COMPUTER PROGRAM
for
TISSUE DOSES
in
DIAGNOSTIC RADIOLOGY

(for VAX and IBM-Compatible PC Systems)

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ABSTRACT

A computer program to estimate the absorbed doses to several tissues of a reference patient for a specified x-ray projection using tissue-air-ratios generated previously by a Monte Carlo technique is described in detail. The computer program also calculates a "cancer detriment index" for the aggregate of the tissue doses. The program can be operated in either an interactive or a batch mode.

The VAX program is written in VAX-FORTRAN and uses formatted and unformatted direct access sequential data files. All subroutines used by the program are also in VAX-FORTRAN.

The IBM-compatible PC program is written in PC-FORTRAN and uses formatted and unformatted direct access sequential data files. All subroutines used by the program are also in PC-FORTRAN.

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INTRODUCTION

This report documents a computer program to estimate absorbed dose to several tissues of a reference patient for a specified x-ray projection. The program follows the procedure given in Section 4 of "Organ Doses in Diagnostic Radiology" (1). In some cases, additional or expanded data are used that were not available at the time of the publication of reference 1. The present computer program includes revisions based on the data currently available and is the one presently operational at the Center for Devices and Radiological Health.

The program was originally developed for radiographic projections and its principal application has been to radiography. Many common radiographic projections can be specified in the program by projection codes. The data required to apply the computer code for radiography are:

Projection and view (limited to AP, PA, and lateral)
X-ray field size at image receptor
X-ray field location relative to anatomical landmarks
Entrance exposure (free-in-air) at skin surface
Beam quality (kVp and HVL)
Source-to-image receptor distance or source-to-skin entrance distance.

The program may also find some limited application to fluoroscopy. The same input data are required for fluoroscopic projections. When, in fluoroscopy, the x-ray table is placed between the x-ray source and the patient, the entrance exposure (free-in-air) and the beam quality are determined at the tabletop. For fluoroscopic projections, the source-to-image receptor distance and the source-to-skin entrance distance are both required, since the patient, x-ray source and image receptor geometry may not be the same as that selected for radiographic projections. The user will need to simulate the dynamic components of a fluoroscopy examination with stationary x-ray fields and derive and specify all the requisite input data (2).

A variety of output tables which list the tissue doses for a projection can be selected by the user. The tissues presently included are the lungs, active bone marrow, ovaries, testes, thyroid, uterus, total trunk (excluding skeletal and lung tissues), and female breasts.

In addition, a quantity called "cancer detriment index" is included that is an indicator of cancer detriment from the aggregate of the relevant tissue doses, based on nominal risk coefficients for various cancers that may be induced by radiation and the severity of those cancers.

The VAX program and all the subroutines used are written in VAX-FORTRAN and are for a VAX System. The program requires 275,000 bytes of storage to operate. Average execution time is about 1.5 seconds per record.

The IBM-compatible PC program and all the subroutines used are written in PC-FORTRAN and are for an IBM-compatible PC system. The program requires 322,000 bytes of storage to operate. Examples of typical execution times per record with a hard-disk (internal) drive are:

5 minutes - XT 8088
85 seconds - AT 80286
25 seconds - XT 8088 with 8087 math coprocessor
15 seconds - AT 80286 with 80287 math coprocessor
5 seconds - AT 80386 with 80387 math coprocessor

PROGRAM DESCRIPTION

A system flow diagram for the computer program described in this report is shown in Figure 1. The FORTRAN programs named are listed in Appendix F, and the input data files noted are described later in the report.

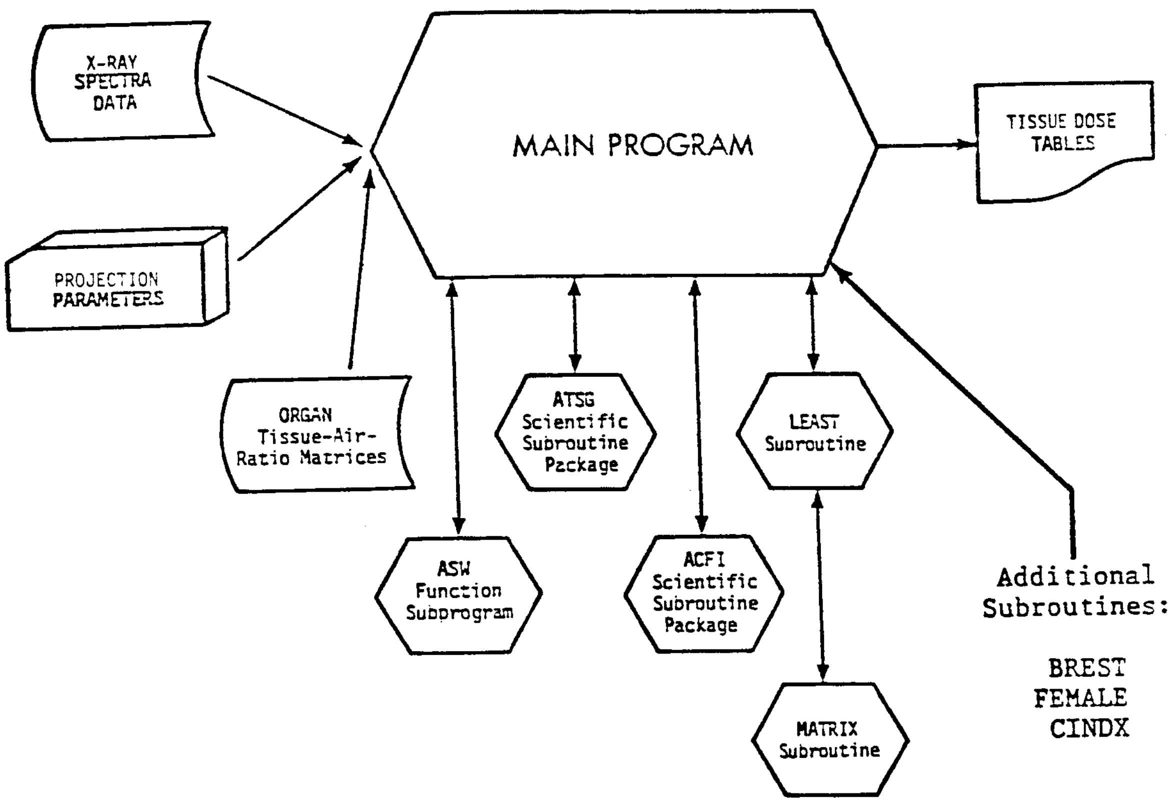

Figure 1. Computer Flow Diagram.

The computer program proceeds as follows:

1. The projection parameters are identified by the user either in the batch or interactive mode. Information not included as part of the input record is maintained within the program and is linked through one or more of the fields specified on the input record.

2. The size of the x-ray field at the image receptor is converted to the size of the x-ray field at the tissue plane, using the relationship:

$$d' = d\ (STP/SID)$$

where:

d' = x-ray field dimension (height or width) in centimeters at the tissue plane,

d = x-ray field dimension (height or width) in centimeters at the image receptor,

SID = source-to-image distance (cm),

and STP = source-to-tissue plane distance (cm).

For radiographic projections, the source-to-skin entrance distance (SSD) is determined first from either the SID input (by subtracting the appropriate body part thickness plus an allowance of 5 centimeters for the tabletop and/or cassette) or from the direct SSD input. The STP is then calculated by adding to the SSD the distance between the tissue plane and the entrance skin plane. For fluoroscopic projections, the appropriate values for both the SID and SSD are input, and the STP is calculated from the SSD as noted above.

3. The tissue-air-ratio (TAR) for the desired x-ray field size and location is computed for each of the available photon energies. The following procedure applies to all tissues except the female breasts.

The x-ray field center-of-interest coordinates can be defined in one of two ways: (a) by identifying the appropriate radiographic projection code in the input field (these codes, projections, and locations are given in Appendix B) or (b) by specifying the coordinates in the input. Whichever method is selected, the x-ray field at the tissue plane is centered at that point. Then, the tissue-air-ratio matrices for the specific tissue, view and photon energy are read. For each tissue-air-ratio matrix, the x-ray field is superimposed over the matrix and the tissue-air-ratios for those grids or portions of grids falling within the x-ray field are summed. For lateral views, the 100-keV TAR sum is calculated as a preselected fraction (0.87-1.0) of the 80-keV TAR. The value selected is dependent on which tissue is being processed. Also, for all views, the TAR for 120 keV is set equal to that of 100 keV, since the TAR is relatively constant at those energies. The 20-keV AP matrix is only partially computed, but the 20-keV TARs in most cases do not make significant contributions to the TARs for the total x-ray spectra. The 20-keV AP matrix is, however, used for the following cases: thyroid, ovaries and testes for all projections and for all tissues in cervical spine projections.

For the female breasts, TAR sums as a function of keV for PA and AP views are stored in the program. These TAR sums have been generated previously from the Monte Carlo radiation transport code for conditions where the breasts are entirely in the x-ray field. During calculation of the breast dose for PA and AP views, the x-ray field dimensions are checked to determine whether both breasts are entirely in the beam. Appendix E gives the dimensions of the breast region that must be encompassed by the x-ray field. If the breasts are not entirely in the beam, or the view is a lateral view, the breast dose is not computed, and appropriate statements are printed in the output table.

4. The tissue-air-ratios for intermediate photon energies are interpolated, x-ray spectra are selected, and the tissue-air-ratios for desired beam qualities are calculated for the x-ray projection.

   Three additional tissue-air-ratios are interpolated and added to the base values found in step 3. These are: for lateral views, TARs at 30, 45, and 67.5 keV; for AP and PA views, TARs at 47.5, 67.5 and 90 keV. These points are found by interpolation.

   Using the base tissue-air-ratios plus the three interpolated values, intermediate tissue-air-ratios from 10 keV to 130 keV at 2-keV intervals are interpolated using the scientific subroutines ATSG and ACFI.

   ATSG orders the base tissue-air-ratios with respect to the energy of the TAR to be found, and ACFI uses the ordered values from ATSG to perform a continued fraction interpolation. If for some reason an error message is passed from the ACFI subroutine, then the program does a linear interpolation for the desired energy, using the three values closest to the desired energy, as ordered in the first subroutine (ATSG).

   In this process of interpolation, there is also an extrapolation to a few energies below the lowest base value. A lower energy cutoff point is determined below which values are set equal to zero. That cutoff is the point at which all the higher energy values are in ascending order and greater than zero.

   Now that the TARs for all the intermediate keV values have been found, the x-ray spectra used to weight the tissue-air-ratios for each energy are selected. For conventional aluminum filtration, there are three sets of nine spectra each. The set desired is specified by the peak kilovoltage (kVp) that is input for the projection. When no value is input for kVp, all 27 spectra are used. For erbium filters, there are two sets of five spectra each; one set for an erbium composite filter and one set for an erbium foil filter.

   For each of the selected spectra, the tissue-air-ratio for each 2-keV increment in energy is multiplied by the corresponding fractional exposure contribution from the x-ray spectrum and the products are summed to produce a tissue-air-ratio for each of the x-ray spectra.

   When the appropriate option is selected, the tissue-air-ratios calculated for the x-ray spectra for conventional aluminum filtration and their corresponding HVLs are passed to a least squares curve fitting subroutine. This subroutine computes the coefficients for a second degree least squares polynomial fit and then solves the equation to yield tissue-air-ratios as a function of HVL.

5. The tissue-air-ratio is converted to tissue dose for a specified skin entrance exposure. The exposure free-in-air at the tissue plane is computed from exposure free-in-air at the skin entrance using the inverse square law. The product of the exposure at the tissue plane and the tissue-air-ratio is the absorbed dose to the tissue.

6. Tissue doses applicable for a female are obtained by minor adjustments to the tissue doses computed for the male reference patient. The initial data are for the phantom with reference male dimensions. For the female, conversion factors are applied to certain tissue doses (active bone marrow, lungs and total trunk) to account for the effect of shielding or scattering due to the female breasts. A table for females is produced and shown immediately below the male table for the requested case. These adjustments are made when the breasts are entirely in the x-ray field. That occurs when the beam center on the upper thorax is between 24 cm and 59 cm, as measured from the vertex of the phantom. See Appendix E. For other conditions and tissues, the female tissue dose is set equal to the male tissue dose.

7. A "cancer detriment index" (CDI) is also computed separately for males and females using the corresponding tissue doses, as described in "Handbooks of Tissue Doses in Diagnostic Radiology" (3). The computation for the CDI is:

$$CDI = \sum_{i=1}^{n} \left[r_i(f) + s_i\, r_i(c) \right] \bar{D}_i$$

where $r_i(f)$ is the lifetime risk coefficient for fatal cancer i (per rad),

$r_i(c)$ is the lifetime risk coefficient for "curable" cancer i (per rad),

s_i is the relative severity associated with successful treatment of cancer i,

and $\bar{D}_i$ is the average absorbed dose in the appropriate tissue for cancer i (rad).

The risk coefficients and relative severities used in the computer program are:

Cancer(i)	$r_i(f)$[a] Male	$r_i(f)$[a] Female	$r_i(c)$[a] Male	$r_i(c)$[a] Female	s_i
Lung	2.0	2.0	0.1	0.1	0.95
Leukemia	2.4	1.6	0.12	0.08	0.95
Thyroid	0.33	0.67	6.3	12.7	0.05
Breast	---	5.0	---	3.0	0.60
Other	5.0	5.0	1.5	1.5	0.75

[a] Multiply table entries for $r_i(f)$ and $r_i(c)$ by 10^{-5} to obtain risk coefficients per rad.

INPUT

There are three forms of input to the computer program: the x-ray spectra, the tissue-air-ratio matrices, and the projection parameters.

The first two are permanent direct access sequential data files created originally by other FORTRAN programs which simply reformat the original sets of data and create the appropriate disk data files. The third input data set is entered by the user.

X-RAY SPECTRA DATA FILE

The x-ray spectra data file is an unformatted direct access sequential data file with fixed length records. It was created by a separate FORTRAN program which used card input containing the spectra. It contains 27 spectra for conventional aluminum filtration and 10 spectra for higher atomic number (i.e., erbium) filters.

The spectra for conventional aluminum filtration were generated experimentally by the Bureau of Radiological Health (4). These data have been arranged into three sets by kVp (<76 kVp, 76-95 kVp, >95 kVp) and ordered by HVL within each set. Each set contains nine spectra as well as the respective kVp and HVL values. When one of these three sets is used, the corresponding ranges of HVL (mm Al) that are computed and presented in the output tables are: 1.0 to 4.0, 1.5 to 6.0, and 2.0 to 6.5, respectively. When all 27 spectra are used, the range of HVL (mm Al) that is computed and presented in the output table is 1.0 to 6.5. When both a kVp range and an HVL are specified, the full range of HVL (mm Al) is computed for the kVp range selected, but only the result for the specified HVL is given in the output table.

The 10 spectra for erbium filters were generated through calculations by E.L. McGuire of the John L. McClellan Memorial Veterans Hospital (5). These data are arranged into two sets of 5 spectra each by type of erbium filter (erbium composite, erbium foil) with the kVp and HVL given for each spectra. When one of these sets is used, values for each of the 5 spectra are presented in the output tables. The spectra range from 70 to 120 kVp, with corresponding HVL values that range from 6.0 to 8.5 mm Al.

The spectra are presented as the fraction of exposure contributed by each 2-keV energy interval, normalized to 1-roentgen exposure for the total spectrum. A total of 50 spectra may be maintained on the two sections of the data file. Currently, the data file has only 37 spectra. The first two records of the spectra data file contain the number of spectra in the file, the filter type (for erbium filtration), the thickness of the filter (for erbium filtration), the HVL, the kVp, and the number of non-zero values for each spectrum.

The subsequent records contain the spectra themselves. Each record is made up of no more than 60 values representing the fractional photon exposure for each photon energy in the range from 10 to 130 keV in intervals of 2 keV. The 37 spectra used in this program are given in Appendix C. The last values given in Appendix C are for 120 keV; values above 120 keV are all 0.0.

TISSUE-AIR-RATIO MATRICES FILE

Tissue-air-ratio matrices are maintained as an unformatted direct access sequential data file with fixed length records. This data set was created by a separate FORTRAN program that reformats a string of 161 grid elements on the original data file into appropriate positions in a 34 x 11 matrix. For each photon energy listed below, the tissue-air-ratios were reformatted and the matrices associated with a single view for one tissue are grouped together on a single record.

AP view	PA view	Lateral view
20 keV	25 keV	25 keV
25 keV	30 keV	35 keV
30 keV	40 keV	55 keV
40 keV	55 keV	80 keV
55 keV	80 keV	
80 keV	100 keV	
100 keV		

Therefore, for each tissue (except the female breasts) there are three records, each record containing the appropriate number of 34 x 11 tissue-air-ratio matrices to correspond to the photon energies tabulated for the view. The records are ordered by tissue (Appendix A) within view, the PA view group being first, the AP view group being next, and the lateral view group being last. The data set is cataloged.

Record No.	Description of data
1-7	Each record representing 6 matrices for PA views for one tissue
8-14	Each record representing 7 matrices for AP views for one tissue
15-21	Each record representing 4 matrices for lateral views for one tissue

Appendix D presents a sample set of matrices for PA view, ovaries: 25, 30, 40, 55, 80, 100 keV.

TISSUE-AIR-RATIOS FOR THE FEMALE BREASTS

For the female breasts, the TAR sums as a function of keV for PA and AP views are stored in the program. These TAR sums (given below) have been generated directly from the Monte Carlo radiation transport code for conditions when the breasts are entirely in the x-ray field.

keV	20	25	30	40	50	80	100
PA	--	0.00218	0.00950	0.0769	0.2017	0.3258	0.3500
AP	0.3304	0.5500	0.7162	0.9985	1.2223	1.3007	1.1240

USER INPUT DATA FILE

Input data are entered directly by the user either in the batch mode or the interactive mode. The input contains mandatory data and some optional input data fields. The data are required to define the type of projection and its parameters.

The input uses one record per projection. In the batch mode, the data must be entered in the form described below. The proper input format is as follows: (A20, I1, I2, I3, F5.2, I6, 6F5.1, 3I1). There are no blanks between indicated fields. In the interactive mode, the proper input formats are indicated in the prompts to the user.

	Field Description	Form	Columns
1.	Projection identification: for user purposes only.	Character	1-20
2.	View: code 1 = PA; code 2 = AP; code 3 = lateral; this field is used throughout the program to identify parameters specific to different views and to find the appropriate tissue-air-ratio matrices for the tissues.	Integer	21
3.	Projection: set of codes ranging from 1 to 43 (Appendix B). This field identifies, for predefined projections, the center-of-interest coordinates of the projection on the phantom. If fields 11 and 12 are entered, this field is left blank. (In the interactive mode, a projection code of 44 is provided. When 44 is entered, the user is further prompted for the additional information that will be necessary for the projection.)	Integer	22-23
4.	kVp: the kVp value is used to select one of the three sets of 9 x-ray spectra for conventional aluminum filtration. If the kVp field is left blank, all 27 spectra will be used.	Integer	24-26
*5.	HVL (mm Al): do not use if the kVp field (field 4) has been left blank. When used, the output table will contain data only for the HVL specified here, rather than the usual range of HVLs.	Real	27-31 (xx.xx)
6.	Exposure (free-in-air) at skin entrance (mR): supplied by user.	Integer	32-37

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* An asterisk beside the field number indicates an optional input field. If the option is not selected, the field is to be left blank.

