE EXTENSIONS

Character Set Description	Defined Term	Standard for Code Extension	ESC sequence	ISO registration number	Number of char-acters	Code element	Character Set
Default repertoire	ISO 2022 IR 6	ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646
Latin alphabet	ISO 2022 IR 100	ISO 2022	ESC 02/13 04/01	ISO-IR 100	96	G1	Supplementary set
No. 1		ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646
Latin alphabet	ISO 2022 IR 101	ISO 2022	ESC 02/13 04/02	ISO-IR 101	96	G1	Supplementary set
No. 2		ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646
Latin alphabet	ISO 2022 IR 109	ISO 2022	ESC 02/13 04/03	ISO-IR 109	96	G1	Supplementary set
No. 3		ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646
Latin alphabet	ISO 2022 IR 110	ISO 2022	ESC 02/13 04/04	ISO-IR 110	96	G1	Supplementary set
No. 4		ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646
Cyrillic	ISO 2022 IR 144	ISO 2022	ESC 02/13 04/12	ISO-IR 144	96	G1	Supplementary set
		ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646
Arabic	ISO 2022 IR 127	ISO 2022	ESC 02/13 04/07	ISO-IR 127	96	G1	Supplementary set
		ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646
Greek	ISO 2022 IR 126	ISO 2022	ESC 02/13 04/06	ISO-IR 126	96	G1	Supplementary set
		ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646
Hebrew	ISO 2022 IR 138	ISO 2022	ESC 02/13 04/08	ISO-IR 138	96	G1	Supplementary set
		ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646
Latin alphabet	ISO 2022 IR 148	ISO 2022	ESC 02/13 04/13	ISO-IR 148	96	G1	Supplementary set
No. 5		ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646

Japanese	ISO 2022 IR 13	ISO 2022	ESC 02/` 9 04/09	ISO-IR 13	94	G1	JIS X 0201: Katakana
		ISO 2022	ESC 02/08 04/10	ISO-IR 14	94	G0	JIS X 0201-1976: Romaji

Note: If the attribute Specific Character Set (0008,0005) has more than one value and value 1 is empty, it is assumed that value 1 is ISO 2022 IR 6.

Table C.12-4
DEFINED TERMS FOR MULTIPLE-BYTE CHARACTER SETS WITH CODE EXTENSIONS

Character Set Description	Defined Term	Standard for Code Extension	ESC sequence	ISO registration number	Number of characters	Code element	Character Set
Japanese	ISO 2022 IR 87	ISO 2022	ESC 02/04 04/02	ISO-IR 87	94^2	G0	JIS X 0208: Kanji
	ISO 2022 IR 159	ISO 2022	ESC 02/04 02/08 04/04	ISO-IR 159	94^2	G0	JIS X 0212: Supplementary Kanji set

C.13 PRINT MANAGEMENT SPECIFIC MODULES

The following Sections specify Modules used for Print Management.

C.13.1 Basic Film Session Presentation Module

Table C.13-1
BASIC FILM SESSION PRESENTATION MODULE ATTRIBUTES

Attribute name	Tag	Attribute Description
Number of Copies	(2000,0010)	Number of copies to be printed for each film of the film session.
Print Priority	(2000,0020)	Specifies the priority of the print job. Enumerated Values: HIGH MED LOW
Medium Type	(2000,0030)	Type of medium on which the print job will be printed. Defined Terms: PAPER CLEAR FILM BLUE FILM
Film Destination	(2000,0040)	Film destination. Defined Terms: MAGAZINE = the exposed film is stored in film magazine PROCESSOR = the exposed film is developed in film processor BIN_i = the exposed film is deposited in a sorter bin where “I” represents the bin number. Film sorter BINs shall be numbered sequentially starting from one and no maxiumu is placed on the number of BINs. The encoding of the BIN number shall not contain leading zeros.
Film Session Label	(2000,0050)	Human readable label that identifies the film session
Memory Allocation	(2000,0060)	Amount of memory allocated for the film session. Value is expressed in KB
Owner ID	(2100,0160)	Identification of the owner of the film session

C.13.2 Basic Film Session Relationship Module

Table C.13-2
BASIC FILM SESSION RELATIONSHIP MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Referenced Film Box Sequence	(2000,0500)	A Sequence which provides references to a set of Film Box SOP Class/Instance pairs. Zero or more Items may be included in this Sequence. Encoded as a sequence of items : (0008,1150) and (0008,1155).
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
Referenced Presentation LUT Sequence	(2050,0500)	A sequence that provides references to a Presentation LUT related SOP Class/Instance pairs. Only a single Item shall be included in this sequence. Encoded as a sequence of items: (0008,1150) and (0008,1155).
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
Proposed Study Sequence	(2130,00A0)	Attributes that may be used to identify Stored Print Storage and Hardcopy Image SOP Instances created to store this Film Session.
>Patient's Name	(0010,0010)	See C.2.2 for description.
>Patient ID	(0010,0020)	See C.2.2 for description.
>Patient's Birth Date	(0010,0030)	See C.2.3 for description.
>Patient's Sex	(0010,0040)	See C.2.3 for description.
>Patient's Birth Time	(0010,0032)	See C.2.3 for description.
>Other Patient ID	(0010,1000)	See C.2.2 for description.
>Other Patient Names	(0010,1001)	See C.2.2 for description.
>Ethnic Group	(0010,2160)	See C.2.3 for description.
>Patient Comments	(0010,4000)	See C.2.3 for description.
>Study Instance UID	(0020,000D)	See C.4.1 for description.
>Study Date	(0008,0020)	See C.4.5 for description.
>Study Time	(0008,0030)	See C.4.5 for description.
>Referring Physician's Name	(0008,0090)	See C.3.4 for description.
>Study ID	(0020,0010)	See C.4.2 for description.
>Accession Number	(0008,0050)	See C.4.1 for description.
>Study Description	(0008,1030)	See C.4.9 for description.
>Name of Physician(s) Reading Study	(0008,1060)	See C.7.2.1 for description.
>Admitting Diagnoses Description	(0008,1080)	See C.7.2.2 for description.
>Patient's Age	(0010,1010)	See C.2.3 for description.
>Patient's Size	(0010,1020)	See C.2.3 for description.

>Patient's Weight	(0010,1030)	See C.2.3 for description.
>Occupation	(0010,2180)	See C.2.3 for description.
>Additional Patient's History	(0010,21B0)	See C.2.4 for description.
>Series Number	(0020,0011)	See C.7.3.1 for description

C.13.3 Basic Film Box Presentation Module

Table C.13-3
BASIC FILM BOX PRESENTATION MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Image Display Format	(2010,0010)	Type of image display format. Enumerated Values: STANDARD\C,R : film contains equal size rectangular image boxes with R rows of image boxes and C columns of image boxes; C and R are integers. ROW\R1,R2,R3, etc. : film contains rows with equal size rectangular image boxes with R1 image boxes in the first row, R2 image boxes in second row, R3 image boxes in third row, etc.; R1, R2, R3, etc. are integers. COL\C1,C2,C3, etc.: film contains columns with equal size rectangular image boxes with C1 image boxes in the first column, C2 image boxes in second column, C3 image boxes in third column, etc.; C1, C2, C3, etc. are integers. SLIDE : film contains 35mm slides; the number of slides for a particular film size is configuration dependent. SUPERSLIDE : film contains 40mm slides; the number of slides for a particular film size is configuration dependent. CUSTOM\i : film contains a customized ordering of rectangular image boxes; i identifies the image display format; the definition of the image display formats is defined in the Conformance Statement; i is an integer
Annotation Display Format ID	(2010,0030)	Identification of annotation display format. The definition of the annotation display formats and the annotation box position sequence are defined in the Conformance Statement
Film Orientation	(2010,0040)	Film orientation. Enumerated Values: PORTRAIT = vertical film position LANDSCAPE = horizontal film position
Film Size ID	(2010,0050)	Film size identification. Defined Terms: 8INX10IN 10INX12IN 10INX14IN 11INX14IN 14INX14IN 14INX17IN 24CMX24CM 24CMX30CM Note: 10INX14IN corresponds with 25.7CMX36.4CM

Magnification Type	(2010,0060)	Interpolation type by which the printer magnifies the image in order to fit the image in the image box on film. Defined Terms: REPLICATE BILINEAR CUBIC NONE
Smoothing Type	(2010,0080)	Further specifies the type of the interpolation function. Values are defined in Conformance Statement. Only valid for Magnification Type (2010,0060) = CUBIC
Border Density	(2010,0100)	Density of the film areas surrounding and between images on the film. Defined Terms: BLACK WHITE i where i represents the desired density in hundreds of OD (e.g. 150 corresponds with 1.5 OD)
Empty Image Density	(2010,0110)	Density of the image box area on the film that contains no image. Defined Terms: BLACK WHITE i where i represents the desired density in hundredths of OD (e.g. 150 corresponds with 1.5 OD)
Min Density	(2010,0120)	Minimum density of the images on the film, expressed in hundredths of OD. If Min Density is lower than minimum printer density than Min Density is set to minimum printer density.
Max Density	(2010,0130)	Maximum density of the images on the film, expressed in hundredths of OD. If Max Density is higher than maximum printer density than Max Density is set to maximum printer density.
Trim	(2010,0140)	Specifies whether a trim box shall be printed surrounding each image on the film. Enumerated Values: YES NO

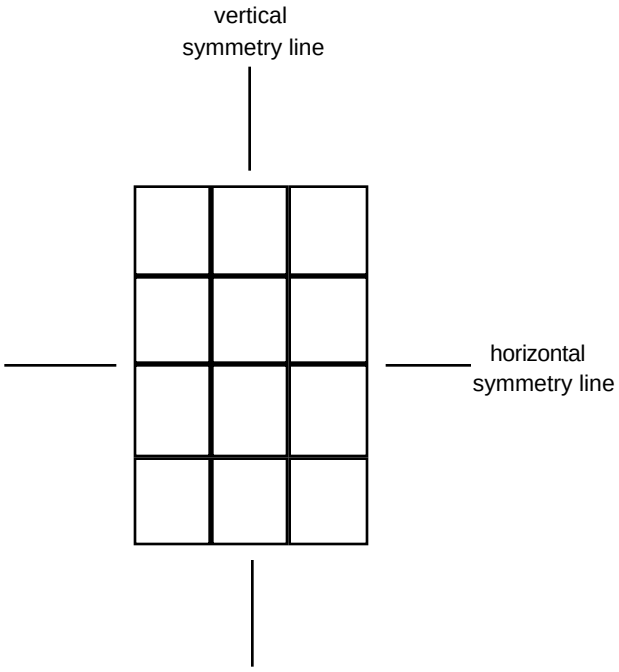
Configuration Information	(2010,0150)	Character string that contains either the ID of the printer configuration table that contains a set of values for implementation specific print parameters (e.g. perception LUT related parameters) or one or more configuration data values, encoded as characters. If there are multiple configuration data values encoded in the string, they shall be separated by backslashes. The definition of values shall be contained in the SCP's Conformance Statement. Defined Terms: CS000-CS999: Implementation specific curve type. Note: It is recommended that for SCPs, CS000 represent the lowest contrast and CS999 the highest contrast levels available.
Illumination	(2010,015E)	Luminance of lightbox illuminating a piece of transmissive film, or for the case of reflective media, luminance obtainable from diffuse reflection of the illumination present. Expressed as L_0, in candelas per square meter (cd/m^2).
Reflected Ambient Light	(2010,0160)	For transmissive film, luminance contribution due to reflected ambient light. Expressed as L_a, in candelas per square meter (cd/m^2).

C.13.3.1 Image display format

C.13.3.1.1 Standard image display format

The standard format subdivides a film into image boxes of equal size. Therefore, the film layout is fully symmetrical, i.e. the arrangement of image boxes on film is left-right and top-bottom symmetric.

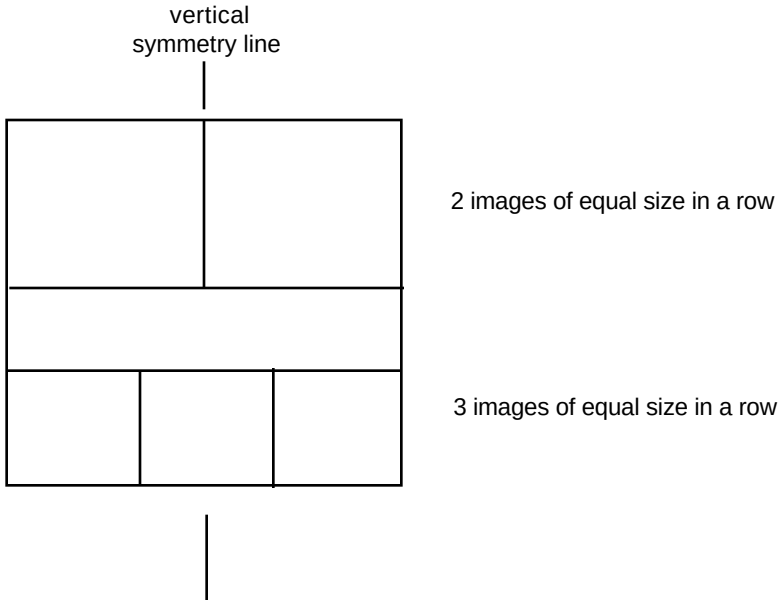
Example : STANDARD\3,4



C.13.3.1.2 Row symmetric image display format

The row symmetric image display format subdivides a film into rows of image boxes of equal size. As a result, the layout is left-right symmetric, the associated symmetry line is vertical (V). There is no top-bottom symmetry.

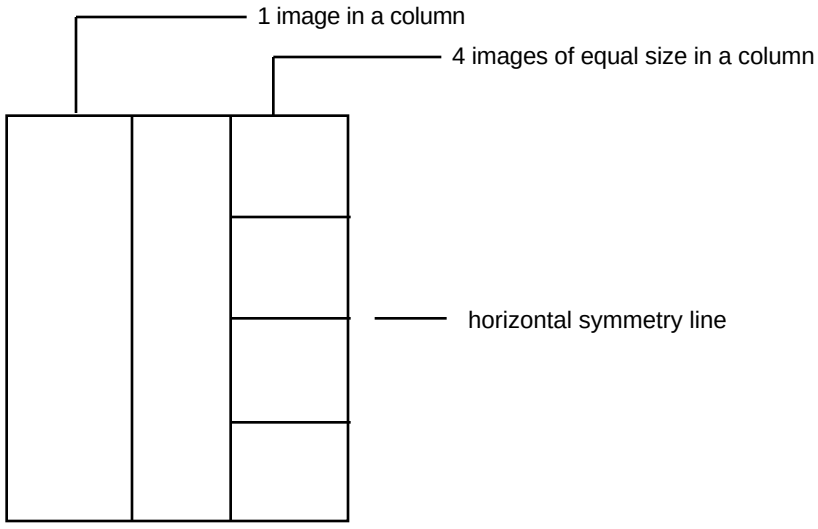
Example : ROW\2,3



C.13.3.1.3 Column symmetric image display format

The column symmetric image display format subdivides a film into columns of image boxes of equal size. As a result, the layout is top-button symmetric, the associated symmetry line is horizontal (H). There is no left-right symmetry.

Example : COL\1,4



C.13.4 Basic Film Box Relationship Module

Table C.13-4
BASIC FILM BOX RELATIONSHIP MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Referenced Film Session Sequence	(2010,0500)	A sequence which provides references to a Film Session SOP Class/Instance pairs. Only a single Item shall be permitted in this Sequence. Encoded as a sequence of items: (0008,1150) and (0008,1155)
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
Referenced Image Box Sequence	(2010,0510)	A sequence which provides references to a set of Image Box SOP Class/Instance pairs. One or more Items may be included in this Sequence. Encoded as a sequence of items: (0008,1150) and (0008,1155)
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
Referenced Basic Annotation Box Sequence	(2010,0520)	A Sequence which provides references to a set of Basic Annotation Box SOP Class/Instance pairs. Zero or more Items may be included in this Sequence. Encoded as a sequence of items: (0008,1150) and (0008,1155).
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
Referenced Presentation LUT Sequence	(2050,0500)	A sequence which provides references to a Presentation LUT related SOP Class/Instance pairs. Only a single Item shall be included in this sequence. Encoded as a sequence of items: (0008,1150) and (0008,1155)
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.

C.13.5 Image Box Pixel Presentation Module

Table C.13-5
IMAGE BOX PIXEL PRESENTATION MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Image Position	(2020,0010)	The position of the image on the film, based on Image Display Format (2010,0010). See C.13.5.1 for specification.
Polarity	(2020,0020)	Specifies whether minimum pixel values (after VOI LUT transformation) are to printed black or white. Enumerated Values: NORMAL = pixels shall be printed as specified by the Photometric Interpretation (0028,0004) REVERSE = pixels shall be printed with the opposite polarity as specified by the Photometric Interpretation (0028,0004) If Polarity (2020,0020) is not specified by the SCU, the SCP shall print with NORMAL polarity.
Magnification Type	(2010,0060)	Description is the same as in Table C.13-3. Overrides the Magnification Type specified for the Film Box
Smoothing Type	(2010,0080)	Description is the same as in Table C.13-3. Overrides the Smoothing Type specified for the Film Box
Configuration Information	(2010,0150)	See Table C.13-3 for description of Configuration Information.
Requested Image Size	(2020,0030)	Width (x-dimension) in mm of the image to be printed. This value overrides the size that corresponds with optimal filling of the Image Box.
Basic Grayscale Image Sequence	(2020,0110)	A sequence which provides the content of the grayscale image pixel data to be printed. This is a specialization of the Image Pixel Module defined in C.7.6.3 of this part. It is encoded as a sequence of Attributes of the Image Pixel Module. Zero or one Item may be included in this Sequence. See PS 3.4 for further description.
>Samples Per Pixel	(0028,0002)	See C.7.6.3 for description of Image Pixel Module. Enumerated Value: 1
>Photometric Interpretation	(0028,0004)	See C.7.6.3 for description of Image Pixel Module. Enumerated Values: MONOCHROME1 MONOCHROME2
>Rows	(0028,0010)	See C.7.6.3 for description of Image Pixel Module
>Columns	(0028,0011)	See C.7.6.3 for description of Image Pixel Module
>Pixel Aspect Ratio	(0028,0034)	See C.7.6.3 for description of Image Pixel Module

>Bits Allocated	(0028,0100)	See C.7.6.3 for description of Image Pixel Module. Enumerated Values: 8 (if Bits Stored = 8) 16 (if Bits Stored = 12)
>Bits Stored	(0028,0101)	See C.7.6.3 for description of Image Pixel Module. Enumerated Values: 8 12
>High Bit	(0028,0102)	See C.7.6.3 for description of Image Pixel Module. Enumerated Values: 7 (if BITS STORED = 8) 11 (if BITS STORED = 12)
>Pixel Representation	(0028,0103)	See C.7.6.3 for description of Image Pixel Module. Enumerated Value: 0000H (unsigned integer)
>Pixel Data	(7FE0,0010)	See C.7.6.3 for description of Image Pixel Module
Basic Color Image Sequence	(2020,0111)	A sequence which provides the content of the color image pixel data to be printed. It is a specialization of the Image Pixel Module defined in C.7.6.3 of this part. It is encoded as a sequence of Attributes of the Image Pixel Module. Zero or one Item may be included in this Sequence. See PS 3.4 for further description.
>Samples Per Pixel	(0028,0002)	See C.7.6.3 for description of Image Pixel Module. Enumerated Value: 3
>Photometric Interpretation	(0028,0004)	See C.7.6.3 for description of Image Pixel Module. Enumerated Value: RGB
>Planar Configuration	(0028,0006)	See C.7.6.3 for description of Image Pixel Module. Enumerated Value: 0001H (frame interleave)
>Rows	(0028,0010)	See C.7.6.3 for description of Image Pixel Module.
>Columns	(0028,0011)	See C.7.6.3 for description of Image Pixel Module.
>Pixel Aspect Ratio	(0028,0034)	See C.7.6.3 for description of Image Pixel Module.
>Bits Allocated	(0028,0100)	See C.7.6.3 for description of Image Pixel Module. Enumerated Value: 8
>Bits Stored	(0028,0101)	See C.7.6.3 for description of Image Pixel Module. Enumerated Value: 8
>High Bit	(0028,0102)	See C.7.6.3 for description of Image Pixel Module. Enumerated Value: 7

>Pixel Representation	(0028,0103)	See C.7.6.3 for description of Image Pixel Module. Enumerated Value: 0000H (unsigned integer)
>Pixel Data	(7FE0,0010)	See C.7.6.3 for description of Image Pixel Module

C.13.5.1 Image Position

The position of the image on the film; the encoding of the image position sequence is based on the selected Image Display Format (2010,0010). The image position sequence shall be increasing order beginning with the value 1. Image Position (2020,0010) is defined as follows:

- STANDARD display format: image box sequence shall be major row order (from left-to-right and from top-to-bottom); top left image position shall be equal to 1.
- ROW display format: image box sequence shall be major row order (from left-to-right and from top-to-bottom); top left image position shall be set to 1.
- COL display format: image box sequence shall be major column order (from top-to-bottom and from left-to-right); top left image position shall be equal to 1.
- SLIDE display format: image box sequence shall be major row order (from left-to-right and from top-to-bottom); top left image position shall be set to 1.
- SUPERSLIDE display format: image box sequence shall be major row order (from left-to-right and from top-to-bottom); top left image position shall be set to 1.
- CUSTOM STANDARD display format: image box sequence shall be defined in the Conformance Statement; top left image position shall be set to 1.

C.13.6 Image Box Relationship Module

Table C.13-6
IMAGE BOX RELATIONSHIP MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Referenced Image Sequence	(0008,1140)	A sequence which provides references to an Image SOP Class/Instance pair and a specific frame number in multi-frame instances. Only a single Item shall be permitted in this Sequence. Encoded as a sequence of items: (0008,1150), (0008,1155), and (0008,1160)
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
>Referenced Frame Number	(0008,1160)	Identifies the frame in the multi-frame image referenced by this Image Sequence. Frame number shall be increasing sequential order beginning with the value 1.
Referenced Image Overlay Box Sequence	(2020,0130)	A sequence which provides references to an Image Overlay Box SOP Class/Instance pair and a specific frame number in multi-frame instances. Zero or one Item may be included in this Sequence. Encoded as a sequence of items: (0008,1150), (0008,1155), and (0008,1160)

>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
>Referenced Frame Number	(0008,1160)	Identifies the frame in the multi-frame overlay(s) referenced by the Overlay Plane Sequence that is referenced by this Image Overlay Box Sequence. Frame number shall be increasing sequential order beginning with the value 1.
Referenced VOI LUT Sequence	(2020,0140)	A sequence which provides reference to a VOI LUT SOP Class/Instance pair. Only a single Item shall be permitted in this Sequence. Encoded as a sequence of items: (0008,1150) and (0008,1155)
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
Referenced Presentation LUT Sequence	(2050,0500)	A sequence which provides references to a Presentation LUT related SOP Class/Instance pairs. Only a single Item shall be included in this sequence. Encoded as a sequence of items : (0008,1150) and (0008,1155)
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
Original Image Sequence	(2130,00C0)	Attributes of the original modality images to be printed in this Film Session.
>Study Instance UID	(0020,000D)	See C.7.2.1 for description.
>Series Instance UID	(0020,000E)	See C.7.3.1 for description.
>Patient ID	(0010,0020)	See C.7.1.1 for description.
>Referenced SOP Class UID	(0008,1150)	SOP Class UID of the original modality image used to create this Image Box.
>Referenced SOP Instance UID	(0008,1155)	SOP Instance UID of the original modality image used to create this Image Box.
>Referenced Frame Number	(0008,1160)	See C.7.3.1 for description.
>Image Number	(0020,0013)	See C.7.3.1 for description.

C.13.7 Basic Annotation Presentation Module

Table C.13-7
BASIC ANNOTATION PRESENTATION MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Annotation Position	(2030,0010)	The position of the annotation box in the parent film box. Annotation position sequence depends on the selected Annotation Display Format ID (2010,0030)
Text String	(2030,0020)	Text string

C.13.8 Print Job Module

Table C.13-8
PRINT JOB MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Execution Status	(2100,0020)	Execution status of print job. Enumerated Values: PENDING PRINTING DONE FAILURE
Execution Status Info	(2100,0030)	Additional information about Execution Status (2100,0020). Defined Terms when the Execution Status is DONE or PRINTING: NORMAL Defined Terms when the Execution Status is FAILURE: INVALID PAGE DES = The specified page layout cannot be printed or other page description errors have been detected. INSUFFIC MEMORY = There is not enough memory available to complete this job. See Section C.13.9.1 for additional Defined Terms when the Execution Status is PENDING or FAILURE.
Creation Date	(2100,0040)	Date of print job creation.
Creation Time	(2100,0050)	Time of print job creation.
Print Priority	(2000,0020)	Priority of print job (see C.13.1 for further explanation).
Printer Name	(2110,0030)	User defined name identifying the printer.
Originator	(2100,0070)	DICOM Application Entity Title that issued the print operation.

C.13.9 Printer Module

Table C.13-9
PRINTER MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Printer Status	(2110,0010)	Printer device status. Enumerated Values: NORMAL WARNING FAILURE
Printer Status Info	(2110,0020)	Additional information about Printer Status (2110,0010). Defined Terms when the Printer Status is equal to NORMAL: NORMAL See Section C.13.9.1 for Defined Terms when the Printer Status is equal to WARNING or FAILURE.
Printer Name	(2110,0030)	User defined name identifying the printer.
Manufacturer	(0008,0070)	Manufacturer of the printer.
Manufacturer Model Name	(0008,1090)	Manufacturer's model number of the printer.
Device Serial Number	(0018,1000)	Manufacturer's serial number of the printer.
Software Versions	(0018,1020)	Manufacturer's designation of software version of the printer.
Date Of Last Calibration	(0018,1200)	Date when the printer was last calibrated.
Time Of Last Calibration	(0018,1201)	Time when the printer was last calibrated.

C.13.9.1 Printer Status Info and Execution Status Info

Additional Defined Terms for Printer Status Info (2110,0020) and Execution Status Info (2100,0030) are:

BAD RECEIVE MGZ	There is a problem with the film receive magazine. Films from the printer cannot be transported into the magazine.
BAD SUPPLY MGZ	There is a problem with a film supply magazine. Films from this magazine cannot be transported into the printer.
CALIBRATING	Printer is performing self calibration, it is expected to be available for normal operation shortly.
CALIBRATION ERR	An error in the printer calibration has been detected, quality of processed films may not be optimal.
CHECK CHEMISTRY	A problem with the processor chemicals has been detected, quality of processed films may not be optimal.
CHECK SORTER	There is an error in the film sorter.
CHEMICALS EMPTY	There are no processing chemicals in the processor, films will not be printed and processed until the processor is back to normal.

