



UNITED STATES  
NUCLEAR REGULATORY COMMISSION

WASHINGTON, D.C. 20555-0001

FEB 27 2002

*Note: Original LTR  
dated 02/25/02*

Information Systems Laboratories, Inc.  
ATTN: James Meyer  
11140 Rockville Pike, Suite 500  
Rockville, MD 20852

SUBJECT: TASK ORDER NO. 2 ENTITLED, "RADTRAD Enhancements and Improvements"  
UNDER CONTRACT NO. NRC-04-02-054

Dear Mr. Meyer:

This letter definitizes Task Order No. 2 in accordance with the enclosed statement of work. The period of performance for Task Order No. 1 is February 25, 2002 through June 30, 2002. The task order estimated cost and fixed fee is changed as follows:

Estimated Costs	\$45,480
Fixed Fee	\$ 3,447
CPFF	\$48,927

\$48,927 in obligated funds is transferred from the basic contract minimum guarantee of \$162,668 to this task order. Since the funds were obligated previously, the accounting data is not restated here. \$113,741 of the funds for minimum guarantee is still available for future task order work.

A summary of obligations for this task order, from award date through the date of this action is given below:

Total FY02 Obligation Amount:	\$48,927
Cumulative total of NRC obligations:	\$48,927

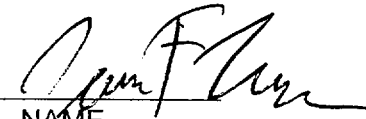
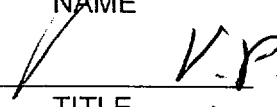
Please indicate your acceptance of Task Order No. 2 by having an official authorized to bind your organization execute three copies of this document, by signing in the space provided, and return two copies to me. You should retain the third copy for your records. All other terms and conditions of this task order remain unchanged.

Should you have any questions, regarding this modification, please contact me on (301) 415-8168.

Sincerely,

  
Stephen M. Pool, Contracting Officer  
Division of Contracts and Property Management  
Office of Administration

ACCEPTED:

  
\_\_\_\_\_  
NAME  
  
\_\_\_\_\_  
TITLE  
2/28/02  
\_\_\_\_\_  
DATE

Task Order No. 2 Statement of Work  
RADTRAD Enhancements and Improvements

BACKGROUND

The NRC has developed a revised (NUREG-1465) fission product source term for use in licensing safety analysis. Use of the revised source term has safety and cost benefits, because it is more realistic than the earlier TID-14844 source term. Several nuclear power plants have voluntarily implemented the revised source term and others have submitted or are planning to submit applications.

The revised source term is used in licensing safety analysis for the design-basis LOCA to show that regulatory dose limits are met at the Exclusion Area Boundary, the Low Population Zone distance, and in the Control Room. To implement the revised source term, licensees perform dose assessments using industry computer codes with the revised source term to show that the regulatory dose limits are met. NRC staff perform calculations using the RADTRAD code to confirm the licensee assessments.

Because of the revised source term's safety and cost benefits, industry has shown a strong interest in RADTRAD. Approximately 40 industry organizations have requested and received RADTRAD. In addition, an industry RADTRAD users group has been formed. As a result of industry use of RADTRAD, industry users have identified and provided corrections for a number of code bugs. The contractor is formally implementing these corrections under the NRC's code maintenance program, and the NRC expects to release a new version that includes these corrections shortly.

NRC staff who use RADTRAD have identified code improvements to increase staff efficiency in performing confirmatory analysis. A list of these proposed improvements is given below.

OBJECTIVE

The objective of this task order is for the contractor to implement RADTRAD improvements. To accomplish this objective, the NRC will meet with the contractor at the beginning of this task to prioritize the improvements and develop a schedule for implementing the improvements.

WORK REQUIREMENTS

Task 1: Improvements to RADTRAD

Improvements to the RADTRAD code include the following:

- a. Situations in which flow changes with time occur routinely (e.g., two redundant fans start and then some time later, operators secure one fan). Modify filter dialogs so they allow flow and efficiency to be varied by time step. Currently, flow is fixed for all periods.
- b. Modify the SOURCE TERM textbox on the compartment form to have separate entries for aerosol, elemental, organic, and noble gases. Model the traditional LOCA in which all noble gases are in the containment atmosphere and the ECCS leakage case that only considers iodines.

c. Revise the NIF and DCF files to incorporate a selection of nuclides more supportive of DBA analyses, e.g., get rid of transuranics and give us all of the traditional kryptons and xenons.

d. Create a NIF/RIF editor that can produce files appropriate for typical DBAs: SGTR, MSLB, REA, FHA, CRDA, and LRA, using a series of accident-specific prompts. This avoids the need for the user to manually generate the data and edit the NIF/RIF.

e. RADTRAD treatment of filters may underestimate the contribution of the decay products. Iodine enters filters and is trapped. This iodine decays to noble gases. However, RADTRAD *apparently* does not "release" the noble gas daughters of the trapped iodine back into the process stream.

f. Change file handling to allow NEW, OPEN EXISTING CASE, COPY EXISTING CASE, and REVERT options. Make it mandatory for the user to enter file name at the start.

g. The maximum 2 hour display for the LPZ and CR in the output report are unnecessary. Report the 30 day dose instead.