Field Description	Form	Columns
7. SID, source-to-image receptor distance (cm): used in field size and exposure conversions at various reference planes. For a radiographic projection only the SID (field 7) or SSD (field 10) is entered. For a fluoroscopic projection, both SID (field 7) and SSD (field 10) are required.	Real	38-42 (xxx.x)
8. Horizontal beam dimension (cm): used in calculation of x-ray field size at tissue plane.	Real	43-47 (xxx.x)
9. Vertical beam dimension (cm): used in calculation of x-ray field size at tissue plane.	Real	48-52 (xxx.x)
*10. SSD, source-to-skin entrance distance (cm): for radiographic projections, enter only if SID (field 7) is not specified. If SSD (field 10) is left blank, and SID (field 7) is specified, a value is calculated within the program using the geometry for the reference patient for radiography. For a fluoroscopic projection, both the SSD (field 10) and the SID (field 7) are required.	Real	53-57 (xxx.x)
*11. x-coordinate (cm): distance from phantom midline in centimeters. Field 3 is omitted when entries are made in fields 11 and 12. Fields 11 and 12 locate the center-of-interest for a projection at coordinates other than the standard ones given in Appendix B (see Appendix E for correct orientation on phantom).	Real	58-62 (xxx.x)
*12. z-coordinate (cm): distance from the phantom vertex (top of the head) in centimeters (see Appendix E).	Real	63-67 (xxx.x)
*13. Alternate tissue dose printout for original x-ray spectra: the TARs computed for the desired x-ray spectra are entered directly into the final computations for tissue doses. The interpolation procedures for HVL intervals are bypassed and a table of tissue doses for the specific x-ray spectra is produced. This is done by entering a 1, otherwise the field is left blank.	Integer	68

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* An asterisk beside the field number indicates an optional input field. If option is not selected, the field is to be left blank.

Field Description	Form	Columns
*14. Erbium filter x-ray spectra: when a 1 is entered in this field, the erbium composite x-ray spectra are used; when a 2 is entered, the erbium foil x-ray spectra are used. When erbium filter x-ray spectra are selected, fields 4 (kVp) and 5 (HVL) are left blank.	Integer	69
*15. Fluoroscopic projection: when a fluoroscopic projection is input, a 1 is entered in this field. Both the SID (field 7) and the SSD (field 10) are required, since the geometry for the reference patient for radiography may not be appropriate.	Integer	70

SAMPLE INPUT/OUTPUT CASES

The output for all computer runs is in tabular form, giving tissue doses as a function of HVL, or for the specific x-ray spectra when fields 13 or 14 are selected. There is one table for each projection record. All tables are headed by the date the table was produced, a page (sequence) number, and a summary of the projection parameters. The input specifications are repeated below the table for easy reference. Six examples of computer runs are given in Appendix G.

REFERENCES

1. Rosenstein, M. Organ Doses in Diagnostic Radiology. HEW Publication FDA 76-8030. Food and Drug Administration, Rockville, Maryland (1976).

2. Suleiman, O.H., J. Anderson, B. Jones, G.U.V. Rao and M. Rosenstein. Organ Doses from the Upper Gastrointestinal Fluoroscopic Examination. Scientific Exhibit, Radiological Society of North America (1988). Copies available from Orhan H. Suleiman, 1901 Chapman Avenue, Center for Devices and Radiological Health, Rockville, Maryland 20857.

3. Rosenstein, M. Handbooks of Tissue Doses in Diagnostic Radiology. In: Radiation Protection Practice, Proceedings of the 7th Congress of the International Radiation Protection Association, Volume II, pages 765-768. Pergamon Press, New York (1988).

4. Fewell, T.R. and R.E. Shuping. The Photon Energy Distribution of Some Typical Diagnostic X-Ray Beams. Med Phys 4:3 (1977). Also: Fewell, T.R. Personal communication (1977).

5. Additional information on the method used to produce the x-ray spectra for erbium composite and erbium foil filters can be obtained from: E.L. McGuire, John L. McClellan Memorial Veterans Hospital, 4300 West Seventh Street, Little Rock, Arkansas 72205.

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* An asterisk beside the field number indicates an optional input field. If option is not selected, the field is to be left blank.

APPENDIX A

TISSUES AND DEPTHS OF TISSUE PLANES FROM SKIN ENTRANCE

APPENDIX A

TISSUES AND DEPTHS OF TISSUE PLANES FROM SKIN ENTRANCE

Tissue	Depth from Skin Entrance (cm) Front (AP View)	Rear (PA View)	Side (Right Lateral View)[a]
Lungs	10	10	17.2
Active bone marrow	10	10	17.2
Ovaries	10	10	17.2
Testes	2	18	17.2
Thyroid	4	16	17.2
Uterus	8	12	17.2
Total trunk[b]	10	10	17.2
Female breasts	4	24	17.2
Cancer Detriment Index	---------not applicable-----------		

[a] When the entire x-ray field in the lateral view is incident only on the head, the depth from skin entrance for all tissues is 7 cm.

[b] Total trunk tissue excludes bone, bone marrow and lung components of the trunk. It is used as a surrogate for other soft tissues in the trunk. Total trunk dose is also used to compute the contribution to the "cancer detriment index" for other cancers.

APPENDIX B

FIELD CENTERS AND X-RAY PROJECTION CODES

APPENDIX B

Field Centers and X-Ray Projection Codes

Projection Code	Projection	Distance from Vertex (cm)	Distance from Midline (cm)
1	AP,PA,LAT Skull	8.5	0.0
2	PA Facial Bones, Nasal Bones, Optic Foramen, Orbits, Sinuses	8.5	0.0
3	PA TMJ, Zygomes, Mandible, Mastoid	14.0	0.0
4	LAT Sella Volume, TMJ	14.0	0.0
5	AP Cervical Spine	17.4	0.0
6	LAT Cervical Spine	22.5	5.0
7	AP Shoulder (one)	31.0	±15.3
8	LAT Shoulder (one)	31.0	0.0
9	AP Shoulder (both)	31.0	0.0
10	AP Scapula (one)	35.8	±13.6
11	LAT Scapula (one)	35.8	0.0
12	AP Scapulae (both)	35.8	0.0
13	AP Humerus (one)	35.8	±16.8
14	LAT Sternum	37.0	0.0
15	AP,PA,LAT Ribs	40.5	0.0
16	AP,PA,LAT Barium Swallow	40.5	0.0
17	AP,PA,LAT Chest	42.4	0.0
18	AP Thoracic Spine	42.4	0.0
19	LAT Thoracic Spine	42.4	5.0
20	AP,LAT Full Spine	50.0	0.0
21	PA Cholecystography	55.5	-8.5
22	AP Lithotripsy	56.0	10.0
23	AP,PA Upper GI	56.6	4.3
24	LAT Upper GI	56.6	-3.0
25	AP Upright Abdomen	60.0	0.0
26	AP Lumbar Spine	66.5	0.0
27	LAT Lumbar Spine	66.5	5.0
28	AP,PA,LAT Retrograde Pyelogram	72.0	0.0
29	AP,PA,LAT KUB	72.0	0.0
30	AP,PA,LAT Barium Enema	72.0	0.0
31	AP,PA,LAT Lumbosacral Spine	72.0	0.0
32	AP,PA,LAT IVP	72.0	0.0
33	AP,PA,LAT Renal Arteriogram	72.0	0.0
34	AP Sacrum,Coccyx,Sacroiliac Joint	80.0	0.0
35	AP,LAT Lumbopelvic	80.0	0.0
36	AP,LAT Pelvis	80.0	0.0
37	AP Urethrogram	84.0	0.0
38	AP Cystography	84.0	0.0
39	AP Hip (one)	88.0	± 8.5
40	LAT Hip (one)	88.0	0.0
41	AP Hip (both)	88.0	0.0
42	AP Femur (one)	107.0	± 8.5
43	LAT Femur (one)	107.0	0.0

APPENDIX C

X-RAY SPECTRA

Appendix C. X-Ray Spectra <76 kVp

HVL	0.98	1.16	1.29	1.36	1.57	2.09	2.19	2.40	3.60
KVP	45	55	60	55	65	65	70	70	70
KNT	20	25	27	25	32	32	35	34	32
10	0.0002	0.0018	0.0085	0.0	0.0037	0.0032	0.0	0.0	0.0
12	0.0083	0.0080	0.0178	0.0012	0.0033	0.0038	0.0031	0.0035	0.0
14	0.0408	0.0317	0.0370	0.0132	0.0118	0.0025	0.0025	0.0028	0.0
16	0.0867	0.0703	0.0650	0.0405	0.0335	0.0086	0.0084	0.0066	0.0021
18	0.1242	0.1002	0.0844	0.0766	0.0644	0.0274	0.0242	0.0200	0.0030
20	0.1359	0.1142	0.0917	0.1024	0.0853	0.0519	0.0477	0.0388	0.0086
22	0.1283	0.1121	0.0912	0.1118	0.0963	0.0731	0.0672	0.0578	0.0184
24	0.1211	0.1123	0.0919	0.1192	0.1060	0.0936	0.0888	0.0773	0.0350
26	0.0990	0.0963	0.0825	0.1076	0.0984	0.0989	0.0948	0.0848	0.0500
28	0.0778	0.0806	0.0727	0.0943	0.0893	0.0978	0.0930	0.0867	0.0623
30	0.0569	0.0625	0.0605	0.0756	0.0731	0.0859	0.0834	0.0796	0.0664
32	0.0429	0.0519	0.0527	0.0630	0.0642	0.0790	0.0766	0.0770	0.0731
34	0.0304	0.0409	0.0444	0.0503	0.0541	0.0686	0.0677	0.0695	0.0733
36	0.0212	0.0325	0.0382	0.0402	0.0451	0.0602	0.0602	0.0633	0.0719
38	0.0134	0.0248	0.0321	0.0307	0.0363	0.0498	0.0510	0.0550	0.0676
40	0.0076	0.0185	0.0262	0.0226	0.0290	0.0409	0.0421	0.0470	0.0625
42	0.0038	0.0141	0.0228	0.0174	0.0243	0.0348	0.0364	0.0419	0.0582
44	0.0013	0.0105	0.0196	0.0129	0.0202	0.0289	0.0312	0.0371	0.0543
46	0.0001	0.0072	0.0163	0.0089	0.0161	0.0231	0.0257	0.0318	0.0490
48	0.0	0.0048	0.0131	0.0058	0.0125	0.0184	0.0214	0.0267	0.0437
50	0.0	0.0028	0.0103	0.0035	0.0096	0.0143	0.0170	0.0220	0.0375
52	0.0	0.0014	0.0083	0.0018	0.0075	0.0114	0.0139	0.0185	0.0340
54	0.0	0.0005	0.0061	0.0006	0.0057	0.0086	0.0117	0.0153	0.0302
56	0.0	0.0001	0.0042	0.0001	0.0041	0.0061	0.0091	0.0120	0.0257
58	0.0	0.0	0.0022	0.0	0.0028	0.0042	0.0073	0.0089	0.0216
60	0.0	0.0	0.0005	0.0	0.0018	0.0027	0.0055	0.0063	0.0175
62	0.0	0.0	0.0	0.0	0.0010	0.0014	0.0040	0.0043	0.0141
64	0.0	0.0	0.0	0.0	0.0004	0.0005	0.0029	0.0028	0.0106
66	0.0	0.0	0.0	0.0	0.0001	0.0001	0.0018	0.0016	0.0069
68	0.0	0.0	0.0	0.0	0.0	0.0	0.0009	0.0007	0.0027
70	0.0	0.0	0.0	0.0	0.0	0.0	0.0003	0.0002	0.0001
72	0.0	0.0	0.0	0.0	0.0	0.0	0.0001	0.0	0.0
74	0.0	0.0	0.0	0.0	0.0	0.0	0.0001	0.0	0.0
76	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
78	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
82	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
86	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
88	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
92	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
94	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
96	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
98	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
102	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
104	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
106	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
108	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
110	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
112	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
114	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
116	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
118	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
120	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix C. X-Ray Spectra 76 to 95 kVp

HVL	1.65	2.38	2.70	2.95	3.67	4.10	4.75	4.80	5.50
KVP	80	80	90	80	90	80	90	80	90
KNT	37	39	44	39	42	37	42	37	42
10	0.0074	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0156	0.0062	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0292	0.0046	0.0057	0.0039	0.0055	0.0	0.0	0.0	0.0
16	0.0499	0.0082	0.0077	0.0034	0.0055	0.0031	0.0042	0.0	0.0
18	0.0690	0.0206	0.0173	0.0087	0.0104	0.0033	0.0033	0.0026	0.0028
20	0.0758	0.0421	0.0341	0.0215	0.0212	0.0067	0.0063	0.0026	0.0032
22	0.0755	0.0590	0.0493	0.0393	0.0327	0.0143	0.0127	0.0059	0.0054
24	0.0797	0.0773	0.0679	0.0606	0.0470	0.0267	0.0230	0.0136	0.0111
26	0.0728	0.0834	0.0753	0.0723	0.0550	0.0396	0.0331	0.0235	0.0193
28	0.0669	0.0843	0.0776	0.0792	0.0607	0.0503	0.0428	0.0352	0.0285
30	0.0559	0.0767	0.0711	0.0764	0.0576	0.0548	0.0467	0.0432	0.0353
32	0.0512	0.0719	0.0681	0.0759	0.0595	0.0610	0.0527	0.0514	0.0432
34	0.0440	0.0648	0.0625	0.0703	0.0563	0.0625	0.0540	0.0571	0.0476
36	0.0395	0.0577	0.0571	0.0651	0.0541	0.0630	0.0550	0.0608	0.0514
38	0.0339	0.0501	0.0501	0.0576	0.0493	0.0600	0.0528	0.0607	0.0517
40	0.0292	0.0423	0.0432	0.0495	0.0448	0.0556	0.0499	0.0587	0.0507
42	0.0261	0.0375	0.0390	0.0450	0.0416	0.0532	0.0479	0.0576	0.0508
44	0.0236	0.0327	0.0348	0.0398	0.0392	0.0511	0.0468	0.0568	0.0502
46	0.0208	0.0278	0.0304	0.0348	0.0358	0.0472	0.0439	0.0530	0.0476
48	0.0182	0.0236	0.0267	0.0295	0.0320	0.0426	0.0398	0.0492	0.0448
50	0.0159	0.0196	0.0229	0.0251	0.0286	0.0380	0.0358	0.0450	0.0416
52	0.0142	0.0174	0.0204	0.0221	0.0267	0.0355	0.0343	0.0425	0.0397
54	0.0127	0.0152	0.0180	0.0197	0.0246	0.0325	0.0320	0.0390	0.0372
56	0.0113	0.0129	0.0162	0.0165	0.0226	0.0296	0.0296	0.0360	0.0350
58	0.0127	0.0124	0.0179	0.0158	0.0290	0.0318	0.0395	0.0384	0.0465
60	0.0107	0.0112	0.0179	0.0149	0.0323	0.0307	0.0418	0.0367	0.0494
62	0.0077	0.0083	0.0113	0.0108	0.0175	0.0214	0.0237	0.0263	0.0282
64	0.0069	0.0069	0.0097	0.0093	0.0159	0.0189	0.0216	0.0234	0.0260
66	0.0066	0.0064	0.0091	0.0082	0.0152	0.0175	0.0223	0.0220	0.0267
68	0.0058	0.0060	0.0094	0.0076	0.0181	0.0166	0.0239	0.0203	0.0286
70	0.0038	0.0042	0.0066	0.0056	0.0120	0.0112	0.0154	0.0135	0.0185
72	0.0030	0.0032	0.0052	0.0042	0.0092	0.0084	0.0126	0.0102	0.0152
74	0.0022	0.0024	0.0045	0.0032	0.0082	0.0063	0.0112	0.0077	0.0136
76	0.0016	0.0017	0.0040	0.0023	0.0073	0.0042	0.0096	0.0048	0.0120
78	0.0008	0.0010	0.0032	0.0012	0.0063	0.0020	0.0086	0.0020	0.0105
80	0.0001	0.0003	0.0022	0.0004	0.0054	0.0002	0.0071	0.0002	0.0087
82	0.0	0.0001	0.0015	0.0001	0.0044	0.0	0.0061	0.0	0.0072
84	0.0	0.0	0.0011	0.0	0.0037	0.0	0.0046	0.0	0.0057
86	0.0	0.0	0.0007	0.0	0.0027	0.0	0.0033	0.0	0.0038
88	0.0	0.0	0.0003	0.0	0.0016	0.0	0.0017	0.0	0.0018
90	0.0	0.0	0.0	0.0	0.0005	0.0	0.0004	0.0	0.0003
92	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
94	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
96	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
98	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
102	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
104	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
106	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
108	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
110	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
112	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
114	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
116	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
118	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
120	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix C. X-Ray Spectra >95 kVp