CHEMICALS LOW	The chemical level in the processor is low, if not corrected, it will probably shut down soon.
COVER OPEN	One or more printer or processor covers, drawers, doors are open.
ELEC CONFIG ERR	Printer configured improperly for this job.
ELEC DOWN	Printer is not operating due to some unspecified electrical hardware problem.
ELEC SW ERROR	Printer not operating for some unspecified software error.
EMPTY 8X10	The 8x10 inch film supply magazine is empty.
EMPTY 8X10 BLUE	The 8x10 inch blue film supply magazine is empty.
EMPTY 8X10 CLR	The 8x10 inch clear film supply magazine is empty.
EMPTY 8X10 PAPR	The 8x10 inch paper supply magazine is empty.
EMPTY 10X12	The 10x12 inch film supply magazine is empty.
EMPTY 10X12 BLUE	The 10x12 inch blue film supply magazine is empty.
EMPTY 10X12 CLR	The 10x12 inch clear film supply magazine is empty.
EMPTY 10X12 PAPR	The 10x12 inch paper supply magazine is empty.
EMPTY 10X14	The 10x14 inch film supply magazine is empty.
EMPTY 10X14 BLUE	The 10x14 inch blue film supply magazine is empty.
EMPTY 10X14 CLR	The 10x14 inch clear film supply magazine is empty.
EMPTY 10X14 PAPR	The 10x14 inch paper supply magazine is empty.
EMPTY 11X14	The 11x14 inch film supply magazine is empty.
EMPTY 11X14 BLUE	The 11x14 inch blue film supply magazine is empty.
EMPTY 11X14 CLR	The 11x14 inch clear film supply magazine is empty.
EMPTY 11X14 PAPR	The 11x14 inch paper supply magazine is empty.
EMPTY 14X14	The 14x14 inch film supply magazine is empty.
EMPTY 14X14 BLUE	The 14x14 inch blue film supply magazine is empty.
EMPTY 14X14 CLR	The 14x14 inch clear film supply magazine is empty.
EMPTY 14X14 PAPR	The 14x14 inch paper supply magazine is empty.
EMPTY 14X17	The 14x17 inch film supply magazine is empty.
EMPTY 14X17 BLUE	The 14x17 inch blue film supply magazine is empty.
EMPTY 14X17 CLR	The 14x17 inch clear film supply magazine is empty.
EMPTY 14X17 PAPR	The 14x17 inch paper supply magazine is empty.
EMPTY 24X24	The 24x24 cm film supply magazine is empty.
EMPTY 24X24 BLUE	The 24x24 cm blue film supply magazine is empty.
EMPTY 24X24 CLR	The 24x24 cm clear film supply magazine is empty.
EMPTY 24X24 PAPR	The 24x24 cm paper supply magazine is empty.
EMPTY 24X30	The 24x30 cm film supply magazine is empty.
EMPTY 24X30 BLUE	The 24x30 cm blue film supply magazine is empty.

EMPTY 24X30 CLR	The 24x30 cm clear film supply magazine is empty.
EMPTY 24X30 PAPR	The 24x30 cm paper supply magazine is empty.
EMPTY A4 PAPR	The A4 paper supply magazine is empty.
EMPTY A4 TRANS	The A4 transparency supply magazine is empty.
EXPOSURE FAILURE	The exposure device has failed due to some unspecified reason.
FILM JAM	A film transport error has occurred and a film is jammed in the printer or processor.
FILM TRANSP ERR	There is a malfunction with the film transport, there may or may not be a film jam.
FINISHER EMPTY	The finisher is empty.
FINISHER ERROR	The finisher is not operating due to some unspecified reason.
FINISHER LOW	The finisher is low on supplies
LOW 8X10	The 8x10 inch film supply magazine is low.
LOW 8X10 BLUE	The 8x10 inch blue film supply magazine is on film.
LOW 8X10 CLR	The 8x10 inch clear film supply magazine is low.
LOW 8X10 PAPR	The 8x10 inch paper supply magazine is low.
LOW 10X12	The 10x12 inch film supply magazine is low.
LOW 10X12 BLUE	The 10x12 inch blue film supply magazine is low.
LOW 10X12 CLR	The 10x12 inch clear film supply magazine is low.
LOW 10X12 PAPR	The 10x12 inch paper supply magazine is low.
LOW 10X14	The 10x14 inch film supply magazine is low.
LOW 10X14 BLUE	The 10x14 inch blue film supply magazine is low.
LOW 10X14 CLR	The 10x14 inch clear film supply magazine is low.
LOW 10X14 PAPR	The 10x14 inch paper supply magazine is low.
LOW 11X14	The 11x14 inch film supply magazine is low.
LOW 11X14 BLUE	The 11x14 inch blue film supply magazine is low.
LOW 11X14 CLR	The 11x14 inch clear film supply magazine is low.
LOW 11X14 PAPR	The 11x14 inch paper supply magazine is low.
LOW 14X14	The 14x14 inch film supply magazine is low.
LOW 14X14 BLUE	The 14x14 inch blue film supply magazine is low.
LOW 14X14 CLR	The 14x14 inch clear film supply magazine is low.
LOW 14X14 PAPR	The 14x14 inch paper supply magazine is low.
LOW 14X17	The 14x17 inch film supply magazine is low.
LOW 14X17 BLUE	The 14x17 inch blue film supply magazine is low.
LOW 14X17 CLR	The 14x17 inch clear film supply magazine is low.
LOW 14X17 PAPR	The 14x17 inch paper supply magazine is low.
LOW 24X24	The 24x24 cm film supply magazine is low.

LOW 24X24 BLUE	The 24x24 cm blue film supply magazine is low.
LOW 24X24 CLR	The 24x24 cm clear film supply magazine is low.
LOW 24X24 PAPR	The 24x24 cm paper supply magazine is low.
LOW 24X30	The 24x30 cm film supply magazine is low.
LOW 24X30 BLUE	The 24x30 cm blue film supply magazine is low.
LOW 24X30 CLR	The 24x30 cm clear film supply magazine is low.
LOW 24X30 PAPR	The 24x30 cm paper supply magazine is low.
LOW A4 PAPR	The A4 paper supply magazine is low.
LOW A4 TRANS	The A4 transparency supply magazine is low.
NO RECEIVE MGZ	The film receive magazine not available
NO RIBBON	The ribbon cartridge needs to be replaced.
NO SUPPLY MGZ	The film supply magazine specified for this job is not available.
CHECK PRINTER	The printer is not ready at this time, operator intervention is required to make the printer available.
CHECK PROC	The processor is not ready at this time, operator intervention is required to make the printer available.
PRINTER DOWN	The printer is not operating due to some unspecified reason.
PRINTER INIT	The printer is not ready at this time, it is expected to become availablewithout intervention. For example, it may be in a normal warm-up state.
PRINTER OFFLINE	The printer has been disabled by an operator or service person.
PROC DOWN	The processor is not operating due to some unspecified reason.
PROC INIT	The processor is not ready at this time, it is expected to become available without intervention. For example, it may be in a normal warm-up state.
PROC OVERFLOW FL	Processor chemicals are approaching the overflow full mark.
PROC OVERFLOW HI	Processor chemicals have reached the overflow full mark.
QUEUED	Print Job in Queue
RECEIVER FULL	The Film receive magazine is full.
REQ MED NOT INST	The requested film, paper, or other media supply magazine is installed in the printer, but may be available with operator intervention.
REQ MED NOT AVAI	The requested film, paper, or other media requested is not available on this printer.
RIBBON ERROR	There is an unspecified problem with the print ribbon.
SUPPLY EMPTY	The printer is out of film.
SUPPLY LOW	The film supply is low.
UNKNOWN	There is an unspecified problem.

C.13.10 Image Overlay Box Presentation Module

Table C.13-10
IMAGE OVERLAY BOX PRESENTATION MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Referenced Overlay Plane Sequence	(2040,0010)	A sequence which provides references to a set of image overlay planes. Zero or more Items may be included in this Sequence. Encoded as a sequence of items: (0008,1150), (0008,1155), and (2040,0011).
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class that describes the overlay plane.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance that contains the overlay plane.
>Referenced Overlay Plane Groups	(2040,0011)	Uniquely identifies the Overlay Plane Groups (60xx) within the referenced SOP Instance that contains the Overlay Plane description. See C.13.10.1 for further description.
Overlay Magnification Type	(2040,0060)	Overlay magnification type. Defined Terms: REPLICATE BILINEAR CUBIC NONE
Overlay Smoothing Type	(2040,0070)	Further specifies the type of interpolation function. Only valid for overlay Magnification Type (2010,0060) = CUBIC
Overlay Foreground Density	(2040,0080)	Overlay foreground density. Defined Terms: BLACK WHITE i where i represents the desired density in hundredths of OD (e.g. 150 corresponds with 1.5 OD)

Overlay Mode	(2040,0090)	Defines the resulting density for pixels which correspond with overlay bit = 1. The density of the other pixels remain unchanged. Defined Terms: REPLACE = overlay replaces image; resulting pixel density is the Overlay Foreground Density (2040,0080) THRESHOLDREPLACE = overlay replaces image depending on original pixel density; resulting pixel density is Overlay Foreground Density if original pixel density <= Threshold Density (2040,0100) resulting pixel density is WHITE if original pixel density > Threshold Density COMPLEMENT = overlay complements the image; resulting pixel density is set to the complement of the original pixel density (maximal contrast between overlay pixel and surrounding pixels)
Threshold Density	(2040,0100)	Threshold density. Defined Terms: BLACK WHITE i where i represents the desired density in hundredths of OD (e.g. 150 corresponds with 1.5 OD)

C.13.10.1 REFERENCED OVERLAY PLANE SEQUENCE

The Referenced Overlay Plane Sequence (2040,0010) identifies the Overlay Planes that shall be printed with the image. The Overlay Planes shall be linked to the image in one of the following ways:

a. Overlay Planes are encoded as part of the Image IOD and are described by the Overlay Plane Module (see C.9.2). In this case the Attribute Referenced SOP Class UID (0008,1150) refers to the Image SOP Class and the Attribute Referenced SOP Instance UID (0008,1155) refers to the Image SOP Instance. The Attribute Referenced Overlay Plane Groups (2040,0011) defines one or more Overlay Plane Groups (60xx,eeee) within the Image SOP Instance.

b. Overlay Planes are encoded as part of the Overlay IOD (see A.9) and are described by the Overlay Plane Module (see C.9.2). In this case the Attribute Referenced SOP Class UID (0008,1150) refers to the Overlay SOP Class and the Attribute Referenced SOP Instance UID (0008,1155) refers to the Overlay SOP Instance. The Attribute Referenced Overlay Plane Groups (2040,0011) defines one or more Overlay Plane Groups (60xx,eeee) within the Overlay SOP Instance.

C.13.11 Image Overlay Box Relationship Module

Table C.13-11
IMAGE OVERLAY BOX RELATIONSHIP MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Referenced Image Box Sequence	(2010,0510)	A sequence which provides reference to an Image Box SOP Class/ Instance pair. Only a single Item shall be permitted in this Sequence. Encoded as a sequence of items: (0008,1150) and (0008,1155)
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.

C.13.12 Print Request Module

Table C.13-12 specifies the Attributes that identify the print request.

Table C.13-12
PRINT REQUEST MODULE ATTRIBUTES

Attribute Name	Tag	Description
Number of Copies	(2000,0010)	See C.13.1 for description.
Print Priority	(2000,0020)	See C.13.1 for description.
Medium Type	(2000,0030)	See C.13.1 for description.
Film Destination	(2000,0040)	See C.13.1 for description.
Film Session Label	(2000,0050)	See C.13.1 for description.
Memory Allocation	(2000,0060)	See C.13.1 for description.
Color Image Printing Flag	(2000,0062)	Flag describing how grayscale printers shall print color images. Enumerated Values : BESTFIT = attempt to print color image pixel data on a grayscale printer REJECT = do not attempt to print color image pixel data on a grayscale printer Meaningful only for grayscale printers
Collation Flag	(2000,0063)	Flag indicating that the films of the print request shall be collated. Enumerated Values : YES NO
Annotation Flag	(2000,0065)	Flag describing how printers that do not support Annotation Content Sequence (2130,0050) shall react if it is contained in the Stored Print IOD. Enumerated Values: BESTFIT = print images without Annotation REJECT = do not attempt to print images

Image Overlay Flag	(2000,0067)	Flag describing how printers that do not support Image Overlay Box Content Sequence (2130,0060) shall react if it is contained in the Stored Print IOD. Enumerated Values: BESTFIT = print images without the Overlay(s) REJECT = do not attempt to print images
Presentation LUT Flag	(2000,0069)	Flag describing how printers that do not support Presentation LUT Content Sequence (2130,0080) shall react if it is contained in the Stored Print IOD. Enumerated Values: BESTFIT = print images without a Presentation LUT REJECT = do not attempt to print images
Image Box Presentation LUT Flag	(2000,006A)	Flag describing how printers that do not support Presentation LUT Content Sequence (2130,0080) at the Image Box level shall react if a Presentation LUT is contained in Image Box Content Sequence (2130,0040). Enumerated Values: BESTFIT = print image with the Presentation LUT specified in Film Box Content Sequence (2130,0030). REJECT = do not attempt to print images
Configuration Information	(2010,0150)	See C.13.3 for description. Value overrides the corresponding attribute value in the referenced Stored Print Storage SOP Instance.
Illumination	(2010,015E)	See C.13.3 for description.
Reflected Ambient Light	(2010,0160)	See C.13.3 for description.
Owner ID	(2100,0160)	See C.13.1 for description.
Referenced Stored Print Sequence	(2000,0510)	Reference to Stored Print Storage SOP Instance. Sequence contains one or more items.
> Retrieve AE Title	(0008,0054)	Application Entity Title where the Stored Print Storage SOP Instance may be retrieved.
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
>Study Instance UID	(0020,000D)	Unique identifier for the Study.
>Series Instance UID	(0020,000E)	Unique identifier for the Series.
>Patient ID	(0010,0020)	Primary hospital identification number or code for the patient.

C.14 STORAGE COMMITMENT MODULE

Table C.14-1 defines the Attributes for referencing SOP Instances which are contained in a Storage Commitment Request/Response.

Table C.14-1
STORAGE COMMITMENT MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Transaction UID	(0008,1195)	Uniquely identifies this Storage Commitment transaction.
Retrieve AE Title	(0008,0054)	Application Entity Title where the SOP Instance(s) may be retrieved via a network based retrieve service.
Storage Media File-Set ID	(0088,0130)	User or implementation specific human readable identification of a Storage Media on which the SOP Instances reside.
Storage Media File-Set UID	(0088,0140)	Uniquely identifies a Storage Media on which the SOP Instances reside.
Referenced SOP Sequence	(0008,1199)	A sequence of repeating Items where each Item references a single SOP Instance for which storage commitment is requested / or has been provided.
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
>Retrieve AE Title	(0008,0054)	Application Entity Title from which the SOP Instance may be retrieved via a network based retrieve service.
>Storage Media File-Set ID	(0088,0130)	The user or implementation specific human readable identifier that identifies a Storage Media on which this SOP Instance resides.
>Storage Media File-Set UID	(0088,0140)	Uniquely identifies a Storage Media on which this SOP Instance resides.
Referenced Study Component Sequence	(0008,1111)	This Attribute identifies a Study Component to which all the SOP Instances for which Storage Commitment is requested belong. Only 1 SOP Class/Instance pair shall be present in this sequence.
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
Failed SOP Sequence	(0008,1198)	A sequence of repeating Items where each Item references a single SOP Instance for which storage commitment could not be provided.
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
>Failure Reason	(0008,1197)	The reason that storage commitment could not be provided for this SOP Instance. See Section C.14.1.1.

Note Conditions under which Attributes are required (i.e. Retrieve AE Title, etc.) are defined in the Storage Commitment Service Class in PS 3.4.

C.14.1 Study Commitment Attribute Description

C.14.1.1 Failure Reason

The following values and semantics shall be used for the Failure Reason Attribute :

0110H - Processing failure
A general failure in processing the operation was encountered.

0112H - No such object instance
One or more of the elements in the Referenced SOP Instance Sequence was not available.

0213H - Resource limitation
The SCP does not currently have enough resources to store the requested SOP Instance(s).

0122H - Referenced SOP Class not supported
Storage Commitment has been requested for a SOP Instance with a SOP Class that is not supported by the SCP.

0119H - Class / Instance conflict
The SOP Class of an element in the Referenced SOP Instance Sequence did not correspond to the SOP class registered for this SOP Instance at the SCP.

0131H - Duplicate transaction UID
The Transaction UID of the Storage Commitment Request is already in use.

C.15 QUEUE MANAGEMENT SPECIFIC MODULES

C.15.1 General Queue Module

Table C.15-1
GENERAL QUEUE MODULE ATTRIBUTES

Attribute Name	Tag	Description
Queue Status	(2120,0010)	Status of the queue; Defined Terms: NORMAL = queue can accept new jobs FULL = queue is full, new jobs cannot be accepted, however existing jobs are being processed by the SCP HALTED = queue is halted (e.g. by a service person), new jobs cannot be accepted, existing jobs may or may not be processed and reprioritizing and deletion of jobs may or may not be accepted by the SCP

C.15.2 Print Queue Module

Table C.15-2
PRINT GENERAL QUEUE MODULE ATTRIBUTES

Attribute Name	Tag	Description
Print Job Description Sequence	(2120,0050)	A list of Attributes describing each Print Job in the queue. Zero or more items shall be included in this sequence. Items in this sequence shall be listed in the following order: Print Job now being printed Pending Print Jobs in the order in which they are expected to be printed Any Print Jobs which have failed and will not be printed Any Print Jobs which have been successfully competed It is not a requirement that the SCP maintain a record and report failed and completed jobs. However, it may choose to maintain and report on these Print Jobs for some time after the Print Jobs have been completed or failed.
>Print Job ID	(2100,0010)	Human readable identification of the Print Job. The ID shall be unique in the context of the Print Job Sequence.
>Execution Status	(2100,0020)	See Execution Status in Section C.13.8.
>Execution Status Info	(2100,0030)	See Execution Status Info in Section C.13.8.
>Creation Date	(2100,0040)	Date of print job creation.
>Creation Time	(2100,0050)	Time of print job creation.
>Print Priority	(2000,0020)	See Table C.13-1.
>Origin AE	(2100,0070)	Application Entity Title that issued the print job.
>Destination AE	(2100,0140)	Application Entity Title that performs the print job.
>Printer Name	(2110,0030)	User defined name identifying the printer.
>Film Destination	(2000,0040)	See Table C.13-1.
>Film Session Label	(2000,0050)	Human readable label that identifies the film session.
>Owner ID	(2100,0160)	Identification of the owner of the film session.
>Medium Type	(2000,0030)	See Table C.13-1.
>Number Of Films	(2100,0170)	Number of films in print job (= number of films in film session times number of copies).
>Referenced Print Job Sequence	(2120,0070)	A sequence which provides references to the corresponding Print Job SOP Class/Instance pair. Only a single Item shall be permitted in this sequence.
>>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the Referenced SOP Class.

>>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the Referenced SOP Instance.

C.16 STORED PRINT SPECIFIC MODULES

The following Modules are used by the Stored Print IOD.

C.16.1 Printer Characteristics Module

Table C.16-1 specifies the Attributes that identify characteristics of a device that printed the Film Box.

Table C.16-1
PRINTER CHARACTERISTICS MODULE ATTRIBUTES

Attribute Name	Tag	Type	Description
Print Management Capabilities Sequence	(2130,0010)	1	A list of Print Management SOP Classes (e.g. Film Session SOP Class, Basic Annotation Box) and Image Storage SOP Classes (e.g. US Image, Hardcopy Grayscale Image) that the Stored Print IOD contains or refers to. One or more Items shall be included in this sequence. Encoded as a sequence of items (0008,1150).
>Referenced SOP Class UID	(0008,1150)	1	SOP Class UID of the SOP Class, that the Stored Print IOD contains or refers to.
Printer Characteristics Sequence	(2130,0015)	2	Printer Characteristics information. Only valid if film session/box has been printed. One Item shall be included in this sequence. Encoded as a sequence of items.
>Creation Date	(2100,0040)	3	Date of print job creation.
>Creation Time	(2100,0050)	3	Time of print job creation.
>Originator	(2100,0070)	2	Application Entity Title that issued the print operation.
>Destination	(2100,0140)	2	Application Entity Title that performed the print operation.
>Printer Name	(2110,0030)	3	User defined name identifying the printer.
>Manufacturer	(0008,0070)	3	Manufacturer of the printer.
>Manufacturer Model Name	(0008,1090)	3	Manufacturer's Model Name of the printer.
>Device Serial Number	(0018,1000)	3	Manufacturer’s serial number of the printer.
>Software Version	(0018,1020)	3	Manufacturer’s designation of software version of the printer.
>Date of Last Calibration	(0018,1200)	3	Date when the printer was last calibrated.
>Time of Last Calibration	(0018,1201)	3	Time when the printer was last calibrated.

C.16.2 Film Box Module

Table C.16-2 specifies the Attributes that identify characteristics of a Film Box.

Table C.16-2
FILM BOX MODULE ATTRIBUTES

Attribute Name	Tag	Type	Description
Image Number	(0020,0013)	2	A number that identifies this film box.
Film Box Content Sequence	(2130,0030)	1	The content of the Film Box SOP Instance. One Item shall be included in this sequence.
>Image Display Format	(2010,0010)	1	See C.13.3 for description.
>Annotation Display Format ID	(2010,0030)	3	See C.13.3 for description.
>Film Orientation	(2010,0040)	2	See C.13.3 for description.
>Film Size ID	(2010,0050)	2	See C.13.3 for description.
>Magnification Type	(2010,0060)	2	See C.13.3 for description.
>Smoothing Type	(2010,0080)	3	See C.13.3 for description.
>Border Density	(2010,0100)	3	See C.13.3 for description.
>Empty Image Density	(2010,0110)	3	See C.13.3 for description.
>Min Density	(2010,0120)	3	See C.13.3 for description.
>Max Density	(2010,0130)	2	See C.13.3 for description.
>Trim	(2010,0140)	3	See C.13.3 for description.
>Configuration Information	(2010,0150)	2	See C.13.3 for description.
>Illumination	(2010,015E)	2C	See C.13.3 for description. Required if Presentation SOP Class is present.
>Reflected Ambient Light	(2010,0160)	2C	See C.13.3 for description. Required if Presentation SOP Class is present.
>Referenced Presentation LUT Sequence	(2050,0500)	1C	Reference to a LUT Instance UID contained in this IOD in Presentation LUT Content Sequence (2130,0080). The referenced LUT is to be applied to all images on this film, unless overridden by another reference contained in Image Box Content Sequence (2130,0040). If included, this sequence shall contain a single item. Required if a Presentation LUT is to be applied to the image.
>>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance; Required if Referenced Presentation LUT Sequence is present.

C.16.3 Image Box List Module

Table C.16-3
IMAGE BOX LIST MODULE ATTRIBUTES

Attribute Name	Tag	Type	Description
Image Box Content Sequence	(2130,0040)	1	The content of the Image Box SOP Instance. One or more Items shall be included in this sequence. Encoded as a sequence of items
>SOP Instance UID	(0008,0018)	1C	SOP Instance UID of the contained Image Box SOP Class. Required if Sequence is sent
>Image Position	(2020,0010)	1	See C.13.5 for description.
>Polarity	(2020,0020)	2	See C.13.5 for description.
>Magnification Type	(2010,0060)	3	See C.13.5 for description.
>Configuration Information	(2010,0150)	3	See C.13.3 for description. The This value overrides any Configuration Information in Film Box Content Sequence (2130,0030)
>Smoothing Type	(2010,0080)	3	See C.13.5 for description.
>Requested Image Size	(2020,0030)	3	See C.13.5 for description.
>Referenced Image Sequence	(0008,1140)	1	See C.13.6 for description. This sequence contains a single item
>>Retrieve AE Title	(0008,0054)	1	Application Entity Title where the Image Storage SOP Instance may be retrieved
>>Referenced SOP Class UID	(0008,1150)	1	See C.13.6 for description
>>Referenced SOP Instance UID	(0008,1155)	1	See C.13.6 for description
>>Study Instance UID	(0020,000D)	1	Unique identifier for the Study
>>Series Instance UID	(0020,000E)	1	Unique identifier for the Series
>>Referenced Frame Number	(0008,1160)	1C	See C.13.6 for description. Required if a Multi-frame Image is being referenced.
>>Patient ID	(0010,0020)	2	Primary hospital identification number or code for the patient
>Referenced Image Overlay Box Sequence	(2020,0130)	1C	Reference to an Overlay Instance UID contained in this IOD in Image Overlay Box Content Sequence (2130,0060). If included, this sequence shall contain a single item. Required if Image Overlay Box Content Sequence (2130,0060) is present.
>>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the Referenced SOP Instance. Required if Referenced Image Overlay Box Sequence is sent.

>Referenced Presentation LUT Sequence	(2050,0500)	1C	Reference to a LUT Instance UID contained in this IOD in Presentation LUT Content Sequence (2130,0080). The referenced LUT overrides any LUT Instance contained in Film Box Content Sequence (2130,0030) If included, this sequence shall contain a single item. Required if a Presentation LUT which is different than any specified for the Film Box is to be applied to the image.
>>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance; Required if Referenced Presentation LUT Sequence is present.

C.16.4 Annotation List Module

Table C.16-4
ANNOTATION LIST MODULE ATTRIBUTES

Attribute Name	Tag	Type	Description
Annotation Content Sequence	(2130,0050)	3	The content of the Annotation SOP Instance. Zero or more Items shall be included in this sequence. Encoded as a sequence of items.
>SOP Instance UID	(0008,0018)	1C	SOP Instance UID of the contained Annotation SOP Class. Required if Sequence is sent.
>Annotation Position	(2030,0010)	1C	See C.13.7 for description. Required if the Annotation Content Sequence is sent.
>Text String	(2030,0020)	1C	See C.13.7 for description. Required if the Annotation Content Sequence is sent.

C.16.5 Image Overlay Box List Module

Table C.16-5
IMAGE OVERLAY BOX LIST MODULE ATTRIBUTES

Attribute Name	Tag	Type	Description
Image Overlay Box Content Sequence	(2130,0060)	3	The content of the Image Overlay Box SOP Instance. If sent, one or more Items shall be included in this sequence. Encoded as a sequence of items.
>SOP Instance UID	(0008,0018)	1C	SOP Instance UID of the contained Image Overlay Box SOP Class. Required if Sequence is sent.

>Referenced Overlay Plane Sequence	(2040,0010)	1C	See C.13.10.1 for description. Overlay planes encoded as part of a Standalone Overlay IOD are not permitted. Required if Sequence is sent.
>>Referenced SOP Class UID	(0008,1150)	1C	See C.13.10 for description. Required if Referenced Overlay Plane Sequence is sent.
>>Referenced SOP Instance UID	(0008,1155)	1C	See C.13.10 for description. Required if Referenced Overlay Plane Sequence is sent.
>> Referenced Frame Number	(0008,1160)	1C	See C.13.6 for description. Required if Overlay Plane Sequence is sent and a Multi-frame Image is referenced.
>>Referenced Overlay Plane Groups	(2040,0011)	1C	See C.13.10 for description. Required if Referenced Overlay Plane Sequence is sent.
>Overlay Magnification Type	(2040,0060)	3	See C.13.10 for description.
>Overlay Smoothing Type	(2040,0070)	3	See C.13.10 for description.
>Overlay Foreground Density	(2040,0080)	3	See C.13.10 for description.
>Overlay Mode	(2040,0090)	3	See C.13.10 for description.
>Threshold Density	(2040,0100)	3	See C.13.10 for description.