h. Add a results summary at the top of the output report. One shouldn't have to scroll through 15 or more pages to check the magnitude of the results.

i. Some analyses involve concurrent elevated and ground level releases. Provide an additional "ENVIRONMENT" compartment so there can be an elevated environment and a ground environment. Doses from each would be reported individually and summed.

j. Some analyses involve both a control room and a TSC. Provide the ability to identify more than one compartment as CONTROL ROOM.

k. Allow a compartment to be designated as a SINK to serve as an end node without the need of assigning a volume.

l. Designate a compartment as SPLIT to allow branching the transfer from a single compartment to two (or more) downstream compartments.

m. Enable arrow key movement between fields in entry tables (e.g., filter efficiency & flows). The left to right and then down action of the TAB key isn't the natural entry order on most of these tables. It is more likely to enter all times first and then data associated with each time.

o. Clarify output and implement additional output. This includes changing to the FORTRAN code to provide more output options. Attachment 1 gives the formatting and other requirements for the enhanced output.

- p. Improve use of RADTRAD with the TID-14844 source term.
- q. The code should be able to automatically stop containment sprays when the spray decontamination factor reaches its cutoff value as described in the Standard Review Plan Section 6.5.2.
- r. Make it practical for the user to develop a deck without the graphical user interface.
- s. Modify the FORTRAN code to allow it to read a deck with an unlimited number of comment lines in it. Currently, comments can only be added on lines designated "plain text" or after numerically formatted data items.
- t. Modify the FORTRAN code to echo the input with RADTRAD-generated comments saying what variable goes with what input value.
- u. Support periodic user group meetings. These meetings could last an hour or two and mainly involve NRR and RES staff.
- v. Improve the graphical user interface (GUI). When opening a new/old file the code needs to clear all fields. This appears to be a major source of errors caused by the GUI.
- w. Add \*.o\* to the list of file types so that output files can be easily viewed.
- x. Improve how the code handles loading input decks.
- y. The Pathway "INACTIVE" switch should be fully implemented. Currently, it deletes the path from the case file. This would facilitate "what if" runs in which the user wanted to turn a path on or off for different cases without having to rebuild the paths. Similarly, add the capability for the code to ignore a compartment that has all feeds and removals set inactive.
- z. Add "what is this" context sensitive help and tool tips.
- aa..The output file name should be displayed on the printout along with the currently displayed NIF, RIF, DCF, and scenario file.
- ab. On tables for entering efficiencies and flows, enable the selection option that allows a user to highlight multiple fields and have the code accept the input for all of the fields.

Following NRC approval of prioritization of RADTRAD improvements and a schedule, the contractor will implement the improvements and test the code to ensure it is functioning correctly. At the completion of this effort, the contractor will provide the NRC with the enhanced version of RADTRAD together with a letter report describing the improvements implemented and testing performed.

Estimated Level of Effort: 2 staff-months.  
Estimated Completion Date: June 30, 2002.

## ATTACHMENT 1

RADTRAD VERSION 3.0 Jun 28 1994 08:18:33 page AA- 1  
 Calculation Title Goes Here up to two lines or 200 characters

## FILE INFORMATION

	PATH NAME (Below put full path name)	DATE TIME SIZE
Plant file name	C:\ACALCS\COOPER\MA2464\FHA\FHA.PMF	date time and size
Inventory file name	DEFAULTS\TID_I131.NIF	
Scenario file name	C:\ACALCS\COOPER\MA2464\FHA\FHA.SDF	
Release file name	DEFAULTS\TID_DEF.RFT	
Dose conversion file name	DEFAULTS\TID14.INP	

## OUTPUT OPTIONS

## PRINT FLAGS

Print card input	No
Print general input parameters	Yes
Print dose conversion factors	No
Print compartment data input	Yes
Print pathway data input	Yes
Print dose location input	Yes
Print activity for each simulation event as a function of isotope and compartment	No
Print activity for each supplemental time step as a function of isotope and compartment	No
Print activity deposited on recirc/pathway filters	No
Print accumulated dose for each simulation event as a function of isotope and compartment	No
Print accumulated dose for each supplemental time step as a function of isotope and compartment	No
Print cumulative dose up to the ending time of each simulation step as a function of isotope and compartment	No
Print I-131 activity summary	Yes
Print summary of cumulative dose for all time steps as a function of whole body, skin & thyroid doses and TEDE	Yes

{Note Above are the default print flag sequence.}

```
#   #   #   #####   #   #   #####  
#   ##  #   #   #   #   #   #   #  
#   #  #   #   #   #   #   #   #  
#   #  #   #####   #   #   #  
#   #   ##  #   #   #   #   #  
#   #   #   #   #   #####   #
```

CARD INPUT HERE



```

#####  #  # ##### #####  #  # #####
#  #  #  #  #  #  #  #  #  #  #
#  #  #  #  #  #  #  #  #  #
#  #  #  #  #  #####  #  #  #
#  #  #  #  #  #  #  #  #  #
#####  #####  #  #  #####  #

```

```

-&l10          Control Characters used for laser printer
-(s16.66H

```

```

*****RADTRAD DER. 3.0*****
A Simplified Model for Radionuclide
Transport And Removal and Dose Estimation
U.S. Nuclear Regulatory Commission
Version 3.xx Issue Date xx/xx/xx
*****

