TECHNICAL REPORT

IEC 61852

First edition
1998-04

Medical electrical equipment – Digital imaging and communications in medicine (DICOM) – Radiotherapy objects

Reference number
IEC 61852:1998(E)

Numbering

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* See web site address on title page.

TECHNICAL REPORT – TYPE 3

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Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE XC

For price, see current catalogue

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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MEDICAL ELECTRICAL EQUIPMENT – DIGITAL IMAGING AND COMMUNICATIONS IN MEDICINE (DICOM) – RADIOTHERAPY OBJECTS

FOREWORD

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- type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;
- type 2, when the subject is still under technical development or where for any other reason there is the future but no immediate possibility of an agreement on an International Standard;
- type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

Technical reports of types 1 and 2 are subject to review within three years of publication to decide whether they can be transformed into International Standards. Technical reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

IEC 61852, which is a technical report of type 3, has been prepared by subcommittee 62C: Equipment for radiotherapy, nuclear medicine and radiation dosimetry, of IEC technical committee 62: Electrical equipment in medical practice.

The text of this technical report is based on the following documents:

Committee draft	Report on voting
62C/183/CDV	62C/201A/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This report has been developed in conjunction with IEC subcommittee 62C, CEN TC251 and the AAPM.

ACR (the American College of Radiology) and NEMA (the National Electrical Manufacturers' Association) formed a joint committee to develop a standard for digital imaging and communications in medicine. This DICOM standard was developed according to the NEMA Procedures.

This report is supplement 11 to the DICOM standard. It is an extension to Part 3, 4 and 6 of the published DICOM standard which consists of the following parts:

Part 1	—	Introduction and Overview
Part 2	—	Conformance
Part 3	—	Information Object Definitions
Part 4	—	Service Class Specifications
Part 5	—	Data Structures and Encoding
Part 6	—	Data Dictionary
Part 7	—	Message Exchange
Part 8	—	Network Communication Support for Message Exchange
Part 9	—	Point-to-Point Communication Support for Message Exchange
Part 10	—	Media Storage and File Format
Part 11	—	Media Storage Application Profiles
Part 12	—	Media Formats and Physical Media
Part 13	—	Print Management Point-to-Point Communication Support

These parts are independent but related documents. Their development level and approval status may differ. Additional parts may be added to this multi-part standard. PS3.1 should be used as the base reference for the current parts of this standard.

A bilingual version of this technical report may be issued at a later date.

INTRODUCTION

This supplement to the DICOM Standard defines a number of information objects applicable to the domain of radiation oncology. The intent of these objects is to support the transfer of radiotherapy-related data between devices found within and outside a radiotherapy department. They are not, however, intended to support the *management* of the transferred data, a function which may be addressed in future revisions of the DICOM Standard.

This task of process management has not been addressed in the current draft due to the absence of a consistent process model for a radiotherapy department, especially in an international context. As a result, the radiotherapy information objects contain a large number of conditional and optional data elements. Essentially the objects are intended to be used as “containers” for related radiotherapy data, with data being added as the object flows through the department.

MEDICAL ELECTRICAL EQUIPMENT – DIGITAL IMAGING AND COMMUNICATIONS IN MEDICINE (DICOM) – RADIOTHERAPY OBJECTS

The following text extends and/or amends Part 3 of DICOM.

Part 3: Addendum radiotherapy information object definitions

1 Scope

This report specifies the following information objects:

1) A DICOM *Image* Information Object for Radiotherapy. It specifies the semantic content of RT Images. It is commonly abbreviated to the RT Image IOD. It also includes the corresponding Storage SOP Class so that this IOD can be used in Network and Media Storage exchanges. The scope of the RT Image IOD is radiotherapy images which have been obtained on a conic imaging geometry, such as that found on conventional simulators and portal imaging devices. It can also be used for calculated images using the same geometry, such as digitally reconstructed radiographs (DRRs).
2) A DICOM *Dose* Information Object for Radiotherapy. It specifies the semantic content of RT Doses. It is commonly abbreviated to the RT Dose IOD. It also includes the corresponding Storage SOP Class so that this IOD can be used in Network and Media Storage exchanges. The scope of the RT Dose IOD is radiotherapy dose distributions which have been calculated on a radiotherapy treatment planning system, represented as two- or three-dimensional dose grids, groups of named or unnamed dose points, isodose curves, and dose-volume histograms (DVHs).
3) A DICOM *Structure Set* Information Object for Radiotherapy. It specifies the semantic content of RT Structure Sets. It is commonly abbreviated to the RT Structure Set IOD. It also includes the corresponding Storage SOP Class so that this IOD can be used in Network and Media Storage exchanges. The scope of the RT Structure Set IOD is radiotherapy patient-related structures which have been identified on devices such as CT scanners, virtual simulation workstations, or treatment planning systems.
4) A DICOM *Plan* Information Object for Radiotherapy. It specifies the semantic content of RT (Treatment) Plans. It is commonly abbreviated to the RT Plan IOD. It also includes the corresponding Storage SOP Class so that this IOD can be used in Network and Media Storage exchanges. The scope of the RT Plan IOD is geometric and dosimetric data specifying a course of external beam and/or brachytherapy treatment.