HVL	3.08	3.44	4.00	4.30	4.60	5.20	5.36	5.60	6.04
KVP	98	105	100	110	120	100	120	110	120
KNT	46	50	47	52	57	47	57	52	57
10	0.0085	0.0083	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0093	0.0104	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0068	0.0075	0.0065	0.0070	0.0079	0.0	0.0095	0.0	0.0
16	0.0112	0.0113	0.0058	0.0063	0.0070	0.0042	0.0059	0.0054	0.0
18	0.0210	0.0201	0.0099	0.0100	0.0097	0.0037	0.0057	0.0042	0.0041
20	0.0335	0.0309	0.0185	0.0178	0.0158	0.0060	0.0080	0.0053	0.0052
22	0.0429	0.0406	0.0285	0.0261	0.0238	0.0104	0.0137	0.0092	0.0087
24	0.0547	0.0514	0.0417	0.0380	0.0342	0.0197	0.0220	0.0175	0.0159
26	0.0583	0.0553	0.0497	0.0449	0.0407	0.0288	0.0296	0.0252	0.0227
28	0.0596	0.0561	0.0545	0.0496	0.0454	0.0378	0.0359	0.0328	0.0293
30	0.0554	0.0521	0.0529	0.0487	0.0451	0.0409	0.0384	0.0362	0.0327
32	0.0535	0.0511	0.0541	0.0501	0.0464	0.0466	0.0415	0.0417	0.0377
34	0.0498	0.0480	0.0520	0.0487	0.0450	0.0481	0.0420	0.0435	0.0393
36	0.0468	0.0450	0.0500	0.0469	0.0442	0.0490	0.0421	0.0445	0.0409
38	0.0420	0.0406	0.0463	0.0436	0.0409	0.0480	0.0400	0.0435	0.0402
40	0.0376	0.0368	0.0422	0.0394	0.0376	0.0457	0.0378	0.0420	0.0385
42	0.0351	0.0343	0.0399	0.0377	0.0358	0.0446	0.0369	0.0409	0.0379
44	0.0329	0.0324	0.0375	0.0355	0.0345	0.0431	0.0360	0.0399	0.0371
46	0.0296	0.0297	0.0343	0.0328	0.0316	0.0406	0.0334	0.0375	0.0354
48	0.0268	0.0264	0.0312	0.0300	0.0290	0.0376	0.0308	0.0351	0.0331
50	0.0238	0.0237	0.0282	0.0272	0.0264	0.0344	0.0287	0.0324	0.0305
52	0.0224	0.0221	0.0264	0.0258	0.0249	0.0325	0.0276	0.0312	0.0296
54	0.0208	0.0210	0.0245	0.0242	0.0236	0.0308	0.0261	0.0298	0.0283
56	0.0192	0.0193	0.0228	0.0226	0.0225	0.0289	0.0248	0.0281	0.0270
58	0.0295	0.0385	0.0331	0.0366	0.0395	0.0449	0.0596	0.0492	0.0655
60	0.0318	0.0295	0.0400	0.0455	0.0503	0.0497	0.0451	0.0562	0.0495
62	0.0154	0.0157	0.0186	0.0188	0.0189	0.0241	0.0210	0.0239	0.0232
64	0.0142	0.0146	0.0169	0.0173	0.0173	0.0223	0.0197	0.0223	0.0216
66	0.0153	0.0187	0.0166	0.0175	0.0177	0.0242	0.0263	0.0253	0.0313
68	0.0175	0.0170	0.0217	0.0241	0.0263	0.0280	0.0259	0.0307	0.0286
70	0.0104	0.0102	0.0140	0.0147	0.0153	0.0169	0.0142	0.0176	0.0154
72	0.0086	0.0089	0.0103	0.0109	0.0111	0.0141	0.0127	0.0143	0.0141
74	0.0079	0.0083	0.0096	0.0103	0.0106	0.0129	0.0120	0.0135	0.0135
76	0.0072	0.0077	0.0090	0.0096	0.0100	0.0120	0.0115	0.0126	0.0130
78	0.0067	0.0073	0.0083	0.0092	0.0096	0.0110	0.0113	0.0121	0.0123
80	0.0060	0.0067	0.0074	0.0083	0.0088	0.0099	0.0106	0.0111	0.0118
82	0.0054	0.0061	0.0068	0.0079	0.0086	0.0091	0.0100	0.0105	0.0111
84	0.0049	0.0058	0.0063	0.0075	0.0082	0.0081	0.0096	0.0100	0.0108
86	0.0044	0.0054	0.0055	0.0070	0.0078	0.0074	0.0093	0.0094	0.0103
88	0.0037	0.0048	0.0049	0.0065	0.0074	0.0064	0.0088	0.0087	0.0099
90	0.0033	0.0045	0.0041	0.0060	0.0071	0.0056	0.0083	0.0078	0.0095
92	0.0026	0.0040	0.0034	0.0055	0.0066	0.0046	0.0078	0.0072	0.0089
94	0.0020	0.0035	0.0027	0.0049	0.0063	0.0035	0.0075	0.0066	0.0083
96	0.0013	0.0029	0.0019	0.0044	0.0057	0.0024	0.0070	0.0060	0.0079
98	0.0006	0.0023	0.0011	0.0038	0.0053	0.0012	0.0065	0.0053	0.0070
100	0.0	0.0017	0.0003	0.0032	0.0049	0.0023	0.0060	0.0043	0.0066
102	0.0	0.0012	0.0	0.0026	0.0044	0.0	0.0055	0.0035	0.0064
104	0.0	0.0006	0.0	0.0021	0.0040	0.0	0.0049	0.0028	0.0057
106	0.0	0.0001	0.0	0.0014	0.0037	0.0	0.0045	0.0019	0.0050
108	0.0	0.0	0.0	0.0009	0.0032	0.0	0.0039	0.0010	0.0047
110	0.0	0.0	0.0	0.0003	0.0027	0.0	0.0033	0.0003	0.0040
112	0.0	0.0	0.0	0.0	0.0022	0.0	0.0029	0.0	0.0032
114	0.0	0.0	0.0	0.0	0.0018	0.0	0.0024	0.0	0.0027
116	0.0	0.0	0.0	0.0	0.0013	0.0	0.0018	0.0	0.0020
118	0.0	0.0	0.0	0.0	0.0008	0.0	0.0012	0.0	0.0013
120	0.0	0.0	0.0	0.0	0.0003	0.0	0.0005	0.0	0.0006

Appendix C. X-Ray Spectra, Erbium Composite

FILT	ErC	ErC	ErC	ErC	ErC
*ADD FILT	3.18	3.18	3.18	3.18	3.18
HVL	6.02	6.49	6.98	7.49	8.53
KVP	70	80	90	100	120
KNT	31	36	41	46	56
10	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0
20	0.0001	0.0001	0.0001	0.0	0.0
22	0.0006	0.0005	0.0004	0.0003	0.0002
24	0.0028	0.0022	0.0017	0.0014	0.0010
26	0.0085	0.0068	0.0055	0.0046	0.0033
28	0.0191	0.0155	0.0129	0.0108	0.0077
30	0.0336	0.0276	0.0232	0.0197	0.0144
32	0.0397	0.0336	0.0283	0.0243	0.0183
34	0.0446	0.0376	0.0322	0.0282	0.0214
36	0.0496	0.0428	0.0370	0.0321	0.0254
38	0.0604	0.0527	0.0461	0.0410	0.0321
40	0.0834	0.0737	0.0659	0.0578	0.0463
42	0.0864	0.0772	0.0685	0.0619	0.0503
44	0.0860	0.0785	0.0707	0.0643	0.0531
46	0.0844	0.0787	0.0735	0.0663	0.0542
48	0.0806	0.0773	0.0718	0.0659	0.0551
50	0.0766	0.0747	0.0701	0.0656	0.0558
52	0.0703	0.0705	0.0681	0.0633	0.0542
54	0.0635	0.0658	0.0644	0.0613	0.0532
56	0.0570	0.0627	0.0616	0.0593	0.0526
58	0.0175	0.0231	0.0267	0.0293	0.0310
60	0.0094	0.0149	0.0196	0.0229	0.0262
62	0.0085	0.0121	0.0134	0.0138	0.0132
64	0.0076	0.0118	0.0132	0.0132	0.0126
66	0.0061	0.0118	0.0140	0.0141	0.0135
68	0.0037	0.0132	0.0181	0.0211	0.0233
70	0.0	0.0104	0.0144	0.0161	0.0166
72	0.0	0.0085	0.0119	0.0129	0.0126
74	0.0	0.0070	0.0115	0.0131	0.0133
76	0.0	0.0055	0.0112	0.0132	0.0138
78	0.0	0.0032	0.0109	0.0133	0.0140
80	0.0	0.0	0.0100	0.0130	0.0143
82	0.0	0.0	0.0084	0.0121	0.0143
84	0.0	0.0	0.0069	0.0119	0.0142
86	0.0	0.0	0.0050	0.0108	0.0139
88	0.0	0.0	0.0030	0.0101	0.0142
90	0.0	0.0	0.0	0.0093	0.0139
92	0.0	0.0	0.0	0.0076	0.0135
94	0.0	0.0	0.0	0.0064	0.0133
96	0.0	0.0	0.0	0.0047	0.0128
98	0.0	0.0	0.0	0.0030	0.0125
100	0.0	0.0	0.0	0.0	0.0117
102	0.0	0.0	0.0	0.0	0.0108
104	0.0	0.0	0.0	0.0	0.0105
106	0.0	0.0	0.0	0.0	0.0096
108	0.0	0.0	0.0	0.0	0.0083
110	0.0	0.0	0.0	0.0	0.0073
112	0.0	0.0	0.0	0.0	0.0058
114	0.0	0.0	0.0	0.0	0.0049
116	0.0	0.0	0.0	0.0	0.0037
118	0.0	0.0	0.0	0.0	0.0021
120	0.0	0.0	0.0	0.0	0.0

* Total filtration consists of 3.18 mm erbium composite plus 2.0 mm Al.

Appendix C. X-Ray Spectra, Erbium Foil

FILT	Er Foil	Er Foil	Er Foil	Er Foil	Er Foil
*ADD FILT	0.25	0.25	0.25	0.25	0.25
HVL	6.25	6.68	7.15	7.65	8.71
KVP	70	80	90	100	120
KNT	31	36	41	46	56
10	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0
22	0.0003	0.0002	0.0002	0.0001	0.0001
24	0.0016	0.0012	0.0010	0.0008	0.0006
26	0.0056	0.0045	0.0036	0.0030	0.0021
28	0.0140	0.0113	0.0095	0.0079	0.0056
30	0.0270	0.0221	0.0186	0.0157	0.0114
32	0.0339	0.0286	0.0240	0.0206	0.0154
34	0.0399	0.0336	0.0287	0.0251	0.0188
36	0.0462	0.0398	0.0344	0.0297	0.0233
38	0.0582	0.0506	0.0442	0.0392	0.0305
40	0.0826	0.0728	0.0650	0.0568	0.0451
42	0.0875	0.0781	0.0692	0.0624	0.0502
44	0.0888	0.0810	0.0728	0.0660	0.0540
46	0.0886	0.0825	0.0769	0.0692	0.0560
48	0.0858	0.0821	0.0761	0.0697	0.0576
50	0.0823	0.0802	0.0752	0.0701	0.0591
52	0.0764	0.0765	0.0738	0.0684	0.0580
54	0.0696	0.0721	0.0704	0.0668	0.0574
56	0.0630	0.0692	0.0679	0.0651	0.0572
58	0.0174	0.0229	0.0264	0.0289	0.0303
60	0.0081	0.0127	0.0167	0.0195	0.0221
62	0.0075	0.0106	0.0117	0.0120	0.0114
64	0.0068	0.0105	0.0118	0.0118	0.0111
66	0.0056	0.0108	0.0128	0.0128	0.0121
68	0.0034	0.0123	0.0168	0.0195	0.0214
70	0.0	0.0099	0.0136	0.0152	0.0155
72	0.0	0.0082	0.0115	0.0124	0.0120
74	0.0	0.0069	0.0112	0.0127	0.0128
76	0.0	0.0055	0.0111	0.0131	0.0134
78	0.0	0.0032	0.0109	0.0133	0.0138
80	0.0	0.0	0.0101	0.0131	0.0143
82	0.0	0.0	0.0085	0.0123	0.0144
84	0.0	0.0	0.0071	0.0122	0.0144
86	0.0	0.0	0.0052	0.0112	0.0142
88	0.0	0.0	0.0031	0.0105	0.0146
90	0.0	0.0	0.0	0.0098	0.0144
92	0.0	0.0	0.0	0.0080	0.0141
94	0.0	0.0	0.0	0.0068	0.0139
96	0.0	0.0	0.0	0.0050	0.0135
98	0.0	0.0	0.0	0.0032	0.0133
100	0.0	0.0	0.0	0.0	0.0125
102	0.0	0.0	0.0	0.0	0.0116
104	0.0	0.0	0.0	0.0	0.0113
106	0.0	0.0	0.0	0.0	0.0104
108	0.0	0.0	0.0	0.0	0.0090
110	0.0	0.0	0.0	0.0	0.0079
112	0.0	0.0	0.0	0.0	0.0063
114	0.0	0.0	0.0	0.0	0.0053
116	0.0	0.0	0.0	0.0	0.0041
118	0.0	0.0	0.0	0.0	0.0023
120	0.0	0.0	0.0	0.0	0.0

* Total filtration consists of 0.25 mm erbium foil plus 2.0 mm Al.

APPENDIX D

SAMPLE TISSUE-AIR-RATIO MATRICES (34 X 11)
PA, OVARIES: 25, 30, 40, 55, 80, 100 keV

Appendix D. Sample Tissue-Air-Ratio Matrices (34 x 11)
PA, Ovaries: 25, 30, 40, 55, 80, 100 keV

ORGAN: OVARIES
VIEW: PA KEV: 25

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.5752E-04	0.0	0.0	0.0	0.5752E-04	0.0	0.0	0.0
0.0	0.0	0.1484E-04	0.1493E-06	0.1844E-05	0.0	0.1844E-05	0.1493E-06	0.1484E-04	0.0	0.0
0.0	0.7273E-05	0.9169E-05	0.3646E-04	0.8395E-04	0.6671E-06	0.8395E-04	0.3646E-04	0.9169E-05	0.7273E-05	0.0
0.0	0.6297E-06	0.1859E-05	0.2573E-03	0.4604E-03	0.2603E-04	0.4604E-03	0.2573E-03	0.1859E-05	0.6297E-06	0.0
0.0	0.6560E-08	0.5386E-04	0.1499E-02	0.1942E-02	0.2937E-03	0.1942E-02	0.1499E-02	0.5386E-04	0.6560E-08	0.0
0.0	0.2460E-06	0.2770E-06	0.2296E-03	0.4456E-03	0.3334E-03	0.4456E-03	0.2296E-03	0.2770E-06	0.2460E-06	0.0
0.0	0.0	0.0	0.3874E-04	0.8733E-04	0.3055E-05	0.8733E-04	0.3874E-04	0.0	0.0	0.0
0.0	0.0	0.0	0.6339E-07	0.6823E-05	0.2517E-04	0.6823E-05	0.6339E-07	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.3045E-08	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.1880E-08	0.0	0.1880E-08	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.6932E-08	0.0	0.6932E-08	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix D (continued)

ORGAN: OVARIES
VIEW: PA KEV: 30

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.1845E-08	0.0	0.0	0.0	0.0	0.0	0.1845E-08	0.0	0.0
0.0	0.0	0.4991E-06	0.1912E-06	0.3035E-07	0.1029E-03	0.3035E-07	0.1912E-06	0.4991E-06	0.0	0.0
0.0	0.1158E-04	0.1316E-05	0.1352E-06	0.1614E-04	0.6219E-04	0.1614E-04	0.1352E-06	0.1316E-05	0.1158E-04	0.0
0.0	0.4837E-05	0.3623E-04	0.1359E-03	0.1356E-03	0.2131E-04	0.1356E-03	0.1359E-03	0.3623E-04	0.4837E-05	0.0
0.2988E-05	0.1128E-03	0.7403E-04	0.3662E-03	0.5410E-03	0.3210E-03	0.5410E-03	0.3662E-03	0.7403E-04	0.1128E-03	0.2988E-05
0.3335E-06	0.2991E-04	0.4439E-03	0.1209E-02	0.1275E-02	0.2035E-03	0.1275E-02	0.1209E-02	0.4439E-03	0.2991E-04	0.3335E-06
0.4517E-05	0.6864E-04	0.5261E-03	0.8415E-02	0.7779E-02	0.1080E-02	0.7779E-02	0.8415E-02	0.5261E-03	0.6864E-04	0.4517E-05
0.0	0.1573E-03	0.1878E-03	0.1607E-02	0.1791E-02	0.8721E-03	0.1791E-02	0.1607E-02	0.1878E-03	0.1573E-03	0.0
0.0	0.2332E-04	0.0	0.3462E-03	0.7024E-03	0.1465E-03	0.7024E-03	0.3462E-03	0.0	0.2332E-04	0.0
0.9916E-08	0.0	0.4519E-05	0.9087E-05	0.2175E-03	0.6777E-04	0.2175E-03	0.9087E-05	0.4519E-05	0.0	0.9916E-08
0.0	0.0	0.9252E-06	0.0	0.9345E-07	0.3370E-04	0.9345E-07	0.0	0.9252E-06	0.0	0.0
0.0	0.0	0.0	0.0	0.4598E-07	0.0	0.4598E-07	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix D. (continued)

ORGAN: OVARIES
VIEW: PA KEV: 40

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.6656E-07	0.3024E-04	0.0	0.3024E-04	0.6656E-07	0.0	0.0	0.0
[illegible]	0.0	0.3217E-06	0.0	0.6602E-05	0.0	0.6602E-05	0.0	0.3217E-06	0.0	0.0
[illegible]	0.0	0.0	0.7327E-06	0.0	0.8838E-08	0.0	0.7327E-06	0.0	0.0	0.1361E-06
[illegible]	0.2145E-06	0.3088E-06	0.1966E-03	0.1350E-03	0.1485E-05	0.1350E-03	0.1966E-03	0.3088E-06	0.2145E-06	0.0
0.0	0.1754E-03	0.3040E-04	0.4544E-03	0.2056E-03	0.9909E-04	0.2056E-03	0.4544E-03	0.3040E-04	0.1754E-03	0.0
0.3748E-05	0.1326E-03	0.7417E-03	0.1112E-02	0.5573E-03	0.1267E-03	0.5573E-03	0.1112E-02	0.7417E-03	0.1326E-03	0.3748E-05
0.1322E-03	0.5287E-03	0.1349E-02	0.2816E-02	0.1929E-02	0.2377E-02	0.1929E-02	0.2816E-02	0.1349E-02	0.5287E-03	0.1322E-03
0.2462E-03	0.3696E-03	0.2567E-02	0.1013E-01	0.9478E-02	0.2936E-02	0.9478E-02	0.1013E-01	0.2567E-02	0.3696E-03	0.2462E-03
0.4224E-04	0.5369E-03	0.3991E-02	0.2898E-01	0.2557E-01	0.8083E-02	0.2557E-01	0.2898E-01	0.3991E-02	0.5369E-03	0.4224E-04
0.2302E-03	0.5017E-03	0.2495E-02	0.6251E-02	0.9396E-02	0.6637E-02	0.9396E-02	0.6251E-02	0.2495E-02	0.5017E-03	0.2302E-03
0.1358E-04	0.4770E-03	0.3025E-03	0.1262E-02	0.3354E-02	0.2173E-02	0.3354E-02	0.1262E-02	0.3025E-03	0.4770E-03	0.1358E-04
0.2194E-07	0.3259E-03	0.1871E-03	0.3661E-03	0.6559E-03	0.9572E-03	0.6559E-03	0.3661E-03	0.1871E-03	0.3259E-03	0.2194E-07
0.0	0.2190E-04	0.2224E-04	0.1464E-03	0.2101E-03	0.2378E-03	0.2101E-03	0.1464E-03	0.2224E-04	0.2190E-04	0.0
0.0	0.1731E-05	0.8349E-05	0.7399E-05	0.1227E-03	0.7898E-04	0.1227E-03	0.7399E-05	0.8349E-05	0.1731E-05	0.0
0.0	0.0	0.8438E-07	0.0	0.1675E-05	0.2832E-05	0.1675E-05	0.0	0.8438E-07	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix D. (continued)