```

RADTRAD      VERSION 3.0      Date 08:18:34      page AA- 6  
 Calculation Title Goes Here up to two lines or 200 characters

## GENERAL INPUT PARAMETERS

SOURCE	
Source Term Compartment	Compartment Numbers
Source Term	User Specified for each compartment/Calc. as f(x) of power
Number of Nuclides	60
Nuclide Inventory File	Default PWR/Default BWR etc...
Inventory Power	xxxx.xx MWth
Plant Power Level	3720.00 MWth
Radioactive Decay	Yes/No
Daughter Products	Yes/No
Iodine Chemical fractions	TID Default, NUREG-1465 Default, User Specified
Aerosol	0.000
Elemental	1.000
Organic	0.000
Delay	x.00000 hours
Dose Conversion Factors	file name used See input designations

Output only when source term is a function of power (default values of all values are 1 for source compartments unless user specifies another value) This is to be used for FHA or other gap release accidents where the gap activity is specified as a fraction of core inventory

## SOURCE COMPARTMENT - MULTIPLIER

COMPARTMENT	sprcont.	unspraid	control rm (Source Compartments Only)
ISOTOPE			
I---131	1.00E+08	1.00E+0	0.00E+00
etc...			

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 Calculation Title Goes Here up to two lines or 200 characters

DOSE CONVERSION FACTORS AND DECAY CONSTANTS  
 TITLE FOR DOSE CONVERSION FACTORS SELECTED (ie. MACCS 60 Isotope Inventory ICRP 60)

ISOTOPE	DECAY CONSTANT (1/sec)	DOSE CONVERSION FACTORS		
		THYROID (rem/Ci)	BETA SKIN (rem * cu. meter)/(Ci * sec)	WHOLE BODY (rem * cu. meter)/(Ci * sec)
I---131	.998E-06	.149E+07	.317E-01	.872E-01
I---132	.843E-04	.143E+05	.132E+00	.513E+00
I---132	.843E-04	.143E+05	.132E+00	.513E+00
I---132	.843E-04	.143E+05	.132E+00	.513E+00
I---133	.921E-05	.269E+06	.735E-01	.155E+00
I---133	.921E-05	.269E+06	.735E-01	.155E+00
I---133	.921E-05	.269E+06	.735E-01	.155E+00
I---134	.220E-03	.373E+04	.923E-01	.532E+00
I---134	.220E-03	.373E+04	.923E-01	.532E+00
I---134	.220E-03	.373E+04	.923E-01	.532E+00
I---135	.291E-04	.560E+05	.129E+00	.421E+00
Kr--83m	.105E-03	.000E+00	.000E+00	.240E-05
Kr--85m	.430E-04	.000E+00	.463E-01	.371E-01
Kr---85	.205E-08	.000E+00	.425E-01	.510E-03
Kr---87	.151E-03	.000E+00	.308E+00	.188E+00
Kr---88	.673E-04	.000E+00	.751E-01	.466E+00
Kr---89	.363E-02	.000E+00	.320E+00	.526E+00
Xe-131m	.682E-06	.000E+00	.151E-01	.290E-02
Xe-133m	.366E-05	.000E+00	.315E-01	.795E-02
Xe--133	.153E-05	.000E+00	.970E-02	.932E-02
Xe-135m	.738E-03	.000E+00	.225E-01	.989E-01
Xe--135	.211E-04	.000E+00	.589E-01	.538E-01
Xe--137	.302E-02	.000E+00	.387E+00	.450E-01
Xe--138	.815E-03	.000E+00	.131E+00	.280E+00

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 Calculation Title Goes Here up to two lines or 200 characters

#### COMPARTMENT DATA INPUT

#### COMPARTMENT VOLUMES AND FEATURES

COMPARTMENT		
NO.	NAME	VOLUME
1	sprayed region	2.255E+07
2	unsprayed region	2.255E+07
etc ...		

FEATURES	
Recirculating Filters, Sprays, Natural Deposition,	
Source Term, Overlying Pool	

For every Feature there should be an echo of the input for that feature.  
 See echo below for Recirculating Filter echo

Also the table should distinguish between the removal model (ie. User defined or Powers)

#### COMPARTMENT PATHWAYS SUMMARY

COMPARTMENT		PATHWAYS
NO.	NAME	
1	sprayed region	Sprayed Region to Environment
1	sprayed region	Sprayed Region to Unsprayed Region
2	unsprayed region	Unsprayed Region to Sprayed Region
2	unsprayed region	Unsprayed Region to Environment
etc ...		

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# COMPARTMENT DATA INPUT

Compartment number x: Compartment Name (ie. Control room etc)

## Compartment Recirculating Filter Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%)		
		Aerosol	Elemental	Organic
0.0000E+00	4.4500E+03	95.11	95.12	30.00
8.3300E-02	4.4500E+03	95.11	95.12	30.00
7.2000E+02	4.4500E+03	95.11	95.12	30.00

## Powers model for Aerosol Removal Coefficients

Fraction Sprayed x.xx  
 Percentile xx %

Time (hr)	Flux (Units)	Height (Units)	Calculated Removal Coefficient (Units)
0.0000E+00	4.4500E+03	4.4500E+03	4.4500E+03
7.2000E+02	4.4500E+03	4.4500E+03	4.4500E+03

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# PATHWAY DATA INPUT

Pathway number 1: SG to Env

## Convection Data

Time (hr)	Flow Rate (% / day)
0.0000E+00	1.2000E+08
7.2000E+02	0.0000E+00

Pathway number 2: Env to Control Room

## Pathway Filter: Removal Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%)		
		Aerosol	Elemental	Organic
0.0000E+00	4.4500E+03	95.11	95.12	30.00
8.3300E-02	4.4500E+03	95.11	95.12	30.00
7.2000E+02	4.4500E+03	95.11	95.12	30.00

Pathway number 3: Control Room to Env.