C.16.6 Presentation LUT List Module

Table C.16-6
PRESENTATION LUT LIST MODULE ATTRIBUTES

Attribute Name	Tag	Type	Description
Presentation LUT Content Sequence	(2130,0080)	3	The content of the Presentation LUT SOP Instance. If sent, one or more Items shall be included in this sequence. Encoded as a sequence of items.
>SOP Instance UID	(0008,0018)	1C	SOP Instance UID of the contained Presentation LUT SOP Class. Required if Sequence is sent
>Presentation LUT Sequence	(2050,0010)	1C	See C.11.4 for description; Required if Presentation LUT Shape (2050,0020) is not present. Not allowed otherwise.
>>LUT Descriptor	(0028,3002)	1C	See C.11.4 for description; Required if Presentation LUT Sequence is sent.
>>LUT Explanation	(0028,3003)	3	See C.11.4 for description;
>>LUT Data	(0028,3006)	1C	See C.11.4 for description; Required if Presentation LUT Sequence is sent.

>Presentation LUT Shape	(2050,0020)	1C	See C.11.4 for description; Required if Presentation LUT Sequence (2050,0010) is not present. Not allowed otherwise. SCPs shall support the Enumerated Values IDENTITY and LIN OD

Annex D Coding Scheme Designators (Normative)

The ANSI HISPP MSDS supports the development of an international health care coding scheme registration authority. The types of coding schemes registered are Diagnostic, Procedure Observation, Drug ID, and Health Outcomes Coding Schemes. Locally defined coding schemes are also supported. Tables D-1 and D-2 identify the allowable Coding Schemes which shall be used when encoding a Coded Entry.

Note: The ANSI HISPP MSDS tables are chosen as an interim source of Coding Scheme Designators. It is expected that these tables will evolve when Coding Scheme Designator UID's are available from a registration authority.

Table D-1
DIAGNOSTIC CODING SCHEMES

Names	Code	Source
American College of Radiology Index for Radiological Diagnosis	ACR	Index for Radiological Diagnosis Revised, 3rd Edition 1986, American Radiology finding codes. College of Radiology, Reston, VA.
CEN ECG diagnostic codes	CE	CEN PT007. A quite comprehensive set of codes (abbreviations) and descriptions codes published as a pre-standard by CEN TC251. Available from CEN TC251 secretariat, c/o Georges DeMoor, State University Hospital Gent, De Pintelaan 185-5K3, 9000 Gent, Belgium or Jos Willems, University of Gathuisberg, 49 Herestraat, 3000 Leuven, Belgium.
EUCLIDES	E	Available from Euclides Foundation International nv, Excelsiorlaan 4A, B-1930 Zaventem, Belgium; Phone: 32 2 720 90 60.
ICD9	I9	World Health Publications, Albany, NY.
ICD9-CM	I9C	Commission on Professional and Hospital Activities, 1968 Green Rd., Ann Arbor, MI 48105.
ICD-10	I10	World Health Publications, Albany, NY.
Local general code	99zzz	Locally defined codes for purpose of sender or receiver. Local codes can be identified by L (for backward compatibility) or 99zzz (where z is an alphanumeric character).
Local billing code	LB	Local billing codes/names (with extensions if needed).
Read Classification	RC	The Read Clinical Classification of Medicine, Park View Surgery, 26 Leicester Rd., Loughborough LE11 2AG (includes drug procedure and other codes, as well as diagnostic codes).
Systematized Nomenclature of Medicine (SNOMED)	SNM	Systematized Nomenclature of Medicine, 2nd Edition 1984 Vols 1, 2, College of American Pathologists, 325 Waukegan Road, Northfield IL 60093-2750.
SNOMED III	S3	See above (about to be released).

SNOMED/DICOM Microglossary	99SDM	SNOMED Project Manager, College of American Pathologists, 325 Waukegan Road, Northfield IL 60093-2750.
Unified Medical Language	UML	National Library of Medicine, 8600 Rockville Pike, Bethesda, MD 20894.

Table D-2
PROCEDURE OBSERVATION/DRUG ID/HEALTH OUTCOMES CODING SCHEMES

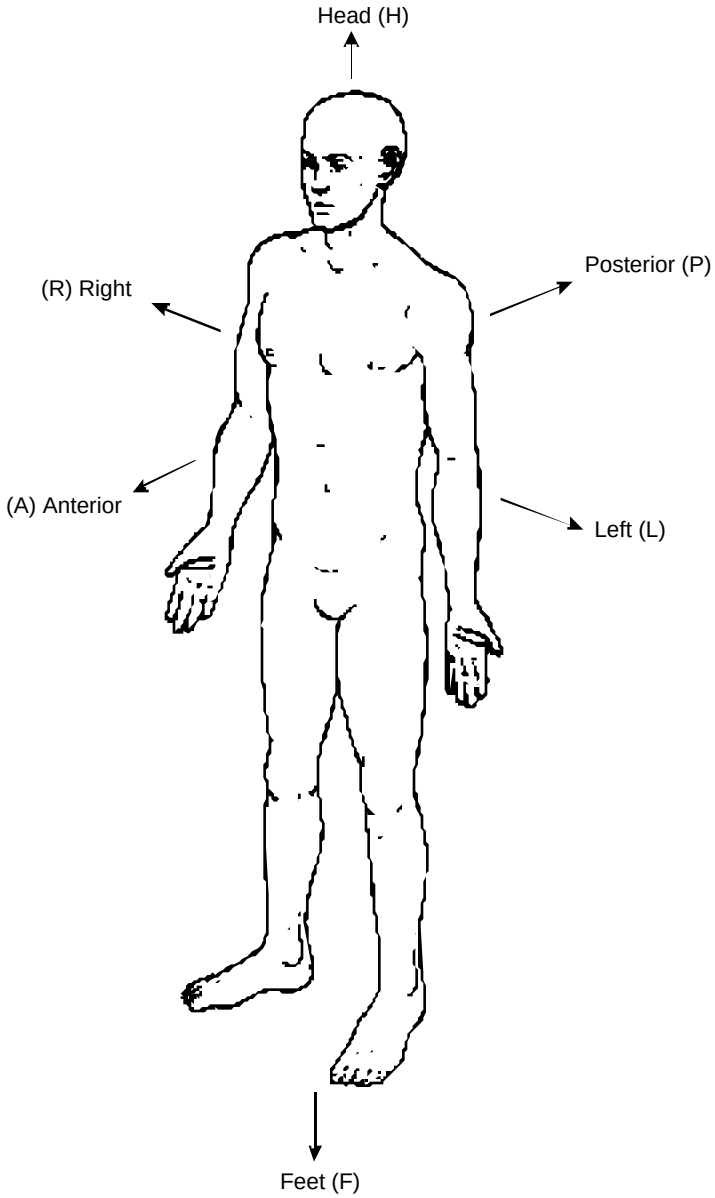
Coding System	Code	Source/Description
ASTM	AS4	American Society for Testing & Materials and CPT4 (see Appendix A of ASTM E1238 and its codes revisions).
Universal		
CPT-4	C4	American Medical Association, P O Box 10946, Chicago, IL 60610.
CPT-5	C5	(under development - same contact as above)
EUCLIDES	E	AFP codes. Available from Euclides Foundation International nv, Excelsiorlaan 4A, B-1930 Zaventem, Belgium; Phone: 32 2 720 90 60.
FDA K10	FDK	Dept. of Health & Human Services, Food & Drug Administration, Rockville, MD 20857. (device & analyte process codes).
HIBCC	HB	Health Industry Business Communications Council, 5110 N. 40th St., Ste 120, Phoenix, AZ 85018.
ICCS	ICS	Commission on Professional and Hospital Activities, 1968 Green Road, Ann Arbor, MI 48105.
ICD-9CM	I9C	Commission on Professional and Hospital Activities, 1968 Green Road, Ann Arbor, MI 48105 (includes all procedures and diagnostic tests).
ISBT	IBT	International Society of Blood Transfusion. Blood Group Terminology "1990". VOX Sanquines 1990 58(2):152-169.
IUPAC/IFCC	IUC	Recommendations of Quantities and Units in Clinical Chemistry DRAFT (to be published in 1992). Henrik Olesen, M.D., D.M.Sc., Chairperson, Department of Clinical Chemistry, KK76.4.2, Rigshospitalet, University Hospital of Copenhagen, DK-2200, Copenhagen.
Local	99zzz	Locally defined codes for purpose of sender or receiver. If multiple local codes exist, the format should be 99zzz, or L where z is an alphanumeric character.
Medicare	MCR	Medicare billing codes/names.
Medicaid	MCD	Medicaid billing codes/names.

UCDS	UC	Uniform Clinical Data Systems. Ms. Michael McMullan, Office of Peer Review Health Care Finance Administration, The Meadows East Bldg., 6325 Security Blvd., Baltimore, MD 21207; (301) 966 6851.
Japanese Chemistry	JC8	Clinical examination classification code. Japan Association of Clinical Pathology. Version 8, 1990. A multiaxial code. including a subject code (e.g., Rubella = 5f395, identification code (e.g., virus ab IGG), a specimen code (e.g., serum = 023) and a method code (e.g., ELISA = 022)
Health Outcomes	HI	Health Outcomes Institute codes for outcome variables available (with responses) from Health Outcomes Institute, 2001 Killebrew Drive, Suite 122, Bloomington, MN 55425; (612) 858 9188. See examples in Appendix A.
Euclides Lab method codes	E6	Available from Euclides Foundation International nv, Excelsiorlaan 4A, B-1930 Zaventem, Belgium; Phone: 32 2 720 90 60.
Euclides Lab equipment codes	E7	Available from Euclides Foundation International nv (see above)
Euclides kind of quantity codes	E5	Available from Euclides Foundation International nv (see above)
Drug codes:		
Chemical abstract codes	CAS	These include unique codes for each unique chemical, including all generic drugs. The codes do not distinguish among different dosing forms. When multiple equivalent CAS numbers exist, use the first one listed in USAN. USAN 1990 and the USP dictionary of drug names, William M. Heller, Ph.D., Executive Editor, United States Pharmacopeial Convention, Inc., 12601 Twinbrook Parkway, Rockville, MD 20852.
National drug codes	NDC	These provide unique codes for each distinct drug, dosing form, manufacturer, and packaging. (Available from the National Drug Code Directory, FDA, Rockville, MD, and other sources.)
WHO rec# drug codes	W1 W2	World Health organization record number code. A unique sequential number is assigned to each unique single component drug and to each multi-component drug. Eight digits are allotted to each such code, six to identify the active agent, and 2 to identify the salt, of single content drugs. Six digits are assigned to each unique combination of drugs in a dispensing unit. The six digit code is identified by W1, the 8 digit code by W2.
WHO rec#	W4	With ASTM extensions (see appendix A of ASTM 1238-91), the WHO codes can be used to report serum (and other) levels, patient compliance with ASTM ext. with drug usage instructions, average daily doses and more (see Appendix A of ASTM 1238-91)

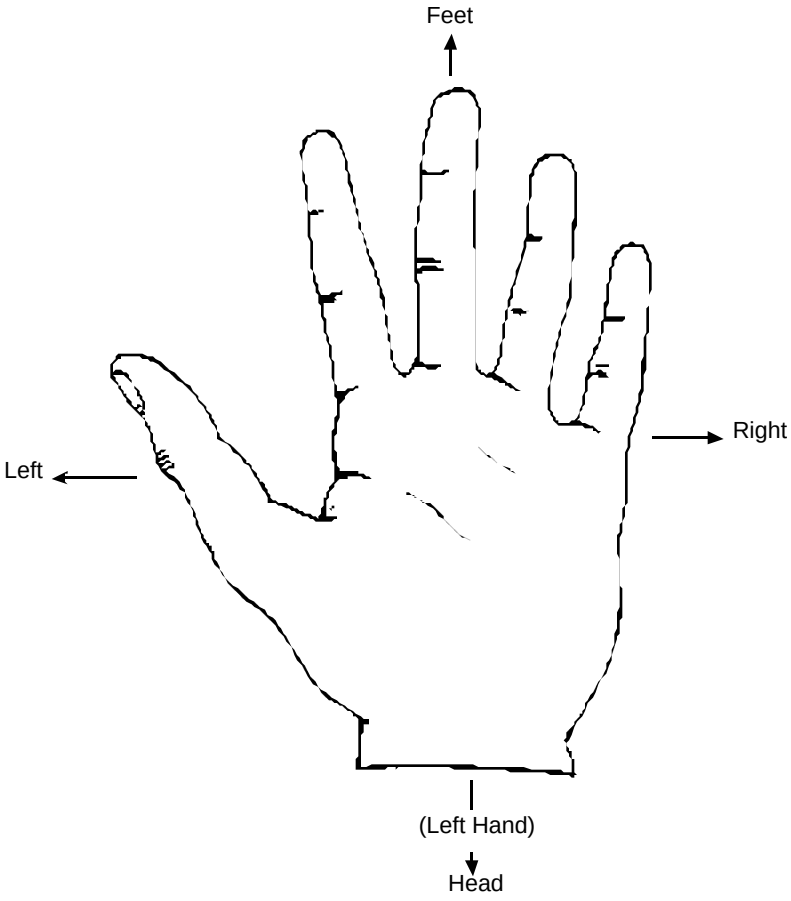
WHO ATC	WC	WHO's ATC codes provide a hierarchical classification of drugs by therapeutic class. They are linked to the record number codes listed above.
Note: The Read and NLM codes in Table D-1 also include drugs. A number of sources of unique drug names exist: British Approved Names (BAN), French-approved non proprietary names (DCF), and International Nonproprietary name (INN). These sources are now being reviewed. Those that also provide unique codes will be added to the "registry" of coding systems, using the abbreviations given in parentheses.		
Device Code		
MDNS	UMD	Universal Medical Device Nomenclature System. ECRI, 5200 Butler Pike, Plymouth Meeting, PA 19462 USA. Phone: 215-825-6000, Fax: 215-834-1275.

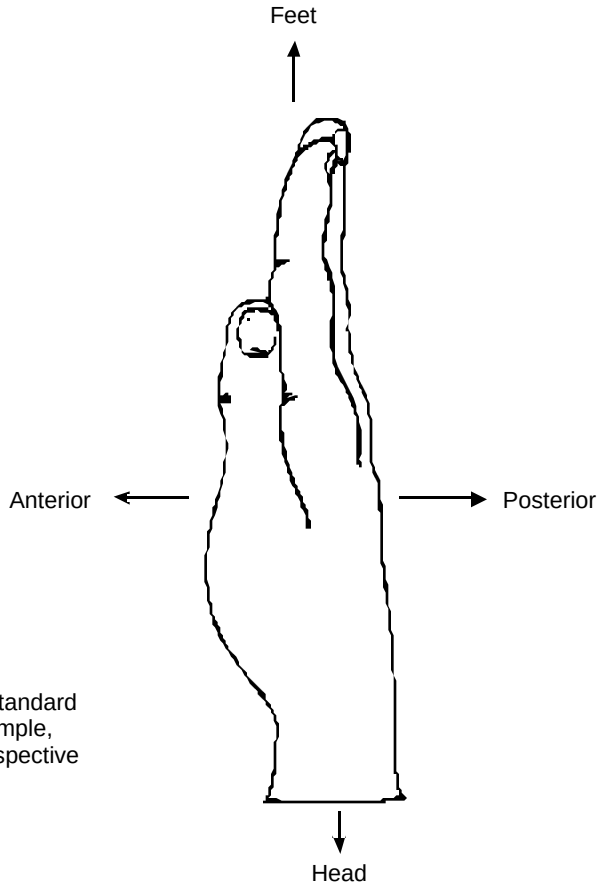
Annex E Explanation of patient orientation (Normative)

This Annex provides an explanation of how to use the patient orientation data elements.

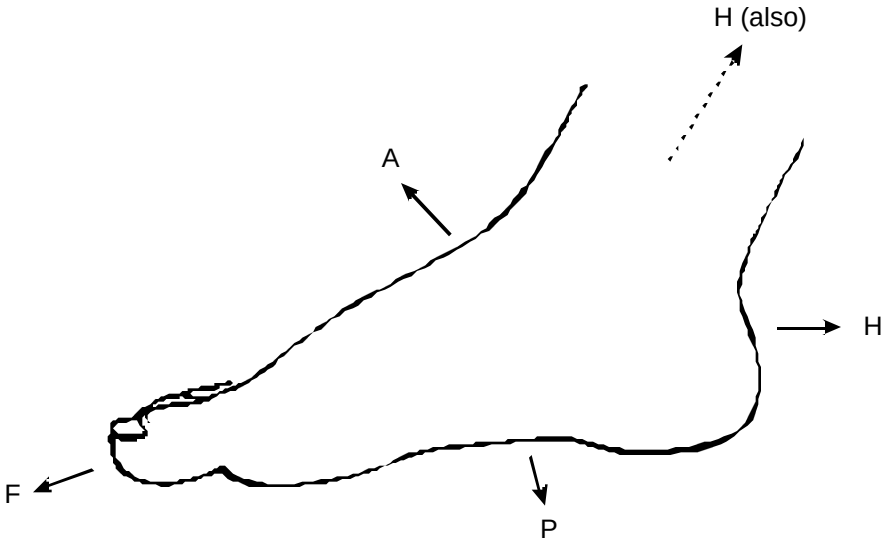


The standard anatomic position is standing erect with the palms facing anterior. This position is used to define a label for the direction of the fingers and toes (toward the Feet (F) while the direction of the wrist and ankle is towards the Head (H). This labeling is retained despite changes in the position of the extremities. For bilaterally symmetric body parts, a laterality indicator (R or L) should be used.

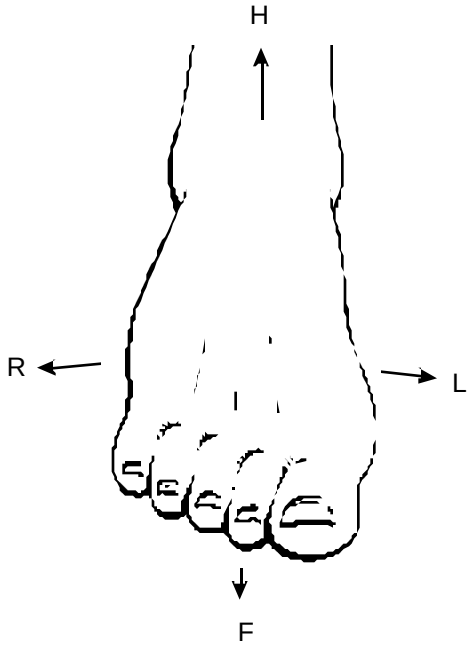




For the hands, the direction labels are based on the standard anatomic position. For the left hand illustrated for example, LEFT will always be in the direction of the thumb, irrespective of position changes.

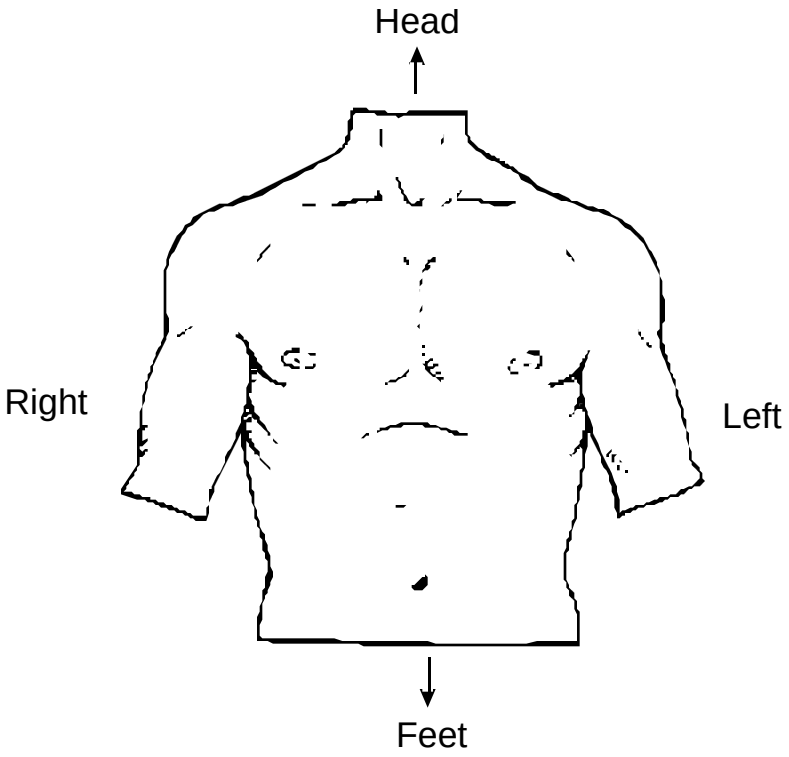


Right Foot

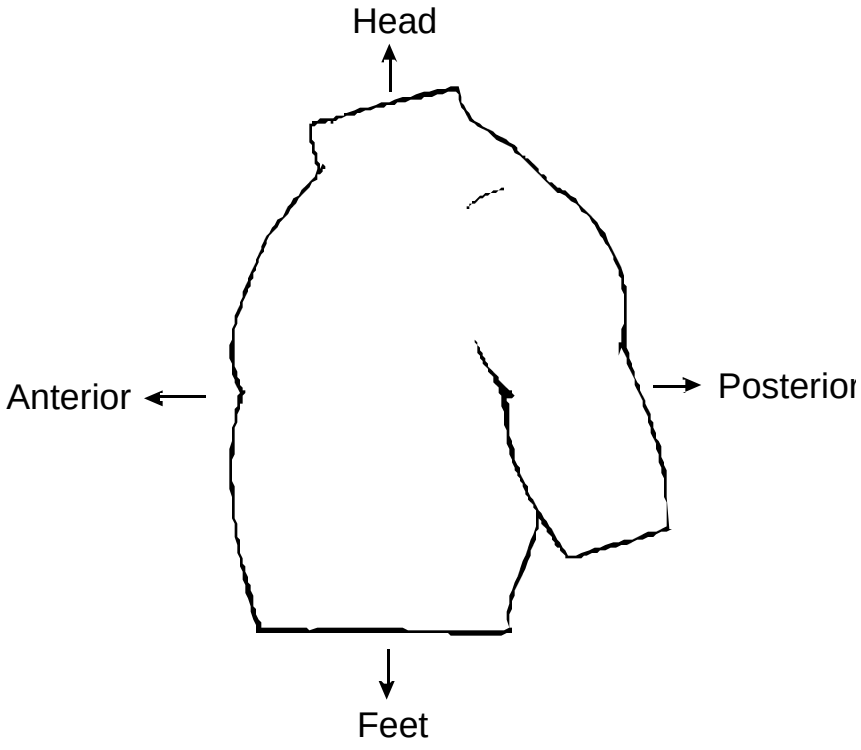


Right Foot - Anterior View

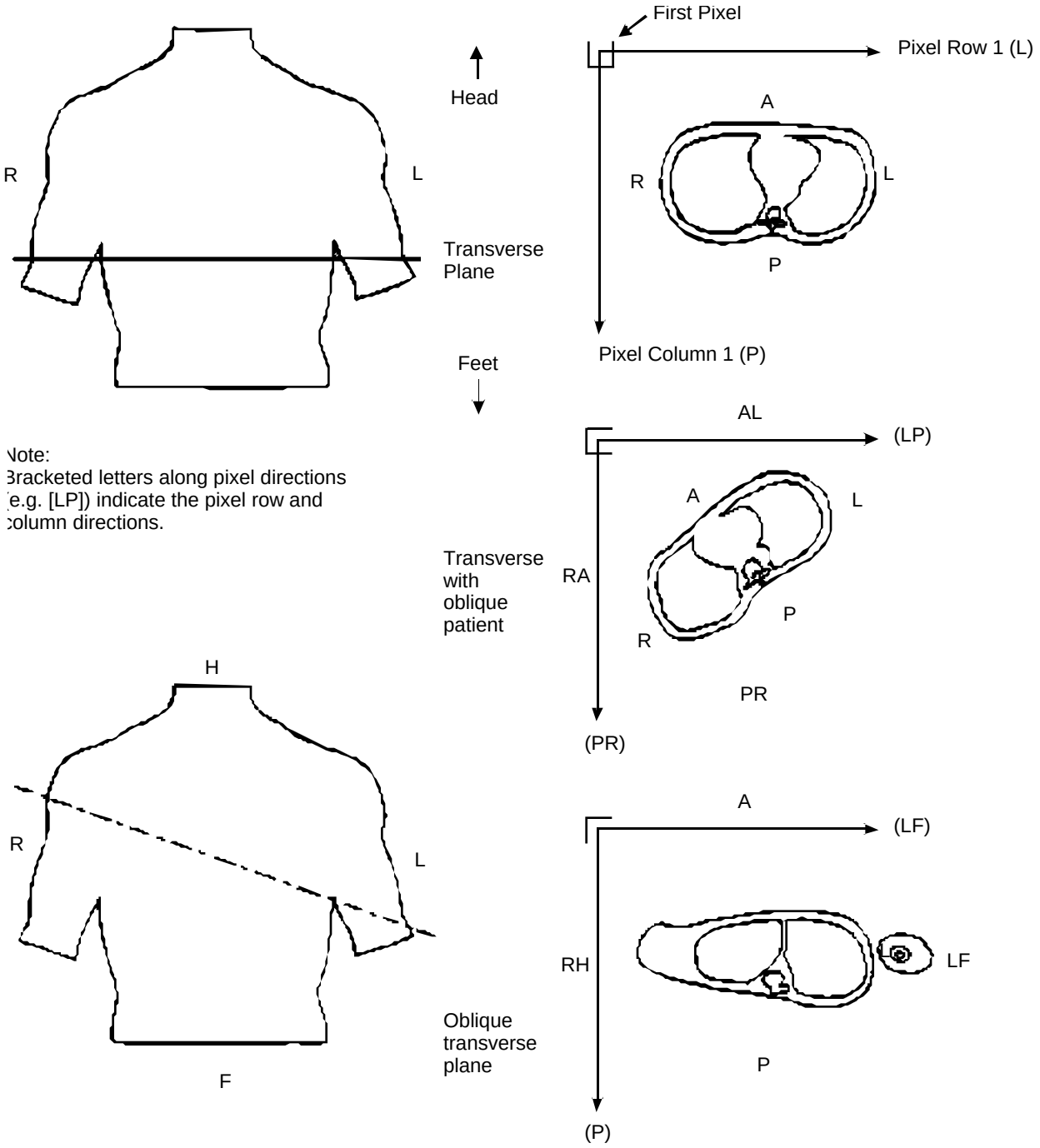
As for the hand, the direction labels are based on the foot in the standard anatomic position. For the right foot, for example, RIGHT will be in the direction of the 5th toe. This assignment will remain constant through movement or positioning of the extremity. This is also true of the HEAD and FOOT directions.



