Rationale for Correction:
The current implementation base of RT Structure Set SOP Instances in the domain of RT mainly produces contours that, if an inner void is to be expressed, does not utilize the “keyholing technique” as described by the DICOM Standard, but performs a combination of an exclusive disjunction.

For safety reasons, it should be possible to express this different technique, while assuring that systems that do not support this can still operate safely and not consume contours using this different technique.

Therefore, a deliberate breaking change is proposed to enable safe operation by introducing a new Enumerated Term on the Contour level of the ROI Contour Sequence. Consuming applications that are unaware of this term will be prevented from misinterpreting new data that does not utilize the keyholing technique.

Correction Wording:

C.8.8.6 ROI Contour Module

In general, a ROI can be defined by either a sequence of overlays or a sequence of contours. This Module, if present, is used to define the ROI as a set of contours. Each ROI contains a sequence of one or more contours, where a contour is either a single point (for a point ROI) or more than one point (representing an open or closed polygon).

Table C.8-42. ROI Contour Module Attributes

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>Tag</th>
<th>Type</th>
<th>Attribute Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROI Contour Sequence</td>
<td>(3006,0039)</td>
<td>1</td>
<td>Sequence of Contour Sequences defining ROIs. One or more Items shall be included in this Sequence.</td>
</tr>
<tr>
<td>&gt;Referenced ROI Number</td>
<td>(3006,0084)</td>
<td>1</td>
<td>Uniquely identifies the referenced ROI described in the Structure Set ROI Sequence (3006,0020).</td>
</tr>
<tr>
<td>&gt;ROI Display Color</td>
<td>(3006,002A)</td>
<td>3</td>
<td>RGB triplet color representation for ROI, specified using the range 0-255.</td>
</tr>
<tr>
<td>Attribute Name</td>
<td>Tag</td>
<td>Type</td>
<td>Attribute Description</td>
</tr>
<tr>
<td>----------------</td>
<td>-----</td>
<td>------</td>
<td>-----------------------</td>
</tr>
</tbody>
</table>
| >Recommended Display Grayscale Value | (0062,000C) | 3 | A default single gray unsigned value in which it is recommended that the contour be rendered on a monochrome display. The units are specified in P-Values from a minimum of 0000H (black) up to a maximum of FFFFH (white).

Note
The maximum P-Value for this Attribute may be different from the maximum P-Value from the output of the Presentation LUT, which may be less than 16 bits in depth. |
| >Recommended Display CIELab Value | (0062,000D) | 3 | A default triplet value in which it is recommended that the contour be rendered on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1. |
| >Contour Sequence | (3006,0040) | 3 | Sequence of Contours defining ROI. One or more Items are permitted in this Sequence. |
| >>Contour Number | (3006,0048) | 3 | Identification number of the contour. The value of Contour Number (3006,0048) shall be unique within the Contour Sequence (3006,0040) in which it is defined. No semantics or ordering shall be inferred from this Attribute. |
| ... | | | |
| >>Contour Geometric Type | (3006,0042) | 1 | Geometric type of contour. See Section C.8.8.6.1. Enumerated Values:

POINT

single point

OPEN_PLANAR

open contour containing coplanar points

OPEN_NONPLANAR

open contour containing non-coplanar points

CLOSED_PLANAR

closed contour (polygon) containing coplanar points

CLOSEDPLANAR_XOR

closed contour (polygon) containing coplanar points of an inner or outer contour combined using an XOR operator |
| ... | | | |

C.8.8.6.1 Contour Geometric Type
A contour can be one of the following geometric types:
• A Contour Geometric Type (3006,0042) of POINT indicates that the contour is a single point, defining a specific location of significance.

• A Contour Geometric Type (3006,0042) of OPEN_PLANAR indicates that the last vertex shall not be connected to the first point, and that all points in Contour Data (3006,0050) shall be coplanar.

• A Contour Geometric Type (3006,0042) of OPEN_NONPLANAR indicates that the last vertex shall not be connected to the first point, and that the points in Contour Data (3006,0050) may be non-coplanar. Contours having a Geometric Type (3006,0042) of OPEN_NONPLANAR can be used to represent objects best described by a single, possibly non-coplanar curve, such as a brachytherapy applicator.

• A Contour Geometric Type (3006,0042) of CLOSED_PLANAR indicates that the last point shall be connected to the first point, where the first point is not repeated in Contour Data (3006,0050). All points in Contour Data (3006,0050) shall be coplanar.

• A Contour Geometric Type (3006,0042) of CLOSEDPLANAR_XOR indicates that the last point shall be connected to the first point, where the first is not repeated in Contour Data (3006,0050). All points in Contour Data (3006,0050) shall be coplanar. More than one Contour is used to describe an ROI and these Contours are combined by geometric exclusive disjunction, see Section C.8.8.6.3. If any of the Contours within an ROI is of Contour Geometric Type (3006,0042) CLOSEDPLANAR_XOR, all Contours of that ROI shall be of the same type.

C.8.8.6.3 Representing Inner and Outer Contours on an Image

Inner and Outer Contours can be represented by two different techniques:

Using the “keyhole” technique, an ROI with an excluded inner part is represented with a single planar Contour. When a single ROI describes an excluded inner volume, this can be encoded with a single contour using a "keyhole" technique. In this method, an arbitrarily narrow channel is used to connect the outer contour to the inner contour, so that it is drawn as a single contour. An example of such a structure is shown in Figure C.8.8.6-1 with the channel at roughly the 12 o’clock position.

Points in space lying along the path defined by the contour are considered to be inside part of the ROI.

Replace Figure C.8.8.6-1 with the new figure below.

![New Figure C.8.8.6-1](image)

Figure C.8.8.6-1. Example of ROI with excluded inner volume

Using the "XOR" technique, an ROI with an excluded inner part is represented by two planar Contours that are combined by a geometric exclusive disjunction, thus extracting the inner from the outer Contour, see Figure C.8.8.6-2. The contours have the Contour Geometric Type (3006,0042) CLOSEDPLANAR_XOR.
Using this technique, it is also possible to create an ROI that includes disjoint parts of the ROI within an interior void. When two or more Contours are present, two Contours are combined using a geometric exclusive disjunction ("XOR"). Then this result is combined by an XOR operation with a third Contour, and so on for all other Contours of this ROI. The order of combination does not matter. An example of the result of an XOR operation of three Contours is visualized in Figure C.8.8.6-3.