## Pathway Filter: Removal Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%)		
		Aerosol	Elemental	Organic
0.0000E+00	4.4500E+03	95.11	95.12	30.00
8.3300E-02	4.4500E+03	95.11	95.12	30.00
7.2000E+02	4.4500E+03	95.11	95.12	30.00

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Calculation Title Goes Here up to two lines or 200 characters

## DOSE LOCATIONS INPUT

ROOM FOR 5 ENTRIES

TIME STEP ( hours )	OCCUPANCY FACTOR		COM P. X LPZ
	COMP. X CONTROL RM	COMP. X EPZ	
.0000E+00 to .3900E-01	1.0	1.0	1.0
.3900E-01 to .1000E+01	0.6	0.4	1.0

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## DOSE LOCATIONS INPUT

TIME STEP ( hours )	BREATHING RATE (cubic meter/sec)		
	COMP. X CONTROL	COMP. X RM EPZ	COMP. X LPZ
.0000E+00 to .3900E-01	3.47E-4	3.47E-4	3.47E-4
.3900E-01 to .1000E+01	3.47E-4	3.47E-4	3.47E-4



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DOSE LOCATIONS INPUT

CHI/Q (sec/cubic meter)

TIME STEP ( hours )	COMP. X CONTROL RM	COMP. X EPZ	COMP. X LPZ
.0000E+00 to .3900E-01	X.1060E-02	X.1300E-03	x.1600E-04
.3900E-01 to .1000E+01	x.1060E-02	x.1300E-03	x.1600E-04

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DISTRIBUTION OF INITIAL ACTIVITIES - BEFORE SHUTDOWN ( Ci )

COMPARTMENT		sprcont.	unspraid	control rm
ISOTOPE	GROUP			
I---131	1	.454E+08	.116E+08	.000E+00
I-- 131	2	.454E+08	.116E+08	.000E+00
I---131	3	.454E+08	.116E+08	.000E+00
I---132	1	.662E+08	.168E+08	.000E+00
I---132	2	.662E+08	.168E+08	.000E+00
I---132	3	.662E+08	.168E+08	.000E+00
I---133	1	.956E+08	.244E+08	.000E+00
I---133	2	.956E+08	.244E+08	.000E+00
I---133	3	.956E+08	.244E+08	.000E+00
I---134	1	.104E+09	.264E+08	.000E+00
I---134	2	.104E+09	.264E+08	.000E+00
I---134	3	.104E+09	.264E+08	.000E+00
I---135	1	.877E+08	.223E+08	.000E+00
I---135	2	.877E+08	.223E+08	.000E+00
I---135	3	.877E+08	.223E+08	.000E+00
Kr--83m	4	.104E+08	.264E+07	.000E+00
Kr--85m	4	.231E+08	.589E+07	.000E+00
Kr---85	4	.104E+07	.264E+06	.000E+00
Kr---87	4	.430E+08	.110E+08	.000E+00
Kr---88	4	.614E+08	.156E+08	.000E+00
Kr---89	4	.749E+08	.191E+08	.000E+00
Xe-131m	4	.622E+06	.158E+06	.000E+00
Xe-133m	4	.263E+08	.670E+07	.000E+00
Xe--133	4	.191E+09	.487E+08	.000E+00
Xe-135m	4	.367E+08	.934E+07	.000E+00
Xe--135	4	.478E+08	.122E+08	.000E+00
Xe--137	4	.167E+09	.426E+08	.000E+00
Xe--138	4	.143E+09	.365E+08	.000E+00

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 Calculation Title Goes Here up to two lines or 200 characters

ACTIVITIES - AFTER .0000E+00 hours ( Ci ) {Activity after delay used for FHA}

COMP. NO.	1	2	3
COMPARTMENT	sprcont.	unspraid	control rm
ISOTOPE GROUP			
I---131 1	.434E+08	.111E+08	.000E+00
I-- 131 2	.909E+06	.231E+06	.000E+00
I---131 3	.114E+07	.289E+06	.000E+00
I---132 1	.632E+08	.161E+08	.000E+00
I---132 2	.132E+07	.337E+06	.000E+00
I---132 3	.165E+07	.421E+06	.000E+00
I---133 1	.913E+08	.233E+08	.000E+00
I---133 2	.191E+07	.487E+06	.000E+00
I---133 3	.239E+07	.609E+06	.000E+00
I---134 1	.989E+08	.252E+08	.000E+00
I---134 2	.207E+07	.528E+06	.000E+00
I---134 3	.259E+07	.660E+06	.000E+00
I---135 1	.837E+08	.213E+08	.000E+00
I---135 2	.175E+07	.447E+06	.000E+00
I---135 3	.219E+07	.558E+06	.000E+00
Kr--83m 4	.104E+08	.264E+07	.000E+00
Kr--85m 4	.231E+08	.589E+07	.000E+00
Kr---85 4	.104E+07	.264E+06	.000E+00
Kr---87 4	.430E+08	.110E+08	.000E+00
Kr---88 4	.614E+08	.156E+08	.000E+00
Kr---89 4	.749E+08	.191E+08	.000E+00
Xe-131m 4	.622E+06	.158E+06	.000E+00
Xe-133m 4	.263E+08	.670E+07	.000E+00
Xe--133 4	.191E+09	.487E+08	.000E+00
Xe-135m 4	.367E+08	.934E+07	.000E+00
Xe--135 4	.478E+08	.122E+08	.000E+00
Xe--137 4	.167E+09	.426E+08	.000E+00
Xe--138 4	.143E+09	.365E+08	.000E+00