Viewing the Front of the Patient

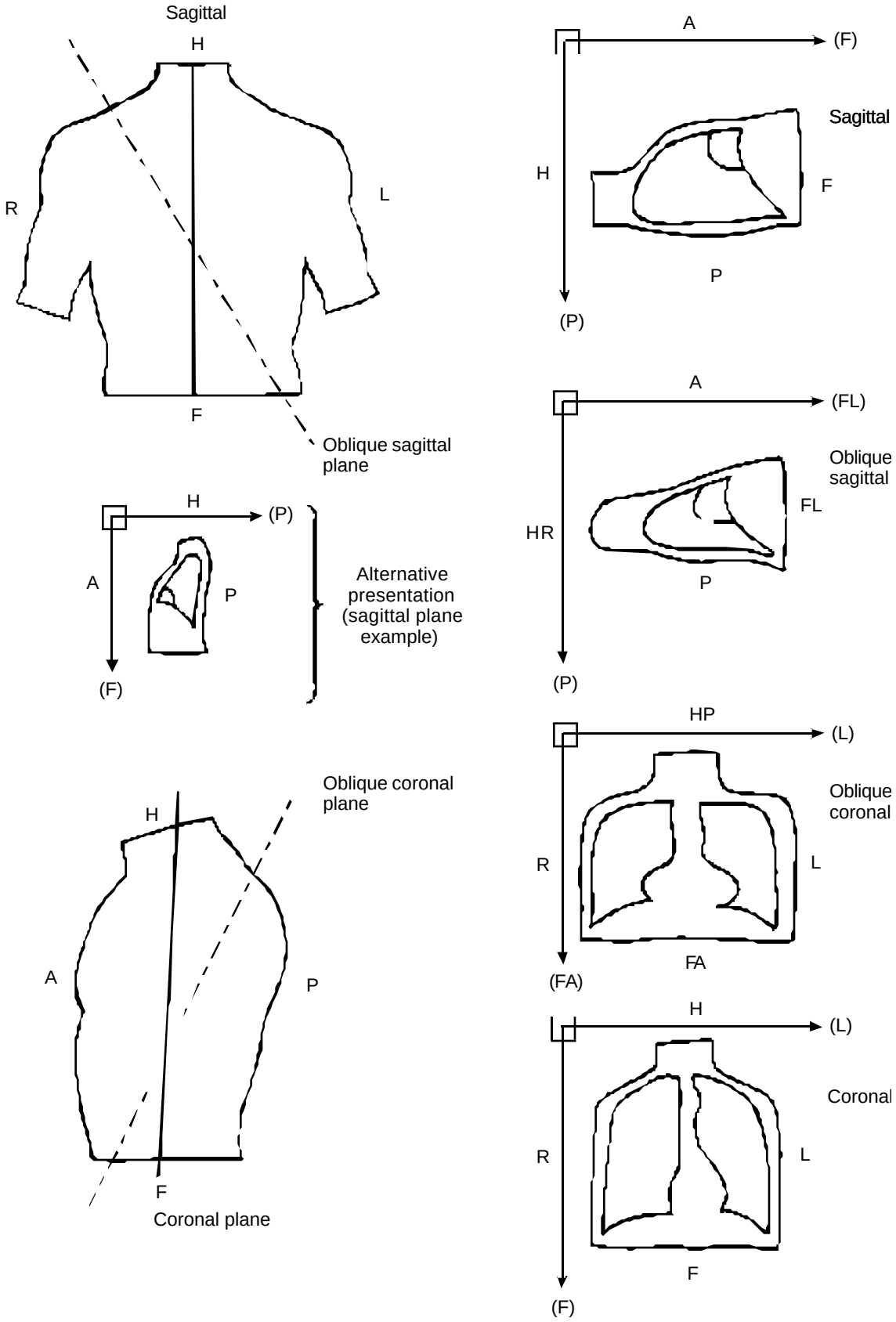


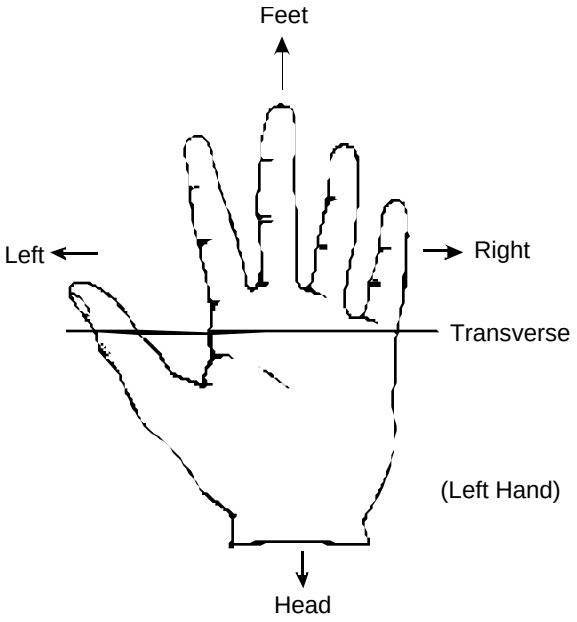
Anterior and left lateral views of the patient. In the view of the left side (bottom illustration) the left arm has been drawn posteriorly.

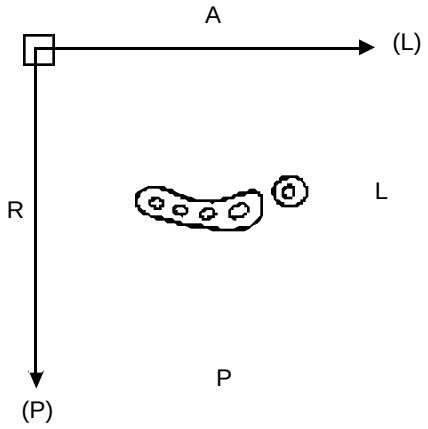


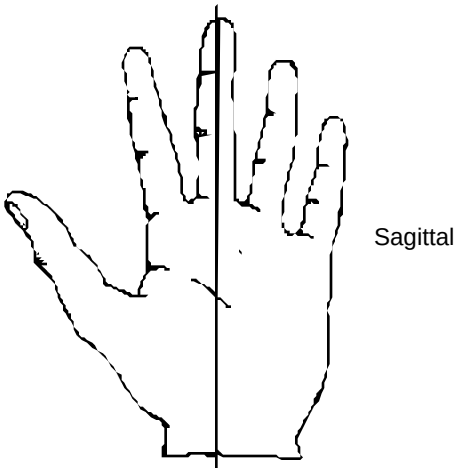
Note:
Bracketed letters along pixel directions (e.g. [LP]) indicate the pixel row and column directions.

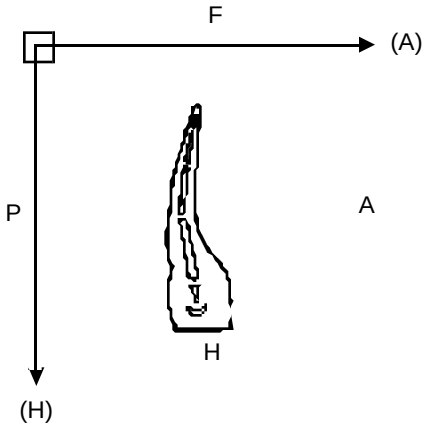
Since the major direction of the transverse plane is right-to-left (or anterior-to-posterior), the first letter of the combinec direction will indicate this. For example, RH—moving right also moves towards the head

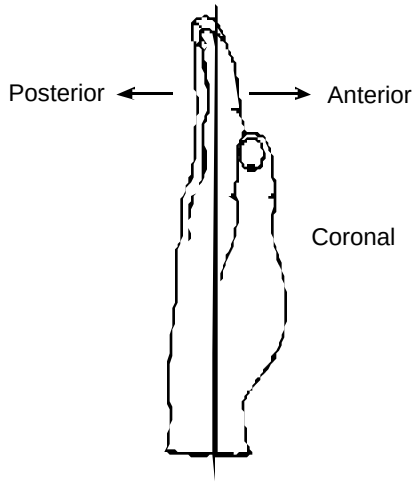

Sagittal
H
R
L
F
Oblique sagittal plane
H
(P)
A
P
(F)
Alternative presentation (sagittal plane example)
Oblique coronal plane
H
A
P
F
Coronal plane
A
(F)
Sagittal
H
F
P
(P)
A
(FL)
Oblique sagittal
FL
HR
P
(P)
HP
(L)
Oblique coronal
R
L
FA
(FA)
H
(L)
Coronal
R
L
F
(F)

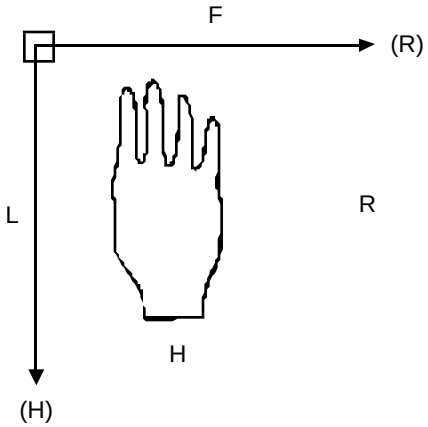

Feet
Left
Right
Transverse
(Left Hand)
Head

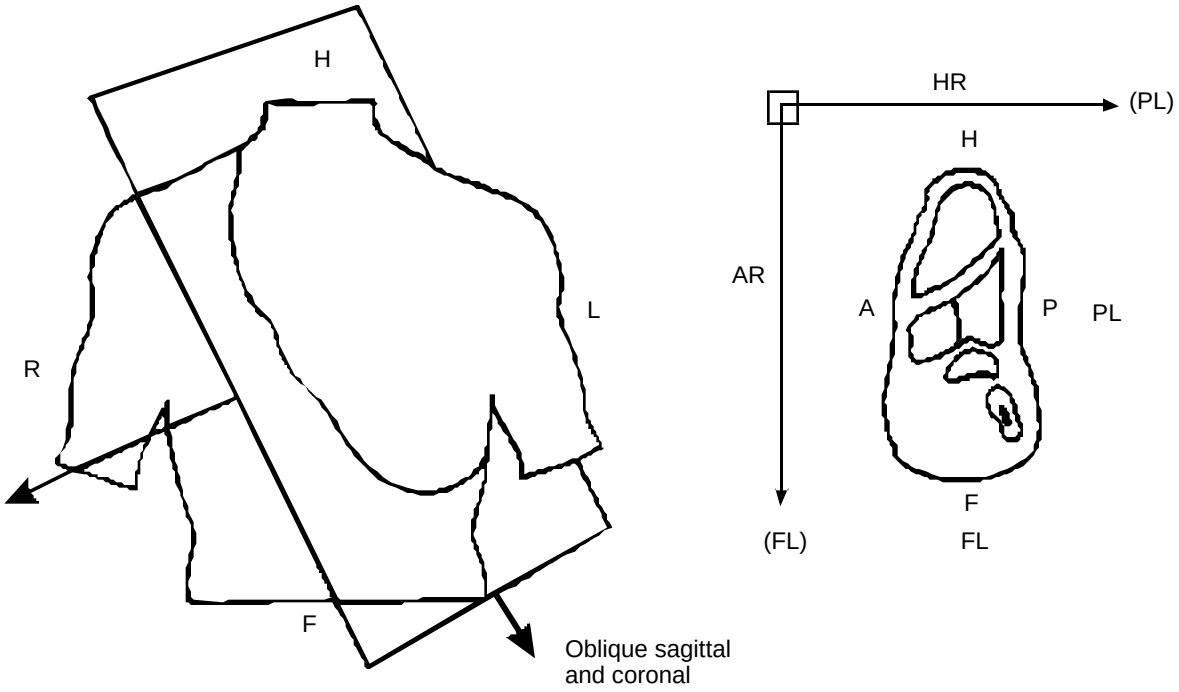

A
(L)
R
L
P
(P)


Sagittal


F
(A)
P
A
H
(H)

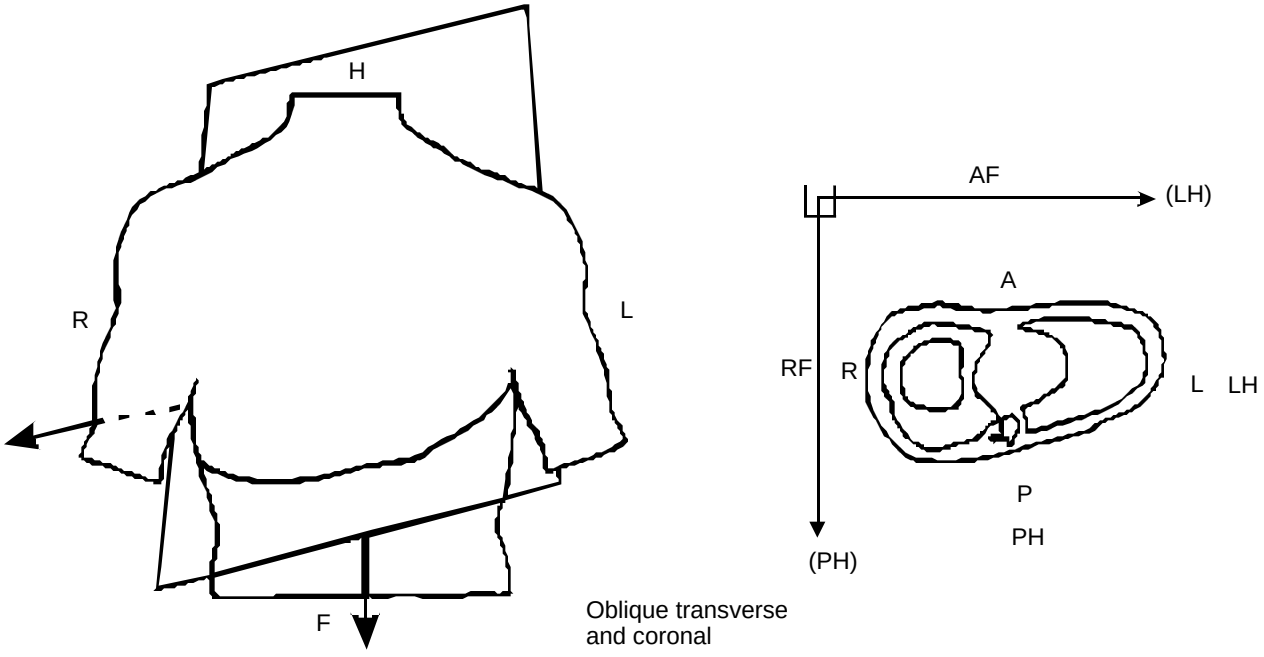

Posterior
Anterior
Coronal


F
(R)
L
R
H
(H)



Oblique sagittal and coronal

Combined tilt planes and possible labels are based on major plane directions.



Oblique transverse and coronal

Annex F Basic Directory Information Object Definition (Normative)

F.1 SCOPE OF THE BASIC DIRECTORY INFORMATION IOD

The Basic Directory Information Object Definition may be used for DICOM Media Storage (See PS 3.10) and the Media Storage Service Class (See PS 3.4). It is an abstraction of the information to:

a. Identify a File-set

b. Provide a directory which facilitates access to the information stored in the files of a File-set based on key medical information. Such a directory facility relies on a hierarchical information model of medical summary information referencing the content of the Files stored in a File-set on a storage medium. Standardizing such a directory function is a key element to facilitate the interchange of medical imaging data and is intended to support the complete range of modality imaging information.

Note: The directory information has been defined so that a future version of this Part may be extended to support the distribution of the directory information among a logical tree of several files (with the DICOMDIR file at its root). However in this version of this Part, the entire directory information is specified to be stored in a single File with a DICOMDIR File ID.

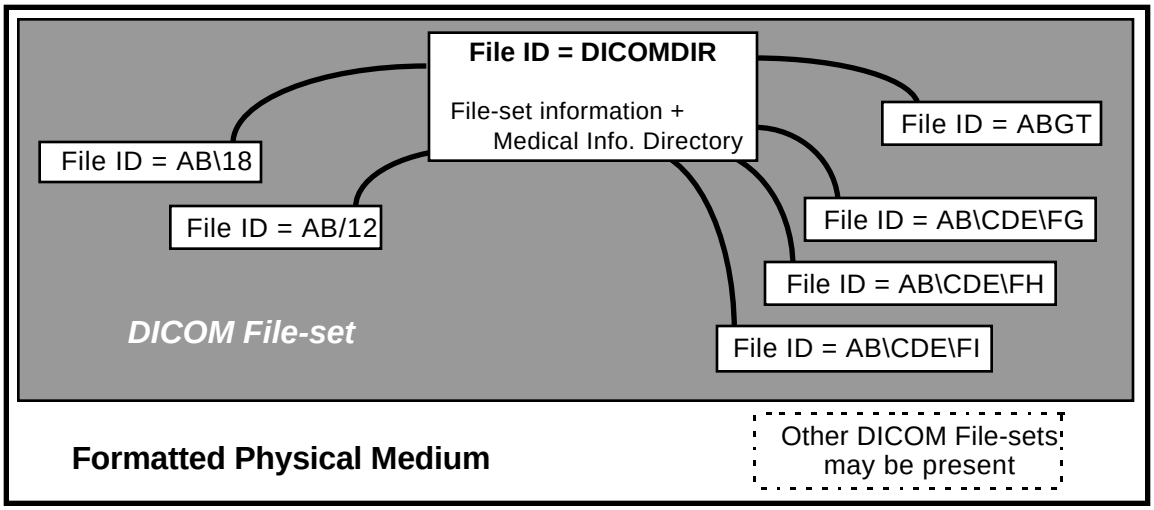


Figure F.1-1
THE DICOMDIR FILE. A CENTRAL ROLE IN A DICOM FILE-SET

Notes: 1. Whether a single File-set or multiple File-sets are allowed on a formatted Physical Media is defined by the Media Format specification (used for each specific Physical Media) in PS 3.12.

2. The DICOMDIR File is identified by a single component File ID, DICOMDIR. Other files in the File-set may have File IDs made of a single component (e.g. "ABGT" in the figure above) or multiple components (e.g. AB\12 or AB\CDE\FI) not to exceed 8 components (See PS 3.10).

This Basic Directory Information Object:

a. is based on a structure of basic medical information. It is not a file system directory such as the one which may be used by the Media Format Layer;
b. is simple enough to meet the requirements of elementary Media Interchange applications;
c. is efficient in supporting update to the directory on rewritable media without a complete rewrite of the entire DICOMDIR File;
d. is extendible for specific applications with specialized selection keys in addition to the standard keys;
e. does not mandate any relationship between the hierarchy of the medical information in the DICOM Directory and the hierarchy of the File ID Components;

Note: Such an independence between the structure of the file identifiers, from which no semantical information shall be inferred, and the DICOM Directory which conveys medical imaging information, ensures that the broadest inter-operability is possible between conforming DICOM media storage implementations.

F.2 BASIC DIRECTORY IOD OVERVIEW

The general organization of the Basic Directory IOD is introduced in this Section. A simple example is also provided to illustrate the application of this organization.

F.2.1 Basic directory IOD organization

The Basic Directory IOD organization is based on a hierarchy of Directory Entities. At the origin of this inverted tree is a root Directory Entity. Each Directory Entity includes one or more Directory Records which in turn, may each reference a lower level Directory Entity.

Directory Records serve to reference objects stored in the Files of the File-set. The organization of the Directory is depicted by the Basic Directory IOD entity/relationship model presented in Figure F.2-1.

Each Directory Record, irrespective of the Directory Entity it is included in, contains four types of information:

a. A reference to a lower level Directory Entity or Referenced Directory Entity. This reference may be absent if such a lower level Directory Entity does not exist for an instance of a directory record;
b. A reference to a File of the File-set in which is stored a "Referenced Object" (formally called in DICOM a Referenced SOP Instance). This reference may be absent if no File is referenced. Files may be referenced either directly by their File ID or indirectly through a Multi-Referenced File Directory Record. The latter case allows the same File to be referenced by several Directory Records;
c. A set of "selection keys," specific to a Referenced Object, which will allow its selection among all the records included in a given Directory Entity;
d. A mechanism to chain the various Directory Records which belong to the same Directory Entity.

This generic content of a Directory Record is further specialized based on its specific type in the context the Basic Directory IOD Information Model specified in Section F.4 (e.g., a Study Record, a Series Record, etc.). A Directory Entity may include Directory Records of different Types. By standardizing a number of specific Directory Records (see Section F.5) in the context of the Basic

Directory IOD Information Model, one allows the definition of a variety of directory contents while maintaining a framework for interoperability.

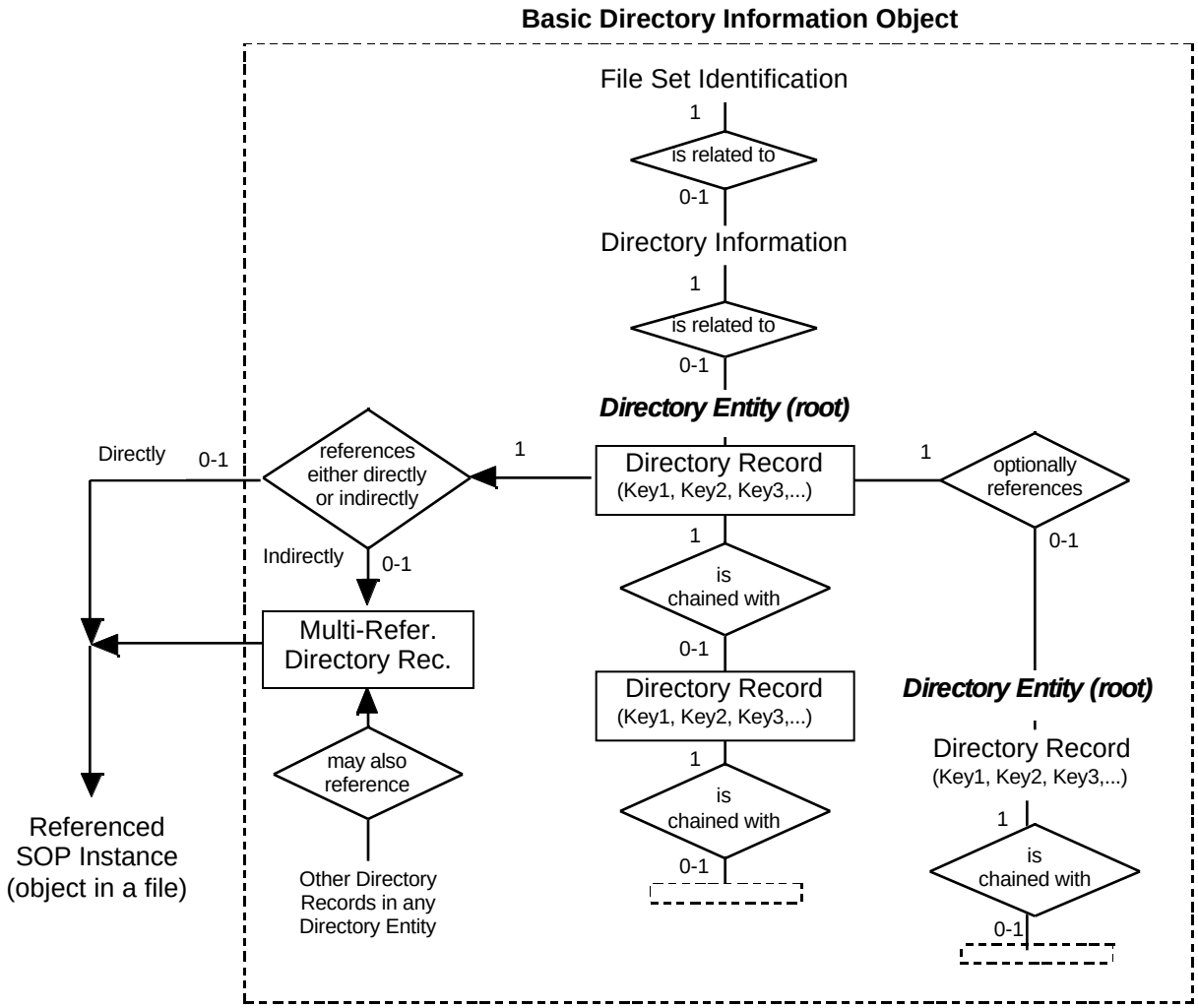


Figure F.2-1
BASIC DIRECTORY INFORMATION OBJECT E-R MODEL

To facilitate the management and update of the Directory Information a number of rules are defined:

a. Any Lower-Level Directory Entity shall be referenced by at most one higher-level Directory Record. Not allowing multiple higher-level Directory Records to reference the same Lower-Level Directory Entity simplifies the management of the deletion (or inactivation) of Directory Records and Lower-Level Directory Entities and associated Directory Records

b. Any Directory Record (except for MRDR) shall belong to a single Directory Entity. This rule and the above rule, makes the Basic Directory IOD itself strictly hierarchical

c. All files referenced by a Directory shall be present in the same File-Set to which the directory belongs

d. Non-DICOM files which are not referenced by the Directory may be included in the File-set space. The means of access to such Files and the semantics associated with their absence from the Directory is beyond the scope of the DICOM Standard

e. If a DICOMDIR contains a Directory Information Module, all DICOM Files of the File-set shall be referenced by a Directory Record

f. Any File of the File-set shall be directly referenced by at most one Directory Record of the Directory. Not allowing multiple Directory Records to directly reference the same File simplifies the management of the deletion of Directory Records and associated Files

g. A single File may be referenced indirectly by several Directory Records (which may or may not belong to the same Directory Entity) through a special Directory Record (called a Multi-Referenced File Directory Record). Such a Directory Record facilitates the management of Directory Record deletion (or inactivation) by keeping an explicit count of the multiple references to a single File.

Notes: 1. Despite the fact that rules a and b make the DICOM Directory strictly hierarchical, rules f and g make the referencing of Files fully relational. This relational flexibility allows the sharing of the content of referenced Files by different Directory Records (e.g. an image belonging to a study as well as a related film session). However, the full use of this flexibility may require the "cloning" of Directory Records due to the strict hierarchy of the Directory. An example of the use of a Multi-Referenced File Directory Record is shown in PS 3.10.

2. Referenced Files may contain SOP Instances of SOP Classes which provide the means to reference by UIDs other SOP Instances which may not be stored in files of the same File-set (e.g. an image referencing a study component).

F.2.2 Example of a directory

The example provided in this Section is only one simple example of a possible directory content and organization. This Section is not normative in nature. Therefore, this example is not meant to specify a conformant directory nor to restrict the range of possible directory organizations supported by this Part of the DICOM Standard.

The overall organization is illustrated at a logical level in Section F.2.2.1. The actual structure of the content is discussed in Section F.2.2.2. Two Annexes of PS 3.10 provide example where further details of the encoding of the file content is depicted.

F.2.2.1 ILLUSTRATION OF THE OVERALL DIRECTORY ORGANIZATION

A simple directory content is used as an example of Directory organization. It is depicted by Figure F.2-2. The left hand side part of Figure F.2-2 depicts the various Objects stored in Files of the File-set. The right hand side presents an example of organization of the directory which facilitates access to the Files of the File-set.

This example shows how stored Files are referenced by Directory Records which are grouped into Directory Entities. The two Study Directory Records (Study 1 and Study 2) are part of the Directory Entity relative to the Patient A.

Thin curved lines depict the referencing mechanism based on File IDs which allow reference to Files containing stored objects. Thick curved lines depict the internal referencing mechanisms which support the reference to a lower-level Directory Entity by a Directory Record,.

Keys which are used to select a specific Directory Record from among the Directory Records of a Directory Entity are not shown on Figure F.2-2.

One may note in this example that certain Directory Records such as the Series Directory Records do not reference Files containing stored objects. Other Directory Records such as the Image Directory Records do not reference lower level Directory Entities. However, a number of Directory Records reference both one lower level Directory Entity and one File containing a stored object. This flexibility allows the definition of a variety of directories.

