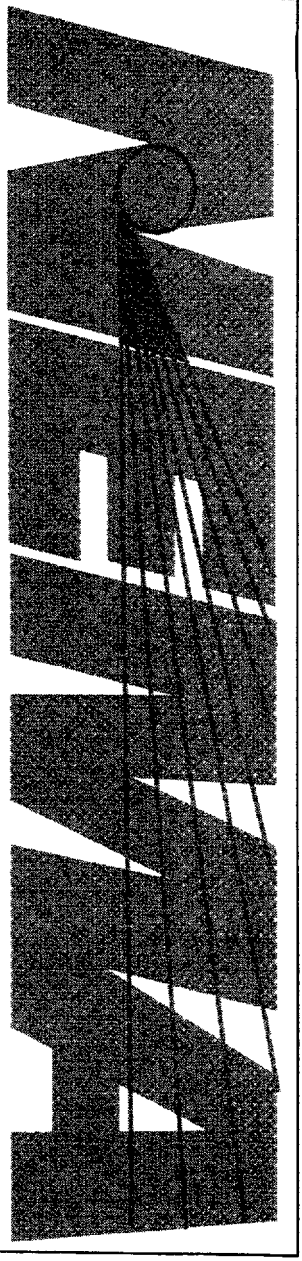
DIAGNOSTIC IMAGING & COMMUNICATIONS IN MEDICINE
(DICOM)



PART 3

Information Object Definitions

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PS 3.3-1996

Digital Imaging and Communications in Medicine (DICOM)
Part 3: Information Object Definitions

Approved by:

The American College of Radiology
The American College of Cardiology

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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:

— 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

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.

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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:

— any necessary information for the semantic description of the IOD

— relationships to associated real-world objects relevant to the IOD

— Attributes which describe the characteristics of the IOD

For each IOD, this Part does not specify:

— the nature of any Service Class Definition intended to reference the IOD

— 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:

— PS 3.4, Service Class Specifications, specifies application level services by grouping DIMSE services with IODs as defined in this Part;

— PS 3.5, Data Structure and Semantics, defines the data encoding used in the DIMSE Protocol when applied to IODs defined in this Part.

— 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

— 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 exension techniques.

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

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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

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)

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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).

3.8.1 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.

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

3.8.3 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.

3.8.4 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.

3.8.5 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.

3.8.6 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.

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

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

3.8.9 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.

3.8.10 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.

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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.

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
CEN TC251	Comite European de Normalisation-Technical Committee 251-Medical Informatics
CCIR	Consultative Committee, International Radio
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
HISPP	Healthcare Information Standards Planning Panel
HL7	Health Level 7
IE	Information Entity
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
MSDS	Healthcare Message Standard Developers Sub-Committee
NEMA	National Electrical Manufacturers Association
OSI	Open Systems Interconnection
SCP	Service Class Provider
SCU	Service Class User
SOP	Service-Object Pair
UID	Unique Identifier

5 CONVENTIONS

5.1 Entity-relationship model

5.1.1 ENTITY

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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.

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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 of PS 3.3) may be used.

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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.

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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.

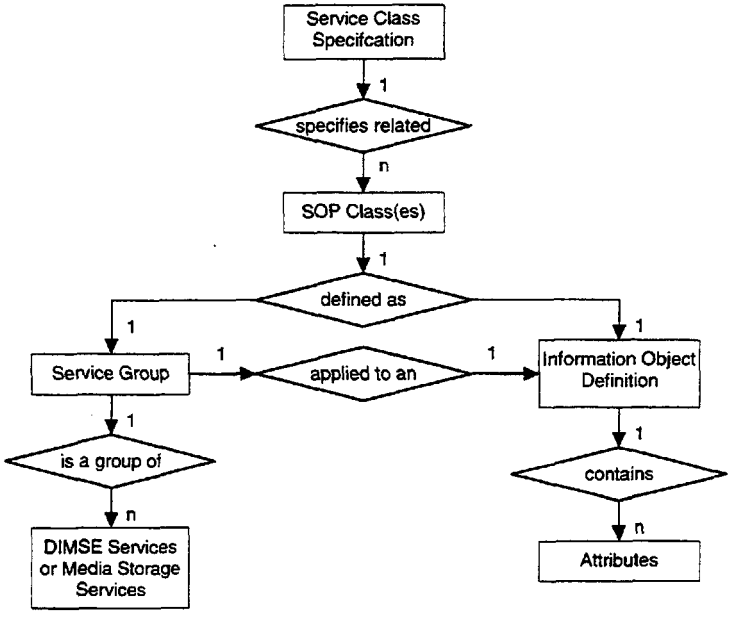

Figure 6-1
MAJOR STRUCTURES OF DICOM INFORMATION MODEL

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 represent a single class of Real-World Objects is called a Normalized Information Object. An IOD which includes information about related Real-World Objects it 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.

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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 represents a single entity in the DICOM Model of the Real-World. Such an IOD includes Attributes which are only inherent in the Real-World Object that the IOD represents.

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.

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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

Figure 7-1 depicts 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.

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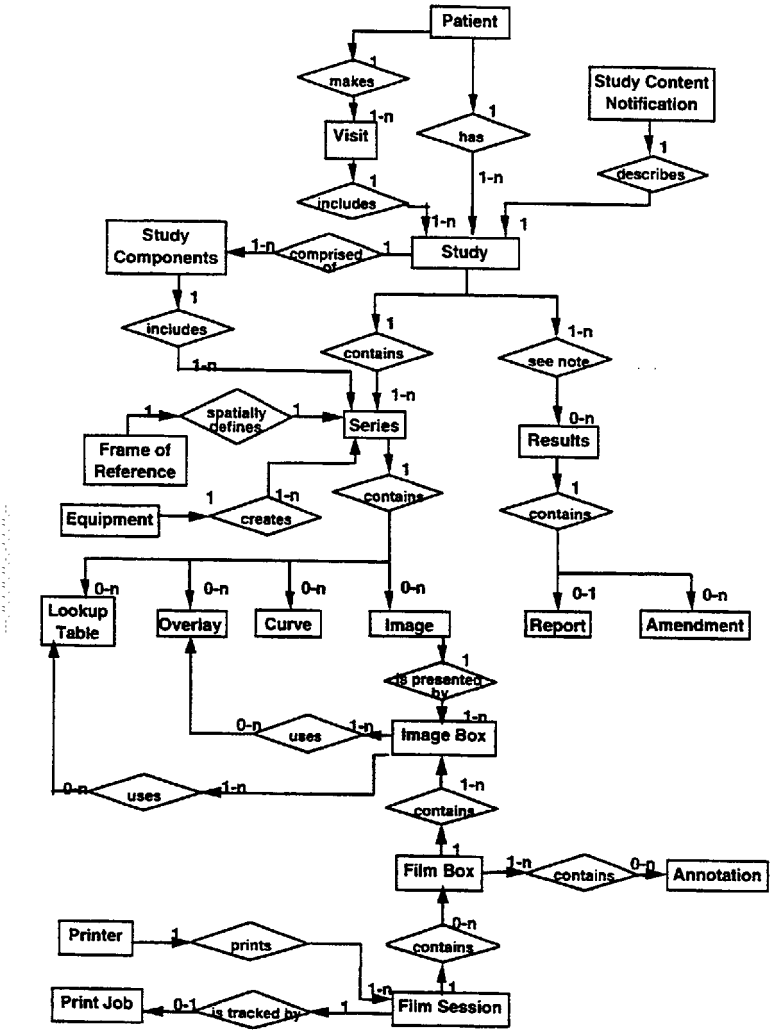

Figure 7-1
DICOM MODEL OF THE REAL-WORLD

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.