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TIME - .0000E+00 to .3900E-01 ( hours )

ACTIVITIES AT TIME .3900E-01 hours ( Ci )

COMP. #		1	2	3	
COMPARTMENT		sprcont.	unspraid	control rm	environment
ISOTOPE	GROUP				
I---131	1	.379E+08	.104E+08	.526E-02	
I-- 131	2	.908E+06	.231E+06	.117E-03	
I---131	3	.114E+07	.289E+06	.109E-03	
I---132	1	.546E+08	.150E+08	.758E-02	
I---132	2	.131E+07	.333E+06	.169E-03	
I---132	3	.163E+07	.416E+06	.157E-03	
I---133	1	.798E+08	.219E+08	.111E-01	
I---133	2	.191E+07	.487E+06	.247E-03	
I---133	3	.239E+07	.608E+06	.229E-03	
I---134	1	.839E+08	.231E+08	.116E-01	
I---134	2	.201E+07	.512E+06	.259E-03	
I---134	3	.251E+07	.640E+06	.241E-03	
I---135	1	.729E+08	.200E+08	.101E-01	
I---135	2	.175E+07	.445E+06	.225E-03	
I---135	3	.218E+07	.556E+06	.209E-03	
Kr--83m	4	.102E+08	.260E+07	.703E-01	
Kr--85m	4	.230E+08	.585E+07	.158E+00	
Kr--85	4	.104E+07	.264E+06	.713E-02	
Kr--87	4	.421E+08	.107E+08	.290E+00	
Kr--88	4	.608E+08	.155E+08	.418E+00	
Kr--89	4	.450E+08	.115E+08	.310E+00	
Xe-131m	4	.622E+06	.158E+06	.428E-02	
Xe-133m	4	.263E+08	.670E+07	.181E+00	
Xe--133	4	.191E+09	.487E+08	.132E+01	
Xe-135m	4	.331E+08	.842E+07	.227E+00	
Xe--135	4	.477E+08	.121E+08	.328E+00	
Xe--137	4	.109E+09	.279E+08	.753E+00	
Xe--138	4	.128E+09	.326E+08	.880E+00	

RADTRAD VERSION 3.0 Date 08:18:47 page AA- 17  
 Calculation Title Goes Here up to two lines or 200 characters

TIME - .0000E+00 to .3900E-01 ( hours )

(THYROID) DOSE ACCUMULATED DURING THIS TIME STEP .3900E-01 hours ( rem )

NODES		1	2	8	9	10
COMPARTMENT		sprcont.	unspraid	control	rm epz	lpz
ISOTOPE	GROUP					
I---131	1	.406E+08	.424E+08	.264E-01	.178E+02	.220E+01
I-- 131	2	.913E+06	.913E+06	.577E-03	.398E+00	.490E-01
I---131	3	.114E+07	.114E+07	.536E-03	.497E+00	.612E-01
I---132	1	.564E+06	.589E+06	.365E-03	.248E+00	.305E-01
I---132	2	.127E+05	.127E+05	.799E-05	.552E-02	.680E-03
I---132	3	.159E+05	.158E+05	.743E-05	.691E-02	.850E-03
I---133	1	.154E+08	.161E+08	.100E-01	.678E+01	.834E+00
I---133	2	.347E+06	.347E+06	.219E-03	.151E+00	.186E-01
I---133	3	.434E+06	.433E+06	.204E-03	.189E+00	.232E-01
I---134	1	.228E+06	.238E+06	.147E-03	.100E+00	.123E-01
I---134	2	.513E+04	.513E+04	.322E-05	.223E-02	.275E-03
I---134	3	.641E+04	.641E+04	.299E-05	.279E-02	.344E-03
I---135	1	.294E+07	.307E+07	.191E-02	.129E+01	.159E+00
I---135	2	.661E+05	.661E+05	.417E-04	.288E-01	.354E-02
I---135	3	.826E+05	.826E+05	.388E-04	.360E-01	.443E-02
Kr--83m	4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Kr--85m	4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Kr---85	4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Kr---87	4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Kr---88	4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Kr---89	4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Xe-131m	4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Xe-133m	4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Xe--133	4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Xe-135m	4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Xe--135	4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Xe--137	4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Xe--138	4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
TOTAL		.628E+08	.654E+08	.404E-01	.276E+02	.339E+01

RADTRAD VERSION 3.0 Date 08:18:47 page AA- 18  
 Calculation Title Goes Here up to two lines or 200 characters