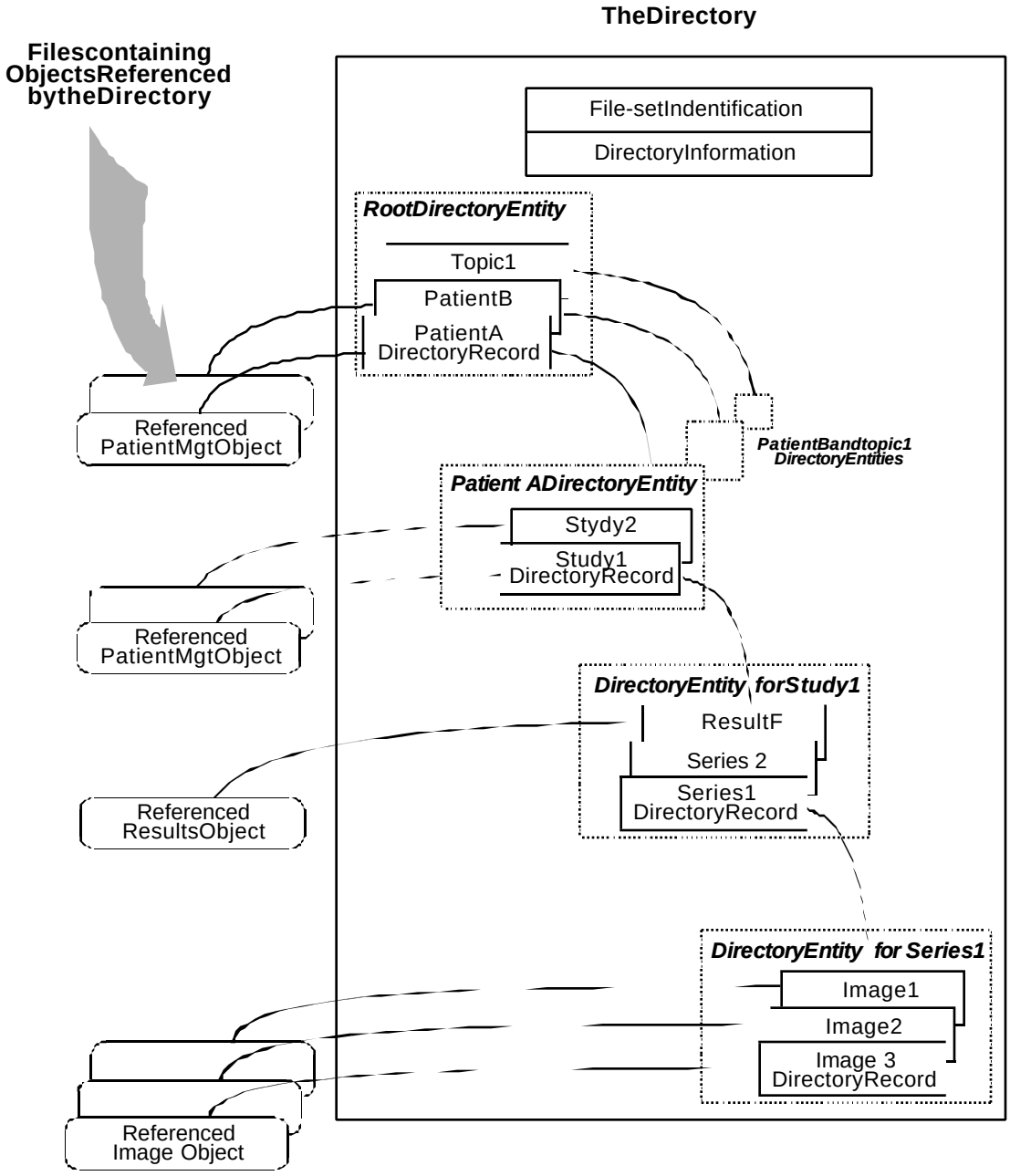


Figure F.2-2
EXAMPLE OF A DIRECTORY ORGANIZATION AND CONTENT

F.2.2.2 EXAMPLE OF A DICOM DIR FILE STRUCTURE

Based on the example discussed in Section F.2.2.1, the internal data structure used by the Basic Directory IOD is depicted in Figure F.2-3. It shows a set of Directory Records where each Directory Record is linked by three different types of "referencing" mechanisms:

a. The chaining of Directory Records to form a Directory Entity. In particular, this facilitates the addition of new Directory Records at the level of any Directory Entity by placing them at the end of the DICOMDIR File. On Figure F.2-3, these chainings are shown by dotted lines:

   1 . #1 shows the chaining of the Directory Records forming the root Directory Entity
   2. #2 shows the chaining of the Directory Records for the Directory Entity related to Patient A
   3. #3 shows the chaining of the Directory Records for the Directory Entity related to Study 1
   4. #4 shows the chaining of the Directory Records for the Directory Entity related to Series 1

b. Thick curved lines depict the reference by a Directory Record to a lower level Directory Entity

c. Thin curved lines depict the reference by a Directory Record to a stored file containing a SOP Class

This example of a DICOMDIR File structure shows one example of a specific order of the Directory Records. Other orderings of Directory Records could result in a functionally equivalent directory.

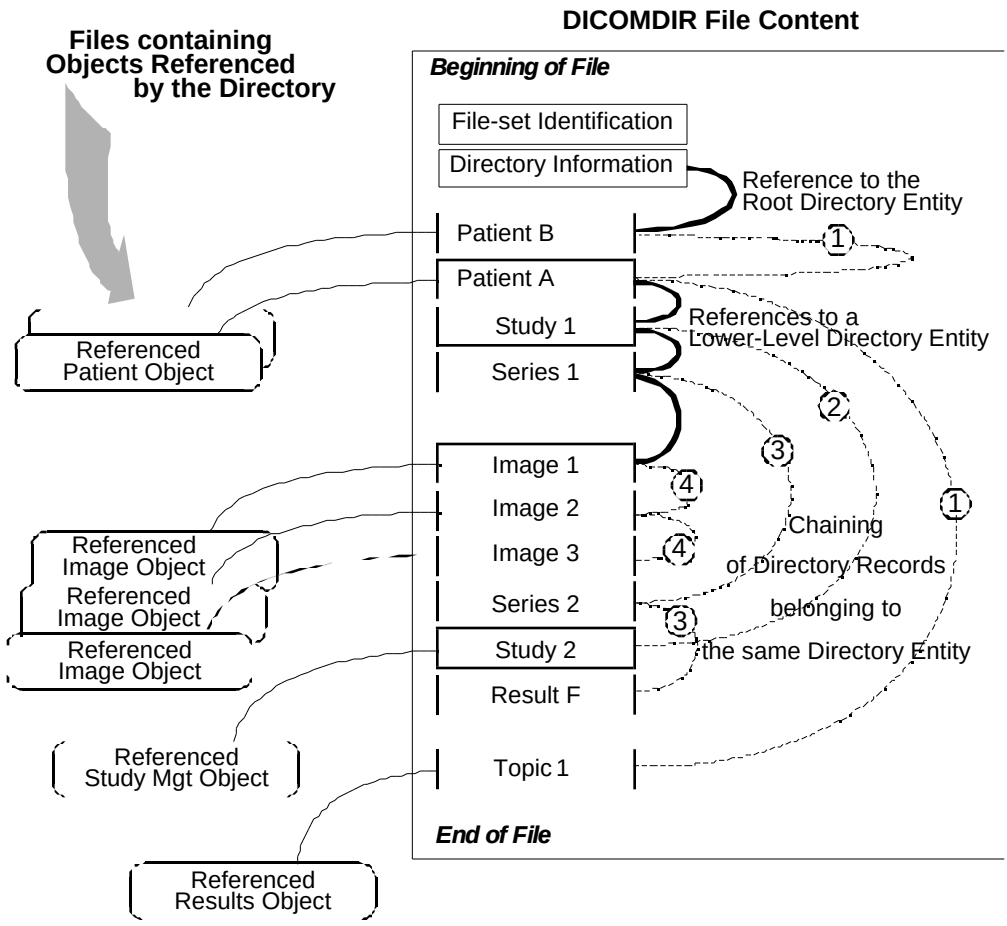


Figure F.2-3
EXAMPLE OF DATA STRUCTURE FOR THE DICOM DIRECTORY INFORMATION

F.3 BASIC DIRECTORY INFORMATION OBJECT DEFINITION

This IOD is based on the Directory Information organization introduced in Section F.2. The model for this Basic Directory IOD is described Section F.2.1 by the Entity/Relationship model in Figure F.2-1. The rules specified in Section F.2.1 apply to this Information Object Definition.

F.3.1 Module table

The Basic Directory IOD includes the Modules specified by Table F.3-1.

Table F.3-1
BASIC DIRECTORY IOD MODULES

Module	Reference	Usage	Module Description
File-set Identification	F.3.2.1	M	File-set identification information
Directory Information	F.3.2.2	U	Directory Information followed by a Sequence of Directory Records. Note: The Directory Information Module is optional. This Directory Information Module should be present in all but primitive environments where a directory is not needed. In this case, only the File-set Identification Information is present.

F.3.2 Modules of the basic directory information object

Attributes of the Basic Directory IOD are defined with a Type designation which indicates if a specific Attribute is required for all Media Storage Operations (See Section 5, Conventions).

F.3.2.1 FILE-SET IDENTIFICATION MODULE

Table F.3-2
FILE-SET IDENTIFICATION MODULE

Attribute Name	Tag	Type	Attribute Description
File-set ID	(0004,1130)	2	User or implementation specific Identifier (up to 16 characters). For definition, see PS 3.10. The File-set ID is intended to be a short human readable label to easily (but not necessarily uniquely) identify a specific File-set to facilitate operator manipulation of the physical media on which the File-set is stored. Assignment of Value and semantics are environment specific.
File-set Descriptor File ID	(0004,1141)	3	ID of a File (in the same File-set) used for user comments related to the File-set (e.g. a readme file). The Specific Character set used may be specified in the Specific Character Set of the File-set Descriptor File (0004,1142). Note: This File is not DICOM formatted (no Preamble, nor DICM Prefix and Meta Information).
Specific Character Set of File-set Descriptor File	(0004,1142)	1C	Character set used in the File-set Descriptor File with a File ID as specified in File-set Descriptor File ID (0004,1141). Required to specify the expanded or replacement character set. If absent, only the Basic Graphic set is used. See C.12.1.1.2 for Defined Terms.

Note: Every File-set is assigned a File-set UID when created. The File-set UID need not be duplicated as a Type 1 Attribute of the File-set Identification Module. It is conveyed as the SOP Instance UID of the Basic Directory IOD. It is included in the DICOMDIR File Meta Information (See PS 3.10)

F.3.2.2 DIRECTORY INFORMATION MODULE

This Module contains a sequence of Directory Records forming one or more Directory Entities. This Module defines at least one Directory Entity, the Root Directory Entity (which may be empty). Each Directory Record is composed of Directory Elements (marked by a ">"). They include:

a. an offset pointer to another Directory Record of the Same Directory Entity

b. an offset pointer to a lower level Directory Entity

c. a Referenced File pointed to by the Directory Record

d. a set of keys representative of the information contained in the Referenced File

Table F.3-3
DIRECTORY INFORMATION MODULE

Attribute Name	Tag	Type	Attribute Description
Offset of the First Directory Record of the Root Directory Entity	(0004,1200)	1	Offset of the first byte (of the Item Data Element) of the first Directory Record of the Root Directory Entity. This Offset is a number of bytes starting with the first byte of the File Meta Information. When the Root Directory Entity contains no Directory Record, this offset shall be set to 00000000H. Note: This offset includes the File Preamble and the DICM Prefix.
Offset of the Last Directory Record of the Root Directory Entity	(0004,1202)	1	Offset of the first byte (of the Item Data Element) of the last Directory Record of the Root Directory Entity. This Offset is a number of bytes starting with the first byte of the File Meta Information. When the Root Directory Entity contains no Directory Record, this offset shall be set to 00000000H. Note: This offset includes the File Preamble and the DICM Prefix.
File-set Consistency Flag	(0004,1212)	1	When set, this Flag indicates that an inconsistency within the Directory or between the Directory and the Files of the File-set may exist. Potential recovery actions are implementation specific and are beyond the scope of this Standard. Enumerated Values: 0000H: no known inconsistencies FFFFH: the FSR or FSU shall assume that inconsistencies are present. This flag shall be set by implementations before a File-set update which, if interrupted, may result in an inconsistent File-set. Note: There may be error conditions where an inconsistency is present but this flag is not set. There may also be conditions where no inconsistencies are present but the flag is set.

Directory Record Sequence	(0004,1220)	2	Sequence of zero or more repeating Items where each Item contains a Directory Record by including the Directory Elements from (0004,1400) to (0004,1511) and Record selection Keys as defined below (marked with a >). A zero length Value indicates that no Directory Records are contained in the Root Directory Entity.
>Offset of the Next Directory Record	(0004,1400)	1C	Offset of the first byte (of the Item Data Element) of the next Directory Record of the same Directory Entity. This Offset is an unsigned integer representing a number of bytes starting with the first byte of the File Meta-information. A zero offset shall be used to mean that there is no other Directory Record in this Directory Entity. Required if the Directory Record Sequence (0004,1220) is not zero length. This Offset may be used to keep an inactive Record (0004,1410) chained with the next Directory Record of the same Directory Entity. Note: This offset includes the File Preamble and the DICM Prefix.
>Record In-use Flag	(0004,1410)	1C	This flag facilitates the deletion of referenced files. Enumerated Values: FFFFH = record is in use. 0000H = record is inactive. All attributes of an inactive Directory Record except (0004,1400) and (0004,1410) shall be ignored. Other Values are reserved and shall not be set by File-set Creators, but if present shall be interpreted as FFFFH by File-set Readers or Updaters. Required if the Directory Record Sequence (0004,1220) is not zero length. If a Directory Record is changed from in use to inactive, the FSU shall ensure that all Directory Records of referenced lower-level Directory Entities are changed to inactive.
>Offset of Referenced Lower-Level Directory Entity	(0004,1420)	1C	Offset of the first byte (of the Item Data Element) of the first Directory Record of the Referenced Lower Level Directory Entity. This Offset is a number of bytes starting with the first byte of the File Meta Information. Required if the Directory Record Sequence (0004,1220) is not zero length. When no lower-level Directory Entity (containing at least one Directory Record) is referenced, this Attribute shall have a Value of 00000000H. Note: This offset includes the File Preamble and the DICM Prefix.

>Directory Record Type	(0004,1430)	1C	Defines a specialized type of Directory Record by reference to its position in the Media Storage Directory Information Model (see Section F.4). Required if the Directory Record Sequence (0004,1220) is not zero length. Enumerated Values (see Section F.5): PATIENT STUDY SERIES IMAGE OVERLAY MODALITY LUT VOI LUT CURVE TOPIC VISIT RESULTS INTERPRETATION STUDY COMPONENT PRINT QUEUE FILM SESSION FILM BOX IMAGE BOX PRIVATE = Privately defined record hierarchy position. Type shall be defined by Private Record UID (0004,1432). MRDR = Special Directory Record which allows indirect reference to a File by multiple Directory Records. Instead of directly referencing a File by its Referenced File ID (0004,1500), a Directory Record of any of the Types define above (except MRDR) may reference a Multi-Referenced File Directory Record which in turn will reference the File by its File ID.
>Private Record UID	(0004,1432)	1C	Required if the Directory Record Type (0004,1430) is of Value PRIVATE. This UID is used to define a non-standard type of Directory Record by reference to its position in a private extension to the Basic Directory IOD Information Model (see Section F.5). This UID shall be registered according to the procedures defined in PS 3.5. Its meaning may or may not be specified in a Conformance Statement.
>Referenced File ID	(0004,1500)	1C	A Multiple Value (See PS 3.5) which represents the ordered components of the File ID containing a "referenced object" or Referenced SOP Instance. A maximum of 8 components, each from 1 to 8 characters shall be used (see Section 8.2). Note: The Referenced File ID provides the means to "locate" the File through the DICOM File Service provided by the Media Format Layer. All referenced Files shall be with the File-set to which the Directory belongs. Any File within the File-set (to which the Directory belongs) shall be referenced by at most one Directory Record. When the Directory Record does not reference any SOP Instance this attribute shall not be present.To reference a single File by more than one Directory Record, a special Directory Record of Directory Record Type (0004,1430) MRDR is used. The Referenced File ID (0004,1500) shall be absent and the MRDR Directory Record Offset (0004, 1504) shall be used to reference the MRDR which indirectly references the File.

>MRDR Directory Record Offset	(0004,1504)	1C	Offset of the first byte (of the Item Data Element) of the Multi-Referenced File Directory Record. This Offset is a number of bytes starting with the first byte of the File Meta Information. When the Directory Record does not reference any SOP Instance this attribute shall not be present. Required if the Directory Record indirectly references a SOP Instance by a MRDR. Shall not be present if the Referenced File ID (0004,1500) is used for direct reference. Shall not be present in a Multi-Referenced File Directory Record. Note: This offset includes the File Preamble and the DICM Prefix.
>Referenced SOP Class UID in File	(0004,1510)	1C	Unique ID for the SOP Class related to the IOD stored in the referenced File. This UID shall be present whether the File is referenced directly by Referenced File ID (0004,1500) or indirectly by an MRDR Directory Record Offset (0004,1504). Required only if the Directory Record references a SOP Instance. Shall not be used in a Multi-Referenced File Directory Record.
>Referenced SOP Instance UID in File	(0004,1511)	1C	Unique Identifier for the SOP Instance related to the IOD stored in the referenced file. This UID shall be present whether the File is referenced directly by Referenced File ID (0004,1500) or indirectly by an MRDR Directory Record Offset. Required only if the Directory Record references a SOP Instance. Shall not be used in a Multi-Referenced File Directory Record.
>Referenced Transfer Syntax UID in File	(0004,1512)	1C	Unique Identifier for the Transfer Syntax used to encode the IOD stored in the referenced file. This UID shall be present whether the File is referenced directly by Referenced File ID (0004,1500) or indirectly by an MRDR Directory Record Offset. Required only if the Directory Record references a SOP Instance. Shall not be used in a Multi-Referenced File Directory Record.
>Record Selection Keys	See F.5	See F.5	A number of DICOM Data Elements which contain specific keys defined for each type of Directory Record (0004,1430) defined in Section F.5.

F.4 BASIC DIRECTORY IOD INFORMATION MODEL

The Basic Directory IOD Information Model defines the relationship between the various types of Directory Records which may be used in constructing DICOM Directories. This model is based on the DICOM Application Model defined in this part of the DICOM Standard. Entities in this Model correspond to Directory Records (DR). These are shown as rectangular boxes. Each Directory Record in this model is part of a Directory Entity (not shown except for the Root Entity) which is referenced by a Directory Record of a higher-level Directory Entity (e.g., a Study Directory Record references a Directory Entity which includes Directory Records describing the content of the Study).

Each Directory Record has a number of mandatory and optional keys which are not shown on this model. They are defined in Section F.5. Conventions used are those used by this part of the

DICOM Standard. The model is depicted as an entity/relationship model in Figure F.4-1. These Directory Record relationships are fully specified in Table F.4-1.

Table F.4-1
RELATIONSHIP BETWEEN DIRECTORY RECORDS

Directory Record Type	Section	Directory Record Types which may be included in the next lower-level directory Entity
(Root Directory Entity)	¾	PATIENT, TOPIC, PRINT QUEUE, PRIVATE
PATIENT	F.5.1	STUDY, PRIVATE
STUDY	F.5.2	SERIES, VISIT, RESULTS, STUDY COMPONENT FILM SESSION, PRIVATE
SERIES	F.5.3	IMAGE, OVERLAY, MODALITY LUT, VOI LUT, CURVE, PRIVATE
IMAGE	F.5.4	PRIVATE
OVERLAY	F.5.5	PRIVATE
MODALITY LUT	F.5.6	PRIVATE
VOI LUT	F.5.7	PRIVATE
CURVE	F.5.8	PRIVATE
TOPIC	F.5.9	STUDY, SERIES, IMAGE, OVERLAY, MODALITY LUT, VOI LUT, CURVE, FILM SESSION, PRIVATE
VISIT	F.5.10	PRIVATE
RESULTS	F.5.11	INTERPRETATION, PRIVATE
INTERPRETATION	F.5.12	PRIVATE
STUDY COMPONENT	F.5.13	PRIVATE
PRINT QUEUE	F.5.14	BASIC FILM SESSION, PRIVATE
BASIC FILM SESSION	F.5.15	BASIC FILM BOX, PRIVATE
BASIC FILM BOX	F.5.16	BASIC IMAGE BOX, PRIVATE
BASIC IMAGE BOX	F.5.17	PRIVATE
PRIVATE	F.6.1	PRIVATE, (any of the above as privately defined)
MRDR	F.6.2	(Not applicable)

F.5 DEFINITION OF SPECIFIC DIRECTORY RECORDS

The following Sections specify a number of Directory Records which were introduced by the Basic Directory IOD Information Model presented in Section F.4. For each one, it identifies the SOP Classes which may be referenced and the related mandatory keys. Keys are assigned a Type designation which indicates if it is required for all Media Storage Operations of the Directory (See Section 5, Conventions).

Type 2 and Type 3 Keys may be changed to Type 1 and Type 2 or 3 respectively by Application Profiles defined in PS 3.11 of the DICOM standard. Keys based on Private Data Elements, or

Private Keys may also be used in addition to Standard defined Keys. However such Private keys may be ignored by any File-set Reader or Updater.

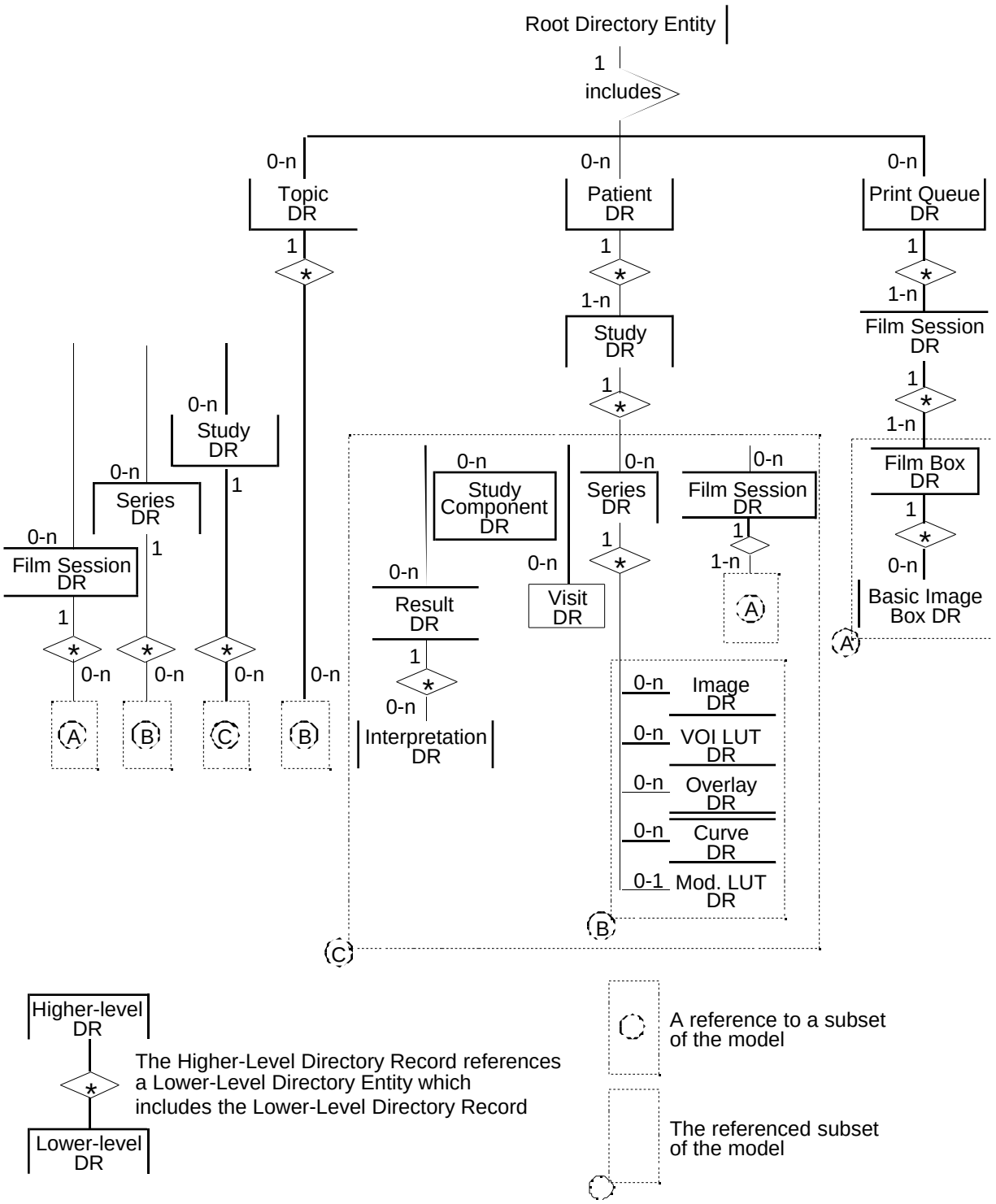


Figure F.4-1
BASIC DIRECTORY IOD INFORMATION MODEL

F.5.1 Patient Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "PATIENT." Table F.5-1 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Patient IOD or the Patient IE of Image IODs. This Directory Record shall be used to reference a Detached Patient Management SOP Instance. This Type of Directory Record may reference a Lower-Level Directory Entity which includes one or more Directory Records as defined in Table F.4-2.

Table F.5-1
PATIENT KEYS

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys
Patient's Name	(0010,0010)	2	
Patient ID	(0010,0020)	1	
Any other Attribute of the Patient IOD or Patient IE Modules		3	

For a given File-set, the Patient ID shall be unique. This means that it shall not appear in different Patient Directory Records.

F.5.2 Study Directory record definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "STUDY." Table F.5-2 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Study IOD or the Study IE of Image IODs. This Directory Record shall be used to reference a Detached Study Management SOP Instance. This Type of Directory Record may reference a Lower-Level Directory Entity which includes one or more Directory Records as defined in Table F.4-2.

Table F.5-2
STUDY KEYS

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys
Study Date	(0008,0020)	1	
Study Time	(0008,0030)	1	
Study Description	(0008,1030)	2	
Study Instance UID	(0020,000D)	1C	Required only if (0004,1511) is absent. (See Note)
Study ID	(0020,0010)	1	
Accession Number	(0008,0050)	2	
Any other Attribute of the Study IOD or Study IE Modules		3	

Note: The Study Instance UID shall be present as a mandatory key only if no file is referenced by this Directory Record. In the case where this Directory Record references a file, the Directory Record contains in the Referenced SOP Instance UID in File (0004,1511). In this case (0004,1511) may be used as a "pseudo" Directory Record Key (See Table F.3-3) and need not be duplicated.

F.5.3 Series Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "SERIES." Table F.5-3 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Series IE and Equipment IE of Image IODs. This type of Directory Record may reference a Lower-Level Directory Entity which includes one or more Directory Records as defined in Table F.4-2.