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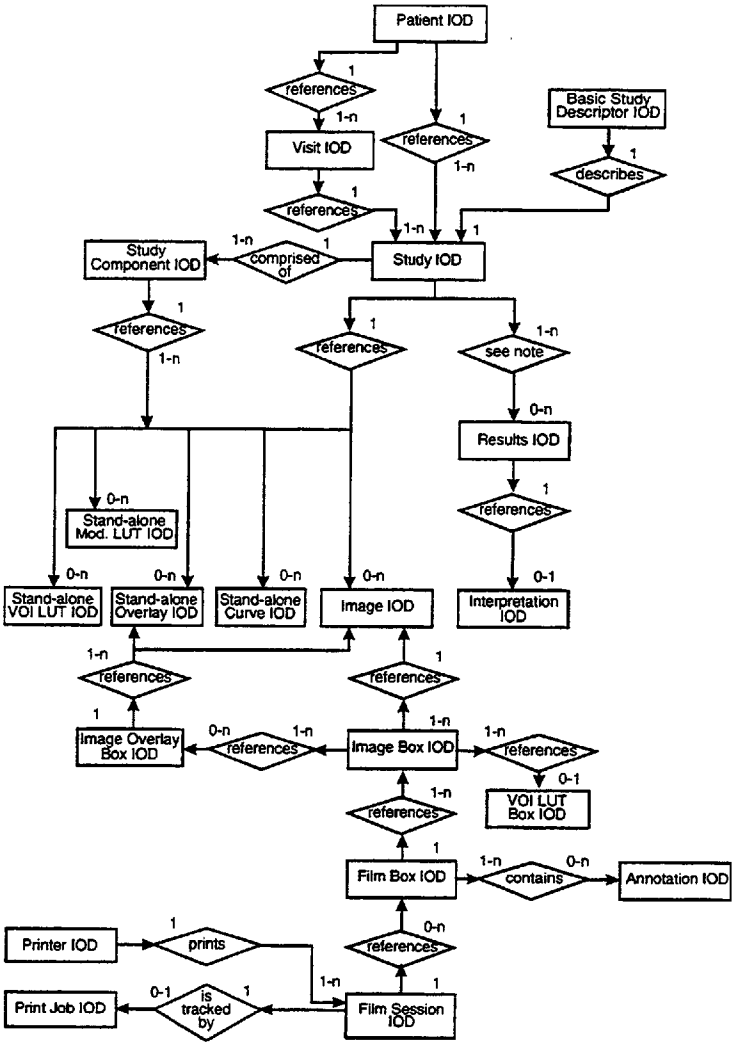

Figure 7-2
DICOM INFORMATION MODEL

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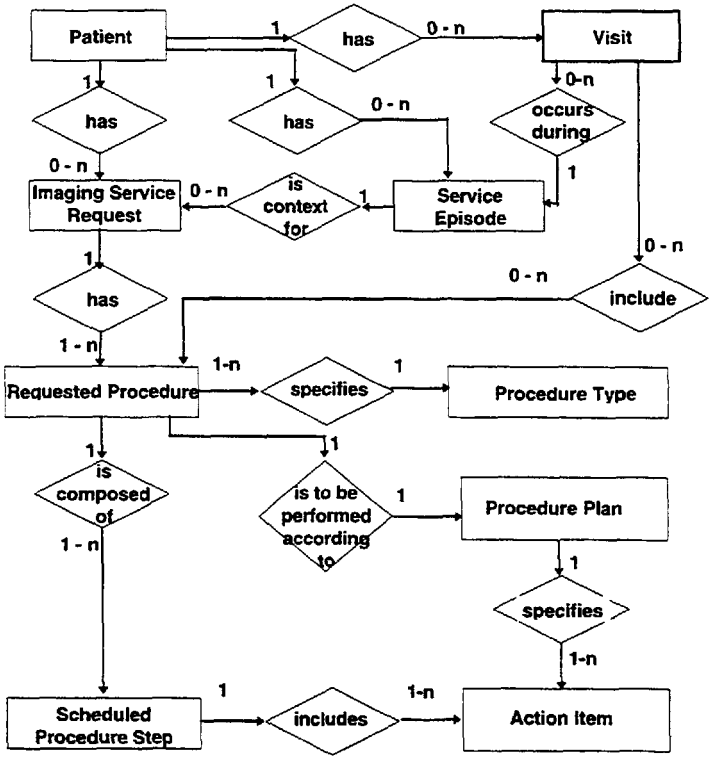

Figure 7-3.
MODEL OF THE REAL WORLD FOR THE PURPOSE OF MODALITY-IS INTERFACE

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 Figure 7-2 identifies 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 Figure 7-2 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.

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7.3 Extension of the DICOM model of the real-world

For the purpose of the Modality Worklist SOP Class in the Basic Worklist Management Service Class 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.

This subset of the real-world model covers the requirements for the Modality Worklist SOP Class in the Basic Worklist Management Service Class.

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 American College of Radiology, National Electrical Manufacturers Association, ACR-NEMA 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 PT3-022, 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

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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.

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.

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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.

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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 descriptions 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.

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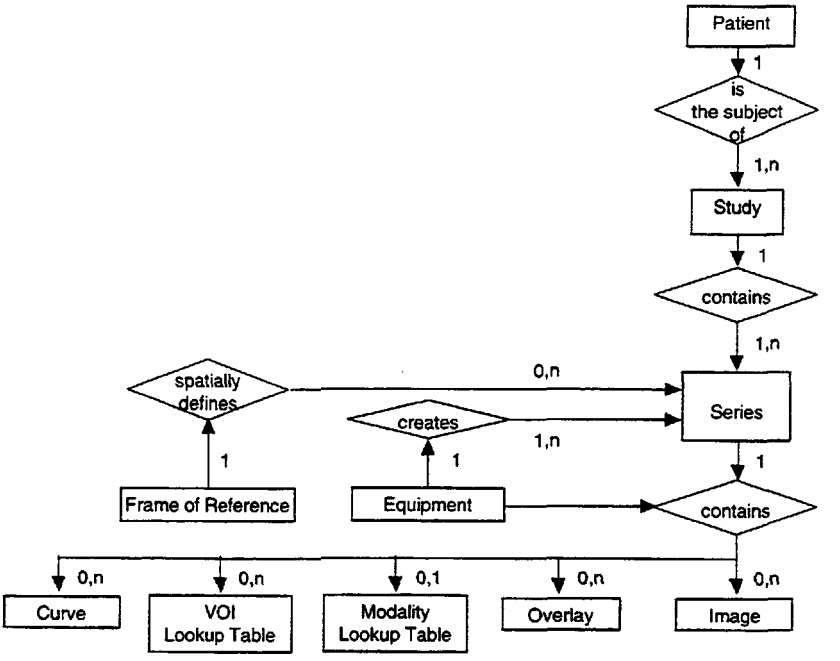

Figure A.1-1
DICOM COMPOSITE IMAGE IOD INFORMATION MODEL

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.

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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

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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.

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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
Patient	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
Patient study	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
CR Series	M														
NM Series				M											
Frame Of Reference		M	M	U	U	U									
U S Frame of Ref.					C	C									
General Equipment	M	M	M	M	M	M	U	M	M		M	M	M	M	M
SC Equipment							M								
General Image	M	M	M	M	M*	M	M						M	M	M
Image Plane		M	M												
Image Pixel	M	M	M	M	M*	M	M						M	M	M
NM Image Pixel				M											
Pallet Color Lookup Table					C	C									

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Contrast/ Bolus	C	C	C		C*	C							C	C	C
Cine						M							C	C	C
Multi-frame				M		M							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											
NM Multi-Gated Acquisition				C											
NM Phase				C											
NM Reconstruction				C											
US Region Calibration					U*	U									
US Image					M*	M									
SC 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	

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Bi-Plane Image														M	
Overlay Identification								M							
Overlay Plane	U	U	U	U	U*		U	M					U	U	U
Multi-frame Overlay				U									C	C	C
Bi-Plane Overlay														C	
Curve Identification					M*	M*			M						
Curve	U			U	M*	M*			M				U	U	U
Audio					U	U									
Modality LUT	U						U				M		C*	C*	C*
VOI LUT	U	U	U	U	U*	U	U					M	U	U	U
LUT Identification											M	M			
SOP Common	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

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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

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	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.

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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.5.4-1
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 Series	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

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	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.6.4-1
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

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	Overplay 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.7.4-1
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

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	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

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	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.

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

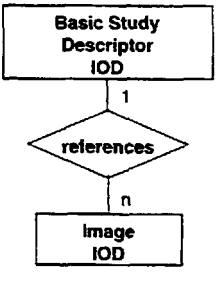

Figure A.11-1
BASIC STUDY DESCRIPTOR INFORMATION OBJECT DEFINITION E-R MODEL

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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.

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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.

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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

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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

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	> 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.

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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

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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

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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.

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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

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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.

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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 Part 4 of the DICOM Standard. 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

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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 Module	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 Descripion
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.

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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.

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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.

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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.

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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 of the DICOM Standard.

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).

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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.
>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
>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.
>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

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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.
>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

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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.

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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.
>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
>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.
>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.

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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.
>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

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

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Referenced Patient Sequence	(0008,1120)	Uniquely identifies the Patient SOP Instance that relates to the Study 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 Results Sequence	(0008,1100)	Uniquely identifies the results SOP Instance for which the interpretation SOP Instance applies
>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 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

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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.
>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

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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
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 zero or more Series.
>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.

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>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).
>>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.

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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)
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.

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>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.
>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 PS 3.3 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).

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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 are: 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 are: HIGH, ROUTINE, MEDIUM, LOW
Names of Intended Recipients of results	(0040,1010)	Names of the physicians, who are intended recipients of results.

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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.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.

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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.
>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.

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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.
>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.

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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. 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.
>Code Value	(0008,0100)	The code value (defined by the coding scheme) that represents the interpretation diagnosis.

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>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. 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 are: 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 reference is allowed. 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.