TIME - .0000E+00 to .3900E-01 ( hours )

(WHOLE BODY) DOSE ACCUMULATED DURING THIS TIME STEP .3900E-01 hours ( rem )

COMP. #	1	2	8	9	10
COMPARTMENT	sprcont.	unspraid	control	rm epz	lpz
ISOTOPE GROUP					
I---131 1	.684E+04	.715E+04	.261E-06	.301E-02	.370E-03
I-- 131 2	.154E+03	.154E+03	.571E-08	.671E-04	.826E-05
I---131 3	.193E+03	.192E+03	.531E-08	.839E-04	.103E-04
I---132 1	.583E+05	.609E+05	.222E-05	.256E-01	.315E-02
I---132 2	.131E+04	.131E+04	.485E-07	.571E-03	.703E-04
I---132 3	.164E+04	.164E+04	.451E-07	.714E-03	.879E-04
I---133 1	.256E+05	.267E+05	.976E-06	.113E-01	.138E-02
I---133 2	.576E+03	.576E+03	.214E-07	.251E-03	.309E-04
I---133 3	.720E+03	.720E+03	.198E-07	.314E-03	.386E-04
I---134 1	.937E+05	.979E+05	.355E-05	.412E-01	.507E-02
I---134 2	.211E+04	.211E+04	.778E-07	.918E-03	.113E-03
I---134 3	.264E+04	.263E+04	.723E-07	.115E-02	.141E-03
I---135 1	.636E+05	.665E+05	.243E-05	.280E-01	.344E-02
I---135 2	.143E+04	.143E+04	.531E-07	.624E-03	.768E-04
I---135 3	.179E+04	.179E+04	.493E-07	.780E-03	.960E-04
Kr--83m 4	.479E-01	.479E-01	.934E-10	.209E-07	.257E-08
Kr--85m 4	.166E+04	.166E+04	.324E-05	.723E-03	.890E-04
Kr---85 4	.103E+01	.103E+01	.201E-08	.448E-06	.551E-07
Kr---87 4	.155E+05	.155E+05	.302E-04	.676E-02	.832E-03
Kr---88 4	.553E+05	.553E+05	.108E-03	.241E-01	.296E-02
Kr---89 4	.589E+05	.589E+05	.105E-03	.257E-01	.316E-02
Xe-131m 4	.350E+01	.350E+01	.685E-08	.153E-05	.188E-06
Xe-133m 4	.407E+03	.406E+03	.795E-06	.177E-03	.218E-04
Xe--133 4	.346E+04	.346E+04	.677E-05	.151E-02	.186E-03
Xe-135m 4	.667E+04	.667E+04	.128E-04	.291E-02	.358E-03
Xe--135 4	.499E+04	.499E+04	.975E-05	.217E-02	.268E-03
Xe--137 4	.118E+05	.117E+05	.213E-04	.512E-02	.630E-03
Xe--138 4	.734E+05	.734E+05	.141E-03	.320E-01	.394E-02
TOTAL	.493E+06	.504E+06	.449E-03	.216E+00	.265E-01

RADTRAD VERSION 3.0 Date 08:18:47 page AA-19  
 Calculation Title Goes Here up to two lines or 200 characters

TIME - .0000E+00 to .3900E-01 ( hours )

(BETA) DOSE ACCUMULATED DURING THIS TIME STEP .3900E-01 hours ( rem )

CMPT. NO.		1	2	8	9	10
COMPARTMENT		sprcont.	unspraid	control	rm epz	lpz
ISOTOPE	GROUP					
I---131	1	.249E+04	.260E+04	.162E-05	.109E-02	.135E-03
I--131	2	.560E+02	.560E+02	.354E-07	.244E-04	.300E-05
I---131	3	.700E+02	.700E+02	.329E-07	.305E-04	.375E-05
I---132	1	.150E+05	.157E+05	.972E-05	.659E-02	.811E-03
I---132	2	.337E+03	.337E+03	.213E-06	.147E-03	.181E-04
I---132	3	.422E+03	.422E+03	.198E-06	.184E-03	.226E-04
I---133	1	.121E+05	.127E+05	.788E-05	.534E-02	.657E-03
I---133	2	.273E+03	.273E+03	.172E-06	.119E-03	.146E-04
I---133	3	.341E+03	.341E+03	.160E-06	.149E-03	.183E-04
I---134	1	.163E+05	.170E+05	.105E-04	.715E-02	.880E-03
I---134	2	.366E+03	.366E+03	.230E-06	.159E-03	.196E-04
I---134	3	.457E+03	.457E+03	.214E-06	.199E-03	.245E-04
I---135	1	.195E+05	.204E+05	.127E-04	.857E-02	.105E-02
I---135	2	.439E+03	.439E+03	.277E-06	.191E-03	.235E-04
I---135	3	.549E+03	.548E+03	.257E-06	.239E-03	.294E-04
Kr--83m	4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Kr--85m	4	.207E+04	.207E+04	.689E-04	.903E-03	.111E-03
Kr---85	4	.855E+02	.855E+02	.285E-05	.373E-04	.459E-05
Kr---87	4	.255E+05	.255E+05	.846E-03	.111E-01	.137E-02
Kr---88	4	.892E+04	.891E+04	.296E-03	.388E-02	.478E-03
Kr---89	4	.359E+05	.358E+05	.109E-02	.156E-01	.192E-02
Xe-131m	4	.182E+02	.182E+02	.607E-06	.794E-05	.977E-06
Xe-133m	4	.161E+04	.161E+04	.536E-04	.701E-03	.863E-04
Xe--133	4	.361E+04	.360E+04	.120E-03	.157E-02	.193E-03
Xe-135m	4	.152E+04	.152E+04	.497E-04	.662E-03	.815E-04
Xe--135	4	.547E+04	.547E+04	.182E-03	.238E-02	.293E-03
Xe--137	4	.101E+06	.101E+06	.312E-02	.440E-01	.541E-02
Xe--138	4	.344E+05	.343E+05	.112E-02	.150E-01	.184E-02
TOTAL		.289E+06	.291E+06	.700E-02	.126E+00	.155E-01