Table F.5-3
SERIES KEYS

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys
Modality	(0008,0060)	1	
Series Instance UID	(0020,000E)	1	
Series Number	(0020,0011)	1	
Icon Image Sequence	(0088,0200)	3	This Icon Image is representative of the Series. It may or may not correspond to one of the images of the Series.
>Image Pixel Module			See Section F.7 of this Part.
Any other Attribute of the Series IE Modules		3	

F.5.4 Image directory record definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "IMAGE." Table F.5-4 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Image IE of Image IODs. This Directory Record shall be used to reference an Image SOP Instance. This type of Directory Record may reference a Lower-Level Directory Entity which includes one or more Directory Records as defined in Table F.4-2.

Table F.5-4
IMAGE KEYS

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Image Number	(0020,0013)	1	
Icon Image Sequence	(0088,0200)	3	This Icon Image is representative of the Image.
>Image Pixel Module			See Section F.7 of this Part.
Any other Attribute of the Image IE Modules		3	

Note: Because (0004,1511) Referenced SOP Instance UID in File may be used as a "pseudo" Directory Record Key (See Table F.3-3), it is not duplicated in this list of keys.

F.5.5 Standalone overlay directory record definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "OVERLAY." Table F.5-5 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Overlay IE of Image IODs. This Directory Record shall be used to reference a Standalone Overlay Image SOP Instance. This Type of Directory Record may reference a Lower-Level Directory Entity which includes one or more Directory Records as defined in Table F.4-2.

Table F.5-5
OVERLAY KEYS

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Overlay Number	(0020,0022)	1	
Icon Image Sequence	(0088,0200)	3	
>Image Pixel Module			See Section F.7 of this Part.
Any other Attribute of the Overlay IE Modules		3	

Note: Because (0004,1511) Referenced SOP Instance UID in File may be used as a "pseudo" Directory Record Key (See Table F.3-3), it is not duplicated in this list of keys.

F.5.6 Standalone modality LUT directory record definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "MODALITY LUT." Table F.5-6 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Modality LUT IE of Image IODs. This Directory Record shall be used to reference a Standalone Modality LUT SOP Instance. This Type of Directory Record may reference a Lower-Level Directory Entity which includes one or more Directory Records as defined in Table F.4-2.

Table F.5-6
Modality LUT Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Lookup table Number	(0020,0026)	1	
Any other Attribute of the Modality LUT IE Modules		3	

Note: Because (0004,1511) Referenced SOP Instance UID in File may be used as a "pseudo" Directory Record Key (See Table F.3-3), it is not duplicated in this list of keys.

F.5.7 Standalone VOI LUT directory record definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "VOI LUT." Table F.5-7 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the VOI LUT IE of Image IODs. This Directory Record shall be used to reference a Standalone VOI LUT SOP Instance. This Type of Directory Record may reference a Lower-Level Directory Entity which includes one or more Directory Records as defined in Table F.4-2.

Table F.5-7
VOI LUT KEYS

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys)
Lookup Table Number	(0020,0026)	1	
Any other Attribute of the VOI LUT IE Modules		3	

Note: Because (0004,1511) Referenced SOP Instance UID in File may be used as a "pseudo" Directory Record Key (See Table F.3-3), it is not duplicated in this list of keys.

F.5.8 Standalone curve directory record definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "CURVE." Table F.5-8 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Curve IE of Image IODs. This Directory Record shall be used to reference a Standalone Curve SOP Instance. This Type of Directory Record may reference a Lower-Level Directory Entity which includes one or more Directory Records as defined in Table F.4-2.

Table F.5-8
CURVE KEYS

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Curve Number	(0020,0024)	1	
Any other Attribute of the Curve IE Modules		3	

Note: Because (0004,1511) Referenced SOP Instance UID in File may be used as a "pseudo" Directory Record Key (See Table F.3-3), it is not duplicated in this list of keys.

F.5.9 Topic directory record definition

The Topic Directory Record is intended to collect a set of subordinate Directory Records. It uses simple textual descriptions as keys. The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "TOPIC." Table F.5-9 lists the set of keys with their associated Types for such a Directory Record Type. This Type of Directory Record may reference a Lower-Level Directory Entity which includes one or more Directory Records as defined in Table F.4-2.

Table F.5-9
TOPIC KEYS

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used
Topic Title	(0088,0904)	1	Text title for the topic addressed by this Directory Record
Topic Subject	(0088,0906)	2	Short Text description of the subject addressed by this topic
Topic Author	(0088,0910)	2	Name of the author or creator of this topic
Topic Key Words	(0088,0912)	2	A multiple Value field including from 1 to 32 key-words related to the topic.

Note: For more complex Directory Records with additional keys, a PRIVATE Directory Record is suggested rather than aTopic Directory Record.

F.5.10 Visit directory record definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "VISIT." Table F.5-10 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Visit IOD. This Directory Record shall be used to reference a Detached Visit Management SOP Instance. This Type of Directory Record may reference a Lower-Level Directory Entity which includes one or more Directory Records as defined in Table F.4-2.

Table F.5-10
VISIT KEYS

Key	Tag	Type	Attribute Description
Admitting Date	(0038,0020)	2	
Admission ID	(0038,0010)	2	
Institution Name	(0008,0080)	2	
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys
Any other Attribute of the Visit IOD Modules		3	

Note: Because (0004,1511) Referenced SOP Instance UID in File may be used as a "pseudo" Directory Record Key (See Table F.3-3), it is not duplicated in this list of keys.

F.5.11 Results directory record definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "RESULTS." Table F.5-11 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Results IOD. This Directory Record shall be used to reference a Detached Results Management SOP Instance. This Type of Directory Record may reference a Lower-Level Directory Entity which includes one or more Directory Records as defined in Table F.4-2.

Table F.5-11
RESULT KEYS

Key	Tag	Type	Attribute Description
Results ID	(4008,0040)	2	
Instance Creation date (Results)	(0008,0012)	2	
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys)
Any other Attribute of the Results IOD Modules		3	

Note: Because (0004,1511) Referenced SOP Instance UID in File may be used as a "pseudo" Directory Record Key (See Table F.3-3), it is not duplicated in this list of keys.

F.5.12 Interpretation directory record definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "INTERPRETATION." Table F.5-12 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Interpretation IOD. This Directory Record shall be used to reference an Interpretation SOP Instance. This Type of Directory Record may reference a Lower-Level Directory Entity which includes one or more Directory Records as defined in Table F.4-2.

Table F.5-12
INTERPRETATION KEYS

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys
Interpretation Transcription Date	(4008,0108)	1	
Interpretation Author	(4008,010C)	2	
Interpretation Diagnosis Description	(4008,0115)	2	
Interpretation Diagnosis Codes Sequence	(4008,0117)	2	
>Code Value	(0008,0100)	1C	Required if (4008,0117) is present
>Coding Scheme Designator	(0008,0102)	1C	Required if (4008,0117) is present
>Code Meaning	(0008,0104)	1C	Required if (4008,0117) is present
Interpretation ID	(4008,0200)	1	
Interpretation Type ID	(4008,0210)	2	

Interpretation Status ID	(4008,0212)	2	
Any Attribute of Interpretation related Modules		3	

Note: Because (0004,1511) Referenced SOP Instance UID in File may be used as a "pseudo" Directory Record Key (See Table F.3-3), it is not duplicated in this list of keys.

F.5.13 Study component directory record definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "STUDY COMPONENT." Table F.5-13 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Study Component IOD. This Directory Record shall be used to reference a Study Component SOP Instance. This Type of Directory Record may reference a Lower-Level Directory Entity which includes one or more Directory Records as defined in Table F.4-2.

Table F.5-13
STUDY COMPONENT KEYS

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys
Modality	(0008,0060)	1	
Study Description	(0008,1030)	2	
Procedure Code Sequence	(0008,1032)	1	
> Code Value	(0008,0100)	1C	Required if (0008,1032) is present
> Coding Scheme Designator	(0008,0102)	1C	Required if (0008,1032) is present
> Code Meaning	(0008,0104)	1C	Required if (0008,1032) is present
Performing Physician's Name	(0008,1050)	2	
Any Attribute of Study Component Modules		3	

Note: Because (0004,1511) Referenced SOP Instance UID in File may be used as a "pseudo" Directory Record Key (See Table F.3-3), it is not duplicated in this list of keys.

F.5.14 Print Queue Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "PRINT QUEUE." Table F.5-14 lists the set of keys with their associated Types for such a Directory Record Type. This Type of Directory Record may reference a Lower-Level Directory Entity which includes one or more Directory Records as defined in Table F.4-2.

Table F.5-14
PRINT QUEUE KEYS

Key	Tag	Type	Attribute Description
Print Queue ID	(2110,0099)	1	User defined identifier for a Print Queue.
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used
Printer Name	(2110,0030)	2	User defined name identifying the printer

F.5.15 Film session directory record definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "FILM SESSION." Table F.5-15 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Film Session and Print Job IOD. This Directory Record shall be used to reference a Film Session SOP Instance. This Type of Directory Record may reference a Lower-Level Directory Entity which includes one or more Directory Records as defined in Table F.4-2.

Table F.5-15
FILM SESSION KEYS

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used
Film_session_label	(2000,0050)	2	Human readable label that identifies the Film session
Execution Status	(2100,0020)	1C	Execution Status of the printing of the Film Session; Enumerated Values: PENDING = to be printed Note: Printing of a Film Session with a PENDING Status may not have been attempted yet, or may have already been attempted but was unsuccessful. DONE = has been successfully printed Required if the Film Session Directory Record is associated with a Print queue.
Any other Attribute of the Film Session IOD Modules		3	

Note: Because (0004,1511) Referenced SOP Instance UID in File may be used as a "pseudo" Directory Record Key (See Table F.3-3), it is not duplicated in this list of keys.

F.5.16 Film box directory record definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "FILM BOX." Table F.5-16 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Basic Film Box IOD. This Directory Record shall be used to reference a Basic Film Box SOP Instance. This Type of Directory Record may reference a Lower-Level Directory Entity which includes one or more Directory Records as defined in Table F.4-2.

Table F.5-16
BASIC FILM BOX KEYS

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys
Execution Status	(2100,0020)	1C	Execution Status of the printing of the Film Box; Enumerated Values: PENDING = to be printed Note: Printing of a Film Box with a PENDING Status may not have been attempted yet, or may have already been attempted but was unsuccessful. DONE = has been successfully printed Required if the Film Box Directory Record is associated with a Print queue.
Any Attribute of Basic Film Box Presentation Module		3	

Note: Because (0004,1511) Referenced SOP Instance UID in File may be used as a "pseudo" Directory Record Key (See Table F.3-3), it is not duplicated in this list of keys.

F.5.17 Basic image box directory record definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "BASIC IMAGE BOX." Table F.5-17 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Basic Greyscale Image Box IOD or the Basic Color Image Box IOD. This Directory Record shall be used to reference a Basic Greyscale Image Box SOP Instance or a Basic Color Image Box SOP Instance. This Type of Directory Record may reference a Lower-Level Directory Entity which includes one or more Directory Records as defined in Table F.4-2.

Table F.5-17
BASIC IMAGE BOX KEYS

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys
Image Position	(2020,0010)	1	
Any Attribute of Basic Image Box Presentation Module		3	

Note: Because (0004,1511) Referenced SOP Instance UID in File may be used as a "pseudo" Directory Record Key (See Table F.3-3), it is not duplicated in this list of keys.

F.6 SPECIAL DIRECTORY RECORDS

F.6.1 Private directory record definition

Private Directory Records may also be used in addition to Standard defined Directory Records. Such Private Records shall follow the specification of Sections F.2 and F.3. In addition, if created by File-set Creators they shall be proper extensions to the DICOM Basic Directory IOD Information Model specified in Section F.4. By proper extensions it is meant that any File-set Creator creating private Directory Records shall still meet the DICOM PS 3.10 conformance requirements. Thus a File-set Reader or File-set Updater which chooses to ignore such privately defined Directory Records will find a conformant Directory.

F.6.2 Multi-referenced file directory record definition

This Directory Record is based on the specification of Section F.3. The Multi-Referenced File Directory Record (MRDR) is a special type of Directory Record which allows indirect reference to a File by multiple Directory Records. Such a Directory Record facilitates the management (deletion/update) of referenced Files by keeping an explicit count of the number of references. Instead of directly referencing a File by its Referenced File ID, a Directory Record of any of the Types define above (except the Multi-Referenced File Directory Record itself) may reference the Multi-Referenced File Directory Record which in turn will reference the File by its File ID. This Type of Directory Record shall not reference a Lower-Level Directory Entity.

The following restrictions apply to this Directory Record:

a. Offset of the Next Directory Record shall be set to 00000000H
b. Offset of Referenced Lower-Level Directory Entity shall be set to 00000000H
c. Directory Record Type shall be set to MRDR
d. Referenced File ID shall be set to the File ID of the Multi-Referenced File
e. Referenced SOP Class UID shall be absent
f. Referenced SOP Instance UID shall be absent

One additional attribute is defined in Table 5.5-19 and shall be included as a "pseudo" Key.

Table F.6-1
MULTI-REFERENCED FILE KEYS

Key	Tag	Type	Attribute Description
Number of References	(0004,1600)	1	Number of References made by other Directory Records to this MDRD Directory Record. When set to 0000H the MRDR record is inactive. The Referenced File ID (0004,1510) value of the MRDR record shall be considered as invalid and ignored. Number of References (0004,1600) shall be reduced by one when a Directory Record of any Type (referencing this Multi-Referenced File Directory Record) is either deleted or when its Record In Use Flag (0004,1410) set to inactive. When a Directory Record of any Type (referencing this Multi-Referenced File Directory Record) is added, the Number of References (0004,1600) shall be increased by one. Note: If the Number of References becomes zero, it is an implementation decision whether the MRDR Directory Record is deleted or left inactive and if the Multi-Referenced File is deleted.

F.7 ICON IMAGE KEY DEFINITION

An Icon Image may be used as a key representative of an Image, Series or Overlay in a corresponding Directory Record to select one or more Image, Series or Overlay among several of them. It is based on the general purpose Image Pixel Module (See Annex C).

The Icon Image Key corresponds to Data Element (0088,0200). It is defined as a Sequence which contains a single Item encapsulating the Data Set made of the Data Elements of the Icon Image. The Data Elements are defined by the Image Pixel Module (see Section C.7.6.3).

The Image Pixel Module usage is restricted in a few areas to facilitate general use in Directory Record across various modality environments. These restrictions are:

a. Only monochrome and palette color images shall be used. Samples per Pixel (0028,0002) shall have a Value of 1, Photometric Interpretation (0028,0004) shall have a Value of either MONOCHROME 1, MONOCHROME 2 or PALETTE COLOR, Planar Configuration (0028,0006) shall not be present

   Note:True color icon images are not supported. This is due to the fact that the reduced size of the Icon Image makes the quality of a palette color image (with 256 colors) sufficient in most cases. This simplifies the handling of Icon Images by File-set Readers and File-set Updaters.

b. If an FSR/FSU supports Icons (i.e. does not ignore them) then it shall support at least a maximum size of 64 by 64 Icons. An FSC may write Icons of any size. Icons larger than 64 by 64 may be ignored by FSRs and FSUs unless specialized by Application Profiles

c. Pixel samples have a Value of either 1 or 8 for Bits Allocated (0028,0100) and Bits Stored (0028,0101). High Bit (0028,0102) shall have a Value of one less than the Value used in Bit Stored

d. Pixel Representation (0028,0103) shall used an unsigned integer representation (Value 0000H)

e. Pixel Aspect Ratio (0028,0034) shall have a Value of 1:1

f. If a Palette Color lookup Table is used, an 8 Bit Allocated (0028,0100) shall be used

Annex G Integration of Modality Worklist and Modality Performed Procedure Step in the Original DICOM Standard (Informative)

DICOM was published in 1993 and effectively addresses image communication for a number of modalities and Image Management functions for a significant part of the field of medical imaging. Since then, many additional medical imaging specialties have contributed to the extension of the DICOM Standard and developed additional Image Object Definitions. Furthermore, there have been discussions about the harmonization of the DICOM Real-World domain model with other standardization bodies. This effort has resulted in a number of extensions to the DICOM Standard. The integration of the Modality Worklist and Modality Performed Procedure Step address an important part of the domain area that was not included initially in the DICOM Standard. At the same time, the Modality Worklist and Modality Performed Procedure Step integration make steps in the direction of harmonization with other standardization bodies (CEN TC 251, HL7, etc.).

The purpose of this ANNEX is to show how the original DICOM Standard relates to the extension for Modality Worklist Management and Modality Performed Procedure Step. The two included figures outline the void filled by the Modality Worklist Management and Modality Performed Procedure Step specification, and the relationship between the original DICOM Data Model and the extended model.

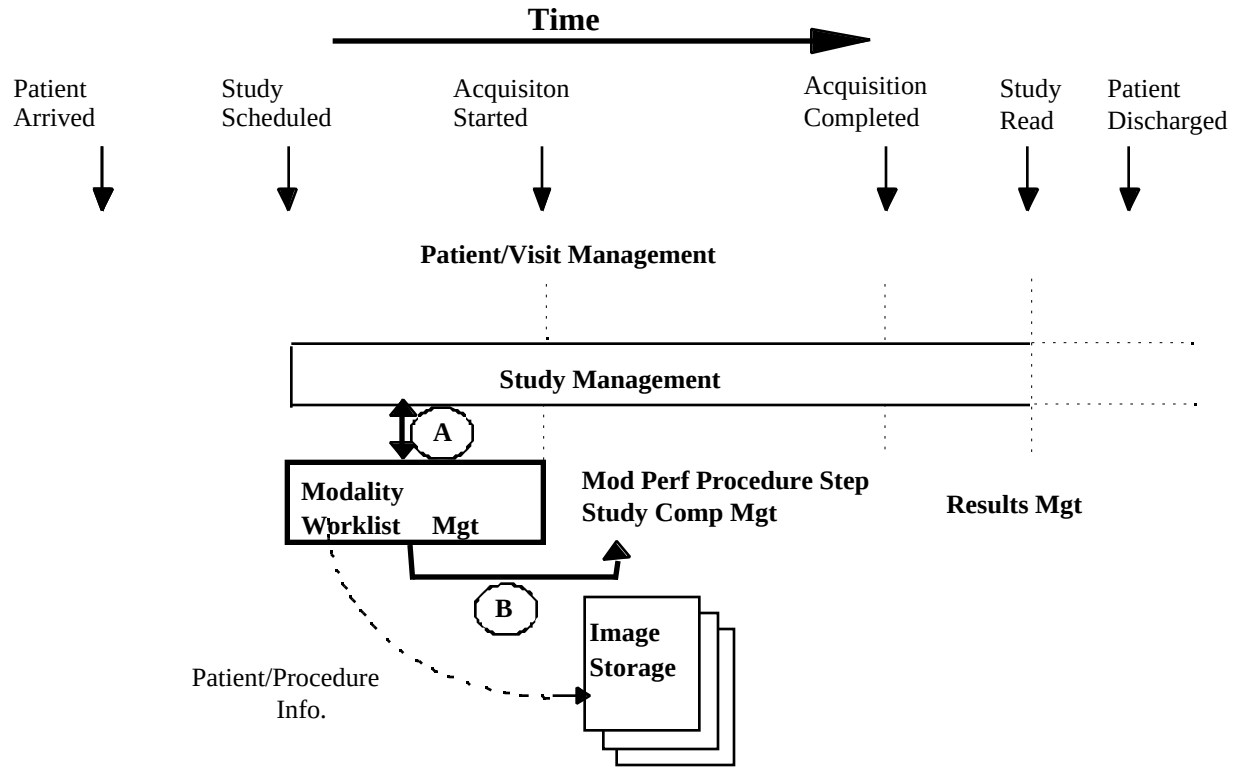


Figure G-1: Functional View - Modality Worklist and Modality Performed Procedure Step Management in the Context of DICOM Service Classes

The management of a patient starts when the patient enters a physical facility (e.g. a hospital, a clinic, an imaging center) or even before that time. The DICOM Patient Management SOP Class provides many of the functions that are of interest to imaging departments. Figure G-1 is an example where one presumes that an order for a procedure has been issued for a patient. The order for an imaging procedure results in the creation of a Study Instance within the DICOM Study Management SOP Class. At the same time (A) the Modality Worklist Management SOP Class enables a modality operator to request the scheduling information for the ordered procedures. A worklist can be constructed based on the scheduling information. The handling of the requested imaging procedure in DICOM Study Management and in DICOM Worklist Management are closely related. The worklist also conveys patient/study demographic information that can be incorporated into the images.

Worklist Management is completed once the imaging procedure has started and the Scheduled Procedure Step has been removed from the Worklist, possibly in response to the Modality Performed Procedure Step (B). However, Study Management continues throughout all stages of the Study, including interpretation. The actual procedure performed (based on the request) and information about the images produced are conveyed by the DICOM Study Component SOP Class or the Modality Performed Procedure Step SOP Classes.

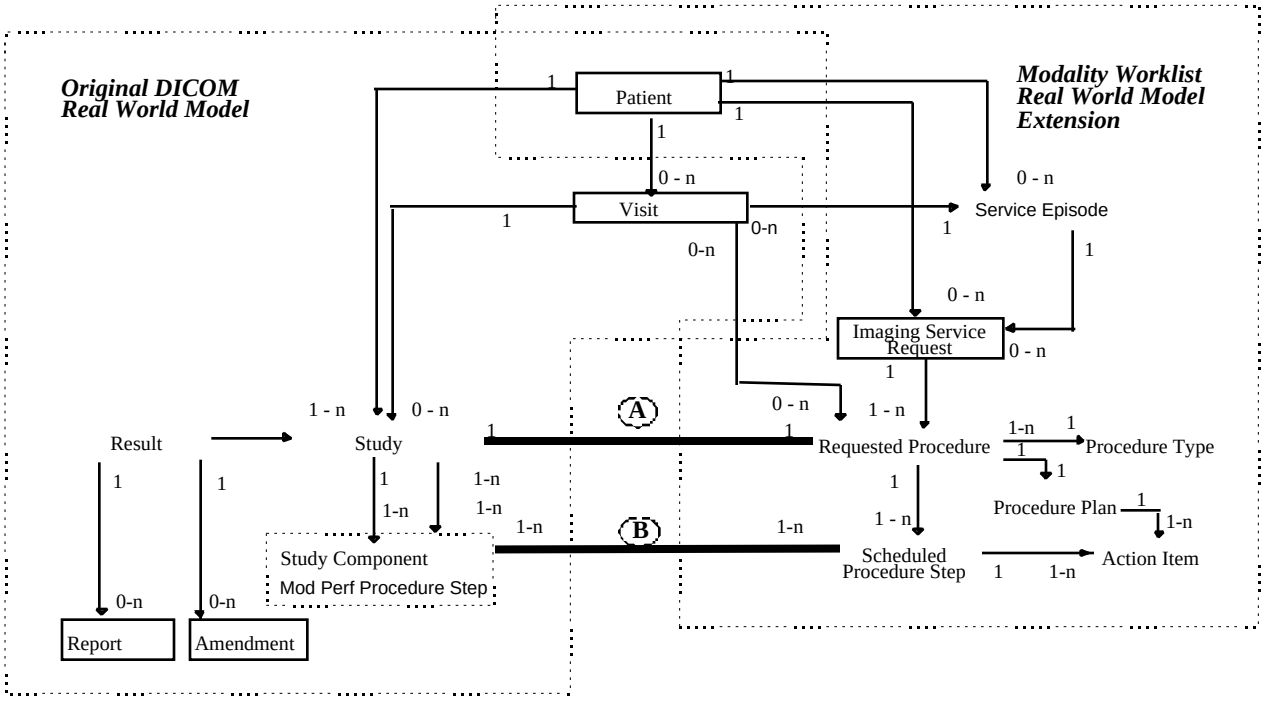


Figure G-2: Relationship of the Original Model and the Extensions for Modality Worklist and Modality Performed Procedure Step Management

Figure G-2 shows the relationship between the original DICOM Real-World model and the extensions of this Real-World model required to support the Modality Worklist and the Modality Performed Procedure Step. The new parts of the model add entities that are needed to request, schedule, and describe the performance of imaging procedures, concepts that were not supported in the original model. The entities required for representing the Worklist form a natural extension of the original DICOM Real-World model.

Common to both the original model and the extended model is the Patient entity. The Service Episode is an administrative concept that has been shown in the extended model in order to pave the way for future adaptation to a common model supported by other standardization groups including HL7, CEN TC 251 WG 3, CAP-IEC, etc. The Visit is in the original model but not shown in the extended model because it is a part of the Service Episode.

There is a 1 to 1 relationship between a Requested Procedure and the DICOM Study (A). A DICOM Study is the result of a single Requested Procedure. A Requested Procedure can result in only one Study.

A n:m relationship exists between a Scheduled Procedure Step and a Modality Performed Procedure Step (B). The concept of a Modality Performed Procedure Step is a superset of the Study Component concept contained in the original DICOM model. The Modality Performed Procedure Step SOP Classes provide a means to relate Modality Performed Procedure Steps to Scheduled Procedure Steps.

Annex H Retired composite information object definitions (Normative)

H.1 NUCLEAR MEDICINE IMAGE INFORMATION OBJECT DEFINITION (RETIRED)

H.1.1 NM Image IOD Description (Retired)

The Nuclear Medicine (NM) Image Information Object Definition (IOD) specifies an image which has been created by a nuclear medicine imaging device. This includes data created by external detection devices which create images of the distribution of administered radioactive materials in the body. Depending on the specific radio pharmaceutical administered and the particular imaging procedure performed, problems involving changes in metabolism, function, or physiology can be investigated and various regional pathologies can be studied.

H.1.2 NM Image IOD Entity-Relationship Model (Retired)

The E-R Model in Section A.1.2 of this Part depicts those components of the DICOM Information Model which directly reference the NM Image IOD. The Modality LUT IE and VOI LUT IE are not components of the NM Image IOD.

H.1.3 NM Image IOD Module Table (Retired)

Table H.1.3
NM Image IOD Modules (Retired)

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	General Series	C.7.3.1	M
	NM Series (Retired)	I.1.1.1	M
Frame of Reference	Frame of Reference	C.7.4.1	U
Equipment	General Equipment	C.7.5.1	M
	NM Equipment (Retired)	I.1.1.2	U
Image (see H.1.3.1)	General Image	C.7.6.1	M
	Image Plane	C.7.6.2	U
	Image Pixel	C.7.6.3	M
	Cine	C.7.6.5	C -Required if pixel data is Multi-frame cine data.
	Multi-frame	C.7.6.6	C - Required if pixel data is Multi-frame data.
	NM Image	I.1.1.3	M

	NM SPECT Acquisition Image (Retired)	I.1.1.4	C - Required if this is a NM SPECT Acquisition Image
	NM Multi-gated Acquisition Image (Retired)	I.1.1.5	C - Required if this is a NM Multi-gated Acquisition Image
	Overlay Plane	C.9.2	U
	Multi-frame Overlay	C.9.3	U
	Curve	C.10.2	U
	VOI LUT	C.11.2	U
	SOP Common	C.12.1	M
Overlay(see H.1.3.1)	Overlay Identification	C.9.1	M
	Overlay Plane	C.9.2	M
	Multi-frame Overlay	C.9.3	M
	SOP Common	C.12.1	M
Curve (see H.1.3.1)	Curve Identification	C.10.1	M
	Curve	C.10.2	M
	SOP Common	C.12.1	M

H.1.3.1 Mutually Exclusive IEs

The Image, Overlay and Curve IEs are mutually exclusive. Each SOP Instance using this IOD shall contain exactly one of these IEs.