ORGAN: OVARIES
VIEW: PA KEV: 55

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.1501E-05	0.0	0.3031E-06	0.0	0.3031E-06	0.0	0.1501E-05	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.7908E-06	0.0	0.7908E-06	0.0	0.0	0.0	0.0
0.0	0.1451E-07	0.0	0.3792E-04	0.0	0.0	0.0	0.3792E-04	0.0	0.1451E-07	0.0
0.1365E-05	0.5067E-05	0.1581E-03	0.9133E-05	0.5608E-04	0.1044E-03	0.5608E-04	0.9133E-05	0.1581E-03	0.5067E-05	0.1365E-05
0.0	0.4679E-05	0.2891E-04	0.1752E-03	0.1531E-03	0.0	0.1531E-03	0.1752E-03	0.2891E-04	0.4679E-05	0.0
0.0	0.2283E-03	0.1323E-03	0.5302E-03	0.1948E-03	0.2720E-03	0.1948E-03	0.5302E-03	0.1323E-03	0.2283E-03	0.0
0.3337E-03	0.2768E-03	0.1232E-02	0.2066E-02	0.1285E-02	0.1032E-02	0.1285E-02	0.2066E-02	0.1232E-02	0.2768E-03	0.3337E-03
0.1164E-03	0.8522E-03	0.1198E-02	0.3845E-02	0.5261E-02	0.2502E-02	0.5261E-02	0.3845E-02	0.1198E-02	0.8522E-03	0.1164E-03
0.3259E-04	0.2138E-02	0.5164E-02	0.8100E-02	0.7427E-02	0.6711E-02	0.7427E-02	0.8100E-02	0.5164E-02	0.2138E-02	0.3259E-04
0.7071E-03	0.4139E-02	0.9054E-02	0.2201E-01	0.2464E-01	0.1276E-01	0.2464E-01	0.2201E-01	0.9054E-02	0.4139E-02	0.7071E-03
0.6113E-03	0.2723E-02	0.9993E-02	0.6663E-01	0.5726E-01	0.2002E-01	0.5726E-01	0.6663E-01	0.9993E-02	0.2723E-02	0.6113E-03
0.8307E-03	0.3283E-02	0.6090E-02	0.1545E-01	0.1709E-01	0.1085E-01	0.1709E-01	0.1545E-01	0.6090E-02	0.3283E-02	0.8307E-03
0.3272E-03	0.2226E-02	0.2798E-02	0.4800E-02	0.6589E-02	0.5289E-02	0.6589E-02	0.4800E-02	0.2798E-02	0.2226E-02	0.3272E-03
0.3079E-03	0.7224E-03	0.1330E-02	0.2126E-02	0.2967E-02	0.3868E-02	0.2967E-02	0.2126E-02	0.1330E-02	0.7224E-03	0.3079E-03
0.0	0.7592E-03	0.5207E-03	0.5508E-03	0.7445E-03	0.1830E-02	0.7445E-03	0.5508E-03	0.5207E-03	0.7592E-03	0.0
0.0	0.0	0.8617E-04	0.2192E-03	0.6110E-03	0.3658E-03	0.6110E-03	0.2192E-03	0.8617E-04	0.0	0.0
0.0	0.0	0.0	0.6496E-06	0.7013E-04	0.7515E-04	0.7013E-04	0.6496E-06	0.0	0.0	0.0
0.0	0.0	0.3870E-06	0.0	0.0	0.0	0.0	0.0	0.3870E-06	0.0	0.0
0.0	0.0	0.0	0.7043E-05	0.1707E-04	0.3781E-06	0.1707E-04	0.7043E-05	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix D. (continued)

ORGAN: OVARIES
VIEW: PA KEV: 80

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.3703E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3703E-04
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.1021E-05	0.0	0.1021E-05	0.0	0.0	0.0	0.0
0.6854E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6854E-04
0.0	0.0	0.8326E-07	0.5288E-05	0.1890E-03	0.0	0.1890E-03	0.5288E-05	0.8326E-07	0.0	0.0
0.0	0.0	0.0	0.3241E-03	0.7708E-05	0.0	0.7708E-05	0.3241E-03	0.0	0.0	0.0
0.0	0.0	0.6874E-04	0.2482E-03	0.3388E-04	0.4401E-04	0.3388E-04	0.2482E-03	0.6874E-04	0.0	0.0
0.9116E-05	0.1907E-03	0.1392E-03	0.4682E-04	0.6542E-03	0.5332E-03	0.6542E-03	0.4682E-04	0.1392E-03	0.1907E-03	0.9116E-05
0.4256E-03	0.3490E-03	0.5237E-03	0.1167E-02	0.3006E-03	0.5115E-06	0.3006E-03	0.1167E-02	0.5237E-03	0.3490E-03	0.4256E-03
0.4037E-05	0.6993E-03	0.1192E-02	0.1211E-02	0.1253E-02	0.9469E-03	0.1253E-02	0.1211E-02	0.1192E-02	0.6993E-03	0.4037E-05
0.2836E-03	0.1337E-02	0.2203E-02	0.2040E-02	0.3300E-02	0.1960E-02	0.3300E-02	0.2040E-02	0.2203E-02	0.1337E-02	0.2836E-03
0.3623E-03	0.1778E-02	0.5798E-02	0.3335E-02	0.6348E-02	0.4272E-02	0.6348E-02	0.3335E-02	0.5798E-02	0.1778E-02	0.3623E-03
0.1440E-02	0.3275E-02	0.6287E-02	0.1274E-01	0.1413E-01	0.1279E-01	0.1413E-01	0.1274E-01	0.6287E-02	0.3275E-02	0.1440E-02
0.4790E-03	0.3720E-02	0.1537E-01	0.3556E-01	0.4201E-01	0.2076E-01	0.4201E-01	0.3556E-01	0.1537E-01	0.3720E-02	0.4790E-03
0.7614E-03	0.4321E-02	0.1168E-01	0.7314E-01	0.8020E-01	0.2737E-01	0.8020E-01	0.7314E-01	0.1168E-01	0.4321E-02	0.7614E-03
0.8374E-03	0.2996E-02	0.7031E-02	0.1904E-01	0.2213E-01	0.1607E-01	0.2213E-01	0.1904E-01	0.7031E-02	0.2996E-02	0.8374E-03
0.4350E-03	0.3168E-02	0.3538E-02	0.6505E-02	0.1031E-01	0.8493E-02	0.1031E-01	0.6505E-02	0.3538E-02	0.3168E-02	0.4350E-03
0.1096E-02	0.5866E-03	0.3608E-02	0.2631E-02	0.4266E-02	0.4486E-02	0.4266E-02	0.2631E-02	0.3608E-02	0.5866E-03	0.1096E-02
0.0	0.1220E-02	0.9366E-03	0.8805E-03	0.1695E-02	0.2873E-02	0.1695E-02	0.8805E-03	0.9366E-03	0.1220E-02	0.0
0.0	0.1938E-03	0.9112E-03	0.7299E-03	0.6124E-03	0.1709E-02	0.6124E-03	0.7299E-03	0.9112E-03	0.1938E-03	0.0
0.0	0.0	0.9250E-04	0.7030E-03	0.6455E-03	0.3492E-03	0.6455E-03	0.7030E-03	0.9250E-04	0.0	0.0
0.0	0.0	0.0	0.7007E-08	0.9151E-04	0.1172E-03	0.9151E-04	0.7007E-08	0.0	0.0	0.0
0.0	0.0	0.0	0.1714E-03	0.0	0.3070E-04	0.0	0.1714E-03	0.0	0.0	0.0
0.0	0.0	0.2008E-03	0.0	0.0	0.0	0.0	0.0	0.2008E-03	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.4147E-07	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

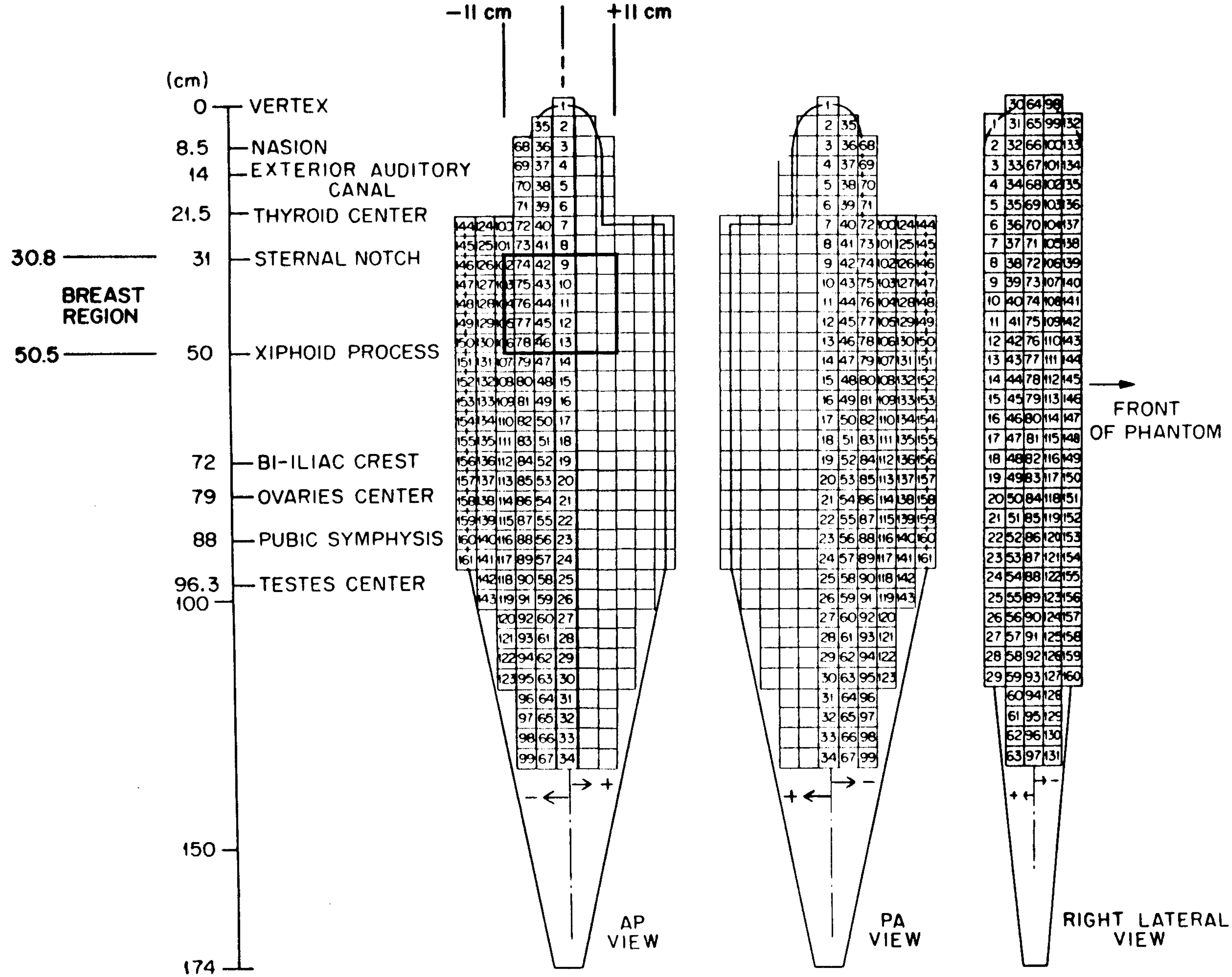
Appendix D. (continued)

ORGAN: OVARIES
VIEW: PA KEV: 100

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.1109E-05	0.0	0.0	0.0	0.1109E-05	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.1006E-05	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.3278E-07	0.3038E-04	0.2773E-05	0.3038E-04	0.3278E-07	0.0	0.0	0.0
0.0	0.1176E-06	0.3619E-05	0.1214E-03	0.0	0.0	0.0	0.1214E-03	0.3619E-05	0.1176E-06	0.0
0.0	0.2701E-03	0.0	0.0	0.7663E-03	0.2295E-03	0.7663E-03	0.0	0.0	0.2701E-03	0.0
0.2181E-03	0.6595E-04	0.6769E-04	0.2260E-03	0.3439E-03	0.1430E-03	0.3439E-03	0.2260E-03	0.6769E-04	0.6595E-04	0.2181E-03
0.0	0.2493E-03	0.2545E-03	0.1192E-03	0.3973E-03	0.6243E-03	0.3973E-03	0.1192E-03	0.2545E-03	0.2493E-03	0.0
0.1082E-04	0.9996E-03	0.9721E-06	0.2890E-03	0.1188E-02	0.7823E-03	0.1188E-02	0.2890E-03	0.9721E-06	0.9996E-03	0.1082E-04
0.4466E-03	0.9244E-03	0.1394E-02	0.9384E-03	0.6585E-03	0.1927E-02	0.6585E-03	0.9384E-03	0.1394E-02	0.9244E-03	0.4466E-03
0.8271E-03	0.3591E-03	0.1198E-02	0.2276E-02	0.3358E-02	0.2872E-02	0.3358E-02	0.2276E-02	0.1198E-02	0.3591E-03	0.8271E-03
0.1080E-02	0.9328E-03	0.3042E-02	0.5847E-02	0.3256E-02	0.4306E-02	0.3256E-02	0.5847E-02	0.3042E-02	0.9328E-03	0.1080E-02
0.1277E-03	0.2733E-02	0.7732E-02	0.1049E-01	0.1883E-01	0.1247E-01	0.1883E-01	0.1049E-01	0.7732E-02	0.2733E-02	0.1277E-03
0.1044E-02	0.3421E-02	0.1423E-01	0.3273E-01	0.3737E-01	0.1685E-01	0.3737E-01	0.3273E-01	0.1423E-01	0.3421E-02	0.1044E-02
0.8817E-03	0.5724E-02	0.1351E-01	0.7844E-01	0.8191E-01	0.2109E-01	0.8191E-01	0.7844E-01	0.1351E-01	0.5724E-02	0.8817E-03
0.6020E-03	0.3168E-02	0.8311E-02	0.1703E-01	0.2114E-01	0.1283E-01	0.2114E-01	0.1703E-01	0.8311E-02	0.3168E-02	0.6020E-03
0.3933E-03	0.2921E-02	0.6433E-02	0.7508E-02	0.1185E-01	0.6511E-02	0.1185E-01	0.7508E-02	0.6433E-02	0.2921E-02	0.3933E-03
0.6085E-03	0.9278E-03	0.2427E-02	0.3202E-02	0.3704E-02	0.4337E-02	0.3704E-02	0.3202E-02	0.2427E-02	0.9278E-03	0.6085E-03
0.0	0.7688E-03	0.9479E-03	0.1775E-02	0.2908E-02	0.1534E-02	0.2908E-02	0.1775E-02	0.9479E-03	0.7688E-03	0.0
0.0	0.4035E-03	0.1147E-02	0.5834E-03	0.2585E-03	0.6335E-03	0.2585E-03	0.5834E-03	0.1147E-02	0.4035E-03	0.0
0.0	0.0	0.1919E-03	0.6093E-03	0.1056E-03	0.4843E-03	0.1056E-03	0.6093E-03	0.1919E-03	0.0	0.0
0.0	0.0	0.1029E-03	0.0	0.8448E-03	0.3676E-03	0.8448E-03	0.0	0.1029E-03	0.0	0.0
0.0	0.0	0.3630E-03	0.8178E-04	0.1154E-04	0.0	0.1154E-04	0.8178E-04	0.3630E-03	0.0	0.0
0.0	0.0	0.0	0.6332E-07	0.0	0.0	0.0	0.6332E-07	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.7572E-04	0.0	0.7572E-04	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

APPENDIX E

SIZE, SHAPE, AND ANATOMICAL LANDMARKS FOR REFERENCE PATIENT WITH SUPERIMPOSED 4-CM X 4-CM GRID SYSTEM



APPENDIX E. Size, shape and anatomical landmarks for reference patient with superimposed 4-cm x 4-cm grid system.

APPENDIX F*

FORTRAN PROGRAMS

(MAIN, CINDX, FEMALE, ASW, ATSG, ACFI, LEAST, MATRIX, BREST)

* The program listed in Appendix F is for the VAX version. The program for the IBM-compatible PC version differs only as noted on pages 31, 33 and 46.

```
      PROGRAM CDI3
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
* VAX COMPUTER PROGRAM TO ESTIMATE THE DOSES TO SEVERAL TISSUES OF       *
* A REFERENCE PATIENT FOR A SPECIFIED X-RAY PROJECTION.  PROGRAM         *
* RUNS IN INTERACTIVE MODE QUERYING THE USER FOR INPUT EXAM DATA OR      *
* IN BATCH MODE USING AN INPUT FILE WHICH CONTAINS EXAM DATA.            *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*                              DESIGN:                                   *
*                     Marvin Rosenstein, Ph.D.                           *
*            Center for Devices and Radiological Health                  *
*                       Rockville, Maryland                              *
*                                                                        *
*                               CODE:                                    *
*                         Leif E. Peterson                               *
*                    Kelsey-Seybold Clinic, P.A.                         *
*                          Houston, Texas                                *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
      DIMENSION CZ(50),CX(50),DEEP(27),NUM(3),RADR(7,11,34),ARG(11),
     1 VAL(11),RAD(11),FAC(9),Y(61),BONE(61),SPEC(50,61),ANS(61),
     2 PRD(61),AVL(50),HV2(50),HV3(50),KN1(50),KV(50),KV2(21),KVP2(2),
     3 THICK(3),IHVL4(3,2),JHVL(12),AHVL(12),BOX(4),FMT(4),FRMT1(5),
     4 FRMT2(50),FRMT3(4),WHO(7),BRST(14),ORGD(10,12),OD(12),IOD(12),
     5 IORN(10),INIORN(10),IVIEW(44)
      REAL KVP(11),KVP1(6)
      CHARACTER SPEC1(50)*8,ORGAN(10)*20,PORGAN*20,
     1 EXAM*20,NODOS1*70,NODOS2*70,RANGE(5)*25,
     2 FILT(2)*16,TODAY*11,PJ(3)*3,IEXAM(44)*37,
     3 ACON*1,AMODE*1,ASKP*1,ACORR*1,AFLT*1,AFLR*1
C
      DATA BONE/ .208,.200,.192,.186,.182,.177,.176,.176,.178,.182,
     1 .186,.191,.197,.204,.211,.220,.231,.244,.258,.272,.283,.300,
     2 .315,.329,.344,.360,.376,.396,.424,.431,.450,.469,.487,.513,
     3 .533,.547,.570,.587,.607,.621,.636,.651,.665,.679,.694,.709,
     4 .717,.732,.741,.755,.764,.773,.781,.790,.799,.809,.812,.821,
     5 .824,.833,.836/
      DATA CX/  0.0,  0.0,  0.0,  0.€,  0.0,  5.0, 15.3,  0.0,  0.0,
     1    13.6,  0.0,  0.0, 16.8,  0.0,  0.0,  0.0,  0.0,  0.0,  5.0,
     2     0.0, -6.5, 10.0,  4.3, -3.0,  0.0,  0.0,  5.0,  0.0,  0.0,
     3     0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  8.5,
     4     0.0,  0.0,  8.5,  0.0, 7*0.0/
      DATA CZ/  8.5,  8.5, 14.0, 14.0, 17.4, 22.5, 31.0, 31.0, 31.0,
     1    35.8, 35.8, 35.8, 35.8, 37.0, 40.5, 40.5, 42.4, 42.4, 42.4,
     2    50.0, 55.5, 56.0, 56.6, 56.6, 60.0, 66.5, 66.5, 72.0, 72.0,
     3    72.0, 72.0, 72.0, 72.0, 80.0, 80.0, 80.0, 84.0, 84.0, 88.0,
     4    88.0, 88.0,107.0,107.0, 7*0.0/
      DATA DEEP/ 10.0, 10.0, 10.0, 18.0, 16.0, 10.0, 12.0, 24.0, 0.0,
     1     10.0, 10.0, 10.0,  2.0,  4.0, 10.0,  8.0,  4.0,  0.0,17.2,
     2     17.2, 17.2, 17.2, 17.2, 17.2, 17.2, 17.2,  0.0/
      DATA FAC / 0.97, 0.87, 0.97, 0.97, 0.88, 0.96, 0.97,  0.0, 0.0/
      DATA BRST/.00216, .00950, .0765, .2017, .3258, .3500, 0.,
     1 .3304, .550, .7162, .9985, 1.2223, 1.3007, 1.1240/
      DATA JHVL/100,150,200,250,300,350,400,450,500,550,600,650/,
     1 KV2/25,30,40,55,80,100,0,20,25,30,40,55,80,100,25,35,55,80,
     2 3*0/,EPS /0.005/,EP1/0.05/,WHO/'75','99','99','115','59','91',
     3'27'/
```

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```
      INTEGER*2 IYR,IMON,IDAY
      CHARACTER SPEC1(50)*8,ORGAN(10)*20,PORGAN*20,EXAM*20,
     1 NODOS1*70,NODOS2*70,RANGE(5)*25,FILT(2)*16,PJ(3)*3,
     2 IEXAM(44)*37,ACON*1,AMODE*1,ASKP*1,ACORR*1,AFLT*1,
     3 AFLR*1
```