RADTRAD      VERSION 3.0      Date 08:18:47      page AA- 20  
 Calculation Title Goes Here up to two lines or 200 characters

TIME - .0000E+00 to .3900E-01 ( hours )

(THYROID) CUMULATIVE DOSE TO .3900E-01 hours ( rem )

CMPT. NO.	1	2	8	9	10
COMPARTMENT	sprcont.	unspraid	control	rm epz	lpz
ISOTOPE GROUP					
I---131 1	.406E+08	.424E+08	.264E-01	.178E+02	.220E+01
I-- 131 2	.913E+06	.913E+06	.577E-03	.398E+00	.490E-01
I---131 3	.114E+07	.114E+07	.536E-03	.497E+00	.612E-01
I---132 1	.564E+06	.589E+06	.365E-03	.248E+00	.305E-01
I---132 2	.127E+05	.127E+05	.799E-05	.552E-02	.680E-03
I---132 3	.159E+05	.158E+05	.743E-05	.691E-02	.850E-03
I---133 1	.154E+08	.161E+08	.100E-01	.678E+01	.834E+00
I---133 2	.347E+06	.347E+06	.219E-03	.151E+00	.186E-01
I---133 3	.434E+06	.433E+06	.204E-03	.189E+00	.232E-01
I---134 1	.228E+06	.238E+06	.147E-03	.100E+00	.123E-01
I---134 2	.513E+04	.513E+04	.322E-05	.223E-02	.275E-03
I---134 3	.641E+04	.641E+04	.299E-05	.279E-02	.344E-03
I---135 1	.294E+07	.307E+07	.191E-02	.129E+01	.159E+00
I---135 2	.661E+05	.661E+05	.417E-04	.288E-01	.354E-02
I---135 3	.826E+05	.826E+05	.388E-04	.360E-01	.443E-02
Kr--83m 4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Kr--85m 4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Kr---85 4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Kr---87 4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Kr---88 4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Kr---89 4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Xe-131m 4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Xe-133m 4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Xe--133 4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Xe-135m 4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Xe--135 4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Xe--137 4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Xe--138 4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
TOTAL	.628E+08	.654E+08	.404E-01	.276E+02	.339E+01



RADTRAD VERSION 3.0 Date 08:18:47 page AA- 21  
 Calculation Title Goes Here up to two lines or 200 characters

TIME - .0000E+00 to .3900E-01 ( hours )

(WHOLE BODY) CUMULATIVE DOSE TO .3900E-01 hours ( rem )

CMPT. NO.	1	2	8	9	10
COMPARTMENT	sprcont.	unspraid	control	rm epz	lpz
ISOTOPE GROUP					
I---131 1	.684E+04	.715E+04	.261E-06	.301E-02	.370E-03
I-- 131 2	.154E+03	.154E+03	.571E-08	.671E-04	.826E-05
I---131 3	.193E+03	.192E+03	.531E-08	.839E-04	.103E-04
I---132 1	.583E+05	.609E+05	.222E-05	.256E-01	.315E-02
I---132 2	.131E+04	.131E+04	.485E-07	.571E-03	.703E-04
I---132 3	.164E+04	.164E+04	.451E-07	.714E-03	.879E-04
I---133 1	.256E+05	.267E+05	.976E-06	.113E-01	.138E-02
I---133 2	.576E+03	.576E+03	.214E-07	.251E-03	.309E-04
I---133 3	.720E+03	.720E+03	.198E-07	.314E-03	.386E-04
I---134 1	.937E+05	.979E+05	.355E-05	.412E-01	.507E-02
I---134 2	.211E+04	.211E+04	.778E-07	.918E-03	.113E-03
I---134 3	.264E+04	.263E+04	.723E-07	.115E-02	.141E-03
I---135 1	.636E+05	.665E+05	.243E-05	.280E-01	.344E-02
I---135 2	.143E+04	.143E+04	.531E-07	.624E-03	.768E-04
I---135 3	.179E+04	.179E+04	.493E-07	.780E-03	.960E-04
Kr--83m 4	.479E-01	.479E-01	.934E-10	.209E-07	.257E-08
Kr--85m 4	.166E+04	.166E+04	.324E-05	.723E-03	.890E-04
Kr---85 4	.103E+01	.103E+01	.201E-08	.448E-06	.551E-07
Kr---87 4	.155E+05	.155E+05	.302E-04	.676E-02	.832E-03
Kr---88 4	.553E+05	.553E+05	.108E-03	.241E-01	.296E-02
Kr---89 4	.589E+05	.589E+05	.105E-03	.257E-01	.316E-02
Xe-131m 4	.350E+01	.350E+01	.685E-08	.153E-05	.188E-06
Xe-133m 4	.407E+03	.406E+03	.795E-06	.177E-03	.218E-04
Xe--133 4	.346E+04	.346E+04	.677E-05	.151E-02	.186E-03
Xe-135m 4	.667E+04	.667E+04	.128E-04	.291E-02	.358E-03
Xe--135 4	.499E+04	.499E+04	.975E-05	.217E-02	.268E-03
Xe--137 4	.118E+05	.117E+05	.213E-04	.512E-02	.630E-03
Xe--138 4	.734E+05	.734E+05	.141E-03	.320E-01	.394E-02
TOTAL	.493E+06	.504E+06	.449E-03	.216E+00	.265E-01