This report includes a number of addenda to existing Parts of DICOM; therefore the reader should have a working understanding of the Standard.

1. Part 3 Addenda (Extension to the body, Annex A, B, C and D)
2. Part 4 Addenda (Extension to Annex B)
3. Part 6 Addenda (Extension to Section 6 and Annex A)

Add to Section 2

2 Normative references

IEC 61217:1996, *Radiotherapy equipment – Coordinates, movements and scales*

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

After Section 3.8 add the following:

3.X Radiotherapy

This part of the standard is based on the concepts developed in IEC 61217 and makes use of the following terms defined in it:

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

In Section 4 add the following:

4 Symbols and abbreviations

BEV	Beam's-eye view
Brachy	Brachytherapy
CC	Counter-clockwise
CTV	Clinical target volume
CW	Clockwise
DRR	Digitally-reconstructed radiograph
DVH	Dose-volume histogram
GTV	Gross tumour volume
Gy	Gray
ICRU	International Commission on Radiation Units
IEC	International Electrotechnical Commission
MeV	Mega electron Volt
MLC	Multileaf (multi-element) collimator
MU	Monitor unit
MV	Megavolt
PTV	Planning target volume
R&V	Record and verify
ROI	Region of interest
RT	Radiotherapy
SAD	Source-axis distance
SID	Source-image distance

Add in figure 7-2

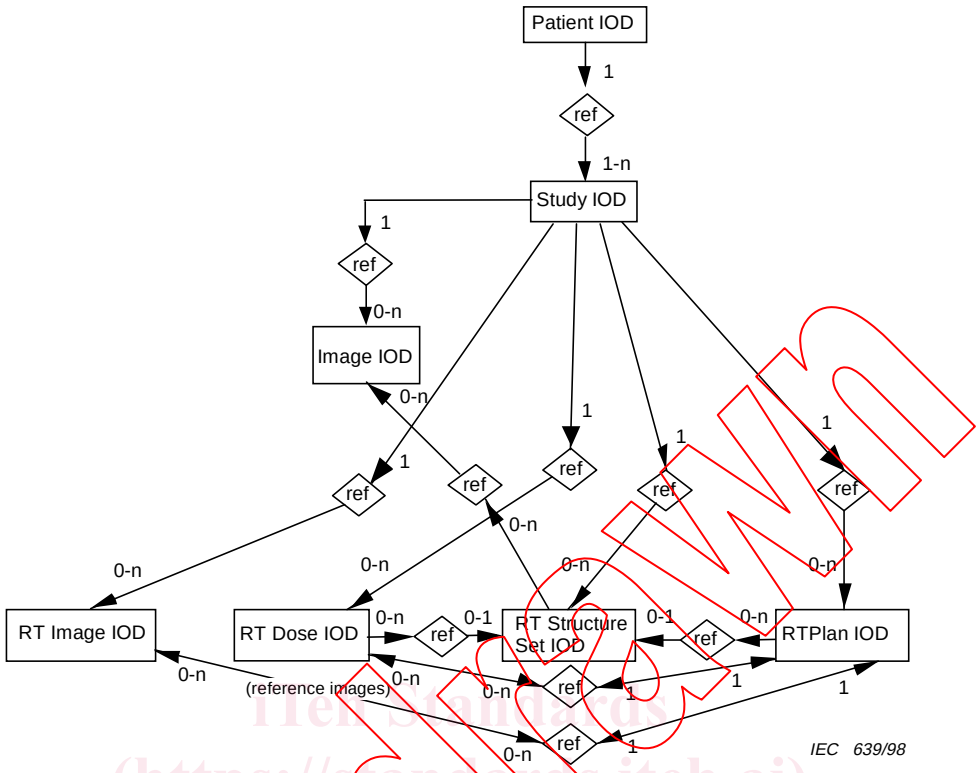

Figure 7-2 – DICOM information model (RT extensions)