H.2 ULTRASOUND IMAGE INFORMATION OBJECT DEFINITION (RETIRED)

H.2.1 US Image IOD Description (Retired)

The Ultrasound (US) Image Information Object Definition (IOD) specifies an image which has been created by an ultrasound imaging device.

H.2.2 US Image IOD Entity-Relationship Model (Retired)

The E-R Model in Section A.1.2 of this Part depicts those components of the DICOM Application Information Model which directly reference the US Image IOD. The Overlay IE, Modality LUT IE and VOI LUT IE are not components of the US Image IOD.

H.2.3 US Image IOD Module Table (Retired)

Table H.2.3
US Image IOD Modules (Retired)

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U

Series	General Series	C.7.3.1	M
Frame of Reference	Frame of Reference	C.7.4.1	U
	US Frame of Reference (Retired)	I.1.2.1	C - Required if images are spatially related
Equipment	General Equipment	C.7.5.1	M
Image (See H.2.3.1)	General Image	C.7.6.1	M
	Image Pixel	C.7.6.3	M
	Contrast/bolus	C.7.6.4	C Required if contrast media was used in this image
	US Region Calibration (Retired)	I.1.2.2	U
	US Image (Retired)	I.1.2.3	M
	Overlay Plane	C.9.2	U
	VOI LUT	C.11.2	U
	SOP Common	C.12.1	M
Curve (See H.2.3.1)	Curve Identification	C.10.1	M
	Curve	C.10.2	M
	Audio	C.10.3	U
	SOP Common	C.12.1	M

H.2.3.1 Mutually Exclusive IEs

The Image and Curve IEs are mutually exclusive. Each SOP Instance using this IOD shall contain exactly one of these IEs.

H.3 ULTRASOUND MULTI-FRAME IMAGE INFORMATION OBJECT DEFINITION (RETIRED)

H.3.1 US Image IOD Description (Retired)

The Ultrasound (US) Multi-frame Image Information Object Definition (IOD) specifies a Multi-frame image which has been created by an ultrasound imaging device.

H.3.2 US Multi-frame Image IOD Entity-Relationship Model (Retired)

The E-R Model in Section A.1.2 of this Part depicts those components of the DICOM Application Information Model which directly reference the US Multi-frame Image IOD. The Overlay IE, Modality LUT IE and VOI LUT IE are not components of the US Multi-frame Image IOD.

H.3.3 US Multi-frame Image IOD Module Table (Retired)

Table H.3.3
US Multi-frame Image IOD Modules (Retired)

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M

Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	General Series	C.7.3.1	M
Frame of Reference	Frame of Reference	C.7.4.1	U
	US Frame of Reference (Retired)	I.1.2.1	C - Required if images are spatially related
Equipment	General Equipment	C.7.5.1	M
Image(See H.3.3.1)	General Image	C.7.6.1	M
	Image Pixel	C.7.6.3	M
	Contrast/bolus	C.7.6.4	C Required if contrast media was used in this image
	Cine	C.7.6.5	C -Required if pixel data is Multi-frame cine data.
	Multi-frame	C.7.6.6	M
	US Region Calibration (Retired)	I.1.2.2	U
	US Image (Retired)	I.1.2.3	M
	VOI LUT	C.11.2	U
	SOP Common	C.12.1	M
Curve (See H.3.3.1)	Curve Identification	C.10.1	M
	Curve	C.10.2	M
	Audio	C.10.3	U
	SOP Common	C.12.1	M

H.3.3.1 Mutually Exclusive IEs

The Image and Curve IEs are mutually exclusive. Each SOP Instance using this IOD shall contain exactly one of these IEs.

Annex I Retired Modules (Normative)

I.1 RETIRED MODALITY SPECIFIC MODULES

The creation of new composite image storage SOP classes and IODs to replace retired SOP classes and IODs defined in previous versions of the standard has resulted in certain modules being retired completely, or replaced with updated versions. For reference purposes, the retired modules are described here.

I.1.1 NUCLEAR MEDICINE (RETIRED)

This Section describes the retired Nuclear Medicine Series, Equipment, and Image Modules. These Modules contain Attributes that are specific to the retired NM Image IOD.

I.1.1.1 NM Series Module (Retired)

Table I.1-1
NM Series Module Attributes (Retired)

Attribute Name	Tag	Type	Attribute Description
Radionuclide	(0018,0030)	2	Name of isotope administered. See (0018,1070-1074). If multiple isotopes, all Attributes shall have values in corresponding order.
Nuclear Medicine Series Type	(0008,0042)	2	Further description of the type of Nuclear Medicine study. Defined Terms: STATIC, DYNAMIC, GATED, WHOLE BODY, STEP_SHOOT TOMO, CONTINUOUS TOMO, GATED TOMO
Scan Velocity	(0018,1300)	2C	The speed of the camera motion over the body in mm/sec. Required if Nuclear Medicine Series Type (0008,0042) contains the value WHOLE BODY.
Whole Body Technique	(0018,1301)	2C	The type of scan performed. Required if Nuclear Medicine Series Type (0008,0042) contains the value WHOLE BODY. Enumerated Values: 1PS = one pass 2PS = two pass PCN = patient contour following employed DIV = diverging collimator used MSP = multiple static images collected into a whole body image.

Scan Length	(0018,1302)	2C	Length of the scan in mm. Required if Nuclear Medicine Series Type (0008,0042) contains the value WHOLE BODY.
Radiopharmaceutical	(0018,0031)	3	Name of the radiopharmaceutical in use.
Energy Window Centerline	(0018,0032)	3	The centerline of the energy window in KeV.
Energy Window Total Width	(0018,0033)	3	Energy window total width expressed as a percentage about the energy window centerline. Half of this percentage is on either side of the energy window center.
Intervention Drug Name	(0018,0034)	3	Name of intervention drug.
Interventional Drug Start Time	(0018,0035)	3	Time of administration of the intervention drug.
Effective Series Duration	(0018,0072)	3	Total time in seconds that data was actually taken.
Syringe Counts	(0018,1045)	3	Syringe count rate in counts/sec.
Trigger Source or Type	(0018,1061)	3	Text indicating trigger source.
Radionuclide Route	(0018,1070)	3	Route of injection.
Radionuclide Volume	(0018,1071)	3	Volume of injection in cubic cm.
Radionuclide Start Time	(0018,1072)	3	Time of start of injection.
Radionuclide Stop Time	(0018,1073)	3	Time of end of injection.
Radionuclide Total Dose	(0018,1074)	3	Total amount of radionuclide injected.
Gantry/Detector Tilt	(0018,1120)	3	Angle of tilt in degrees of the scanning detector as normally given by this device.
Isotope Number	(0020,0014)	3	A subset of an acquisition corresponding to a given energy window.

I.1.1.2 NM Equipment Module (Retired)

The table in this Section contains IOD Attributes that describe Nuclear Medicine equipment used to produce an image.

Table I.1-2
NM Equipment Module Attributes (Retired)

Attribute Name	Tag	Type	Attribute Description
Center of Rotation Offset	(0018,1145)	3	Average center of rotation offset of Nuclear Medicine camera in mm.
Field of View Shape	(0018,1147)	3	Shape of the field of view of the Nuclear Medicine camera. Defined Terms: RECTANGLE ROUND HEXAGONAL

Field of View Dimension (s)	(0018,1149)	3	Dimensions of the Field of View (0018,1147) in mm. If Rectangle, row dimension followed by column; if Round, diameter; if Hexagonal, maximum row dimension.
Collimator/grid name	(0018,1180)	3	Label describing any collimator (LEAP, hires, etc.)
Collimator Type	(0018,1181)	3	Collimator type. Defined Terms: PARA = Parallel PINH = Pinhole FANB = Fan-beam CONE = Cone-beam SLNT = Slant hole ASTG = Astigmatic
Focal Distance	(0018,1182)	3	Focal distance, in mm. A value of 0 means infinite distance for parallel collimation.
X Focus Center	(0018,1183)	3	Center of focus in x dimension
Y Focus Center	(0018,1184)	3	Center of focus in y dimension

I.1.1.3 NM Image Module (Retired)

Table I.1-3 contains the Attributes that describe Nuclear Medicine Images.

Table I.1-3
NM Image Module Attributes (Retired)

Attribute Name	Tag	Type	Attribute Description
Frame Increment Pointer	(0028,0009)	1C	Contains the Data Element Tag of the attribute which is used as the frame increment in Multi-frame pixel data. Required if Number of Frames (0028,0008) is sent. See I.1.1.3.1.1 for further specialization.
Zoom Factor	(0028,0031)	2	The amount of magnification applied to each pixel in the image, specified by a numeric pair: row value (delimiter) column value
Counts Accumulated	(0018,0070)	2	Sum of all gamma events
Referenced Overlay Sequence	(0008,1130)	3	A sequence which provides reference to a set of SOP Class/Instance pairs which are related independent Overlays. Uniquely identifies Overlays significantly related to this Image. Encoded as sequence of items: (0008,1150) and (0008,1155)
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Overlay Sequence(0008,1130) is sent.

>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Reference Overlay Sequence(0008,1130) is sent.
Referenced Curve Sequence	(0008,1145)	3	A sequence which provides reference to a set of SOP Class/Instance pairs which are related independent Curves. Uniquely identifies Curves significantly related to this Image. Encoded as sequence of items: (0008,1150) and (0008,1155)
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Curve Sequence(0008,1145) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Reference Curve Sequence(0008,1145) is sent.
Acquisition Termination Condition	(0018,0071)	3	Description of how the data collection was stopped. Defined Terms: CNTS = counts DENS = density MANU = manual OVFL = data overflow TIME = time TRIG = physiological trigger
Reconstruction Diameter	(0018,1100)	3	Diameter in mm. of the region from within which data were used in creating the reconstruction of the image. Data may exist outside this region and portions of the patient may exist outside this region.
Distance Source to Detector	(0018,1110)	3	Distance in mm from source to detector center
Table Height	(0018,1130)	3	The distance in mm of the top of the patient table to the center of rotation; below the center is positive.
Table Traverse	(0018,1131)	3	Location of the patient table (or gantry relative to the table) in mm.
Angular Position	(0018,1141)	3	Position of the detector about the patient in degrees. Zero degrees is referenced to the origin at the patient's back. Viewing from the patient's feet, angle increases in an anti-clockwise direction (detector normal rotating from the patient's back towards the patient's left side).
Radial Position	(0018,1142)	3	Radial distance of the detector from the center of rotation, in mm.
Convolution Kernel	(0018,1210)	3	A label describing the convolution kernel or algorithm used to reconstruct the data .

Actual Frame Duration	(0018,1242)	3	Elapsed time of data acquisition in msec
Count Rate	(0018,1243)	3	Maximum number of counts achieved during the acquisition in counts/sec.
Preprocessing Function	(0018,5020)	3	Code or description of preprocessing function applied to the data in the receiver portion of the equipment. In general, a signal processing function applied before or as the data is written to scan converter memory.
Postprocessing Function	(0018,5021)	3	Code or description of postprocessing function applied to the data in the scan converter portion of the equipment. In general, an image processing function applied to the image after storage in memory and before or as the data is being sent to the display.
Phase Number	(0020,0015)	3	A subset of an acquisition in which each image has the same duration of collection
Interval Number	(0020,0016)	3	A subset of acquisition corresponding to cardiac cycles that fall into a defined window of R to R intervals
Time Slot Number	(0020,0017)	3	A subset of acquisition including all the data corresponding to one time slice of a cardiac cycle
Angle Number	(0020,0018)	3	A subset of acquisition including all the data corresponding to one angular position of the detector
Zoom Center	(0028,0032)	3	The amount of offset from (0,0) applied to each pixel in the image before application of the zoom factor, specified by a numeric pair: row value (delimiter) column value (in mm).
Corrected Image	(0028,0051)	3	A value that indicates which, if any, corrections have been applied to the image. Defined Terms: UNIF = flood corrected COR = center of rotation corrected NCO = non-circular orbit corrected DECY = decay corrected ATTN = attenuation corrected SCAT = scatter corrected DTIM = dead time corrected

I.1.1.3.1 NM Image Attribute Descriptions (Retired)

I.1.1.3.1.1 Frame Increment Pointer

If NM Images are Multi-frame Images, the Frame Increment Pointer (0028,0009) of the Multi-frame Module (see Section C.7.6.6) is specified by the following Defined Terms:

00180050 = sequencing by Slice Thickness (0018,0050)

00181063 = sequencing by Frame Time (0018,1063)

00181144 = sequencing by Angular Step (0018,1144)

I.1.1.4 NM SPECT Acquisition Image Module (Retired)

This Module applies to a SPECT Multi-frame Image.

Table I.1-4
NM SPECT Acquisition Image Module Attributes (Retired)

Attribute Name	Tag	Type	Attribute Description
Frame Increment Pointer	(0028,0009)	1	Contains the Data Element Tag of the attribute which is used as the frame increment in Multi-frame pixel data (see C.7.6.6). Enumerated Value: 00181144 = Angular Step (0018,1144)
Angular Step	(0018,1144)	1	The angular scan arc step between views of the SPECT acquisition, in degrees.
Zoom Factor	(0028,0031)	2	The amount of magnification applied to each pixel in the image, specified by a numeric pair: row value (delimiter) column value
Scan Arc	(0018,1143)	2C	The angular range of the scan data in degrees. Required if the image is tomographic.
Reconstruction Diameter	(0018,1100)	3	Diameter in mm. of the region from within which data were used in creating the reconstruction of the image. Data may exist outside this region and portions of the patient may exist outside this region.
Distance Source to Detector	(0018,1110)	3	Distance in mm from source to detector center
Table Height	(0018,1130)	3	The distance in mm of the top of the patient table to the center of rotation; below the center is positive.
Table Traverse	(0018,1131)	3	Location of the patient table (or gantry relative to the table) in mm.

Rotation Direction	(0018,1140)	3	Direction of rotation of the source when relevant, about nearest principal axis of equipment. Enumerated Values: CW = clockwise CC = counter clockwise
Angular Position	(0018,1141)	3	Position of the detector about the patient in degrees. For Multi-frame images, this attribute only applies to the first frame. Zero degrees is referenced to the origin at the patient's back. Viewing from the patient's feet, angle increases in an anti-clockwise direction (detector normal rotating from the patient's back towards the patient's left side).
Radial Position	(0018,1142)	3	Radial distance of the detector from the center of rotation, in mm.
Rotation Offset	(0018,1146)	3	Actual offset from center of rotation of image in mm. The offset can be positive or negative. This attribute is specific to tomographic acquisitions.
Angle Number	(0020,0018)	3	A subset of acquisition including all the data corresponding to one angular position of the detector. For Multi-frame images with Frame Increment Pointer = Angular Step, This attribute applies only to the first frame.
Zoom Center	(0028,0032)	3	The amount of offset from (0,0) applied to each pixel in the image before application of the zoom factor, specified by a numeric pair: row value (delimiter) column value (in mm).

I.1.1.4.1 NM SPECT Acquisition Attribute Descriptions (Retired)

I.1.1.4.1.1 Angular Step

Angular Step (0018,1144) is the nominal frame-to-frame incremental angle for SPECT acquisition images, defined in degrees. The Angular Step may be signed, but is not required to be signed. To avoid redundancy, the Angular Step is assumed to be the Scan Arc divided by the number of views. Summation of Angular Step values is not defined to give accurate Angular Position or Scan Arc values. If the NM Series Type is CONTINUOUS TOMO, the Angular Step is the effective angular spacing between resultant frames of the Multi-framed planar image data.

I.1.1.5 NM Multi-gated Acquisition Image Module (Retired)

Table I.1-5 contains Attributes that describe a multi-gated acquisition image performed on the patient.

Table I.1-5
NM Multi-gated Acquisition Image Module Attributes (Retired)

Attribute Name	Tag	Type	Attribute Description
Frame Increment Pointer	(0028,0009)	1	Contains the Data Element Tag of the attribute which is used as the frame increment in Multi-frame pixel data (see C.7.6.6). Enumerated Value: 00181063 = Frame Time (0018,1063)
Trigger Source or Type	(0018,1061)	2	Text indicating trigger source.
Frame Time	(0018,1063)	2	Nominal time per individual frame in seconds.
Trigger Time	(0018,1060)	3	Time interval measured in msec from the start of the R-wave to the beginning of data taking
Nominal Interval	(0018,1062)	3	Average R-R interval used for these data, in msec
Framing Type	(0018,1064)	3	Description of type of framing performed such as forward, backward, forward/backward by thirds, phase.
Beat Rejection Flag	(0018,1080)	3	Beat length sorting has been applied. Enumerated Values: Y = yes N = no
Low R-R Value	(0018,1081)	3	R-R interval low limit for beat rejection, in msec
High R-R Value	(0018,1082)	3	R-R interval high limit for beat rejection, in msec
Intervals Acquired	(0018,1083)	3	Number of R-R intervals acquired.
Intervals Rejected	(0018,1084)	3	Number of R-R intervals rejected.
PVC Rejection	(0018,1085)	3	Description of type of PVC rejection criteria used.
Skip Beats	(0018,1086)	3	Number of beats skipped after a detected arrhythmia
Heart Rate	(0018,1088)	3	Beats per minute.
Cardiac Number of Images	(0018,1090)	3	Number of Images per cardiac cycle.

I.1.2 Ultrasound (Retired)

This Section describes the retired Ultrasound Frame of Reference and Image Modules. These Modules contain Attributes that are specific to Ultrasound images.

I.1.2.1 US Frame of Reference Module (Retired)

Table I.1-6 contains IOD Attributes that describe an ultrasound Frame of Reference.

Table I.1-6
US Frame of Reference Module Attributes (Retired)

Attribute Name	Tag	Type	Attribute Description
Region Location Min x_0	(0018,6018)	1	The bounds of a rectangle specifying the location of the region, x_0,y_0,x_1,y_1. See I.1.2.1.1.1 for further explanation.
Region Location Min y_0	(0018,601A)	1	The bounds of a rectangle specifying the location of the region, x_0,y_0,x_1,y_1. See I.1.2.1.1.1 for further explanation.
Region Location Max x_1	(0018,601C)	1	The bounds of a rectangle specifying the location of the region, x_0,y_0,x_1,y_1. See I.1.2.1.1.1 for further explanation.
Region Location Max y_1	(0018,601E)	1	The bounds of a rectangle specifying the location of the region, x_0,y_0,x_1,y_1. See I.1.2.1.1.1 for further explanation.
Physical Units X Direction	(0018,6024)	1	The physical units of the dimensions of the region. See I.1.2.1.1.2 for Enumerated Values.
Physical Units Y Direction	(0018,6026)	1	The physical units of the dimensions of the region. See I.1.2.1.1.2 for Enumerated Values.
Physical Delta X	(0018,602C)	1	The physical value increments per positive X pixel increment. The units are as specified in the Physical units data element.
Physical Delta Y	(0018,602E)	1	The physical value increments per positive Y pixel increment. The units are as specified in the Physical units data element.
Reference Pixel x_0	(0018,6020)	3	This coordinate pair, x_0,y_0 defines the location of a virtual "reference" pixel. See I.1.2.1.1.3 for further explanation.
Reference Pixel y_0	(0018,6022)	3	This coordinate pair, x_0,y_0 defines the location of a virtual "reference" pixel. See I.1.2.1.1.3 for further explanation.
Ref. Pixel Physical Value X	(0018,6028)	3	The Physical Value at the reference pixel x location. The units are specified in the Physical Units field.
Ref. Pixel Physical Value Y	(0018,602A)	3	The Physical Value at the reference pixel y location. The units are specified in the Physical Units field.

I.1.2.1.1 US Frame Of Reference Attribute Definitions (Retired)

I.1.2.1.1.1 Region Location Min x_0, Region Location Min y_0, Region Location Max x_1, Region Location Max y_1

The bounds of a rectangle specifying the location of the region, Region Location Min x_0 (0018,6018), Region Location Min y_0 (0018,601A), Region Location Max x_1 (0018,601C), Region Location Max y_1 (0018,601E). The upper left corner of the entire image is x=0,y=0 and the lower right corner is x=image width - 1, and y=image length - 1. Thus, a region will be specified as within these bounds. Where x_0,y_0 is the coordinate of the upper left corner of the region and x_1,y_1 is the coordinate of the lower right corner of the region.

I.1.2.1.1.2 Physical Units X Direction and Physical Units Y Direction

Physical Units X Direction (0018,6024) and Physical Units Y Direction (0018,6026) provide Enumerated Values indicating the physical units of the dimensions of the region.

Value	Meaning
0000H	None or not applicable
0001H	Percent
0002H	dB
0003H	cm
0004H	seconds
0005H	hertz($seconds^{-1}$)
0006H	dB/seconds
0007H	cm/sec
0008H	cm^2
0009H	cm^2/sec
000AH	cm^3
000BH	cm^3/sec
000CH	degrees

I.1.2.1.1.3 Reference Pixel x_0 and Reference Pixel y_0

This coordinate pair, Reference Pixel x_0 (0018,6020), Reference Pixel y_0 (0018,6022) defines the location of a virtual "reference" pixel. The reference pixel is used to tie the image's pixel coordinate system to the physical coordinate system. For example, the reference pixel could be defined where a depth of zero centimeters occurs in the 2D image, or it could define where the baseline (i.e.: zero frequency) resides in a spectral display. The reference pixel location is the relative offset from the region location, not necessarily the image origin. The location is not required to be within the region or even within the image boundary. For this reason, the Reference Pixel Location can be positive or negative.

Recommended locations are:

Sector	Skin line
Linear	Skin line left corner
Doppler Spectral	Baseline left
M-Mode	Skin line left
Physio	Baseline left (where baseline = 0)

I.1.2.2 US Region Calibration Module (Retired)

The US Region Calibration Module has been introduced into the ultrasound IOD to provide access to the full range of data which may be present in a single US image. US images often contain multiple regions which have independent data regions, e.g. quad screen loops which may have different calibration information. The data presented in the various regions of a US image can represent a multiplicity of physical parameters, e.g., spatial distance, blood velocity, time, volume, etc., and these are often contained in the value of the pixel itself. It is therefore imperative that physical information be available for the various regions of a single region independent of each other.

Table I.1-7
US Region Calibration Module Attributes (Retired)

Attribute Name	Tag	Type	Attribute Description
Sequence of Ultrasound Regions	(0018,6011)	1	Defines a sequence of Ultrasound Regions.
>Region Location Min x_0	(0018,6018)	1	The bounds of a rectangle specifying the location of the region, x_0,y_0,x_1,y_1. See I.1.2.1.1.1 for further explanation.
>Region Location Min y_0	(0018,601A)	1	The bounds of a rectangle specifying the location of the region, x_0,y_0,x_1,y_1. See I.1.2.1.1.1 for further explanation.
>Region Location Max x_1	(0018,601C)	1	The bounds of a rectangle specifying the location of the region, x_0,y_0,x_1,y_1. See I.1.2.1.1.1 for further explanation.
>Region Location Max y_1	(0018,601E)	1	The bounds of a rectangle specifying the location of the region, x_0,y_0,x_1,y_1. See I.1.2.1.1.1 for further explanation.
>Physical Units X Direction	(0018,6024)	1	The physical units of the dimensions of the region. See I.1.2.1.1.2 for Enumerated Values.
>Physical Units Y Direction	(0018,6026)	1	The physical units of the dimensions of the region. See I.1.2.1.1.2 for Enumerated Values.
>Physical Delta X	(0018,602C)	1	The physical value increments per positive X pixel increment. The units are as specified in the physical units data element.

>Physical Delta Y	(0018,602E)	1	The physical value increments per positive Y pixel increment. The units are as specified in the physical units data element.
>Reference Pixel x_0	(0018,6020)	3	This coordinate pair, x_0,y_0 defines the location of a virtual "reference" pixel. See I.1.2.1.1.3 for further explanation.
>Reference Pixel y_0	(0018,6022)	3	This coordinate pair, x_0,y_0 defines the location of a virtual "reference" pixel. See I.1.2.1.1.3 for further explanation.
>Ref. Pixel Physical Value X	(0018,6028)	3	The Physical Value at the reference pixel x location. The units are specified in the Physical Units field.
>Ref. Pixel Physical Value Y	(0018,602A)	3	The Physical Value at the reference pixel y location. The units are specified in the Physical Units field.
>Region Spatial Format	(0018,6012)	1	The spatial organization of the data within the region. See I.1.2.2.1.1 for Enumerated Values.
>Region Data Type	(0018,6014)	1	The type of data within the region. See I.1.2.2.1.2 for Enumerated Values.
>Region Flags	(0018,6016)	1	Flags used for special handling of the region. See I.1.2.2.1.3 for Enumerated Values and further explanation.
>Pixel Component Organization	(0018,6044)	1C	Describing how the components of a pixel can be described, either by bit aligned positions or ranges of values. The absence of this Data Element means that pixel component calibration does not exist for this region. See I.1.2.2.1.4 for Enumerated Values and further explanation.
>Pixel Component Mask	(0018,6046)	1C	This value is ANDed with the composite pixel code for each pixel within the region, then shifted right by the number of contiguous least significant zeros in the mask to obtain what will be referred to as the "Shifted Masked Composite Pixel Code" (SMCPC). Required if Pixel Component Organization = Bit aligned. See I.1.2.2.1.5 for further explanation.

>Pixel Component Range Start	(0018,6048)	1C	Defines the start of the numeric range of values within the composite pixel where calibration is to be defined by the "pixel physical calibration table". To be used only when ranges are used to describe the portion of the composite pixel. Required if Pixel Component Organization = Ranges.
>Pixel Component Range Stop	(0018,604A)	1C	Defines the stop of the numeric range of values within the composite pixel where calibration is to be defined by the "pixel physical calibration table". To be used only when ranges are used to describe the portion of the composite pixel. Required if Pixel Component Organization = Ranges.
>Pixel Component Physical Units	(0018,604C)	1C	The physical units to be applied to the pixel component. Required if Pixel Component Organization exists. See I.1.2.2.1.6 for further explanation.
>Pixel Component Data Type	(0018,604E)	1C	The type of data for the pixel component. Required if Pixel Component Organization exists. See I.1.2.2.1.7 for further explanation.
>Number of Table Break Points	(0018,6050)	1C	The number of break point coordinate pairs used to describe a piece wise linear curve. Required if Pixel Component Organization exists. See I.1.2.2.1.8 for further explanation.
>Table of X Break Points	(0018,6052)	1C	An array of X values used to create the piece wise linear curve. Required if Pixel Component Organization exists. See I.1.2.2.1.9 for further explanation.
>Table of Y Break Points	(0018,6054)	1C	An array of Y values used to create the piece wise linear curve. Required if Pixel Component Organization exists. See I.1.2.2.1.9 for further explanation.
>Transducer Frequency	(0018,6030)	3	The manufacturer defined description of center frequency of the interrogating ultrasound energy. The units are Kilohertz.