```
      DATA IHVL4(1,1)/100/,IHVL4(1,2)/400/,IHVL4(2,1)/150/,
     1 IHVL4(2,2)/600/,IHVL4(3,1)/200/,IHVL4(3,2)/650/,KVP1/30.,45.,
     2 67.5,47.5,67.5,90./,KVP2/76,96/
      DATA INIORN/1,2,5,6,8,9,3,4,7,0/
      DATA NODOS1/ 'DOSE IS NEGLIGIBLE - X-RAY FIELD COMPLETELY OUTSIDE
     1 OF BREAST REGION.'/,NODOS2/ 'NOT CALCULATED, HOWEVER BREASTS AR
     2E NEAR OR PARTIALLY IN X-RAY FIELD.'/
      DATA FRMT1/'A2','F6.1','F6.2','I6','A20'/
      DATA FRMT2/'(T6,','     ','T27,','     ','F6.1',',','T35,',
     1 '     ','F6.1',',','T43,','     ','F6.1',',','T51,','     ','F6.1',
     2 ',','T59,','     ','F6.1',',','T67,','     ','F6.1',',','T75,',
     3 '     ','F6.1',',','T83,','     ','F6.1',',','T91,','     ','F6.1',
     4 ',','T99,','     ','F6.1',',T','107,','     ','F6.1',',T','115,',
     5 '     ','F6.1',')'/
      DATA FRMT3/'(T6,','A20,','T30,','A70)'/
      DATA FMT/'(T6,','75  ','(''-''',')'/
      DATA ORGAN/ 'LUNGS','ACTIVE BONE MARROW ','OVARIES','TESTES',
     1 'THYROID','TRUNK TISSUE','UTERUS','BREASTS','CDI (TIMES E-5)',
     2 '* CDI (TIMES E-5)'/
      DATA RANGE/'KVP RANGE:  < 76','KVP RANGE:  76 - 95',
     1 'KVP RANGE:  > 95','KVP RANGE:  (NOT LIMITED)',
     2 'KVP RANGE:  70 - 120'/
      DATA PJ,THICK,NUM/'PA','AP','LAT',2*20.,37.2,6,7,4/
      DATA PLUS/' +'/,BLK/'   '/,FOUR/'4X'/
      DATA FILT/'ERBIUM COMPOSITE','ERBIUM FOIL'/
      DATA IEXAM/'  1. AP,PA,LAT Skull','23. AP,PA Upper GI',
     1'  2. PA Facial Bones, Sinuses','24. LAT Upper GI',
     2'  3. PA TMJ, Mandible, Mastoid','25. AP Upright Abdomen',
     3'  4. LAT Sella Volume, TMJ','26. AP Lumbar Spine',
     4'  5. AP Cervical Spine','27. LAT Lumbar Spine',
     5'  6. Lat Cervical Spine','28. AP,PA,LAT Retrograde Pyelogram',
     6'  7. AP Shoulder (one)','29. AP,PA,LAT KUB',
     7'  8. LAT Shoulder (one)','30. AP,PA,LAT Barium Enema',
     8'  9. AP Shoulders (both)','31. AP,PA,LAT Lumbosacral Spine',
     9' 10. AP Scapula (one)','32. AP,PA,LAT IVP',
     1' 11. LAT Scapula (one)','33. AP,PA,LAT Renal Arteriogram',
     2' 12. AP Scapulae (both)','34. AP Sacrum,Coccyx,Sacroiliac Joint',
     3' 13. AP Humerus (one)','35. AP,LAT Lumbopelvic',
     4' 14. LAT Sternum','36. AP,LAT Pelvis',
     5' 15. AP,PA,LAT Ribs','37. AP Urethrogram',
     6' 16. AP,PA,LAT Barium Swallow','38. AP Cystography',
     7' 17. AP,PA,LAT Chest','39. AP Hip (one)',
     8' 18. AP Thoracic Spine','40. LAT Hip (one)',
     9' 19. LAT Thoracic Spine','41. AP Hips (both)',
     1' 20. AP,LAT Full Spine','42. AP Femur (one)',
     2' 21. PA Cholecystography','43. LAT Femur (one)',
     3' 22. AP Lithotripsy','44. Other Exam (requires X and Z)'/
C
C VIEWS FOR EACH PROJECTION CODE.
C
      DATA IVIEW/0,1,1,3,2,3,2,3,2,2,3,2,2,3,0,0,0,2,3,0,1,2,0,3,2,
     1 2,3,0,0,0,0,0,0,2,0,0,2,2,2,3,2,2,3,0/
C
```