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>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. Only a single reference is allowed. Encoded as sequence of items: (0008,1150) and (0008,1155)

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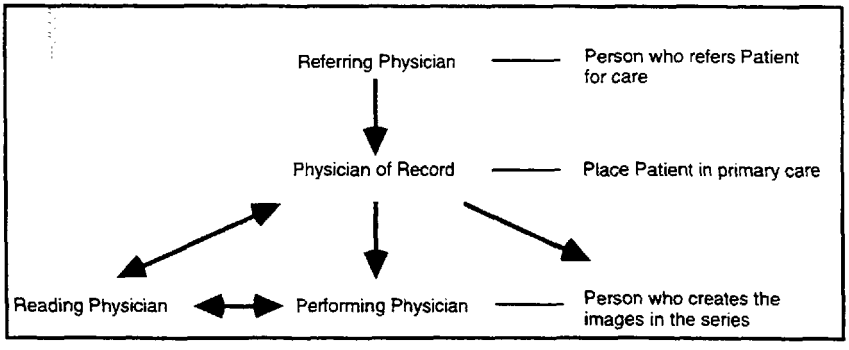
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced Study Sequence (0008,1110) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced Study Sequence (0008,1110) is sent.

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.

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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 Instances to which the Series is related.
>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.

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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.

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

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.

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

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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.

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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.

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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 more 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 more explanation.

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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. 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

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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).

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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.

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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.

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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.

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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.

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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;

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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 (0028,1201-203) 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

--`,,`,,`-`-`,,`,,`,`,,`---

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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

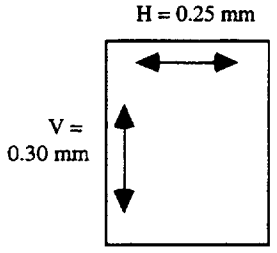
Palette Color Lookup Table Data (0028,1201-1203) contain the lookup table data corresponding to the Lookup Table Descriptor (0028,1101-1103). If padding is required to complete a full word, the padding value shall be 0.

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.

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>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

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>>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.

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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

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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.

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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.

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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.

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>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.

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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 are: 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 (0018,1500) 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 (0018,1500) 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 (0018,1500) 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 (0018,1500) 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 (0018,1500) is CIRCULAR. Radius of the circular shutter with respect to pixels in the image given as a number of pixels along the row direction.

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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.

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.

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>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

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>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

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>>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.

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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 zero or more Series.
>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).

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>>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.

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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.

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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

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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 + 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 + 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

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C.8 MODALITY SPECIFIC MODULES

C.8.1 Computed Radiography

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.

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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.
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

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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.

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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.

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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

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.

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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

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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

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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 columns.

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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.

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C.8.4 Nuclear Medicine

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 Series Module

Table C.8-5 specifies the Attributes that describe the NM Series.

Table C.8-5
NM SERIES 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).

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> 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 Series 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".

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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).

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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 nth element in the indexing vector represents the index for the nth 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 nth element in the indexing vector represents the index for the nth 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:

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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 11th value in these four vectors tells you that the 11th 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.

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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.

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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).

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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 nth element of this vector is the energy window number for the nth 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 nth element of this vector is the detector number of the nth 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 nth element of this vector is the phase number of the nth 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 nth element of this vector is the rotation number of the nth frame in this image, and shall have a value from 1 to Number of Rotations (0054,0051).

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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 nth element of this vector is the interval number of the nth 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 nth element of this vector is the time slot number of the nth 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 nth element of this vector is the slice number of the nth 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 nth element of this vector is the angular view number of the nth 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 nth element of this vector is the time slice number of the nth 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.

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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.

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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.

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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).

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> 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.

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>> 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

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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.

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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.

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>> 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).

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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.

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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)

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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.

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> 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.

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> 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.

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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".

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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.

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> 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.

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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.

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>> 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.

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> 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.

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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

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.

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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

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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.

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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.
>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.

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>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	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. 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.

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>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.

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>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
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

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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

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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.

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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.

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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)	1	Indicates whether the pixel data are sent color-by-plane or color-by-pixel. 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.

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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. 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.

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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

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>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).

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> 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

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>>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.

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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

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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 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.

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' ≡ 0 everywhere on the echo plane. (x, y, z) is a similar right-handed system. The origin of (x',

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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:

$$\begin{bmatrix} a_{11} & a_{12} & a_{13} & x_0 \\ a_{21} & a_{22} & a_{23} & y_0 \\ a_{31} & a_{32} & a_{33} & z_0 \end{bmatrix} \begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

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:

$$\begin{bmatrix} a_{11} & a_{12} & 0 & x_0 \\ a_{21} & a_{22} & 0 & y_0 \\ a_{31} & a_{32} & 0 & z_0 \end{bmatrix} \begin{bmatrix} x' \\ y' \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

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:

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$$\text{FAN:}\begin{bmatrix}1 & 0\\ 0 & \cos\theta\\ 0 & \sin\theta\end{bmatrix} \qquad \text{PROP:}\begin{bmatrix}\cos\theta & 0\\ 0 & 1\\ -\sin\theta & 0\end{bmatrix} \qquad \text{PAN:}\begin{bmatrix}\cos\theta & -\sin\theta\\ \sin\theta & \cos\theta\\ 0 & 0\end{bmatrix}$$

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

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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

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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)

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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

C.8.6.1 SC Equipment Module

This Module describes equipment used to convert images into a DICOM format.

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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 are 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.

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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.

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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.

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>>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.

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>>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 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 more 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.

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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.

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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.

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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 ModuleTable C.8-27

X-Ray Acquisition Module

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.

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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.

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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.

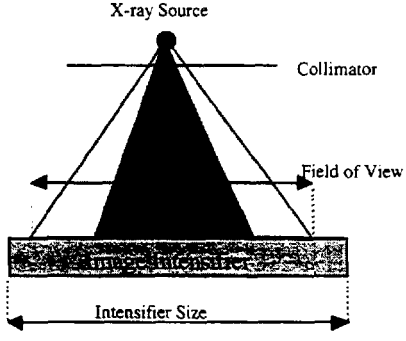

Figure C.8-1
Relationships of X-Ray Collimator

Table C.8-28
X-Ray Collimator Module

Attribute Name	Tag	Type	Attribute Description
Collimator Shape	(0018,1700)	1	Shape(s) of the collimator. Enumerated Values are: 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 (0018,1500) 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 (0018,1500) is RECTANGULAR. Location of the right edge of the rectangular collimator with respect to pixels in the image given as column.

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Collimator Upper Horizontal Edge	(0018,1706)	1C	Required if Collimator Shape (0018,1500) 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 (0018,1500) 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 (0018,1500) 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 (0018,1500) 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 (0018,1500) 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.

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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.

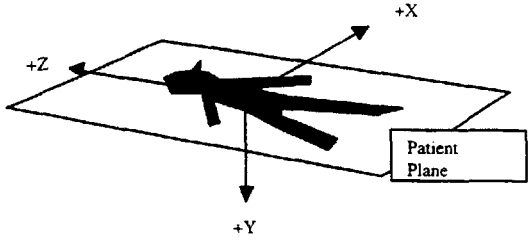

Figure C.8-2
Table Motion Vector Coordinates

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.

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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.

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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.

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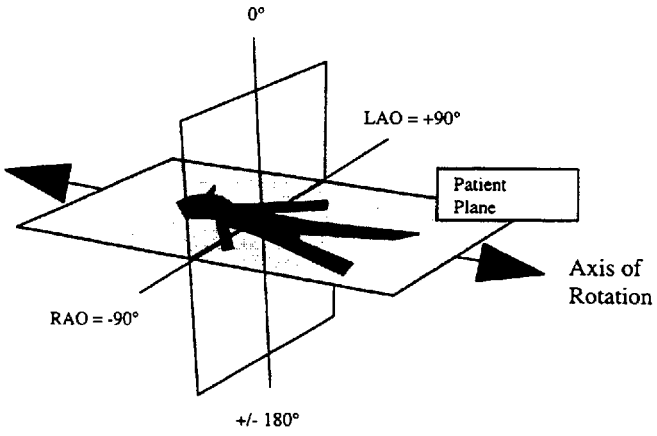

Figure C.8-3
Positioner Primary Angle

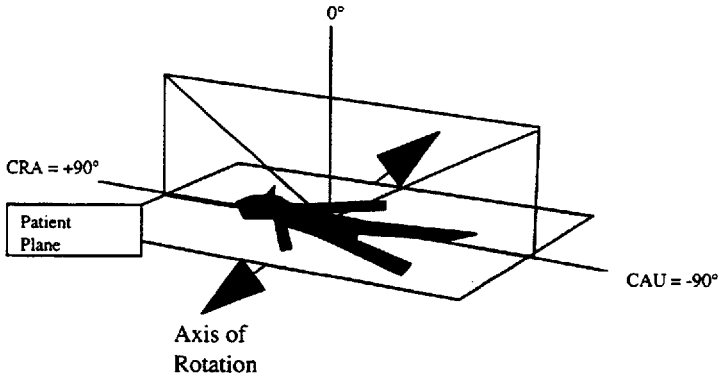

Figure C.8-4
Positioner Secondary Angle

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.