>Pulse Repetition Frequency	(0018,6032)	3	The ultrasound pulse repetition frequency, as defined by the manufacturer, used to collect data in the region. The units are in hertz.
>Doppler Correction Angle	(0018,6034)	3	The Doppler correction angle. The units are degrees.
>Steering Angle	(0018,6036)	3	The steering angle, as defined by the manufacturer, used for a steered 2D image. The units are degrees.
>Doppler Sample Volume X Position	(0018,6038)	3	The x displacement, in pixels, from the Reference pixel to the center of the Doppler sample volume.
>Doppler Sample Volume Y Position	(0018,603A)	3	The y displacement, in pixels, from the Reference pixel to the center of the Doppler sample volume.
>TM-Line Position x_0	(0018,603C)	3	The starting and ending coordinates pairs of the m-line. Where the X_0,Y_0 are the starting point and X_1,Y_1 are the end point of the tm-line. See I.1.2.2.1.10 for further explanation.
>TM-Line Position y_0	(0018,603E)	3	The starting and ending coordinates pairs of the m-line. Where the X_0,Y_0 are the starting point and X_1,Y_1 are the end point of the tm-line. See I.1.2.2.1.10 for further explanation.
>TM-Line Position x_1	(0018,6040)	3	The starting and ending coordinates pairs of the m-line. Where the X_0,Y_0 are the starting point and X_1,Y_1 are the end point of the tm-line. See I.1.2.2.1.10 for further explanation.
>TM-Line Position y_1	(0018,6042)	3	The starting and ending coordinates pairs of the m-line. Where the X_0,Y_0 are the starting point and X_1,Y_1 are the end point of the tm-line. See I.1.2.2.1.10 for further explanation.

I.1.2.2.1 US Region Calibration Attribute Definitions (Retired)

I.1.2.2.1.1 Region Spatial Format

Enumerated Values for Region Spatial Format (0018,6012) indicate the spatial organization of the data within the region.

Value	Meaning
0000H	None or not applicable
0001H	2D(tissue or flow)

0002H	M-Mode(tissue or flow)
0003H	Spectral(CW or PW Doppler)
0004H	Wave form(physiological traces, doppler traces,....)
0005H	Graphics

I.1.2.2.1.2 Region Data Type

Enumerated Values for Region Data Type (0018,6014) indicate the type of data within the region.

Value	Meaning
0000H	None or not applicable
0001H	Tissue
0002H	Color Flow
0003H	PW Spectral Doppler
0004H	CW Spectral Doppler
0005H	Doppler Mean Trace
0006H	Doppler Mode Trace
0007H	Doppler Max Trace
0008H	Volume Trace
0009H	d(volume)/dt Trace
000AH	ECG Trace
000BH	Pulse Trace
000CH	Phonocardiogram Trace
000DH	Gray bar
000EH	Color bar
000FH	Integrated Backscatter
0010H	Area Trace
0011H	d(area)/dt
0012H	Other Physiological (Amplitude vs. Time) input

I.1.2.2.1.3 Region Flags

Region Flags (0018,6016) are used for special handling of the region.

Enumerated Values for Bit 0 (lsb) Transparency:

1 = Transparent

0 = Opaque

If the region is transparent, then measurements may be done on regions underneath this region. This most useful for ECG overlays region overlapping with a 2D region.

Enumerated Values for Bit 1 Scaling Protection:

1 = Protected

0 = Not Protected

Ultrasound systems should set this to 1 if the image is scaled automatically by the ultrasound system. If the image is frame grabbed and scaling is not available then it should be set to 0. If the region is protected, the region can not be manually rescaled. That is the data defined by the region calibration Module can not be overridden by a reader of that image.

Enumerated Values for Bit 2 Doppler Scale Type:

1 = Frequency

0 = Velocity

Valid for PW and CW regions only. Indicates which type of doppler scale is used.

Bit 3-31 Reserved for future use, shall be set to zero.

I.1.2.2.1.4 Pixel Component Organization

Pixel Component Organization (0018,6044) provides an Enumerated Value describing how the components of a pixel can be described, either by bit aligned positions or ranges of values. The absence of this data element means that pixel component calibration does not exist for this region. Where:

0 = Bit aligned positions

1 = Ranges

Other values reserved for future use, shall be set to zero.

I.1.2.2.1.5 Pixel Component Mask

Pixel Component Mask (0018,6046) is ANDed with the composite pixel code for each pixel within the region, then shifted right by the number of contiguous least significant zeros in the mask to obtain what will be referred to as the "Shifted Masked Composite Pixel Code" (SMCPC). A composite pixel code is formed by concatenating all samples of the pixel, with samples occurring first in the file representing the less significant portions of the pixel code, regardless of byte swapping or planar configuration formats. Said another way, as each sample is encountered in the file it should be added as a prefix to the accruing composite pixel code. For example, if SamplesPerPixel = 2, then, regardless of byte swapping or Planar Configuration, the first byte encountered in the file for a given pixel represents the least significant byte. The composite pixel code would be the MSbyteLSbyte- a 16 byte value.

The mask will most likely (but not necessarily) contain a block of contiguous ones, surrounded by leading and trailing zeros. The purpose of this mask is to keep only those bits within the composite pixel code which pertain to the region. It is to be used only when Pixel Organization is bit aligned positions.

I.1.2.2.1.6 Pixel Component Physical Units

For Pixel Component Physical Units (0018,604C), the Enumerated Values describing the physical units to be applied to the pixel component are:

Value	Meaning
0000H	None or not applicable
0001H	Percent
0002H	dB
0003H	cm
0004H	seconds
0005H	hertz($seconds^{-1}$)

0006H	dB/seconds
0007H	cm/sec
0008H	cm^2
0009H	cm^2/sec
000AH	cm^3
000BH	cm^3/sec
000CH	degrees

I.1.2.2.1.7 Pixel Component Data Type

For Pixel Component Data Type (0018,604E), the Enumerated Values indicating the type of data for the pixel component are:

Value	Meaning
0000H	None or not applicable
0001H	Tissue
0002H	Spectral doppler
0003H	Color Flow Velocity
0004H	Color Flow Variance
0005H	Color Flow Intensity
0006H	Gray bar
0007H	Color bar
0008H	Integrated Backscatter
0009H	Computed Border

I.1.2.2.1.8 Number of Table Break Points

The Number of Table Break Points (0018,6050) coordinate are pairs used to describe a piece wise linear curve. This curve maps the value of the pixel component to it's actual physical value (units defined in Pixel Component Physical Units Data Element).

I.1.2.2.1.9 Table of X Break Points and Table of Y Break Points

Table of X Break Points (0018,6052) and Table of Y Break Points (0018,6054) are individual arrays of coordinates which interpreted together are used to create the piece wise linear curve. Note that the units for each direction are different. The x direction for the curve has no units and the y direction units are as described in the Pixel Component Physical Units Data Element.

I.1.2.2.1.10 TM-Line Position X_0, TM-Line Position Y_0, TM-Line Position X_1, TM-Line Position Y_1

The TM-Line Position X_0 (0018,603C) and TM-Line Position Y_0 (0018,603E) are the coordinates of the starting point and TM-Line Position X_1 (0018,6040), TM-Line Position Y_1 (0018,6042) are the coordinates of the end point of the tm-line. The coordinate is defined as the displacement, in pixels, from the Reference pixel. Typically used for M-mode line and CW doppler.

I.1.2.3 US Image Module (Retired)

Table I.1.8 specifies the Attributes that describe ultrasound images.

Table I.1-8
US Image Module Attributes (Retired)

Attribute Name	Tag	Type	Attribute Description
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. See I.1.2.3.1.2 for specialization.
Pixel Representation	(0028,0103)	1	Data representation of pixel samples. See I.1.2.3.1.3 for specialization.
Frame Increment Pointer	(0028,0009)	1C	Contains the Data Element Tag of the attribute which is used as the frame increment in Multi-frame pixel data (see C.7.6.6). Required if Number of Frames is sent. See I.1.2.3.1.4 for specialization.
Image Type	(0008,0008)	2	Image identification characteristics. See I.1.2.3.1.1 for specialization.
Number of Stages	(0008,2124)	2C	Number of Stages in this protocol. Required if image was acquired in a Stage protocol.
Number of Views in Stage	(0008,212A)	2C	Number of views in this Stage. Required if image was acquired in a Stage protocol.
Referenced Overlay Sequence	(0008,1130)	3	A sequence which provides reference to a set of SOP Class/Instance pairs which are related independent Overlays. Uniquely identifies Overlays significantly related to this Image. Encoded as sequence of items: (0008,1150) and (0008,1155)
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Overlay Sequence(0008,1130) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Reference Overlay Sequence(0008,1130) is sent.
Referenced Curve Sequence	(0008,1145)	3	A sequence which provides reference to a set of SOP Class/Instance pairs which are related independent Curves. Uniquely identifies Curves significantly related to this Image. Encoded as sequence of items: (0008,1150) and (0008,1155)
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Curve Sequence(0008,1145) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Reference Curve Sequence(0008,1145) is sent.

Stage Name	(0008,2120)	3	A Stage is a particular time slice of a protocol in which a set of images are collected. The names can be free form text. Recommended text for Stress Echo stage names are: PRE-EXERCISE, POST-EXERCISE, PEAK-EXERCISE, RECOVERY, BASELINE, LOW DOSE, PEAK DOSE
Stage Number	(0008,2122)	3	A number that identifies the Stage. Stage Number starts at one.
View Number	(0008,2128)	3	A number that identifies the View. View Number starts at one.
Number of Event Timers	(0008,2129)	3	The number of event timers used at the time of acquisition of a Multi-frame image.
Event Elapsed Time(s)	(0008,2130)	3	An array of values associated with each event timer. Units in milliseconds.
Event Timer Name(s)	(0008,2132)	3	Name that identifies the event timer.
Transducer Position	(0008,2200)	3	Position of the Transducer. See I.1.2.3.1.5 for Defined Terms
Transducer Orientation	(0008,2204)	3	Provides the transducer orientation for TTE and TEE. See I.1.2.3.1.6 for Defined Terms.
Anatomic Structure	(0008,2208)	3	Description of the anatomic structure under current interrogation, either by imaging or Doppler. See I.1.2.3.1.7 for Defined Terms.
Trigger Time	(0018,1060)	3	Time interval measured in msec from the start of the R-wave to the beginning of data taking
Nominal Interval	(0018,1062)	3	Average R-R interval used for these data, in msec
Beat Rejection Flag	(0018,1080)	3	Beat length sorting has been applied. Enumerated Values: Y = yes N = no
Low R-R Value	(0018,1081)	3	R-R interval low limit for beat rejection, in msec
High R-R Value	(0018,1082)	3	R-R interval high limit for beat rejection, in msec
Heart Rate	(0018,1088)	3	Beats per minute.
Output Power	(0018,5000)	3	Manufacturer defined character string description of ultrasound output level(s) used in generating a given image. Data may be expressed in dB, %, W/cm^2, etc.

Transducer Data	(0018,5010)	3	Manufacturer defined code or description of ultrasound transducer used.
Transducer Type	(0018,6031)	3	Defined Terms: SECTOR_PHASED SECTOR_MECH SECTOR_ANNULAR LINEAR CURVED LINEAR SINGLE CRYSTAL SPLIT XTAL CWD IV_PHASED IV_ROT XTAL IV_ROT MIRROR ENDOCAV_PA ENDOCAV_MECH ENDOCAV_CLA ENDOCAV_AA ENDOCAV_LINEAR VECTOR_PHASED
Focus Depth	(0018,5012)	3	The depth, from the transducer face, of the manufacturer defined beam focus used for the image, in cm.
Preprocessing Function	(0018,5020)	3	Manufacturer defined description of processing of echo information. Data may include code or description of gain (initial, overall, TGC, dynamic range, etc.), preprocessing, postprocessing, Doppler processing parameters, e.g. cutoff filters, etc., as used in generating a given image.
Mechanical Index	(0018,5022)	3	See I.1.2.3.1.8 for Description.
BoneThermal Index	(0018,5024)	3	See I.1.2.3.1.8 for Description.
Cranial Thermal Index	(0018,5026)	3	See I.1.2.3.1.8 for Description.
Soft Tissue Thermal Index	(0018,5027)	3	See I.1.2.3.1.8 for Description.
Soft Tissue-focus Thermal Index	(0018,5028)	3	See I.1.2.3.1.8 for Description.
Soft Tissue-surface Thermal Index	(0018,5029)	3	See I.1.2.3.1.8 for Description.
Depth of Scan Field	(0018,5050)	3	The depth, in mm, from the transducer face to the deepest point included in the displayed image– the field of view.
Image Transformation Matrix	(0018,5210)	3	Transformation Matrix, as described in I.1.2.3.1.9. Used for spatially related images where the relationship includes rotations.

Image Translation Vector	(0018,5212)	3	Translation Vector as described in I.1.2.3.1.9. Used for spatially related images where the relationship includes translations.

I.1.2.3.1 US Image Attribute Descriptions (Retired)

I.1.2.3.1.1 Image Type

For US Images, Image Type (0008,0008) is specified to be Type 2. The Defined Terms for Value 3 are:

ABDOMINAL	BREAST	CHEST
ENDOCAVITARY	ENDORECTAL	ENDOVAGINAL
EPICARDIAL	FETAL HEART	GYNECOLOGY
INTRACARDIAC	INTRAOPERATIVE	INTRAVASCULAR
MUSCULOSKELETAL	NEONATAL HEAD	OBSTETRICAL
OPHTHALMIC	PEDIATRIC	PELVIC
RETROPERITONEAL	SCROTAL	SMALL PARTS
TEE	THYROID	TRANSCRANIAL
TTE	US BIOPSY	VASCULAR

Value 4 is constructed as a modality bit map to allow for a description of multi-modality displays. In using this bit map, the sum of the values of the various modalities will unambiguously determine the constituent modalities.

0001 = 2D Imaging	0002 = M-Mode
0004 = CW Doppler	0008 = PW Doppler
0010 = Color Doppler	0020 = Color M-Mode
0040 = 3D Rendering	

Notes: 1. All Values are hexadecimal encoded as a CS. See Part 5 of the DICOM Standard.

2. For example, Color Flow with CW spectral Doppler would have a value 4 = 0015. Note that no assumption should be made in Color Doppler or Color M-Mode regarding underlying B or M-Mode, respectively.

I.1.2.3.1.2 Photometric Interpretation

For US Images, Photometric Interpretation (0028,0004)

is specified to use the following Defined Terms:

MONOCHROME2
PALETTE COLOR
RGB
ARGB

I.1.2.3.1.3 Pixel Representation

For US Images, Pixel Representation (0028,0103) is specified to use the following Enumerated Value:

0000H = unsigned integer

I.1.2.3.1.4 Frame Increment Pointer

For US Multi-frame images, the Attribute Frame Increment Pointer (0028,0009) of the Multi-frame Module (see Section C.7.6.6) is specified by the following Defined Terms:

00180063 = sequencing by Frame Time (0018,1063)

00181065 = sequencing by Frame Time Vector (0018,1065)

I.1.2.3.1.5 Transducer Position

For US images, Transducer Position (0008,2200) shall use the following Defined Terms:

ANTERIOR	L SUBCLAVIAN	R SUBCLAVIAN
AORTA	LSUPRACLAVICULAR	RSUPRACLAVICULAR
APICAL	L UIQ	R UIQ
ARTERY	L UOQ	R UOQ
BASAL ESOPHAGUS	L VENTRICLELATERAL	R VENTRICLE
BYPASS GRAFT	LEFT	RIGHT
CAUDAL	LEFT PARA	RIGHT PARA
CRANIAL	LOWER ESOPHAGUS	SUBCLAVIAN
DISTAL	MEDIAL	SUBCOSTAL
ENDOVAGINAL	MID ESOPHAGUS	SUP STERN NOTCH
ENDORECTAL	MIDLINE	SUPERIOR
EPICARDIAL	OCCIPITAL	SUPRACLAVICULAR
ESOPHAGUS	POSTERIOR	SURFACE
GASTRIC	PROXIMAL	TRANSGASTRIC
INFERIOR	PULMONARY ART	TRANSORBITAL
L ATRIUM	R ATRIUM	TRANSTEMPORAL
L CORONARY ART	R CORONARY ART	UPPER ESOPHAGUS
L LIQ	R LIQ	VEIN
L LOQ	R LOQ	
L PARASTERN	R PARASTERN	

I.1.2.3.1.6 Transducer Orientation

For US images, Transducer Orientation (0008,2204) shall use the following Defined Terms:

2 CHAMBER	CORONAL	OBLIQUE
4 CHAMBER	L PARASAG	R PARASAG
5 CHAMBER	LONG AXIS	SAGITTAL
AXIAL	LONGITUDINAL	SHORT AXIS
		TRANSVERSE

I.1.2.3.1.7 Anatomic Structure

For US images, Anatomic Structure (0008,2208) shall use the following Defined Terms:

4 CH HEART	3RD VENTRICLE	4TH VENTRICLE
AC	ADRENAL	AMNIOTIC FLUID
AORTA	APPENDIX	ASCENDING COLON
BASILAR ART	BILE DUCT	BLADDER
BPD	C SPINE	CELIAC ART
CENTRAL ZONE	CEREBELLUM	CEREB HEMISPHERE
CERVIX	COLON	CUL DE SAC
DESCENDING COLON	DUODENUM	ENDOMETRIUM
FETAL ARMS	FETAL DIGITS	FETAL HEART
FETAL LEGS	FETAL POLE	FEMUR LENGTH
FUNDUS	GALLBLADDER	GEST SAC
HC	HEPATIC ART	ILEUM
ISTHMUS	INF MES ART	INF VENA CAVA
L ACA	L AXILLARY A	L AXILLARY V
L BRACHIAL A	L BRACHIAL V	L BREAST
L BULB	L CCA	L CFA
L CFV	L CHOROID PLEXUS	L COM ILIAC ART
L COM ILIAC V	L ECA	L EPIDIDYMIS
L EXT ILIAC A	L EXT ILIAC V	L EXT JUG V
L EYE	L FEMUR	L GSV
L HEPATIC V	L HUMERUS	L ICA
L ILIAC A	L ILIAC V	L INT JUG V
L KIDNEY	L MCA	L OVARY
L PCA	L POP A	L POP V
L PROF FEM A	L PROF FEM V	L RADIAL A
L RADIUS	L RENAL ART	L RENAL V
L SEM VESICLE	L SAPH V	L SFA
L SFV	L SPINE	L SUBCLAVIAN A
L SUBCLAVIAN V	L TESTIS	L THALAMUS
L TIB FIB	L ULNA	L ULNAR ART
L VENTRICLE	L VERT	LAT VENTRICLES
LIVER	L PORTAL V	MID HEPATIC V
MORRISONS POUCH	OFD	PANCREAS
PENILE VESSELS	PERIPHERAL ZONE	PLACENTA
PORTAL V	PROSTATE	R ACA
R AXILLARY A	R AXILLARY V	R BRACHIAL A
R BRACHIAL V	R BREAST	R BULB
R CCA	R CFA	R CFV
R CHOROID PLEXUS	R COM ILIAC ART	R COM ILIAC V
R ECA	R EYE	R EPIDIDYMIS

R EXT ILIAC A
R EXT ILIAC V
R EXT JUV V
R FEMUR
R GSV
R HEPATIC V
R HUMERUS
R ICA
R ILIAC A
R ILIAC V
R INT JUG V
R KIDNEY
R MCA
R OVARY
R PCAR POP A
R POP V
R PROF FEM A
R PROF FEM V
R RADIAL A
R RADIUS
R RENAL ART
R RENAL V
R SAPH V
R SEM VESICLE
R SFA
R SFV
R SUBCLAVIAN A
R SUBCLAVIAN V
R TESTIS
R THALAMUS
R TIB FIB
R ULNA
R ULNAR ART
R VENTRICLE
R VERT
R PORTAL V
RECTUM
RETROPERITONEUM
SACRUM
SCROTUM
SIGMOID
SMA
SMALL INTESTINE
SMV
SPLEEN
SPLENIC ART
SPLENIC V
STOMACH
TESTICLE
T SPINE
THYROID
TRANSITION ZONE
TRANSVERSE COLON
SIGMOID
UMB CORD
UTERINE FUNDUS
UTERUS
VAGINA
YOLK SAC
ABD AO
AO ANNULUS
AO ARCH
AO LFLT TIPS
AO VALVE
ASCENDING AO
ASD
AZYGOS VEIN
CORONARY SINUS
DIAGONAL
DISTAL LAD
DISTAL LCX
DISTAL RCA
IAS
INNOMINATE A
INT ATRIAL SEPT
INT VENT SEPT
IVS
L ATRIAL APPEN
L ATRIUM
L FOOT
L GERMINAL MATRX
L HIP
L SHOULDER
L MAIN COR ART
L SAPH V
L SVC
LAD
LAD D1
LAD D2
LAD D3
LAD S1
LAD S2
LCX
LCX DM1
LCX DM2
LIMA
LLPV
LOWER DESC AO
LPA
LPV
LUPV
LV APEX
LV BASE
LV CAVITY
LV MID
LVOT
MAIN PA
MID LAD
MID LCX
MID RCA
MITRAL ANNULUS
MITRAL LFLT TIPS
MITRAL VALVE
OBTUSE MARGINAL
PERINEUM
PLV COR ART
POST DESC ART
POST LV BRANCH
PROX CIRC
PROX LAD

PROX LCX	PROX RCA	PULM ANNULUS
PULM VALVE	PULM VEIN	PV TIPS
R ATRIUM	R FOOT	R GERMINAL MATRX
R HIP	R PV	R SAPH V
R SHOULDER	RAA	RCA
RIMA	RLPV	RPA
RUPV	RV CAVITY	RVOT
SAPH V GRAFT LAD	SUP VENA CAVA	SVG D
SVG LAD	SVG LCX	SVG OM
SVG PDA	SVG PLV	SVG RCA
TRICUSPID ANN	TRICUSPID TIPS	TRICUSPID VALVE
UPPER DESC AO	VSD	

I.1.2.3.1.8 Mechanical Index, Bone Thermal Index, Cranial Thermal Index, Soft Tissue Thermal Index

The thermal and/or mechanical indices, when made available by a manufacturer, are defined according to the *Standard for Real-Time Display of Thermal and Mechanical Acoustic Output Indices on Diagnostic Ultrasound Equipment*, a voluntary performance standard jointly published by AIUM and NEMA.

I.1.2.3.1.9 Image Transformation Matrix and Image Translation Vector

In spatially related US images it is necessary to be able to convert data from the (x', y', z') coordinate system of the echo plane into the (x, y, z) coordinate system of the frame of reference. It is assumed that the echo-plane is a right handed, orthogonal Cartesian coordinate system, with its origin at the Reference Pixel as defined in the US Frame Of Reference Module, such that +x' is directed to the right, +y' is directed toward the top of the screen, and +z' is directed out of the screen toward the viewer. From this definition $z' \equiv 0$ everywhere on the echo plane. (x, y, z) is a similar right-handed system. The origin of (x', y', z') lies at the point (x_0, y_0, z_0) in the (x, y, z) system ($\mathbf{x_0}$ in vector notation). Once the appropriate translation has been applied, the two coordinate systems are related by a 3x3 rotation matrix **A**, such that a point **r'** in (x', y', z') may be converted to **r** in ((x, y, z) by a matrix multiplication and translation:

$$\mathbf{r} = \mathbf{A}\mathbf{r}' + \mathbf{x_0}.$$

These two operations may be combined in a single matrix multiplication by appending the translation vector to the rotation matrix:

$$\begin{bmatrix} a_{11} & a_{12} & a_{13} & x_0 \\ a_{21} & a_{22} & a_{23} & y_0 \\ a_{31} & a_{32} & a_{33} & z_0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

Eq I.1-1

Where each a_{ij} represents the cosine of the angle between the ith unit vector of the (x', y', z') system and the jth unit vector of the (x, y, z) system, or i· j. These nine rotation components are not independent, but rather are constrained by the orthonormality condition to

$$\sum_{i=1}^{3} a_{ij}a_{ik} = \delta_{jk}$$

where δ_{jk} is the Kronecker delta function, 0 for j≠k, and 1 for j=k.

Taking advantage of the fact that z' ≡ 0, Eq. I.1-1 can be reduced to:

$$\begin{bmatrix} a_{11} & a_{12} & 0 & x_0 \\ a_{21} & a_{22} & 0 & y_0 \\ a_{31} & a_{32} & 0 & z_0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x' \\ y' \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} x \\ y \\ z \\ \end{bmatrix}$$

Eq I.1-2

The Image Transformation Matrix (0018,5210)shall consist of the direction cosines in the following order:

$$a_{11}, a_{21}, a_{31}, a_{12}, a_{22}, a_{32}.$$

The Image Translation Vector (0018,5212) shall consist of the translation elements from Eq I.1-2 in the following order:

$$x_0, y_0, z_0.$$

The frame of reference (x, y, z) shall be defined by the first image in a spatially related series. Subsequent rotations of θ about x (fan), y (propeller) or z (panorama) shall have the following Image Transformation Matrices:

FAN: $\begin{bmatrix} 1 & 0 \\ 0 & \cos\theta \\ 0 & \sin\theta \end{bmatrix}$ PROP: $\begin{bmatrix} \cos\theta & 0 \\ 0 & 1 \\ -\sin\theta & 0 \end{bmatrix}$ PAN: $\begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \\ 0 & 0 \end{bmatrix}$

The convention used for rotation shall be positive when it appears counterclockwise when looking from the +x axis of rotation to the origin.

I.2 Retired Overlay Plane Module Attributes

The following Attributes have been retired from Table C.9-2 Overlay Plane Module Attributes.

Attribute Name	Tag	Type	Attribute Description
Overlay Descriptor - Gray	(60xx,1100)	3	The number of bits in each entry of (60xx,1200)
Overlay Descriptor - Red	(60xx,1101)	3	The number of bits in each entry of (60xx,1201)

Overlay Descriptor - Green	(60xx,1102)	3	The number of bits in each entry of (60xx,1202)
Overlay Descriptor - Blue	(60xx,1103)	3	The number of bits in each entry of (60xx,1203)
Overlays- Gray	(60xx,1200)	3	Overlay bits. A value of 1 indicted that the pixel is part of the overlay plane.
Overlays - Red	(60xx,1201)	3	Overlay bits. A value of 1 indicted that the pixel is part of the overlay plane.
Overlays - Green	(60xx,1202)	3	Overlay bits. A value of 1 indicted that the pixel is part of the overlay plane.
Overlays- Blue	(60xx,1203)	3	Overlay bits. A value of 1 indicted that the pixel is part of the overlay plane.

Annex J Index

(0004,1130).....401
(0004,1141).....401
(0004,1142).....401
(0004,1200).....402
(0004,1202).....402
(0004,1212).....402
(0004,1220).....403, 404
(0004,1400).....403
(0004,1410).....403, 418
(0004,1420).....403
(0004,1430).....404, 405
(0004,1432).....404
(0004,1500).....404, 405
(0004,1504).....405
(0004,1510).....405, 418
(0004,1511).....403, 405, 409, 410, 411, 412, 413, 414, 415, 416, 417
(0004,1512).....405
(0004,1600).....418
(0008,0005).....343, 344, 346, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417
(0008,0008)36, 116, 117, 119, 152, 153, 155, 158, 165, 167, 168, 169, 170, 171, 172, 174, 182, 185, 186, 188, 189, 202, 208, 217, 220, 236, 238, 239, 314, 318, 444, 447
(0008,0012).....343, 414
(0008,0013).....343
(0008,0014).....343
(0008,0016).....343
(0008,0018).....343, 376, 377, 378
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