Add in table A.1-1 – all modifications to existing table are in BOLD type

Table A.1-1– Composite Information Object Modules Overview

IODs Modules	**RT Image**	**RT Dose**	**RT Struct Set**	**RT Plan**
Patient	**M**	**M**	**M**	**M**
Patient Summary				
General Study	**M**	**M**	**M**	**M**
Patient Study	**U**	**U**	**U**	**U**
Study Content				
General Series				
CR Series				
NM Series				
RT Series	**M**	**M**	**M**	**M**
Frame Of Reference	**U**	**M**		
US Frame of Ref.				
General Equipment	**M**	**M**	**M**	**M**
NM Equipment				
SC Equipment				
General Image	**M**	**C**		
Image Plane		**C**		
Image Pixel	**M**	**C**		
Contrast/Bolus	**C**			
Cine	**C**			
Multi-frame	**C**	**C**		
CR Image				
CT Image				
MR Image				
NM Image				
NM SPECT				
NM Multi-Gated				
US Region Calibration				
US Image				
SC Image				
RT Image	**M**			
RT Dose		**M**		
RT DVH		**U**		
Structure Set		**C**	**M**	
ROI Contour		**C**	**M**	
RT Dose ROI		**C**		
RT ROI Observations			**M**	
RT General Plan				**M**
RT Prescription				**U**
RT Tolerance Tables				**U**
RT Patient Setup				**U**
RT Fraction Scheme				**U**
RT Beams				**C**
RT Brachy Application Setups				**C**
Approval	**U**		**U**	**U**
Overlay Identification				
Overlay Plane		**U**		
Multi-frame Overlay		**U**		

IODs Modules	RT Image	RT Dose	RT Struct Set	RT Plan
Curve Identification				
Curve	**U**			
Audio	**U**	**U**	**U**	**U**
Modality LUT	**U**	**U**		
VOI LUT	**U**			
LUT Identification				
SOP Common	**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.

After Section A.14 add the following:

A.U RT Image INFORMATION OBJECT DEFINITION

A.U.1 RT Image IOD Description

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

A.U.2 RT Image IOD entity-relationship model

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

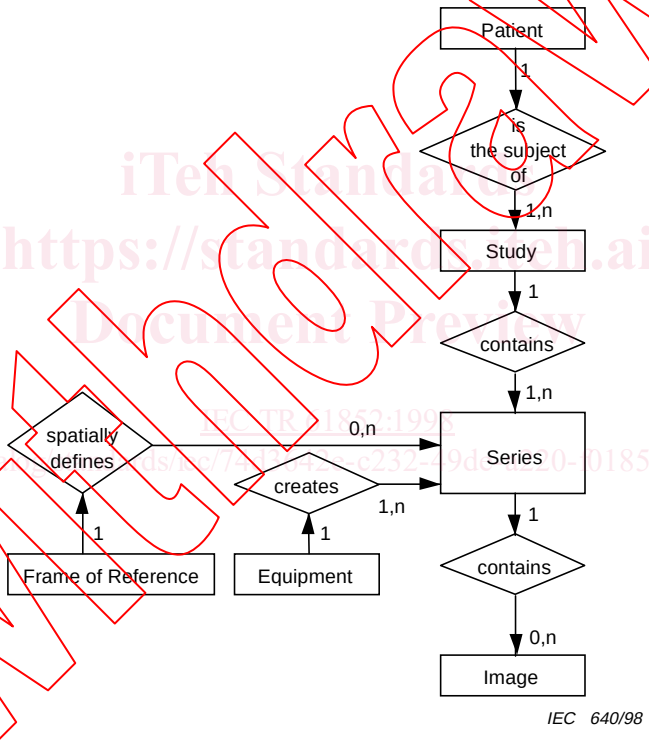

Figure A.U-1 – DICOM RT Image IOD information model

A.U.3 RT Image IOD Module Table

Table A.U.3-1 – RT Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
Series	RT Series	C.8.X.1	M
Frame of Reference	Frame of Reference	C.7.4.1	U
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	Image Pixel	C.7.6.3	M
	Contrast/bolus	C.7.6.4	C – Required if contrast media was used in this image.
	Cine	C.7.6.5	C – Required if multi-frame image is a cine image.
	Multi-Frame	C.7.6.6	C – Required if pixel data is multi-frame data.
	RT Image	C.8.X.2	M
	Modality LUT	C.11.1	U
	VOI LUT	C.11.2	U
	Approval	C.8.X.16	U
	Curve	C.10.2	U
	Audio	C.10.3	U
	SOP Common	C.12.1	M

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

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

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

Curve Dimensions (50xx, 0005)	= 2
Number of Points (50xx, 0010)	= Number of data points in curve
Type of Data (50xx, 0020)	= ROI
Data Value Representation (50xx, 0103)	= US (unsigned short)
Curve Data (50xx, 3000)	= (x,y) pixel coordinates
Curve Description (50xx,0022)	= Structure/Target name

Note that there is no facility for representing multi-frame curves (i.e. all curves are interpreted as being related to the first image frame in a multi-frame image). Curves other than patient structures might also be represented using the HIST, POLY or TABL curve types (see P3.3, C.10.2.1).

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

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

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