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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

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).

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Table C.8-32
XRF Tomography Acquisition Module

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.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. 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.

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.

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Overlay Type	(60xx,0040)	1	Indicates whether this overlay represents a region of interest or other graphics. Enumerated Values: G = Graphics R = ROI.
Origin	(60xx,0050)	1	Location of first overlay point with respect to pixels in the image, given as row and column. Rows and columns are numbered from 1. Row is the vertical offset and column is the horizontal offset.
Overlay Bits Allocated	(60xx,0100)	1	Number of Bits Allocated in the Overlay.
Bit Position	(60xx,0102)	1	Bit in which Overlay is stored.
Overlay Data	(60xx,3000)	1C	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.
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 indicates that the pixel is part of the overlay plane.
Overlays - Red	(60xx,1201)	3	Overlay bits. A value of 1 indicates that the pixel is part of the overlay plane.
Overlays - Green	(60xx,1202)	3	Overlay bits. A value of 1 indicates that the pixel is part of the overlay plane.
Overlays - Blue	(60xx,1203)	3	Overlay bits. A value of 1 indicates that the pixel is part of the overlay plane.

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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

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.

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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. 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.

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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. 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. 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.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.

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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)	1	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	1	Uniquely identifies the referenced SOP Instance.
>Referenced Overlay Group	(50xx,2610)	1	The Group number of the related overlay.

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
PROF = image profile
ROI = polygraphic region of interest
FILT = filter kernel
ECG = ecg data

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PRESSURE = pressure data
FLOW = flow data
PHYSIO = physio 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.

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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

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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. 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.

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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).

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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.

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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. 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.12 GENERAL MODULES

The SOP Common Module shall be mandatory for all DICOM IODs.

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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 (Media Storage see PS 3.10).

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:

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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 characters	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

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No. 1		ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646
Latin alphabet No. 2	ISO 2022 IR 101	ISO 2022	ESC 02/13 04/02	ISO-IR 101	96	G1	Supplementary set
		ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646
Latin alphabet No. 3	ISO 2022 IR 109	ISO 2022	ESC 02/13 04/03	ISO-IR 109	96	G1	Supplementary set
		ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646
Latin alphabet No. 4	ISO 2022 IR 110	ISO 2022	ESC 02/13 04/04	ISO-IR 110	96	G1	Supplementary set
		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 No. 5	ISO 2022 IR 148	ISO 2022	ESC 02/13 04/13	ISO-IR 148	96	G1	Supplementary set
		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.

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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	942	G0	JIS X 0208: Kanji
	ISO 2022 IR 159	ISO 2022	ESC 02/04 02/08 04/04	ISO-IR 159	942	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

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

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Memory Allocation	(2000,0060)	Amount of memory allocated for the film session; value is expressed in KB

C.13.2 Basic Film Session Relationship Module

Table C.13-2
BASIC FILM SESSION RELATIONSHIP MODULE

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. 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.

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C.13.3 Basic Film Box Presentation Module

Table C.13-3
BASIC FILM BOX PRESENTATION MODULE

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

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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.

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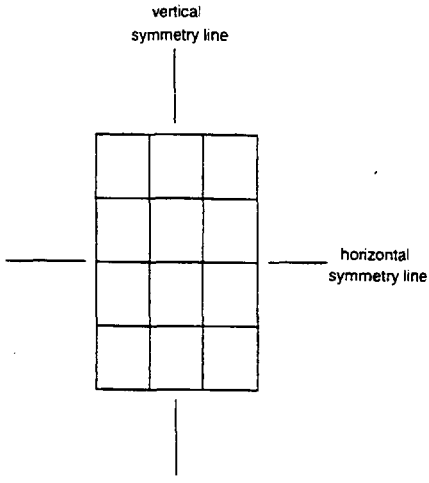
C.13.3.1 Image display format

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



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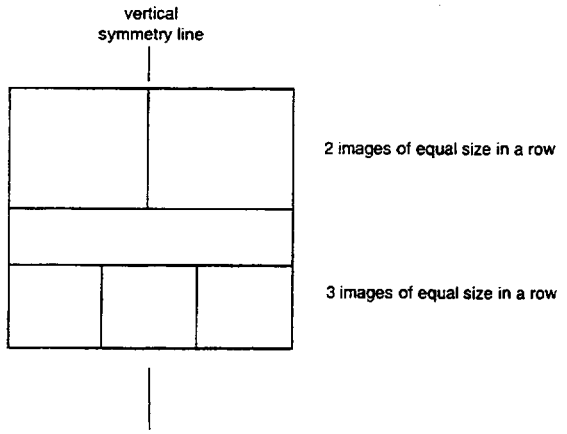
C.13.3.1.2 Row symmetric image display format

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 !

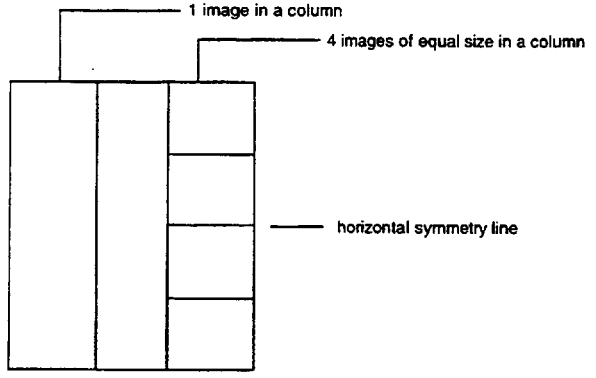
Example : ROW\2,3



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



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C.13.4 Basic Film Box Relationship Module

Table C.13-4
BASIC FILM BOX RELATIONSHIP MODULE

Attribute Name	Tag	Attribute Description
Referenced Film Session Sequence	(2010,0500)	A sequence which provides references to a Film Session SOP Class/Instance pairs. 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. 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. 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

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

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Requested Image Size	(2020,0030)	Length in mm that Image rows of the Image are to be printed. This value overrides the size that corresponds with optimal filling of the Image Box.
Preformatted Grayscale Image Sequence	(2020,0110)	A sequence which provides the content of the Preformatted Grayscale Image Pixel Attributes. The Preformatted Grayscale Image Pixel Attributes are 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. See C.13.5.2 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
Preformatted Color Image Sequence	(2020,0111)	A sequence which provides the content of the Preformatted Color (RGB) Image Pixel Attributes. The Preformatted Color Image (RGB) Pixel Attributes are 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. See C.13.5.3 for further description.

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>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.

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C.13.5.2 Preformatted Grayscale Image

The Preformatted Grayscale Image is an abstraction of a 8/12 bit grayscale image where annotation, graphics, overlays are burned in and where the LUT operations are already performed (see PS 3.4). The preformatted grayscale image is a displayable image where the polarity of the intended display is specified by Photometric Interpretation (0028,0004).

C.13.5.3 Preformated Color Image

The Preformatted Color Image is an abstraction of a color image where annotation, graphics, overlays are burned. The color image is encoded by frame interleaving of the RGB components (see PS 3.4).

C.13.6 Image Box Relationship Module

Table C.13-6
IMAGE BOX RELATIONSHIP MODULE

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. 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. 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 references to a VOI LUT SOP Class/Instance pair. 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..

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C.13.7 Basic Annotation Presentation Module

Table C.13-7
BASIC ANNOTATION PRESENTATION MODULE

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

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 when Execution Status (2100,0020) is PENDING or FAILURE. Defined Terms when the Execution Status is equal to PENDING: QUEUED = Print Job in queue NO SUPPLY MGZ = Supply magazine not available NO RECEIVE MGZ = Receiver magazine not available SUPPLY EMPTY = Printer is out of film RECEIVER FULL = Film receiver magazine full FILM JAM = Film jam No Defined Terms are currently specified for when the Execution Status is equal to 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

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C.13.9 Printer Module

Table C.13-9
PRINTER MODULE

Attribute Name	Tag	Attribute Description
Printer Status	(2110,0010)	Printer device status; Enumerated Values: NORMAL WARNING FAILURE
Printer Status Info	(2110,0020)	Additional information when Printer Status (2110,0010) is WARNING or FAILURE. Defined Terms when the Printer Status is equal to WARNING: SUPPLY EMPTY = Printer is out of film SUPPLY LOW = Film supply low RECEIVER FULL = Film receiver magazine full FILM JAM = Film Jam No Defined Terms are currently specified for when the Execution Status is equal to 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.13.10 Image Overlay Box Presentation Module

Table C.13-10
IMAGE OVERLAY BOX PRESENTATION MODULE

Attribute Name	Tag	Attribute Description
Referenced Overlay Plane Sequence	(2040,0010)	A sequence which provides references to a set of image overlay planes. 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.