```
C OPEN INPUT/OUTPUT FILES.
C
      OPEN(UNIT=2,FILE='CDI3TAR.DAT',FORM='UNFORMATTED',
     1 STATUS='OLD',ACCESS='DIRECT',RECL=2618)
      OPEN(UNIT=4,FILE='CDI3HVL.DAT',FORM='UNFORMATTED',
     1 STATUS='OLD',ACCESS='DIRECT',RECL=76)
      OPEN(UNIT=8,FILE='CDI3.OUT',STATUS='NEW')
      OPEN(UNIT=9,FILE='CDI3.DAT',STATUS='OLD')
      CALL LIB$DATE_TIME(TODAY)
      IPG = 0
```

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```
     1 STATUS='OLD',ACCESS='DIRECT',RECL=10472)

     1 STATUS='OLD',ACCESS='DIRECT',RECL=704)
      OPEN(UNIT=8,FILE='CDI3.OUT',STATUS='UNKNOWN')

      CALL GETDAT(IYR,IMON,IDAY)
```

```
C
C READ X-RAY SPECTRA DATA.
C
      READ (4,REC=1)K1,(SPEC1(I),AVL(I),HV3(I),KV(I),KN1(I),I=1,25)
      READ (4,REC=2)K1,(SPEC1(I),AVL(I),HV3(I),KV(I),KN1(I),I=26,50)
      DO 3 I = 1,K1
      K = I + 2
3     READ (4,REC=K)(SPEC(I,J),J=1,60)
4     CONTINUE
C
C QUERY USER FOR INPUT DATA.
C
      IF (ITER.GT.0) GO TO 11
      WRITE(6,5)
5     FORMAT(/////,
     1/T12'* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *',
     2/T12'* VAX COMPUTER PROGRAM TO ESTIMATE THE DOSES TO SEVERAL   *',
     3/T12'* TISSUES OF A REFERENCE PATIENT FOR A SPECIFIED X-RAY    *',
     4/T12'* PROJECTION.  PROGRAM RUNS IN INTERACTIVE MODE QUERYING  *',
     5/T12'* THE USER FOR INPUT EXAM DATA OR IN BATCH MODE USING AN  *',
     6/T12'* INPUT FILE WHICH CONTAINS EXAM DATA.                    *',
     7/T12'* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *',
     8/T12'* DESIGN:         Marvin Rosenstein, Ph.D.                *',
     9/T12'*         Center for Devices and Radiological Health      *',
     1/T12'*                     Rockville, Maryland                 *',
     2/T12'*                                                         *',
     3/T12'*   CODE:              Leif E. Peterson                   *',
     4/T12'*                  Kelsey-Seybold Clinic, P.A.            *',
     5/T12'*                       Houston, Texas                    *',
     6/T12'* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *',
     7/////)
6     CONTINUE
      WRITE(6,7)
7     FORMAT(T5'NOTE:  SET CAPS LOCK ON',//,T5'BATCH OR ',
     1'INTERACTIVE MODE (B/I)?',$)
      READ(5,8,ERR=6)AMODE
8     FORMAT(A1)
      IF (AMODE.EQ.'I') GO TO 9
      IF (AMODE.EQ.'B') GO TO 67
      IF (AMODE.NE.'B'.AND.AMODE.NE.'I') GO TO 6
9     CONTINUE
      WRITE(6,10)
10    FORMAT(//,T5'NOTE:  INPUT FORMAT FOR EACH FIELD MUST CONFORM',
     1/T5'TO INPUT FIELD DESCRIPTION IN REFERENCE REPORT',/,
     2/T5'NOTE:  INPUT FIELDS MARKED WITH AN ASTERISK ARE OPTIONAL',
     3//T5'PRESS ENTER TO CONTINUE',$)
      READ(5,60)ACORR
```

```
11    CONTINUE
      WRITE(6,12)(IEXAM(I),I = 1,44)
12    FORMAT(T29'LIST OF VIEW/PROJECTIONS',/,22(T2,A33,A37,/),
     1T5'SELECT PROJECTION CODE:',$)
      READ(5,13,ERR=11)IPRJ
13    FORMAT(I2)
      IF (IPRJ.LT.1.OR.IPRJ.GT.44) GO TO 11
      IVEW = IVIEW(IPRJ)
500   CONTINUE
      IFLR = 0
      AFLR = 'N'
      IF (IPRJ.EQ.44)THEN
      WRITE(6,501)
501   FORMAT(T5'FLUOROSCOPIC PROJECTION (Y/N)',$)
      READ(5,502,ERR=500)AFLR
502   FORMAT(A1)
      IF (AFLR.NE.'Y'.AND.AFLR.NE.'N') GO TO 500
      IF (AFLR.EQ.'Y') IFLR = 1
      IF (ICORR.NE.0) GO TO 56
      ENDIF
14    CONTINUE
      WRITE(6,15)
15    FORMAT(T5'ENTER PROJECTION NAME (EX: CHEST ):',$)
      READ(5,16,ERR=14)EXAM
16    FORMAT(A20)
      IF (ICORR.NE.0) GO TO 56
      IF (IVEW.EQ.0)THEN
17    CONTINUE
      WRITE(6,18)
18    FORMAT(T5'SELECT A VIEW (1-PA 2-AP 3-LAT):',$)
      READ(5,19,ERR=17)IVEW
19    FORMAT(I1)
      IF (IVEW.LT.1.OR.IVEW.GT.3) GO TO 17
      IF (ICORR.NE.0) GO TO 56
      ENDIF
20    CONTINUE
      IFLT = 0
      AFLT = 'N'
      WRITE(6,21)
21    FORMAT(T4'*USE X-RAY SPECTRA FOR HI-Z FILTERS (Y/N)?',$)
      READ(5,22,ERR=20)AFLT
22    FORMAT(A1)
      IF (AFLT.NE.'Y'.AND.AFLT.NE.'N') GO TO 20
      IF (AFLT.EQ.'Y')THEN
23    CONTINUE
      ISKP = 0
      ASKP = 'N'
      HHVL = 0.
      WRITE(6,24)
24    FORMAT(//T5'1.  Erbium Composite (3.18 mm + 2.00 mm Al) for ',
     1'70,80,90,100,120 kVp',/T5'2.  Erbium Foil (0.25 mm + 2.00 mm',
     2' Al) for 70,80,90,100,120 kVp',//T5'ENTER SELECTION:',$)
      READ(5,25,ERR=23)IFLT
25    FORMAT(I1)
      IF (IFLT.LT.0.OR.IFLT.GT.2) GO TO 23
```

```
      ENDIF
      IF (ICORR.NE.0) GO TO 56
C
C WHEN HI-Z SPECTRA SELECTED, SKIP QUERIES FOR KVP AND HVL INPUT.
C
26    CONTINUE
      IF (AFLT.EQ.'N')THEN
      WRITE(6,27)
27    FORMAT(T5'ENTER THE TUBE POTENTIAL (kVp):',$)
      READ(5,28,ERR=26)KVP4
28    FORMAT(I3)
      IF (KVP4.LT.0) GO TO 26
      IF (KVP4.EQ.0)THEN
      IFLT = 0
      AFLT = 'N'
      ENDIF
      IF (ICORR.NE.0) GO TO 56
29    CONTINUE
      IF (KVP4.GT.0)THEN
      WRITE(6,30)
30    FORMAT(T4'*ENTER THE HVL (mm Al):',$)
      READ(5,31,ERR=29)HHVL
31    FORMAT(F5.2)
      IF (HHVL.LT.0.) GO TO 29
      IF (HHVL.NE.0.)THEN
      ISKP = 0
      ASKP = 'N'
      IFLT = 0
      AFLT = 'N'
      ENDIF
      IF (ICORR.NE.0) GO TO 56
      ENDIF
      ENDIF
32    CONTINUE
      WRITE(6,33)
33    FORMAT(T5'ENTER THE SKIN ENTRANCE EXPOSURE (mR):',$)
      READ(5,34,ERR=32)IEXP1
34    FORMAT(I6)
      IF (IEXP1.LT.0) GO TO 32
      IF (ICORR.NE.0) GO TO 56
      SIDI = 0.
      SSDI = 0.
35    CONTINUE
      IF (IFLR.EQ.1)WRITE(6,503)
503   FORMAT(T5'NOTE:  FOR FLUOROSCOPIC PROJECTIONS, BOTH THE',
     1' SOURCE-TO-SKIN',/T5'ENTRANCE DISTANCE AND SOURCE-TO-IMAGE',
     2' RECEPTOR DISTANCE ARE REQUIRED')
      WRITE(6,36)
36    FORMAT(T5'ENTER THE SOURCE-TO-IMAGE RECEPTOR DISTANCE (cm):',$)
      READ(5,37,ERR=35)SIDI
37    FORMAT(F5.1)
      IF (SIDI.LT.0.) GO TO 35
      IF (ICORR.NE.0) GO TO 56
C
C WHEN SOURCE-TO-IMAGE RECEPTOR DISTANCE IS ZERO OR INPUT DATA FOR A
```

```
C FLUOROSCOPIC PROJECTION, QUERY USER FOR SOURCE-TO-SKIN ENTRANCE DISTANCE.
C
38     CONTINUE
       IF (SIDI.EQ.0..OR.IFLR.EQ.1)THEN
       WRITE (6,39)
39     FORMAT(T4'*ENTER THE SOURCE-TO-SKIN ENTRANCE DISTANCE (cm):',$)
       READ(5,40,ERR=38)SSDI
40     FORMAT(F5.1)
       IF (SSDI.LT.0.)GO TO 38
       IF (ICORR.NE.0) GO TO 56
       ENDIF
41     CONTINUE
       WRITE(6,42)
42     FORMAT(T5'ENTER THE HORIZONTAL IMAGE RECEPTOR SIZE (cm):',$)
       READ(5,43,ERR=41)HB
43     FORMAT(F5.1)
       IF (HB.LT.1..OR.HB.GT.150.) GO TO 41
       IF (ICORR.NE.0) GO TO 56
44     CONTINUE
       WRITE(6,45)
45     FORMAT(T5'ENTER THE VERTICAL IMAGE RECEPTOR SIZE (cm):'$)
       READ(5,46,ERR=44)VB
46     FORMAT(F5.1)
       IF (VB.LT.1..OR.VB.GT.150.) GO TO 44
       IF (ICORR.NE.0) GO TO 56
C
C WHEN EXAM NUMBER 44 IS SELECTED, QUERY USER FOR X- AND Z-COORDINATES.
C
       X1I = 0.
       Z1I = 0.
       IF (IPRJ.EQ.44)THEN
47     CONTINUE
       WRITE(6,48)
48     FORMAT(T5'ENTER DISTANCE FROM MIDLINE OF REFERENCE PATIENT - X',
      1' (cm):',$)
       READ(5,49,ERR=47)X1I
49     FORMAT(F5.1)
       IF (X1I.GT.20.) GO TO 47
       IF (ICORR.GT.0) GO TO 56
50     CONTINUE
       WRITE(6,51)
51     FORMAT(T5'ENTER DISTANCE FROM VERTEX OF REFERENCE PATIENT - Z',
      1' (cm):',$)
       READ(5,52,ERR=50)Z1I
52     FORMAT(F5.1)
       IF (Z1I.LT.0..OR.Z1I.GT.175.) GO TO 50
       IF (ICORR.GT.0) GO TO 56
       ENDIF
C
C WHEN KVP AND HVL NOT EQUAL TO ZERO, AND HI-Z SPECTRA NOT SELECTED,
C QUERY USER FOR ALTERNATE SPECTRA PRINTOUT, WHICH CAUSES PROGRAM TO
C SKIP INTERPOLATION OF TISSUE DOSES AS A FUNCTION OF HVL.  ACTUAL
C SPECTRA ARE PRINTED IN TISSUE DOSE TABLE.
C
53     CONTINUE
```

```
      ASKP = 'N'
      IF ((KVP4.GT.0.AND.HHVL.EQ.0..AND.AFLT.EQ.'N').OR.(ICORR.
     1 GT.0))THEN
      WRITE(6,54)
 54   FORMAT(T4'*PRINT TISSUE DOSES FOR ORIGINAL X-RAY SPECTRA',
     1' (Y/N)?',$)
      READ(5,55,ERR=53)ASKP
 55   FORMAT(A1)
      ISKP = 0
      IF (ASKP.NE.'Y'.AND.ASKP.NE.'N') GO TO 53
      IF (ASKP.EQ.'Y')THEN
      ISKP = 1
      IFLT = 0
      AFLT = 'N'
      HHVL = 0.
      ENDIF
      ENDIF
 56   CONTINUE
      ICORR = 0
      WRITE(6,57)
 57   FORMAT(T5'THE FOLLOWING INPUT DATA HAVE BEEN SPECIFIED BY',
     1' THE USER:')
      WRITE(6,58)EXAM,PJ(IVEW),KVP4,HHVL,IEXP1,SIDI,SSDI,HB,VB,
     1X1I,Z1I,ASKP,AFLT,AFLR
 58   FORMAT(/T5' 1 -    EXAM:  ' ,A20,/T5' 2 -    VIEW:  ',A4,
     1/T5' 3 -    KVP:  ',I3,
     2/T5' 4 - * HVL (mm Al):  ',F5.2,/T5' 5 -    EXPOSURE (mR):  ',I6,
     3/T5' 6 -    SOURCE-TO-IMAGE RECEPTOR DISTANCE (cm):  ',F5.1,
     4/T5' 7 - * SOURCE-TO-SKIN ENTRANCE DISTANCE (cm):  ',F5.1,
     5/T5' 8 -    HORIZONTAL IMAGE RECEPTOR SIZE (cm):  ',F5.1,
     6/T5' 9 -    VERTICAL IMAGE RECEPTOR SIZE (cm):  ',F5.1,
     7/T5'10 - * DISTANCE FROM PHANTOM MIDLINE - X (cm):  ',F5.1,
     8/T5'11 - * DISTANCE FROM PHANTOM VERTEX - Z (cm):  ',F5.1,
     9/T5'12 - * PRINT TISSUE DOSES FOR ORIGINAL X-RAY SPECTRA:  ',A1,
     1/T5'13 - * USE X-RAY SPECTRA FOR HI-Z FILTERS:  ',A1,
     2/T5'14 - * FLUOROSCOPIC PROJECTION:  ',A1)
      WRITE(6,59)
 59   FORMAT(//T5'ARE ALL INPUT DATA CORRECT (Y/N) ?',$)
      READ(5,60,ERR=56)ACORR
 60   FORMAT(A1)
      IF (ACORR.NE.'Y'.AND.ACORR.NE.'N') GO TO 56
      IF (ACORR.EQ.'N')THEN
      WRITE(6,61)
 61   FORMAT(/T5'ENTER CHOICE TO CORRECT:',$)
      READ(5,62,ERR=56)ICORR
 62   FORMAT(I2)
      IF (ICORR.EQ.1) GO TO 11
      IF (ICORR.EQ.2) GO TO 17
      IF (ICORR.EQ.3.AND.IFLT.EQ.0) GO TO 26
      IF (ICORR.EQ.3.AND.IFLT.NE.0) GO TO 23
      IF (ICORR.EQ.4)THEN
      IF (KVP4.EQ.0)THEN
      WRITE(6,63)
 63   FORMAT(//T5'WHEN HVL IS ENTERED, KVP MUST ALSO BE ENTERED. ',
     1/T5'ALSO, OPTION USING ORIGINAL SPECTRA AND OPTION USING HI-Z',
```

```
     2/T5'SPECTRA MUST BE "NO"')
      WRITE (6,64)
 64   FORMAT(//T5'PRESS ENTER TO CONTINUE',$)
      READ(5,60)ACORR
      GO TO 26
      ENDIF
      GO TO 29
      ENDIF
      IF (ICORR.EQ.5) GO TO 32
      IF (ICORR.EQ.6) GO TO 35
      IF (ICORR.EQ.7) GO TO 38
      IF (ICORR.EQ.8) GO TO 41
      IF (ICORR.EQ.9) GO TO 44
      IF (ICORR.EQ.10) GO TO 47
      IF (ICORR.EQ.11) GO TO 50
      IF (ICORR.EQ.12)THEN
      WRITE(6,65)
 65   FORMAT(//T5'WHEN TISSUE DOSES FROM ORIGINAL SPECTRA REQUESTED,',
     1/,T5'A KVP VALUE AND HVL OF ZERO ARE REQUIRED')
      WRITE(6,64)
      READ(5,60)ACORR
      GO TO 53
      ENDIF
      IF (ICORR.EQ.13)THEN
      WRITE(6,66)
 66   FORMAT(//T5'WHEN USE OF HI-Z SPECTRA REQUESTED, AN HVL OF ZERO',
     1/T5'AND KVP OF ZERO ARE REQUIRED')
      WRITE(6,64)
      READ(5,60)ACORR
      GO TO 20
      ENDIF
      IF (ICORR.EQ.14) GO TO 500
      ENDIF
 67   CONTINUE
      WRITE(6,68)
 68   FORMAT(//T5'OUTPUT FILENAME IS "CDI3.OUT"',///T5'PLEASE WAIT...')
      IF (AMODE.EQ.'I') GO TO 71
 69   CONTINUE
      READ(9,70,END=450)EXAM,IVEW,IPRJ,KVP4,HHVL,IEXP1,SIDI,
     1 HB,VB,SSDI,X1I,Z1I,ISKP,IFLT,IFLR
 70   FORMAT(A20,I1,I2,I3,F5.2,I6,6F5.1,3I1)
 71   CONTINUE
C
C ZERO TISSUE DOSE VALUES FOR THIS CASE.
C
      DO 72 J = 2,12,2
      OD(J) = 0.
      OD(J-1) = 0.
      IOD(J) = 0
      IOD(J-1) = 0
      DO 72 I = 1,10
      ORGD(I,J) = 0.
      ORGD(I,J-1) = 0.
 72   CONTINUE
      IF (IVEW.EQ.0)GO TO 140
```

```
C
C  DETERMINE PATIENT THICKNESS FOR SPECIFIC PROJECTION VIEW.
C
      BPT = THICK(IVEW)
      KNN = 0
      INOUT = 0
C
C FOR EACH TISSUE REQUESTED, CALCULATE TISSUE DOSE.
C
      DO 130 II = 1,10
      IORN(II) = INIORN(II)
      IF (IORN(II).EQ.0) GO TO 130
      KNN = KNN + 1
      IF (IORN(II).EQ.9) GO TO 130
      IOR = IORN(II)
      I = (7 * (IVEW - 1)) + IOR
      IJK = (9 * (IVEW - 1)) + IOR
      KN = NUM(IVEW)
      DPT = DEEP(IJK)
C
C FIND PROJECTION FIELD CENTERS.
C
      X1 = 0.
      Z1 = 0.
      SSD = 0.
      SID = 0.
      X1 = X1I
      Z1 = Z1I
      SSD = SSDI
      SID = SIDI
      IF (Z1.NE.0.)GO TO 73
      X1 = CX(IPRJ)
      Z1 = CZ(IPRJ)
73    IF (VB.NE.0.)GO TO 74
      HB = HB * .9
      VB = HB
74    ISED = 0
C
C ERROR MESSAGES FOR FLUOROSCOPIC AND RADIOGRAPHIC PROJECTIONS.
C
      IUNIT = 8
      IF (AMODE.EQ.'I')IUNIT = 6
      IF (IFLR.EQ.1.AND.(SSDI.EQ.0..OR.SIDI.EQ.0.))THEN
      WRITE(IUNIT,504)
504   FORMAT('1',T5'THIS RECORD WAS NOT PROCESSED FOR THE FOLLOWING',
     1' REASON:',//)
      WRITE(IUNIT,505)
505   FORMAT(T5'INPUT ERROR: FOR FLUOROSCOPIC PROJECTIONS, BOTH THE',
     1/,T5'SOURCE-TO-SKIN ENTRANCE DISTANCE AND SOURCE-TO-IMAGE ',
     2/,T5'RECEPTOR DISTANCE ARE REQUIRED.')
      GO TO 166
      ENDIF
      IF (IFLR.NE.1.AND.(SSDI.GT.0..AND.SIDI.GT.0.))THEN
      WRITE(IUNIT,504)
      WRITE(IUNIT,506)
```

```
506   FORMAT(T5'INPUT ERROR: FOR FLUOROSCOPIC PROJECTIONS, A "1"',
     1/,T5'IS REQUIRED IN INPUT FIELD 15 WHEN USING BATCH MODE,',/,
     2T5'AND A "Y" IS REQUIRED AT THE PROMPT "FLUOROSCOPIC',/,
     3T5'PROJECTION (Y/N)?" WHEN USING INTERACTIVE MODE.  FOR',/,
     4T5'RADIOGRAPHIC PROJECTIONS, INPUT EITHER THE SOURCE-TO-SKIN',
     5/,T5'ENTRANCE DISTANCE OR SOURCE-TO-IMAGE RECEPTOR DISTANCE,',/,
     6T5,'BUT NOT BOTH.')
      GO TO 166
      ENDIF
      IF (IFLR.EQ.1.AND.SIDI.LT.SSDI)THEN
      WRITE(IUNIT,504)
      WRITE(IUNIT,507)
507   FORMAT(T5'INPUT ERROR: FOR FLUOROSCOPIC PROJECTIONS, IT IS',
     1/,T5'REQUIRED THAT THE SOURCE-TO-SKIN ENTRANCE DISTANCE BE',
     2/,T5'LESS THAN THE SOURCE-TO-IMAGE RECEPTOR DISTANCE.')
      GO TO 166
      ENDIF
C
C FOR FLUOROSCOPIC PROJECTIONS, DETERMINE THE BODY PART THICKNESS FOR LATERAL
C VIEWS IN THE SKULL REGION.  FOR LATERAL VIEWS, WHEN THE FIELD CENTER IS
C LESS THAN OR EQUAL TO 19 CM FROM THE VERTEX OF THE REFERENCE PATIENT AND
C THE BOTTOM FIELD EDGE ON THE EXIT SIDE OF THE HEAD IS LESS THAN 25 CM FROM
C THE VERTEX, USE A BODY PART THICKNESS OF 14 CM AND AN ORGAN DEPTH OF 7 CM.
C OTHERWISE, USE A BODY PART THICKNESS OF 37.2 AND AN ORGAN DEPTH OF 17.2.
C
      IF (IFLR.EQ.1)THEN
      IF (IVEW.NE.3) GO TO 77
      IF (IPRJ.NE.1.AND.IPRJ.NE.2.AND.Z1.GT.19.) GO TO 77
      A = SSD + 14.
      B = A * (1./SID)
      BL = VB * B
      HP = Z1 + (BL * 0.5)
      IF (HP.LT.25..AND.Z1.LE.19.)THEN
      DPT = DEEP(IJK) - 10.2
      IF (DPT.LT.0.) DPT = 0.
      ENDIF
      GO TO 77
      ENDIF
C
C FOR RADIOGRAPHIC PROJECTIONS, WHEN SOURCE-TO-SKIN ENTRANCE DISTANCE INPUT,
C DETERMINE SOURCE-TO-IMAGE RECEPTOR DISTANCE AND DETERMINE THE BODY PART
C THICKNESS FOR LATERAL VIEWS IN THE SKULL REGION.  FOR LATERAL VIEWS,
C WHEN THE FIELD CENTER IS LESS THAN OR EQUAL TO 19 CM FROM THE VERTEX OF
C THE REFERENCE PATIENT AND THE BOTTOM FIELD EDGE ON THE EXIT SIDE OF THE
C HEAD IS LESS THAN 25 CM FROM THE VERTEX, USE A BODY PART THICKNESS OF 14
C CM AND AN ORGAN DEPTH OF 7 CM.  OTHERWISE, USE A BODY PART THICKNESS OF
C 37.2 AND AN ORGAN DEPTH OF 17.2.
C
      IF (SSD.NE.0.)THEN
      ISED = 1
      SID = SSD + 5. + BPT
      IF (IVEW.NE.3) GO TO 77
      IF (IPRJ.NE.1.AND.IPRJ.NE.2.AND.Z1.GT.19.) GO TO 77
      A = SID - 5.
      B = A * (1./SID)
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```
      BL = VB * B
      HP = Z1 + (BL * 0.5)
      IF (HP.LT.25..AND.Z1.LE.19.)THEN
      BPT = 14.
      DPT = DEEP(IJK) - 10.2
      IF (DPT.LT.0.) DPT = 0.
      SID = SSD + 5. + BPT
      ENDIF
      GO TO 77
      ENDIF
C
C FOR RADIOGRAPHIC PROJECTIONS, WHEN SOURCE-TO-IMAGE RECEPTOR DISTANCE
C INPUT, DETERMINE SOURCE-TO-SKIN ENTRANCE DISTANCE AND DETERMINE THE BODY
C PART THICKNESS FOR LATERAL VIEWS IN THE SKULL REGION.  FOR LATERAL VIEWS,
C WHEN THE FIELD CENTER IS LESS THAN OR EQUAL TO 19 CM FROM THE VERTEX OF
C THE REFERENCE PATIENT AND THE BOTTOM FIELD EDGE ON THE EXIT SIDE OF THE
C HEAD IS LESS THAN 25 CM FROM THE VERTEX, USE A BODY PART THICKNESS OF 14
C CM AND AN ORGAN DEPTH OF 7 CM.  OTHERWISE, USE A BODY PART THICKNESS OF
C 37.2 AND AN ORGAN DEPTH OF 17.2.
C
      IF (IVEW.NE.3) GO TO 77
      IF (IPRJ.NE.1.AND.IPRJ.NE.2.AND.Z1.GT.19.) GO TO 77
      A = SID - 5.
      B = A * (1./SID)
      BL = VB * B
      HP = Z1 + (BL * 0.5)
      IF (HP.LT.25..AND.Z1.LE.19.) GO TO 76
      GO TO 77
76    BPT = 14.
      DPT = DEEP(IJK) - 10.2
      IF (DPT.LT.0.) DPT = 0.
77    IF (ISED.EQ.0.AND.IFLR.NE.1) SSD = SID - 5. - BPT
C
C FIND BEAM SIZE AT TISSUE PLANE AND FIND PHANTOM COORDINATES FITTING
C THE BEAM SIZE AT THE TISSUE PLANE.
C
      A = (SSD + DPT) * (1./SID)
      BW = HB * A
      BL = VB * A
      WP = X1 + (BW * 0.5)
      WM = X1 - (BW * 0.5)
      HP = Z1 + (BL * 0.5)
      HM = Z1 - (BL * 0.5)
C
C CHECK THAT BREASTS ARE TOTALLY IN THE BEAM.
C
      I78 = 0
      I130 = 0
      IF (IOR.EQ.8)CALL BREST(WP,WM,HP,HM,IVEW,BOX,INOUT,I78,I130)
      IF (I78.EQ.1) GO TO 78
      IF (I130.EQ.1) GO TO 130
C
C READ TAR MATRIX FOR SPECIFIC TISSUE.
C
      READ (2,REC=I)RADR
```

```
78    M = 0
C
C SUM TISSUE-AIR-RATIOS.
C
      DO 79 J = 1,KN
      DOSES = 0.
      IF (IOR.EQ.8)M = M + 1
      IF (IOR.EQ.8)GO TO 80

C
C DO NOT USE 20 KEV AP MATRIX UNLESS EXAM IS A CERVICAL SPINE
C PROJECTION OR TISSUE IS THE THYROID, OVARIES, OR TESTES FOR ALL
C OTHER PROJECTIONS.
C
      IF (J.EQ.1)THEN
      IF (IVEW.EQ.2.AND.IOR.NE.3.AND.IOR.NE.4.AND.IOR.NE.5.
     1 AND.IPRJ.NE.5) GO TO 79
      ENDIF
      M = M + 1
C
C FIND WHAT PORTION OF MATRIX UNIT CONTAINED IN THE BEAM AND MULTIPLY
C THAT BY THE TAR ASSOCIATED WITH THAT UNIT AND ADD TO TOTAL FOR BEAM.
C
      DO 81 K = 1,11
      DO 81 L = 1,34
      IK = 4 * (K - 6)
      IL = 4 * (L - 1)
      AP = IK + 2.
      AM = IK - 2.
      CP = IL + 2.
      CM = IL - 2.
      AREA = (ASW(WM,WP,AM,AP)) * (ASW(HM,HP,CM,CP))
      FACT = AREA * 0.0625
      DOSES = DOSES + (FACT * RADR(J,K,L))
81    CONTINUE
      RAD(M) = DOSES
      GO TO 82
80    RAD(M) = BRST(7 * (IVEW - 1) + J)
C
C MOVE APPROPRIATE KEV VALUES TO WORK AREA.
C
82    KVP(M) = KV2(7 * (IVEW-1) + J)
79    CONTINUE
      IF (IOR.EQ.8)GO TO 83
      IF (IVEW.EQ.2)THEN