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>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)

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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.12) 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

Attribute Name	Tag	Attribute Description
Referenced Image Box Sequence	(2010,0510)	A sequence which provides references to an Image Box SOP Class/ Instance pair. 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.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

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.

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>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.

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0131H - Duplicate transaction UID
The Transaction UID of the Storage Commitment Request is already in use.

--`,,`,`,,`-`-`,,`,,`,`,,`---

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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).

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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.

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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.

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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.

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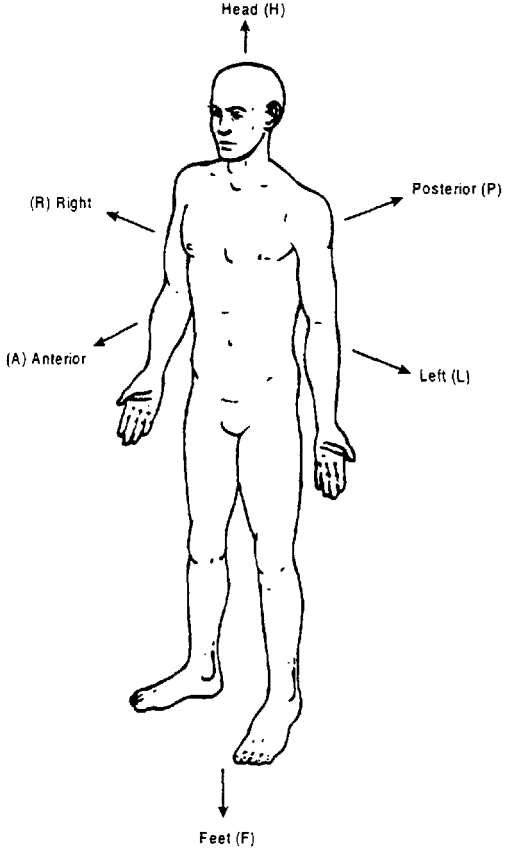
Annex E Explanation of patient orientation (Normative)

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.

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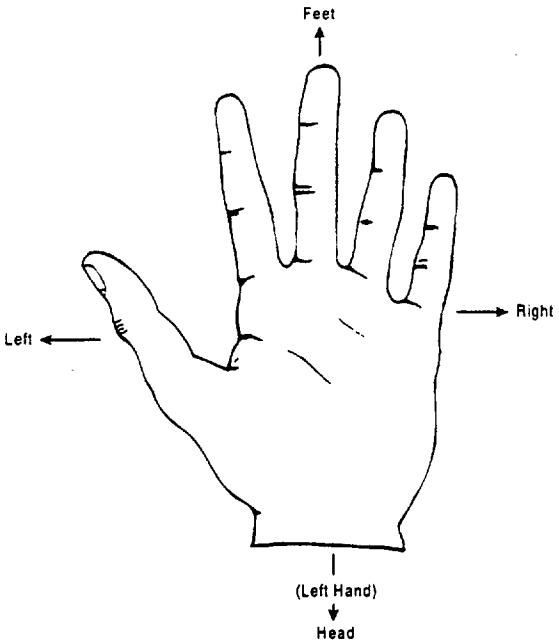

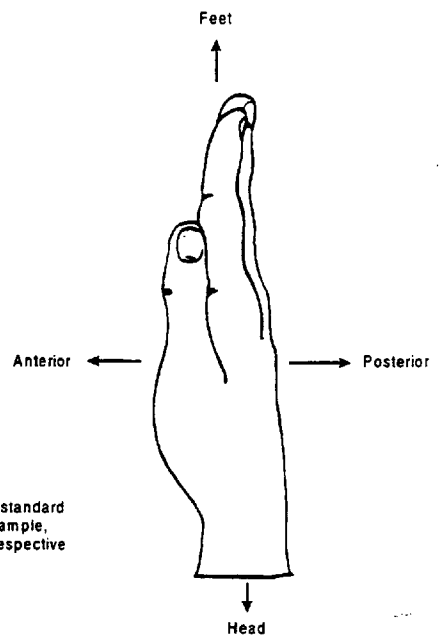

For the hands, the direction labels are based on the standard anatomic position. For the left hand illustrated for example, LEFT will always be in the direction of the thumb, irrespective of position changes.

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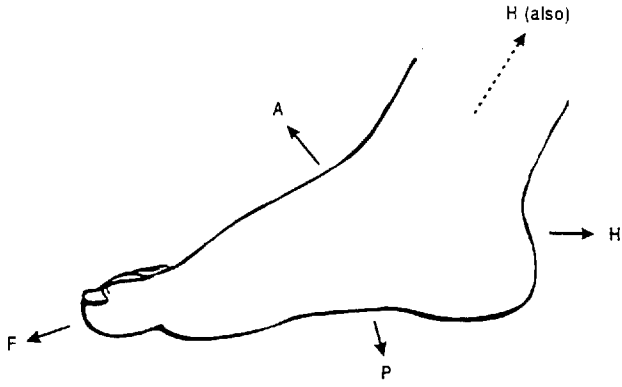
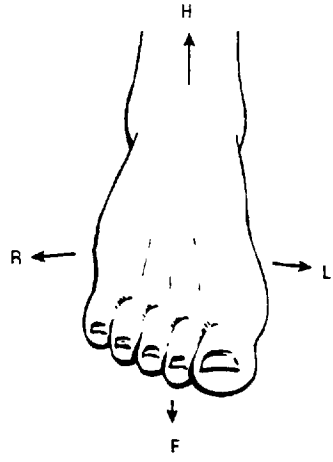


Right Foot



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.

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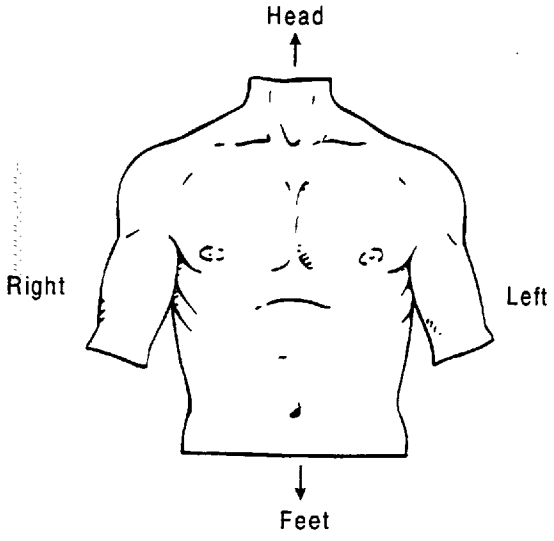
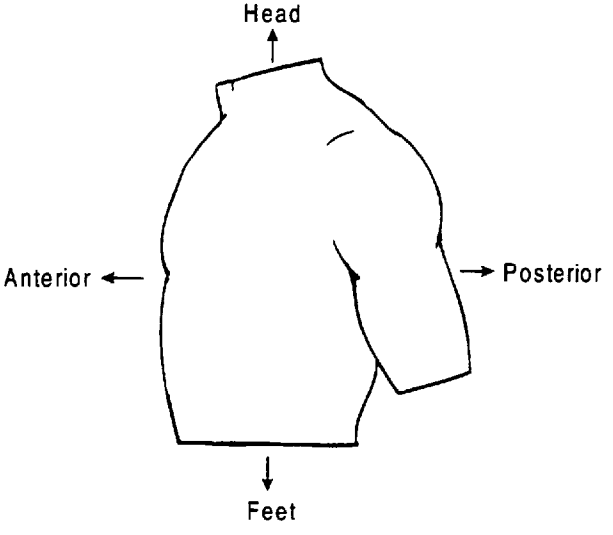


Viewing the Front of the Patient



Anterior and left lateral views of the patient. In the view of the left side (bottom illustration) the left arm has been drawn posteriorly.