      IF (IOR.NE.3.AND.IOR.NE.4.AND.IOR.NE.5.AND.IPRJ.NE.5)KN = KN - 1
      ENDIF
83    IF (IVEW.NE.3)GO TO 84
C
C EXPAND KEV TO 120 WITH THEIR CORRESPONDING TARS.
C
      RAD(M+1) = RAD(M) * FAC(IOR)
      KVP(M+1) = KVP(M) + 20.
      KN = KN + 1
      M = M + 1
```

```
 84     RAD(M+1) = RAD(M) - .000001
        KVP(M+1) = KVP(M) + 20.
        KN = KN + 1
C
C WHEN SUMMED TAR IS INSIGNIFICANT, IGNORE FURTHER PROCESSING.
C
        SUM = 0.
        DO 85 J = 2,KN,2
        SUM = SUM + RAD(J) + RAD(J-1)
 85     CONTINUE
        IF (SUM.LT.5.5E-4)GO TO 130
        M = 4
        N = 6
C
C TO AFFECT A SMOOTHER FIT, THREE PRESELECTED KEV VALUES HAVE THEIR TARS
C INTERPOLATED AND ARE ADDED TO THE LIST FOR THE 2-KEV INTERVAL
C INTERPOLATION.
C
        IF (IVEW.NE.3)GO TO 86
        M = 1
        N = 3
 86     K = 0
        Z = 0.
        K3 = KN - 1
        DO 88 J = M,N
        K = K + 1
        RAD(KN+K) = 0.
        X = KVP1(J)
        CALL ATSG(X,KVP,RAD,K3,ARG,VAL)
        IF (VAL(1).EQ.0..AND.VAL(2).EQ.0.) GO TO 87
        CALL ACFI(X,ARG,VAL,Z,K3,IER,EP1)
 87     KVP(KN+K) = KVP1(J)
        RAD(KN+K) = Z
 88     CONTINUE
        K3 = KN + K
        LL = KN + 1
        KLL = KN + 3
        K4 = 7
        KK = 0
        KL = 0
C
C INTERPOLATE TARS AT 2-KEV INTERVALS.  WHEN FOR SOME REASON
C INTERPOLATION CANNOT BE ACCOMPLISHED IN THE ESTABLISHED SUBROUTINE,
C THEN A LINEAR INTERPOLATION IS USED BETWEEN THE THREE CLOSEST KEV
C VALUES.
C
        ZZ = 0.
        DO 96 J = 10,130,2
        KK = KK + 1
        X = FLOAT(J)
        Y(KK) = 0.
        Z = 0.
        CALL ATSG(X,KVP,RAD,K3,ARG,VAL)
        IF (VAL(1).EQ.0..AND.VAL(2).EQ.0.)GO TO 91
        R = ARG(1)
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```
      S = VAL(1)
      T = ARG(2)
      U = VAL(2)
      V = ARG(3)
      W = VAL(3)
      KA = K3
      IF (X.LT.KVP(1).OR.X.GT.KVP(KN))KA = 5
      CALL ACFI(X,ARG,VAL,Z,KA,IER,EPS)
      IF (IER.EQ.0)GO TO 90
      IF (X.LT.KVP(1).OR.X.GT.KVP(KN))GO TO 90
      IF (R.GT.X)GO TO 89
      R = T
      S = U
      IF (R.GT.X)GO TO 89
      R = V
      S = W
89    Z = ZZ + (((X-(X-2.)) * (1./(R-(X-2.)))) * (S-ZZ))
90    Y(KK) = Z
      ZZ = Z
91    IF (Y(KK).LT.0.)Y(KK) = 0.
C
C FOR ACTIVE BONE MARROW, APPLY PHOTOELECTRON ENHANCEMENT FACTORS.
C
      IF (IOR.EQ.2)Y(KK) =  Y(KK) * BONE(KK)
      IF (KK.EQ.1)GO TO 92
C
C CHECK LOW ORDER CUTOFF.
C
      IF (Y(KK).EQ.0.) GO TO 92
      IF ((Y(KK).GT.0..AND.Y(KK-1).LT.Y(KK)).OR.X.GT.26.)GO TO 96
      IF (X.GT.KVP(KN))GO TO 96
92    KL = KK
96    CONTINUE
      KLK = 8 + (2 * KL)
      KHVL = 0
      KHVL = IFIX(HHVL * 100.)
      IHVL = 0
      IF (KHVL.NE.0)IHVL = KHVL
C
C WHEN NO HVL SPECIFIED ON INPUT, USE ALL 27 SPECTRA.
C
      IF (KHVL.EQ.0)IHVL = 300
      K2 = 1
      K3 = 27
      IF (KVP4.EQ.0)GO TO 99
C
C FIND APPROPRIATE X-RAY SPECTRA WHEN KVP SPECIFIED ON INPUT.
C
      DO 97 J = 1,2
      IF (KVP4.LT.KVP2(J))GO TO 98
97    CONTINUE
      J = 3
98    IF (IHVL.LT.IHVL4(J,1).OR.IHVL.GT.IHVL4(J,2))GO TO 99
      K2 = (9 * (J-1)) + 1
      K3 = (9 * (J-1)) + 9
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```
 99     J = 0
        KJNT = 0
        IF (KVP4.EQ.0)ISKP = 0
        IF (KHVL.GT.0)ISKP = 0
        IF (IFLT.EQ.0) GO TO 102
        K2 = (5 * (IFLT-1)) + 28
        K3 = K2 + 4
 102    CONTINUE
C
C FOR EACH X-RAY SPECTRUM, SUM THE PRODUCT OF THE 2-KEV INTERVAL TARS
C AND THEIR CORRESPONDING FRACTIONAL EXPOSURE CONTRIBUTIONS AT THAT
C KEV LEVEL.
C
        DO 110 M = K2,K3
        J = J + 1
        K = KN1(M)
        PRD(J) = 0.
        SUM = 0.
        HV2(J) = ALOG(HV3(M))
        DO 105 L = 1,K
        IF (L.LE.KL)GO TO 105
        SUM = SUM + (SPEC(M,L) * Y(L))
 105    CONTINUE
        PRD(J) = SUM
        IF (ISKP.EQ.1)GO TO 110
        IF (IFLT.NE.0)GO TO 110
        IF (PRD(J).LT.0.)PRD(J) = 0.
        IF (PRD(J).EQ.0.)GO TO 110
        PRD(J) = ALOG(PRD(J))
        KJNT = KJNT + 1
 110    CONTINUE
C
C WHEN ALTERNATE TISSUE DOSE PRINTOUT FOR ORIGINAL X-RAY SPECTRA IS
C SELECTED, SKIP THE POLYNOMIAL FIT.
C
        DEN = (SSD * (1./(SSD + DPT)))**2
        JI = 1
        IF (KHVL.EQ.0) JI = 12
        IF (ISKP.EQ.1)GO TO 128
        IF (IFLT.NE.0)GO TO 128
        IF (KJNT.EQ.0)GO TO 130
        JJ = J
C
C COMPUTE COEFFICIENTS FOR SECOND DEGREE LEAST SQUARE POLYNOMIAL FIT.
C
        CALL LEAST(JJ,PRD,HV2,ANS)
        DO 125 IJ = 1,JI
        IF (KHVL.EQ.0)IHVL = JHVL(IJ)
        HVL = IHVL * .01
        IF (HVL.EQ.1.0)HVL = 1.0001
        AHVL(IJ) = HVL
        HVL = ALOG(HVL)
C
C SOLVE LEAST SQUARE POLYNOMIAL FIT.
C
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```
      TEMP = ANS(1) + (ANS(2) * HVL) + (ANS(3) * HVL**2)
      TAR = EXP(TEMP)
C
C CALCULATE DOSE TO THE TISSUE, BASED ON SKIN ENTRANCE EXPOSURE.
C
      DOSE = (FLOAT(IEXP1) * DEN) * TAR
      ORGD(II,IJ) = DOSE
125   CONTINUE
      GO TO 130
C
C WHEN ALTERNATE TISSUE DOSE PRINTOUT IS REQUESTED, CALCULATE TISSUE
C DOSE USING THE COMPUTED TARS FOR THE DESIRED X-RAY SPECTRA.
C
128   DO 129 IJ = 1,JI
      ORGD(II,IJ) = (FLOAT(IEXP1) * DEN) * PRD(IJ)
129   CONTINUE
130   CONTINUE
140   CONTINUE
C
C  PRINT TABLE HEADINGS AND SPECIFICS OF THE REQUESTED EXAMINATION FOR
C  MALE TISSUE DOSE, FOLLOWED BY FEMALE TISSUE DOSES.
C
C
      IPG = IPG + 1
      WRITE (8,131)TODAY,IPG,PJ(IVEW),EXAM,IEXP1
131   FORMAT ('1',T10'RUN DATE:  ',A11,T105,
     1'PAGE:  ',I3,/T10'EXAM:  'A3,' ',A20,
     2' - TISSUE DOSES (mrad) FOR',I6,' mR',
     3' EXPOSURE AT SKIN ENTRANCE (FREE-IN-AIR)')
C
C
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      WRITE(8,141)CHAR(012)
141   FORMAT(A4)
      WRITE(8,131)IMON,IDAY,IYR,IPG,PJ(IVEW),EXAM,IEXP1
131   FORMAT(T10'RUN DATE:  ',I2,'/',I2,'/',I4,T105'PAGE:',
     1'  ',I3,/T10'EXAM:  ',A3,' ',A20,' - TISSUE',
     2' DOSES (mrad) FOR',I6,' mR EXPOSURE AT SKIN ',
     3'ENTRANCE (FREE-IN-AIR)')
```

```
      IF (ISKP.EQ.1)WRITE (8,132)STFD
132   FORMAT (T10'SID:  ',F5.1,' (cm)',T44'FOR ORIGINAL X-RAY ',
     1 'SPECTRA.')
      IF (ISKP.NE.1)WRITE(8,133)SID
133   FORMAT(T10'SID:  ',F5.1,' (cm)')
      WRITE(8,134)HB,VB,Z1,X1
134   FORMAT (T10'FIELD SIZE AT FILM:  ',F5.1,' (cm)  X ',F5.1,' (cm)',
     1 /T10'DISTANCE FROM VERTEX:  ',F5.1,' (cm)',
     2 /T10'DISTANCE FROM PHANTOM MIDLINE:  ',F5.1,' (cm)')
      IF (IFLT.NE.0.AND.KVP4.EQ.0)WRITE(8,135)FILT(IFLT)
135   FORMAT(T10'FILTRATION:  ',A16)
C
C FOR EACH SEX, PRINT TISSUE DOSE TABLE AND HEADINGS.
C
      DO 180 II = 1,2
C
C CALCULATE FEMALE TISSUE DOSES AND PRINT FEMALE TISSUE
C DOSE TABLES.
C
      IF (II.EQ.2)CALL FEMALE(ORGD,IVEW,Z1,IORN,KNN,KNT)
C
C PASS DATA TO SUBROUTINE WHICH RETURNS LAST TISSUE DOSE VALUE AS 'CDI'.
C
      CALL CINDX(ORGD,II)
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```
      K = 2
      IF (KVP4.LT.76)K = 1
      IF (KVP4.GT.95)K = 3
      IF (KVP4.EQ.0)K = 4
      IF (IFLT.NE.0)K = 5
C
C PRINT KVP RANGES.
C
      IF (IFLT.EQ.0.AND.II.EQ.1.AND.K.LT.5)WRITE(8,138)RANGE(K)
138   FORMAT(T10,A25)
      IF (II.EQ.1.AND.K.EQ.5)WRITE(8,139)RANGE(K)
139   FORMAT(T10,A20)
      IF (II.EQ.2.AND.KNT.EQ.0)GO TO 180
      IF (II.EQ.1)WRITE(8,1375)
1375  FORMAT (T10,'MALE ')
      IF (II.EQ.2)WRITE(8,1380)
1380  FORMAT(/T10,'FEMALE ')
      LL = 1
      MM = JI
C
C PRINT KVP AND HVL RANGES.
C
      IF (ISKP.EQ.1)K = 6
      IF (JI.EQ.1)K = 7
      IF (K.EQ.1)MM = 7
      IF (K.EQ.2)LL = 2
      IF (K.EQ.2)MM = 11
      IF (K.EQ.3)LL = 3
      IF (K.EQ.3)MM = 12
      IF (K.EQ.4)MM = 12
      IF (K.EQ.5)MM = 5
      IF (K.EQ.6)MM = 9
      IF (ISKP.EQ.1.OR.IFLT.NE.0)WRITE(8,334)(KV(J),J=K2,K3)
334   FORMAT(T21,'KVP',1X,12(5X,I3))
      IF (ISKP.EQ.1.OR.IFLT.NE.0)WRITE(8,335)(HV3(J),J=K2,K3)
335   FORMAT(T13'HVL (mm Al)',1X,12(4X,F4.2))
      IF (ISKP.EQ.0.AND.IFLT.EQ.0) WRITE(8,336)(AHVL(J),J=LL,MM)
336   FORMAT(T13'HVL (mm Al)',1X,12(4X,F4.1))
      FMT(2) = WHO(K)
      WRITE(8,FMT)
      WRITE(8,FMT)
C
C PRINT LABEL FOR TISSUE AND PRINT TISSUE DOSES.
C
      DO 146 I = 1,KNN
      DO 342 J = LL,MV
      OD(J) =  ORGD(I,J)
      IOD(J) =  IFIX(OD(J) + .5)
342   CONTINUE
      DO 343 NN = LL,MM
      IF(IORN(I).NE.9.AND.OD(NN).GT.10.) GO TO 344
343   CONTINUE
      NNN = 0
      GO TO 346
344   CONTINUE
```

```
      NNN = MM
 346  CONTINUE
      IF (IORN(I).EQ.0)GO TO 146
      IF (IORN(I).EQ.9)WRITE(8,FMT)
      IF (IORN(I).EQ.8.AND.II.NE.2) GO TO 146
      IF ((IORN(I).EQ.3.OR.IORN(I).EQ.7.OR.IORN(I).EQ.8).AND.II.EQ.1)
     1 GO TO 146
      IF (IORN(I).EQ.4.AND.II.EQ.2)GO TO 146
      K = 1
      DO 350 J = LL,MM
      K = K + 3
      FRMT2(K) = BLK
      K = K + 1
      FRMT2(K) = FRMT1(2)
      IF (ISKP.EQ.1.AND.J.GT.LL.AND.IORN(I).NE.9.AND.OD(J-1).GT.10.)
     1 FRMT2(K) = FRMT1(4)
      IF (IORN(I).NE.9.AND.OD(J).GT.10.)FRMT2(K) = FRMT1(4)
      IF (IORN(I).EQ.9)FRMT2(K) = FRMT1(3)
      IF (OD(J).GE.0.05) GO TO 350
      IF (IORN(I).EQ.9.AND.OD(J).GE.0.0005) GO TO 350
      K = K - 1
      FRMT2(K) = FOUR
      K = K + 1
      FRMT2(K) = FRMT1(1)
      OD(J) = PLUS
 350  CONTINUE
      DO 147 J = 1,10
      IF (II.NE.2.AND.J.EQ.8)GO TO 147
      IF (IORN(I).EQ.8.AND.J.EQ.8.AND.INOUT.EQ.1)GO TO 245
      IF (IORN(I).EQ.8.AND.J.EQ.8.AND.INOUT.EQ.2)GO TO 246
      IF (IORN(I).EQ.9.AND.J.EQ.9.AND.II.EQ.2.AND.INOUT.EQ.2)
     1 GO TO 244
      IF (IORN(I).EQ.J)GO TO 243
 147  CONTINUE
 243  FRMT2(2) = FRMT1(5)
      PORGAN = ORGAN(J)
      WRITE(8,FRMT2)PORGAN,(OD(J),J=LL,NN-1),(IOD(M),M=NN,NNN)
      GO TO 248
 244  FRMT2(2) = FRMT1(5)
      PORGAN = ORGAN(10)
      WRITE(8,FRMT2)PORGAN,(OD(J),J=LL,MM)
      GO TO 248
 245  PORGAN = ORGAN(J)
      WRITE(8,FRMT3)PORGAN,NODOS1
      GO TO 248
 246  PORGAN = ORGAN(J)
      WRITE(8,FRMT3)PORGAN,NODOS2
 248  WRITE(8,FMT)
      IF (IORN(I).EQ.9)WRITE(8,FMT)
 146  CONTINUE
 180  CONTINUE
C
C PRINT VALUES OF INPUT FIELDS SPECIFIED BY USER AS WELL AS FOOTNOTES.
C
      WRITE(8,164)
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 164    FORMAT(T10'+  < 0.05 mrad')
        IF (INOUT.EQ.2)WRITE(8,165)BOX,DEEP(9*(IVEW-1)+8)
 165    FORMAT(T8'* BREAST DOSE NOT INCLUDED IN CDI - CDI SHOULD ',
       1'BE MODIFIED.',/T10'THE X-COORDINATES OF THE FIELD EDGE OF ',
       2'THIS RUN ARE ',F4.1,' AND ',F5.1,'.  THE Z-COORDINATES OF ',
       3'THE FIELD',/T10'EDGE OF THIS RUN ARE ',F5.1,' AND ',F5.1,
       4'.  ALL COORDINATES ARE AT THE BREAST PLANE, D = ',F4.1,' CM.')
 166    CONTINUE
        WRITE(8,170)EXAM,IVEW,IPRJ,KVP4,HHVL,IEXP1,SIDI,HB,VB,SSDI,
       1 X1I,Z1I,ISKP,IFLT,IFLR
 170    FORMAT(/T10'12345678901234567890123456789012345678901234567890123456789',
       1'0123456789012345678901234567890',/,9X,A20,I1,I2,I3,F5.2,I6,6F5.1,3I1)
        IF (AMODE.EQ.'B') GO TO 69
        IF (AMODE.EQ.'I')THEN
        WRITE(6,171)
 171    FORMAT(T5'INPUT ANOTHER RECORD (Y/N)?',$)
        READ(5,172)ACON
 172    FORMAT(A1)
        IF (ACON.EQ.'Y') GO TO 11
        IF (ACON.EQ.'N') GO TO 450
        ENDIF
        GO TO 69
 450    CLOSE(2)
        CLOSE(4)
        CLOSE(8)
        CLOSE(9)
        STOP
        END
        SUBROUTINE ATSG(X,KVP,RD1,KN,ARG,VAL)
C
C SORTS KVP AND RD1 ARRAYS IN ASCENDING ORDER ACCORDING TO VALUES IN KVP
C AND THEIR RELATIONSHIP TO X.
C
        DIMENSION RD1(11),ARG(11),VAL(11),WORK(11)
        REAL KVP(11)
 10     B = 0.
        DO 20 I = 1,KN
        ARG(I) = 0.
        VAL(I) = 0.
        DELTA = ABS(KVP(I)-X)
        IF (DELTA.LE.B) GO TO 20
        B = DELTA
 20     WORK(I) = DELTA
        B = B + 1
        DO 40 I = 1,KN
        DELTA = B
        DO 30 J = 1,KN
        IF (WORK(J).GE.DELTA)GO TO 30
        K = J
        DELTA = WORK(J)
 30     CONTINUE
        ARG(I) = KVP(K)
        VAL(I) = RD1(K)
        WORK(K) = B
 40     CONTINUE
```

```
      RETURN
      END
      SUBROUTINE ACFI(X,ARG,VAL,Y,KN,IER,EPS)
C
C  USES THE ORDERED VALUES TO PERFORM A CONTINUED FRACTION INTERPOLATION
C  WITH A TOLERANCE OF 0.005
C
      DIMENSION ARG(11),VAL(11)
      IER = 2
      Y = VAL(1)
      DELT2 = 0.
      P2 = 1.
      P3 = Y
      Q2 = 0.
      Q3 = 1.
      DO 70 I = 2,KN
      P1 = P2
      K = 0
      P2 = P3
      Q1 = Q2
      Q2 = Q3
      Z = Y
      DELT1 = DELT2
      JEND = I - 1
 10   AUX = VAL(I)
      DO 40 J = 1,JEND
      H = VAL(I) - VAL(J)
      IF (ABS(VAL(I)).LT.5.46E-38)GO TO 30
      IF (ABS(H).GT.1.E-6*ABS(VAL(I)))GO TO 30
      IF (ARG(I).EQ.ARG(J))GO TO 80
      IF (J.LT.JEND)GO TO 20
      K = K + 1
      L = I + K
      IF (L.GT.KN)GO TO 100
      VAL(I) = VAL(L)
      VAL(L) = AUX
      AUX = ARG(I)
      ARG(I) = ARG(L)
      ARG(L) = AUX
      GO TO 10
 20   VAL(I) = 1.E38
      GO TO 40
 30   VAL(I) = (ARG(I)-ARG(J)) * (1./H)
 40   CONTINUE
      P3 = (VAL(I) * P2) + ((X-ARG(I-1)) * P1)
      Q3 = (VAL(I) * Q2) + ((X-ARG(I-1)) * Q1)
      IF (Q3.EQ.0.)GO TO 50
      Y = P3 * (1./Q3)
      GO TO 60
 50   Y = 1.E38
 60   DELT2 = ABS(Z-Y)
      IF (DELT2.LE.EPS)GO TO 100
      IF (I.LT.8)GO TO 70
      IF (DELT2.GE.DELT1)GO TO 90
 70   CONTINUE
```

```
      RETURN
 80   IER = 3
      RETURN
 90   IER = 1
      Y = Z
      RETURN
 100  IER = 0
      RETURN
      END
      SUBROUTINE LEAST(K1,PRD,HV2,ANS)
      DIMENSION PRD(K1),HV2(K1),DM(60,61),ANS(60)
      DATA MAX/3/
      MAXA = MAX + 1
      DO 10 I = 1,MAX
      DO 10 J = 1,MAXA
 10   DM(I,J) = 0.
      DO 20 I = 1,MAX
      DO 20 J = 1,MAX
      DO 20 K = 1,K1
 20   DM(I,J) = DM(I,J) + (HV2(K)**(I+J-2))
      DO 30 I = 1,MAX
      DO 30 J = 1,K1
 30   DM(I,MAXA) = DM(I,MAXA) + (PRD(J) * (HV2(J)**(I-1)))
      CALL MATRIX(ANS,DM,MAX,MAXA)
      RETURN
      END
      SUBROUTINE FEMALE(ORGD,IVEW,Z1,IORN,KNN,KNT)
C
C WHEN UPPER AND LOWER BOUNDS OF THE BEAM ARE WITHIN THE GIVEN RANGE FOR
C CALCULATION OF FEMALE TISSUE DOSES AND FOR THE SPECIFIED TISSUE,
C FEMALE DOSE FACTORS ARE APPLIED TO THE ORIGINALLY CALCULATED TISSUE
C DOSES.
C
      DIMENSION ORGD(10,12),IORN(10),JORN(6),FACT(18)
      DATA JORN/1,2,3,5,6,7/,FACT/1.05,0.85,1.00,1.00,0.85,1.00,
     1 0.75,0.85,1.00,1.00,0.80,1.00,1.15,0.80,1.00,1.00,0.85,1.00/
      KNT = 1
      IF (Z1.GE.24..AND.Z1.LE.59.)GO TO 20
      RETURN
 20   DO 60 I = 1,6
      DO 30 J = 1,KNN
      IF (IORN(J).EQ.JORN(I))GO TO 40
 30   CONTINUE
      GO TO 60
 40   KNT = KNT + 1
      DO 50 K = 2,12,2
      ORGD(J,K-1) = ORGD(J,K-1) * FACT(6 * (IVEW-1) + I)
      ORGD(J,K) = ORGD(J,K) * FACT(6 * (IVEW-1) + I)
 50   CONTINUE
 60   CONTINUE
      KNT = KNT - 1
      RETURN
      END
      SUBROUTINE CINDX(ORGD,II)
C
```

```
C THIS SUBROUTINE CALCULATES THE CANCER DETRIMENT INDEX, INCORPORATING
C RISK COEFFICIENTS AND RELATIVE SEVERITIES FOR THE TISSUES INVOLVED.
C OTHER TISSUES AND THEIR RISKS AND SEVERITIES MAY BE ADDED LATER.
C
      DIMENSION ORGD(10,12),SEVER(5),FATAL(10),CURE(10)
      DATA FATAL,CURE,SEVER/2.0,2.4,.33,5.0,0.0,2.0,1.6,0.67,5.0,5.0,
     1 0.1,0.12,6.3,1.5,0.0,0.1,0.08,12.7,1.5,3.0,0.95,0.95,0.05,0.75,
     2 0.60/
      K = 4
      IF (II.EQ.2)K = 5
      KK = 6
      DO 10 I = 2,12,2
      ORGD(KK,I) = 0.
      ORGD(KK,I-1) = 0.
10    CONTINUE
      DO 30 J = 2,12,2
      DO 20 I = 1,K
      ORGD(KK,J-1) = ((FATAL(5*(II-1)+I)+(CURE(5*(II-1)+I)*SEVER(I)))
     1 * ORGD(I,J-1)) + ORGD(KK,J-1)
      ORGD(KK,J) = ((FATAL(5*(II-1)+I)+(CURE(5*(II-1)+I)*SEVER(I)))
     1 * ORGD(I,J)) + ORGD(KK,J)
20    CONTINUE
      ORGD(KK,J-1) = ORGD(KK,J-1) * 0.001
      ORGD(KK,J) = ORGD(KK,J) * 0.001
30    CONTINUE
      RETURN
      END
      SUBROUTINE BREST(WP,WM,HP,HM,IVEW,BOX,INOUT,I78,I130)
C
C  DETERMINES WHETHER ENTIRE BREAST IS IN THE BEAM.
C
      DIMENSION BOX(4)
      INTEGER*4 I78,I130
      BOX(1) = WP
      BOX(2) = WM
      BOX(3) = HP
      BOX(4) = HM
      I78 = 0
      I130 = 0
C
C WHEN BREASTS TOTALLY IN BEAM, CALCULATE BREAST DOSE.
C
      IF (IVEW.NE.3.AND.((WP.GE.11..AND.WM.LE.-11.).AND.(HP.GE.50.5.
     1 AND.HM.LE.30.8)))THEN
      I78 = 1
      RETURN
      ENDIF
C
C FOR PA AND AP VIEWS WHEN TOP BEAM EDGE IS 3 CM OR MORE BELOW BOTTOM EDGE
C OF BREAST REGION, OR BOTTOM BEAM EDGE IS 3 CM OR MORE ABOVE TOP EDGE OF
C BREAST REGION, OR LEFT BEAM EDGE IS 3 CM OR MORE TO THE RIGHT OF BREAST
C REGION, OR RIGHT BEAM EDGE IS 3 CM OR MORE FROM THE LEFT EDGE OF BREAST
C REGION, DO NOT CALCULATE BREAST DOSE AND RETURN TO MAIN PROGRAM TO PRINT
C "DOSE IS NEGLIGIBLE - X-RAY FIELD COMPLETELY OUTSIDE OF BREAST REGION" IN
```

```
C TISSUE DOSE TABLE.
C
      IF (IVEW.NE.3.AND.((WP.LT.-14..OR.WM.GT.14.).OR.(HP.LT.27.8.OR.
     1 HM.GT.53.5)))GO TO 10
C
C FOR LATERAL VIEWS, USE THE SAME CRITERIA ABOVE (AS IN THE CASE OF PA
C AND AP VIEWS), HOWEVER, USE ONLY TOP AND BOTTOM BEAM DIMENSIONS
C
      IF (IVEW.EQ.3.AND.(HP.LT.27.8.OR.HM.GT.53.5))GO TO 10
C
C WHEN ANY BEAM EDGE FALLS WITHIN 3 CM FROM ANY BORDER OF BREAST
C REGION, DON'T CALCULATE BREAST DOSE AND PRINT "NOT CALCULATED, HOWEVER
C BREASTS ARE NEAR OR PARTIALLY IN X-RAY FIELD" IN THE TISSUE DOSE TABLE.
C
      INOUT = 2
      I130 = 1
      RETURN
10    INOUT = 1
      I130 = 1
      RETURN
      END
      SUBROUTINE MATRIX(ANS,DM,MAX,MAXA)
      DIMENSION ANS(60),DM(60,61)
      DO 50 K = 1,MAX
      TEMP = DM(K,K)
      DO 10 J = 1,MAXA
10    DM(K,J) = DM(K,J) * (1./TEMP)
      DO 40 I = 1,MAX
      IF (I.EQ.K) GO TO 40
      TEMP = DM(I,K)
      DO 30 J = 1,MAXA
      DM(I,J) = DM(I,J) - (TEMP * DM(K,J))
30    CONTINUE
40    CONTINUE
50    CONTINUE
      DO 60 I = 1,MAX
60    ANS(I) = DM(I,MAXA)
      RETURN
      END
      FUNCTION ASW(P1,A1,P2,A2)
C
C FINDS PROPORTION OF GRID IN BEAM.
C
      ASW = AMIN1((A1-P2),(A2-P1))
      IF (ASW.GT.0.)GO TO 10
      ASW = 0.
      RETURN
10    IF ((A2.LT.A1).AND.(P1.LT.P2))ASW = (A2 - P2)
      IF (A1.LT.A2.AND.P2.LT.P1)ASW = (A1 - P1)
      RETURN
      END
```