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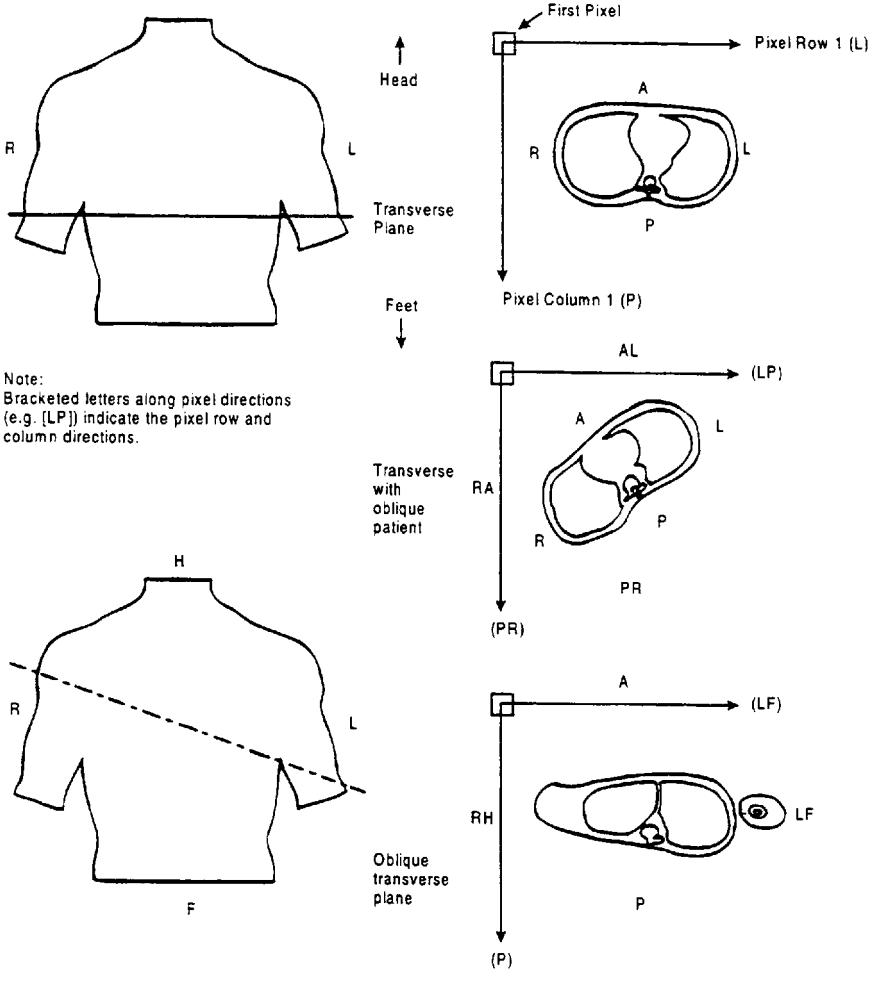

Since the major direction of the transverse plane is right-to-left (or anterior-to-posterior), the first letter of the combined direction will indicate this. For example, RH—moving right also moves towards the head.

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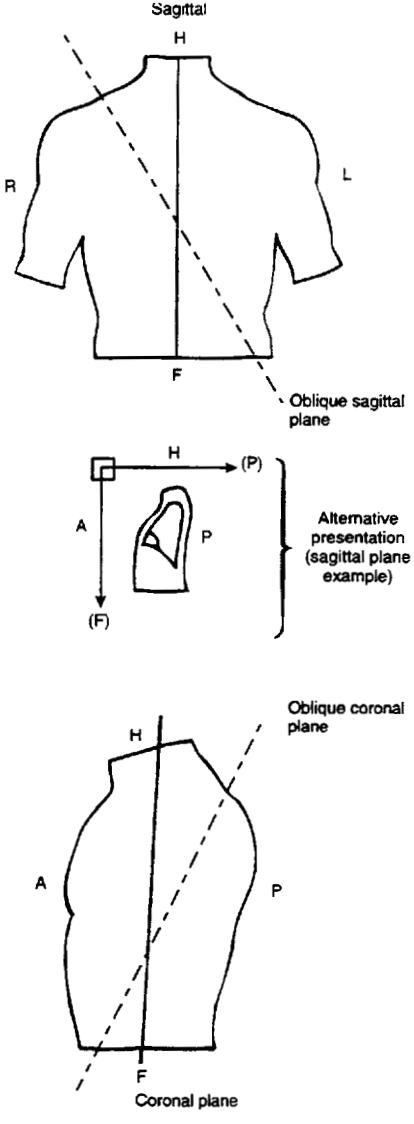

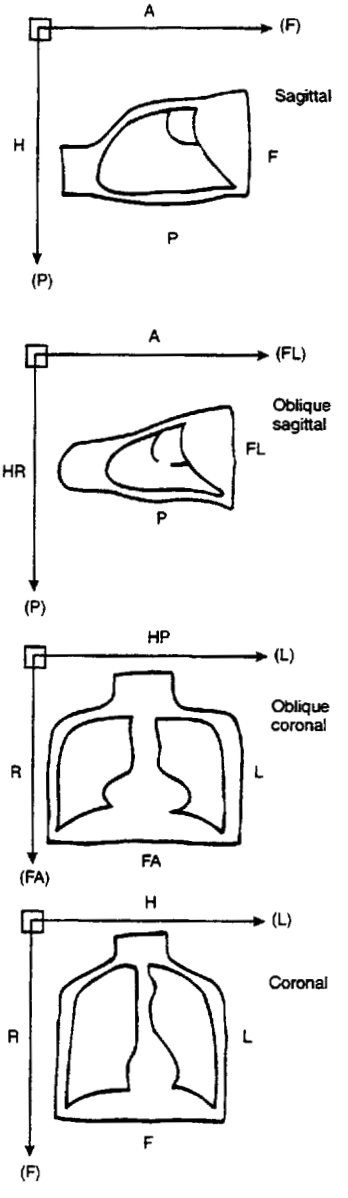

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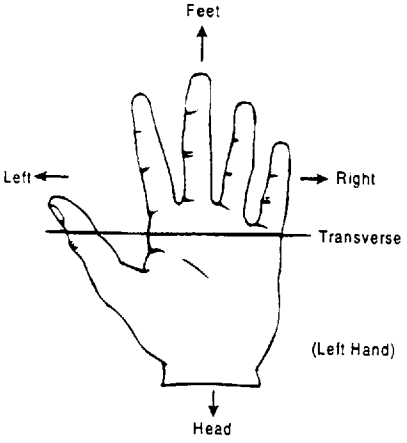

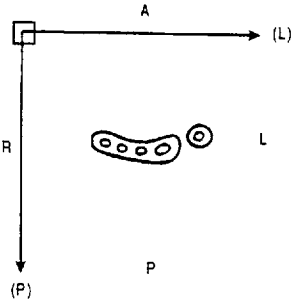

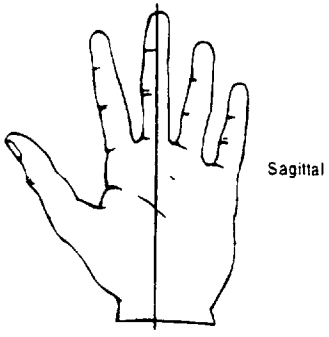

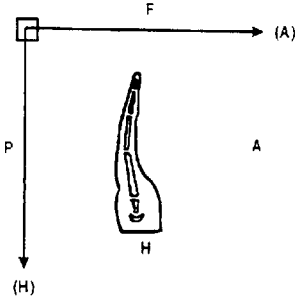

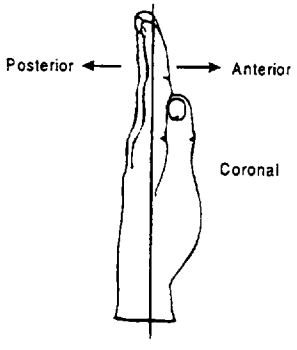

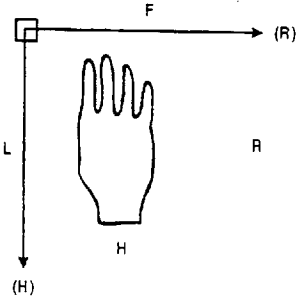

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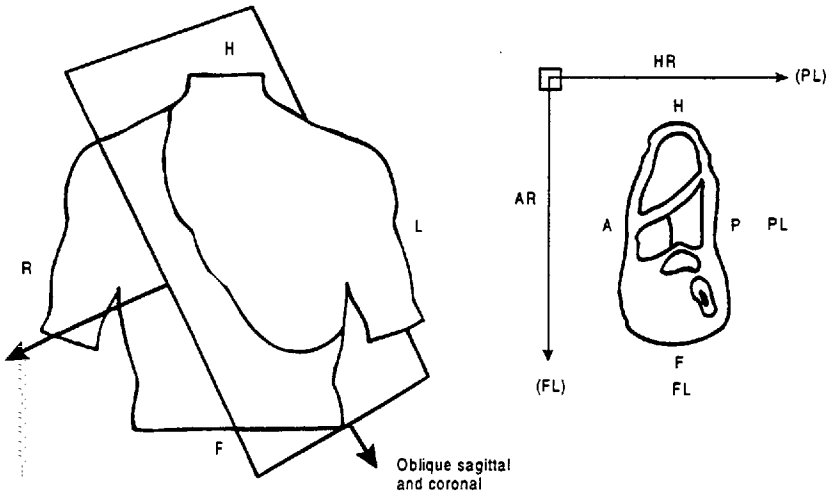
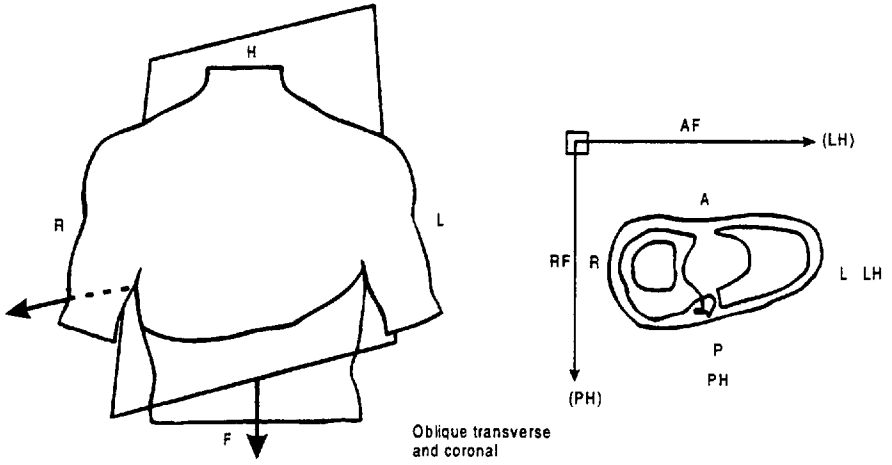


Oblique sagittal and coronal

Combined tilt planes and possible labels are based on major plane directions.



Oblique transverse and coronal

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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.

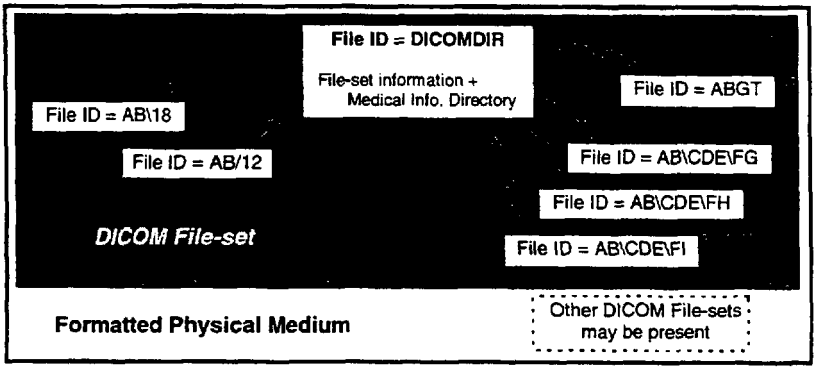

Figure F.1-1
THE DICOMDIR FILE. A CENTRAL ROLE IN A DICOM FILE-SET

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;

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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.

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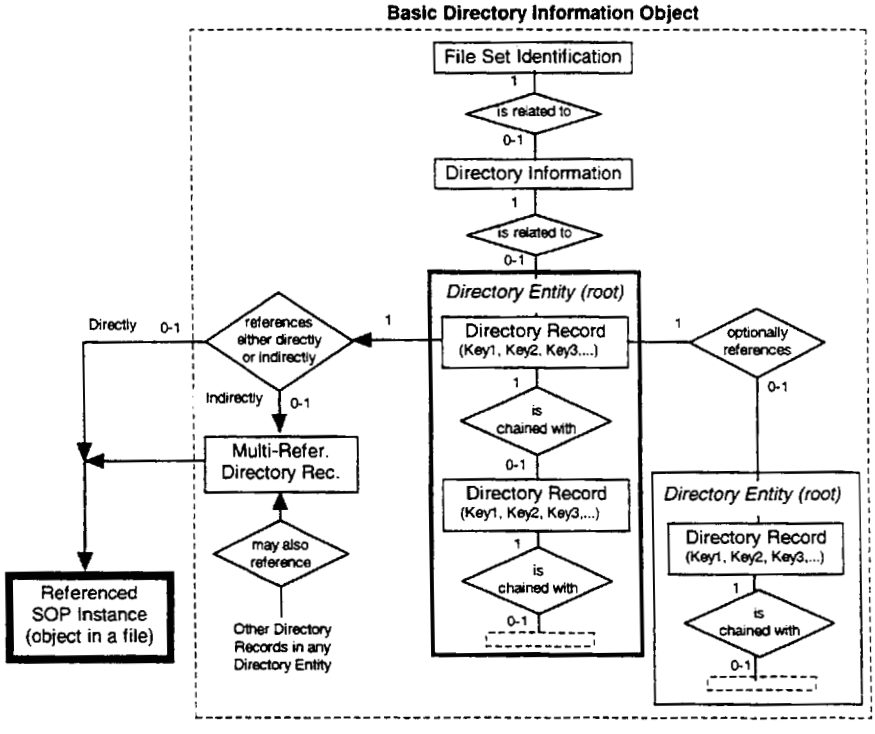

Figure F.2-1
BASIC DIRECTORY INFORMATION OBJECT E-R MODEL

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

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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.

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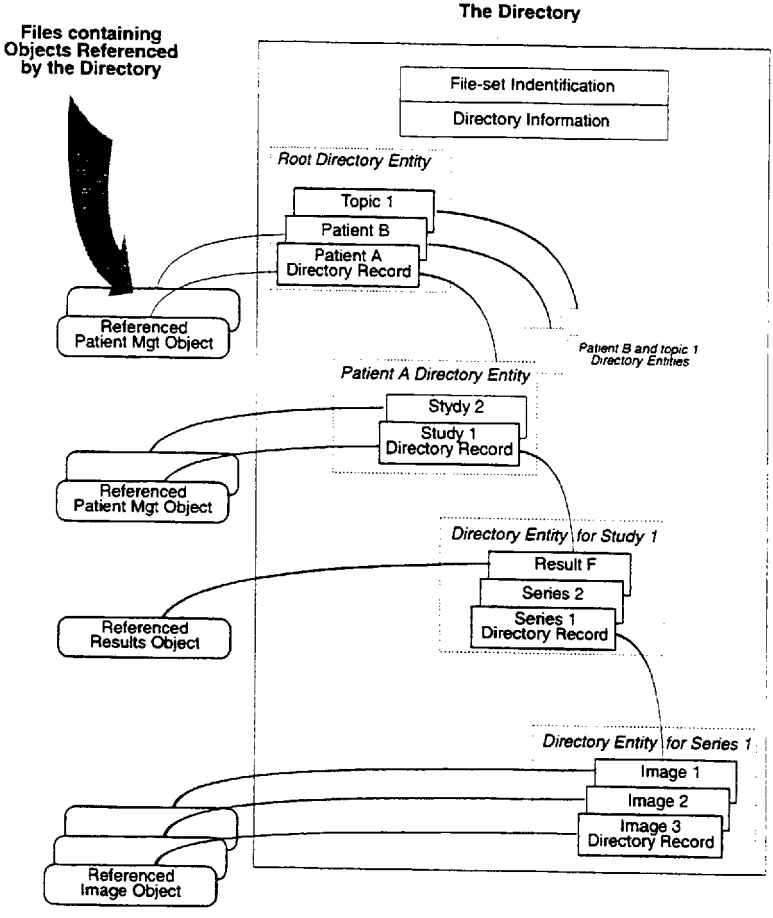

Figure F.2-2
EXAMPLE OF A DIRECTORY ORGANIZATION AND CONTENT

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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.

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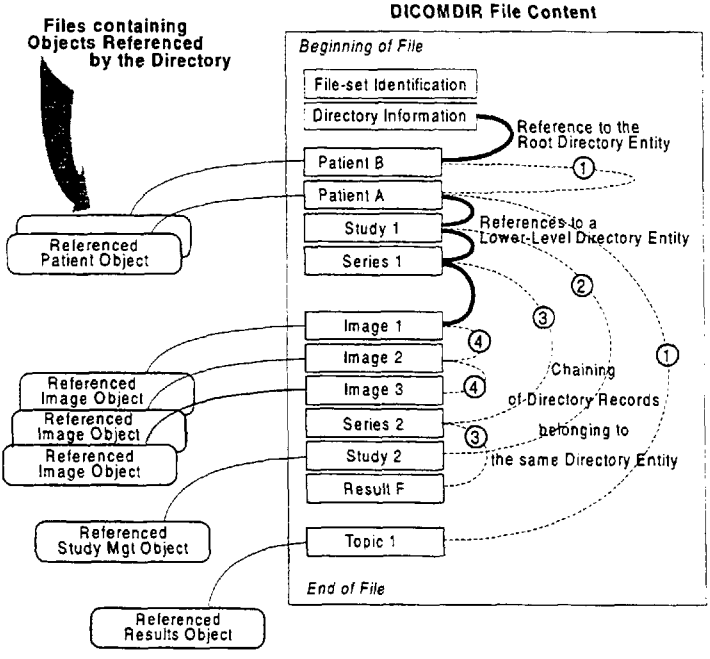

Figure F.2-3
EXAMPLE OF DATA STRUCTURE FOR THE DICOM DIRECTORY INFORMATION

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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

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(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 be set. They 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.