APPENDIX G

SAMPLE INPUT/OUTPUT CASES*

EXAMPLE 1: Tissue doses for conventional aluminum filtration (as a function of HVL), specified kVp range, LAT Thoracic Spine, projection code listed in Appendix B, 1000 mR.

EXAMPLE 2: Tissue doses for conventional aluminum filtration (for original x-ray spectra), specified kVp range, AP Thoracic Spine, projection code listed in Appendix B, 1000 mR.

EXAMPLE 3: Tissue doses for conventional aluminum filtration (as a function of HVL), kVp range not limited, LAT Shoulder, specified x-ray field center-of-interest coordinates, 1000 mR.

EXAMPLE 4: Tissue doses for conventional aluminum filtration (for specific HVL), specified kVp range and HVL, PA Chest, specified x-ray field center-of-interest coordinates, 25 mR.

EXAMPLE 5: Tissue doses for erbium composite filters (for 5 x-ray spectra), PA Chest, specified x-ray field center-of-interest coordinates, 25 mR.

EXAMPLE 6: Tissue doses for a fluoroscopic projection (as a function of HVL), specified kVp range, AP Upper Esophagus, specified x-ray field center-of-interest coordinates, specified field dimensions, specified SID and SSD, 1000 mR.

* The tables in Appendix G were produced with the VAX version of the program in batch mode.

Example 1. Tissue doses for conventional aluminum filtration (as a function of HVL) - specified kVp range

RUN DATE: 14-APR-1989 PAGE: 1
EXAM: LAT THORACIC SPINE - TISSUE DOSES (mrad) FOR 1000 mR EXPOSURE AT SKIN ENTRANCE (FREE-IN-AIR)
SID: 102.0 (cm)
FIELD SIZE AT FILM: 35.6 (cm) X 43.2 (cm)
DISTANCE FROM VERTEX: 42.4 (cm)
DISTANCE FROM PHANTOM MIDLINE: 5.0 (cm)
KVP RANGE: 76 - 95

MALE

HVL (mm Al)	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
LUNGS	85	106	125	143	160	177	193	209	224	239
ACTIVE BONE MARROW	17	20	24	28	32	36	40	44	48	52
THYROID	4.6	5.6	6.9	8.2	9.7	11	13	15	17	19
TRUNK TISSUE	32	38	44	50	55	60	65	70	74	79
CDI (TIMES E-5)	0.42	0.51	0.60	0.68	0.76	0.84	0.91	0.98	1.06	1.13
TESTES	+	+	+	+	+	+	+	+	0.1	0.1

FEMALE

HVL (mm Al)	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
LUNGS	98	122	144	164	184	204	222	240	258	275
ACTIVE BONE MARROW	13	16	19	22	25	29	32	35	38	42
THYROID	4.6	5.6	6.9	8.2	9.7	11	13	15	17	19
TRUNK TISSUE	27	33	38	43	47	51	55	59	63	67
BREASTS	NOT CALCULATED, HOWEVER BREASTS ARE NEAR OR PARTIALLY IN X-RAY FIELD.									
* CDI (TIMES E-5)	0.40	0.49	0.57	0.65	0.73	0.80	0.88	0.94	1.01	1.08
OVARIES	0.2	0.2	0.3	0.4	0.5	0.5	0.7	0.8	0.9	1.1
UTERUS	0.2	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.8	0.9

+ < 0.05 mrad
* BREAST DOSE NOT INCLUDED IN CDI - CDI SHOULD BE MODIFIED.
THE X-COORDINATES OF THE FIELD EDGE OF THIS RUN ARE 18.4 AND -8.4. THE Z-COORDINATES OF THE FIELD EDGE OF THIS RUN ARE 58.7 AND 26.1. ALL COORDINATES ARE AT THE BREAST PLANE, D = 17.2 CM.

```
1234567890123456789012345678901234567890123456789012345678901234567890
THORACIC SPINE       319 80 0.00  1000102.0 35.6 43.2  0.0  0.0  0.0000
```

Example 2. Tissue doses for conventional aluminum filtration (for original x-ray spectra)

RUN DATE: 14-APR-1989 PAGE: 2
EXAM: AP THORACIC SPINE - TISSUE DOSES (mrad) FOR 1000 mR EXPOSURE AT SKIN ENTRANCE (FREE-IN-AIR)
SID: 102.0 (cm) FOR ORIGINAL X-RAY SPECTRA.
FIELD SIZE AT FILM: 35.6 (cm) X 43.2 (cm)
DISTANCE FROM VERTEX: 42.4 (cm)
DISTANCE FROM PHANTOM MIDLINE: 0.0 (cm)
KVP RANGE: 76 - 95

MALE

KVP / HVL (mm Al)	80 / 1.65	80 / 2.38	90 / 2.70	80 / 2.95	90 / 3.67	80 / 4.10	90 / 4.75	80 / 4.80	90 / 5.50
LUNGS	277	353	395	408	477	521	560	571	610
ACTIVE BONE MARROW	30	37	44	44	58	60	70	67	79
THYROID	80	99	112	114	136	147	160	162	175
TRUNK TISSUE	85	106	118	121	142	153	166	167	181
CDI (TIMES E-5)	1.23	1.54	1.73	1.78	2.10	2.27	2.47	2.50	2.70
TESTES	+	+	+	+	+	+	+	+	+

FEMALE

KVP / HVL (mm Al)	80 / 1.65	80 / 2.38	90 / 2.70	80 / 2.95	90 / 3.67	80 / 4.10	90 / 4.75	80 / 4.80	90 / 5.50
LUNGS	208	265	296	306	358	391	420	428	458
ACTIVE BONE MARROW	26	32	37	37	49	51	60	57	67
THYROID	80	99	112	114	136	147	160	162	175
TRUNK TISSUE	68	85	94	97	114	122	133	134	144
BREASTS	595	710	752	771	830	880	912	928	960
CDI (TIMES E-5)	5.04	6.08	6.52	6.69	7.35	7.83	8.20	8.33	8.71
OVARIES	1.0	1.1	1.5	1.4	2.3	2.4	3.0	2.8	3.5
UTERUS	0.8	0.9	1.2	1.1	1.9	1.9	2.4	2.2	2.8

+ < 0.05 mrad

```
1234567890123456789012345678901234567890123456789012345678901234567890
THORACIC SPINE      218 80 0.00  1000102.0 35.6 43.2  0.0  0.0  0.0100
```

Example 3. Tissue doses for conventional aluminum filtration (as a function of HVL) - kVp range not limited

RUN DATE: 14-APR-1989 PAGE: 3
EXAM: LAT SHOULDER(ONE) - TISSUE DOSES (mrad) FOR 1000 mR EXPOSURE AT SKIN ENTRANCE (FREE-IN-AIR)
SID: 102.0 (cm)
FIELD SIZE AT FILM: 25.4 (cm) X 30.5 (cm)
DISTANCE FROM VERTEX: 31.0 (cm)
DISTANCE FROM PHANTOM MIDLINE: 0.0 (cm)
KVP RANGE: (NOT LIMITED)

MALE HVL (mm Al)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5
LUNGS	18	34	50	65	78	89	99	107	114	120	125	129
ACTIVE BONE MARROW	5.2	9.6	14	18	23	27	30	34	37	40	43	45
THYROID	79	129	172	208	237	261	281	297	309	319	327	333
TRUNK TISSUE	11	18	24	29	34	38	42	45	47	50	52	54
CDI (TIMES E-5)	0.17	0.29	0.40	0.50	0.58	0.65	0.72	0.77	0.82	0.86	0.90	0.93
TESTES	+	+	+	+	+	+	+	+	+	+	+	+

FEMALE HVL (mm Al)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5
LUNGS	21	39	58	75	89	102	113	123	131	138	143	148
ACTIVE BONE MARROW	4.2	7.7	11	15	18	21	24	27	30	32	34	36
THYROID	79	129	172	208	237	261	281	297	309	319	327	333
TRUNK TISSUE	9.2	15	20	25	29	32	35	38	40	42	44	46
BREASTS	NOT CALCULATED, HOWEVER BREASTS ARE NEAR OR PARTIALLY IN X-RAY FIELD.											
* CDI (TIMES E-5)	0.21	0.36	0.49	0.60	0.70	0.79	0.86	0.92	0.97	1.02	1.05	1.08
OVARIES	+	+	+	+	+	0.1	0.1	0.1	0.1	0.1	0.1	0.1
UTERUS	+	+	+	+	+	0.1	0.1	0.1	0.1	0.1	0.1	0.1

+ < 0.05 mrad
* BREAST DOSE NOT INCLUDED IN CDI - CDI SHOULD BE MODIFIED.
THE X-COORDINATES OF THE FIELD EDGE OF THIS RUN ARE 9.6 AND -9.6. THE Z-COORDINATES OF THE FIELD EDGE OF THIS RUN ARE 42.5 AND 19.5. ALL COORDINATES ARE AT THE BREAST PLANE, D = 17.2 CM.

```
1234567890123456789012345678901234567890123456789012345678901234567890
SHOULDER(ONE)       3 0   0 0.00  1000102.0 25.4 30.5  0.0  0.0 31.0000
```

Example 4. Tissue doses for conventional aluminum filtration (for specific HVL)

```
RUN DATE:  14-APR-1989                                                                   PAGE:    4
EXAM:  PA  CHEST                  - TISSUE DOSES (mrad) FOR    25 mR EXPOSURE AT SKIN ENTRANCE (FREE-IN-AIR)
SID:  183.0 (cm)
FIELD SIZE AT FILM:   35.6 (cm)  X  43.2 (cm)
DISTANCE FROM VERTEX:   42.4 (cm)
DISTANCE FROM PHANTOM MIDLINE:    0.0 (cm)
KVP RANGE:  > 95
MALE
   HVL (mm Al)      2.7
```

LUNGS	11
ACTIVE BONE MARROW	3.0
THYROID	1.1
TRUNK TISSUE	3.8
CDI (TIMES E-5)	0.05
TESTES	+

FEMALE

HVL (mm Al)	2.7
LUNGS	11
ACTIVE BONE MARROW	2.5
THYROID	1.1
TRUNK TISSUE	3.2
BREASTS	1.6
CDI (TIMES E-5)	0.06
OVARIES	0.1
UTERUS	0.1

+ < 0.05 mrad

```
1234567890123456789012345678901234567890123456789012345678901234567890
CHEST                  1 0100 2.70     25183.0 35.6 43.2  0.0  0.0 42.4000
```

Example 5. Tissue doses for erbium composite filters (for 5 x-ray spectra)

RUN DATE: 14-APR-1989 PAGE: 5
EXAM: PA CHEST - TISSUE DOSES (mrad) FOR 25 mR EXPOSURE AT SKIN ENTRANCE (FREE-IN-AIR)
SID: 183.0 (cm)
FIELD SIZE AT FILM: 35.6 (cm) X 43.2 (cm)
DISTANCE FROM VERTEX: 42.4 (cm)
DISTANCE FROM PHANTOM MIDLINE: 0.0 (cm)
FILTRATION: ERBIUM COMPOSITE
KVP RANGE: 70 - 120

MALE

KVP	70	80	90	100	120
HVL (mm Al)	6.02	6.49	6.98	7.49	8.53
LUNGS	15	16	17	18	19
ACTIVE BONE MARROW	3.8	4.3	4.7	5.3	6.2
THYROID	1.5	1.7	1.9	2.1	2.5
TRUNK TISSUE	5.1	5.4	5.8	6.0	6.5
CDI (TIMES E-5)	0.07	0.08	0.08	0.09	0.10
TESTES	+	+	+	+	+

FEMALE

KVP	70	80	90	100	120
HVL (mm Al)	6.02	6.49	6.98	7.49	8.53
LUNGS	16	17	18	19	20
ACTIVE BONE MARROW	3.3	3.6	4.0	4.5	5.3
THYROID	1.5	1.7	1.9	2.1	2.5
TRUNK TISSUE	4.4	4.6	4.9	5.1	5.5
BREASTS	2.2	2.5	2.8	3.1	3.7
CDI (TIMES E-5)	0.08	0.09	0.10	0.10	0.11
OVARIES	+	0.1	0.1	0.1	0.2
UTERUS	0.1	0.1	0.1	0.1	0.2

+ < 0.05 mrad

```
1234567890123456789012345678901234567890123456789012345678901234567890
CHEST                1 0   0 0.00     25183.0 35.6 43.2  0.0   0.0 42.4010
```

Example 6. Tissue doses for a fluoroscopic projection (as a function of HVL) - specified kVp range

RUN DATE: 14-APR-1989 PAGE: 6
EXAM: AP UPPER ESOPHAGUS - TISSUE DOSES (mrad) FOR 1000 mR EXPOSURE AT SKIN ENTRANCE (FREE-IN-AIR)
SID: 80.0 (cm)
FIELD SIZE AT FILM: 11.4 (cm) X 22.9 (cm)
DISTANCE FROM VERTEX: 27.5 (cm)
DISTANCE FROM PHANTOM MIDLINE: 2.0 (cm)
KVP RANGE: > 95

MALE

HVL (mm Al)	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5
LUNGS	12	13	15	17	18	20	21	23	25	26
ACTIVE BONE MARROW	5.2	5.9	6.7	7.5	8.3	9.2	10	11	12	13
THYROID	430	470	505	536	564	590	614	637	658	678
TRUNK TISSUE	13	14	16	17	19	20	21	22	24	25
CDI (TIMES E-5)	0.39	0.43	0.47	0.51	0.54	0.57	0.60	0.62	0.65	0.68
TESTES	+	+	+	+	+	+	+	+	+	+

FEMALE

HVL (mm Al)	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5
LUNGS	8.7	9.9	11	12	14	15	16	17	18	20
ACTIVE BONE MARROW	4.4	5.0	5.7	6.4	7.1	7.8	8.5	9.3	10	11
THYROID	430	470	505	536	564	590	614	637	658	678
TRUNK TISSUE	10	12	13	14	15	16	17	18	19	20
BREASTS	NOT CALCULATED, HOWEVER BREASTS ARE NEAR OR PARTIALLY IN X-RAY FIELD.									
* CDI (TIMES E-5)	0.65	0.71	0.77	0.82	0.87	0.91	0.95	0.99	1.03	1.07
OVARIES	+	+	+	+	+	+	+	+	+	+
UTERUS	+	+	+	+	+	+	+	+	+	+

\+ < 0.05 mrad
* BREAST DOSE NOT INCLUDED IN CDI - CDI SHOULD BE MODIFIED.
THE X-COORDINATES OF THE FIELD EDGE OF THIS RUN ARE 5.8 AND -1.8. THE Z-COORDINATES OF THE FIELD EDGE OF THIS RUN ARE 35.2 AND 19.8. ALL COORDINATES ARE AT THE BREAST PLANE, D = 4.0 CM.

```
1234567890123456789012345678901234567890123456789012345678901234567890
UPPER ESOPHAGUS     2 0100 0.00  1000 80.0 11.4 22.9 50.0  2.0 27.5001
```