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>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.

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>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 of the DICOM Standard. 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.

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>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.

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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)	—	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.

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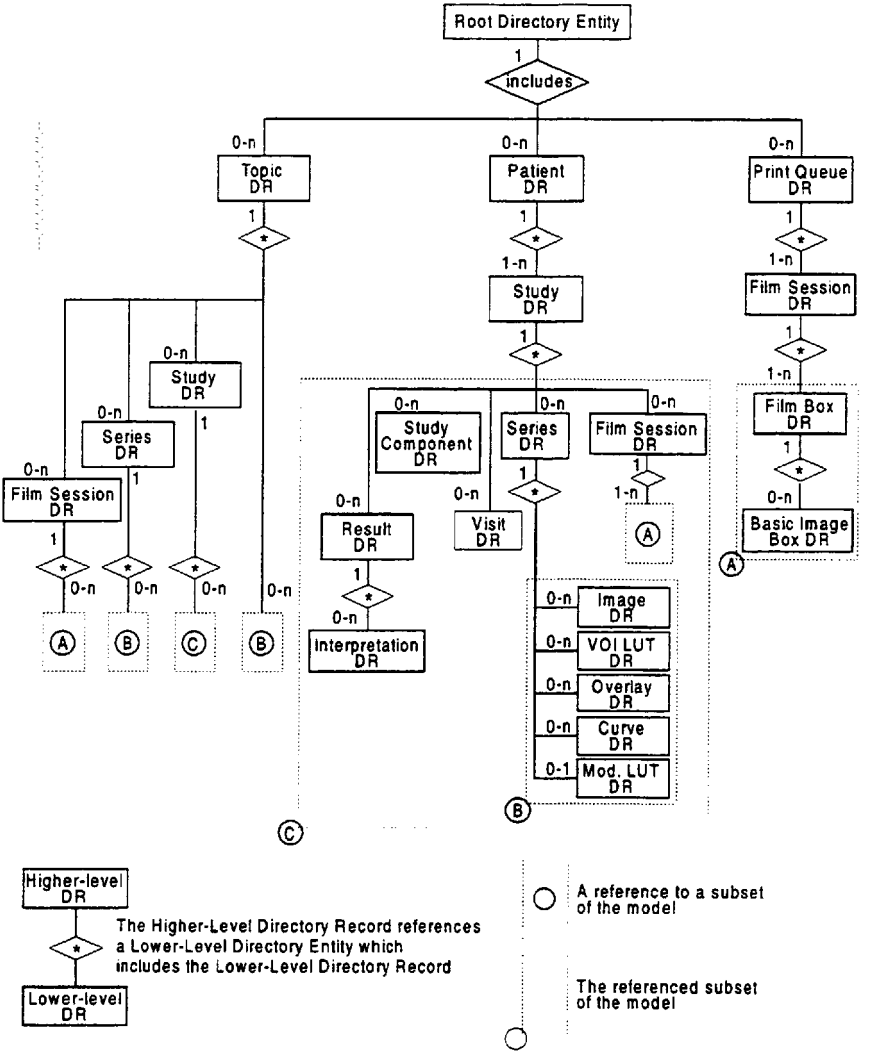

Figure F.4-1
BASIC DIRECTORY IOD INFORMATION MODEL

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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	

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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.

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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

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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.

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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.

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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.

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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.

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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.

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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	

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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.

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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.5-19
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

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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

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Annex G Integration of Modality Worklist 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 addresses an important part of the domain area that was not included initially in the DICOM Standard. At the same time, the Modality Worklist integration makes a step 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. The two included figures outline the void filled by the Modality Worklist Management specification and the relationship between the original DICOM Data Model and the extended model.

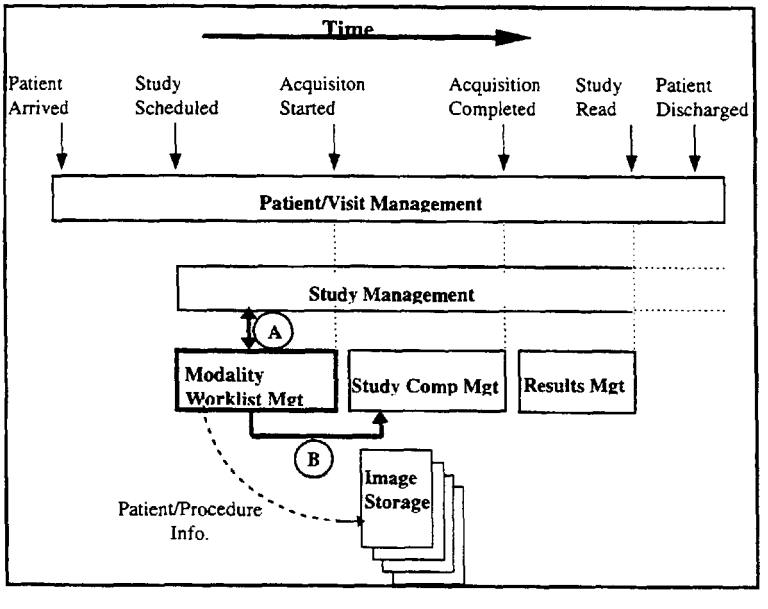

Figure G-1: Functional View - Modality Worklist Management in the Context of DICOM Service Classes

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The management of a patient starts when the patient enters a physical facility (e.g. a hospital, a clinic, a 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 X-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 scheduled imaging procedure has started (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.

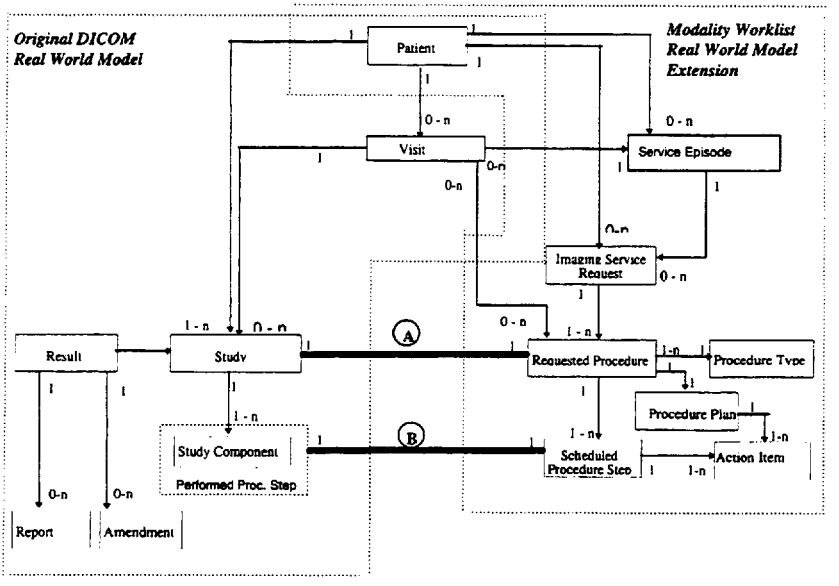

Figure G-2: Relationship of the Original Model and the Extensions for Modality Worklist Management

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. The new parts of the model add entities that are needed to request and to schedule imaging procedures, a concept that is not supported in the original model. The entities required for representing the Worklist form a natural extension of the original DICOM Real-World model.

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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 1 to 1 relationship exists between a Scheduled Procedure Step and a Performed Procedure Step (B). The concept of a Performed Procedure Step is a superset of the Study Component concept contained in the original DICOM model. There is no means to relate previously Scheduled Procedure Steps using Study Component information. This may be a candidate for future extensions of the Study Component into the more general concept of Performed Procedure Step.

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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

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	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

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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

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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.

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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.

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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.)

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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)

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>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.

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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.

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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.

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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.

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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.

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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

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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.

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>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.

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>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.

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>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)

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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.

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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

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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.

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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.

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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.

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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.

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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)

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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

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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

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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

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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:

$$\begin{bmatrix} a_{11} & a_{12} & a_{13} & x_0 \\ a_{21} & a_{22} & a_{23} & y_0 \\ a_{31} & a_{32} & a_{33} & z_0 \end{bmatrix} \begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

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 $i \bullet j$. 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 $j \neq k$, and 1 for $j = k$.

Taking advantage of the fact that $z' \equiv 0$, Eq. I.1-1 can be reduced to:

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$$\begin{bmatrix} a_{11} & a_{12} & 0 & x_0 \\ a_{21} & a_{22} & 0 & y_0 \\ a_{31} & a_{32} & 0 & z_0 \end{bmatrix} \begin{bmatrix} x' \\ y' \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

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.

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Annex J Index to attribute tags (Informative)

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