RADTRAD VERSION 3.0 Date 08:18:47 page AA- 22  
 Calculation Title Goes Here up to two lines or 200 characters

TIME - .0000E+00 to .3900E-01 ( hours )

(BETA) CUMULATIVE DOSE TO .3900E-01 hours ( rem )

CMPT. NO.	1	2	8	9	10
COMPARTMENT	sprcont.	unspraid	control	rm epz	lpz
ISOTOPE GROUP					
I---131 1	.249E+04	.260E+04	.162E-05	.109E-02	.135E-03
I-- 131 2	.560E+02	.560E+02	.354E-07	.244E-04	.300E-05
I---131 3	.700E+02	.700E+02	.329E-07	.305E-04	.375E-05
I---132 1	.150E+05	.157E+05	.972E-05	.659E-02	.811E-03
I---132 2	.337E+03	.337E+03	.213E-06	.147E-03	.181E-04
I---132 3	.422E+03	.422E+03	.198E-06	.184E-03	.226E-04
I---133 1	.121E+05	.127E+05	.788E-05	.534E-02	.657E-03
I---133 2	.273E+03	.273E+03	.172E-06	.119E-03	.146E-04
I---133 3	.341E+03	.341E+03	.160E-06	.149E-03	.183E-04
I---134 1	.163E+05	.170E+05	.105E-04	.715E-02	.880E-03
I---134 2	.366E+03	.366E+03	.230E-06	.159E-03	.196E-04
I---134 3	.457E+03	.457E+03	.214E-06	.199E-03	.245E-04
I---135 1	.195E+05	.204E+05	.127E-04	.857E-02	.105E-02
I---135 2	.439E+03	.439E+03	.277E-06	.191E-03	.235E-04
I---135 3	.549E+03	.548E+03	.257E-06	.239E-03	.294E-04
Kr--83m 4	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
Kr--85m 4	.207E+04	.207E+04	.689E-04	.903E-03	.111E-03
Kr---85 4	.855E+02	.855E+02	.285E-05	.373E-04	.459E-05
Kr---87 4	.255E+05	.255E+05	.846E-03	.111E-01	.137E-02
Kr---88 4	.892E+04	.891E+04	.296E-03	.388E-02	.478E-03
Kr---89 4	.359E+05	.358E+05	.109E-02	.156E-01	.192E-02
Xe-131m 4	.182E+02	.182E+02	.607E-06	.794E-05	.977E-06
Xe-133m 4	.161E+04	.161E+04	.536E-04	.701E-03	.863E-04
Xe--133 4	.361E+04	.360E+04	.120E-03	.157E-02	.193E-03
Xe-135m 4	.152E+04	.152E+04	.497E-04	.662E-03	.815E-04
Xe--135 4	.547E+04	.547E+04	.182E-03	.238E-02	.293E-03
Xe--137 4	.101E+06	.101E+06	.312E-02	.440E-01	.541E-02
Xe--138 4	.344E+05	.343E+05	.112E-02	.150E-01	.184E-02
TOTAL	.289E+06	.291E+06	.700E-02	.126E+00	.155E-01

RADTRAD VERSION 3.0 Date 08:19:02 page AA- 35  
 Calculation Title Goes Here up to two lines or 200 characters

I-131 ACTIVITY (Ci) SUMMARY AS A FUNCTION OF TIME

CMPT. NO. COMPARTMENT TIME STEP	1 sprcont.	2 unspraid	3 control rm	4 epz	5 lpz	Should include: any overlying pools or sumps modeled
0.0000e+00	.249E+04	.260E+04	.162E-05	0.00E-02	0.000e+00	
x.xxxxexx	.560E+02	.560E+02	.354E-07	.244E-04	.300E-05	
x.xxxxexx	.700E+02	.700E+02	.329E-07	.305E-04	.375E-05	
x.xxxxexx	.150E+05	.157E+05	.972E-05	.659E-02	.811E-03	
x.xxxxexx	.337E+03	.337E+03	.213E-06	.147E-03	.181E-04	
x.xxxxexx	.422E+03	.422E+03	.198E-06	.184E-03	.226E-04	
x.xxxxexx	.121E+05	.127E+05	.788E-05	.534E-02	.657E-03	
x.xxxxexx	.273E+03	.273E+03	.172E-06	.119E-03	.146E-04	

RADTRAD      VERSION 3.0      Date 08:19:02      page AA- 35  
 Calculation Title Goes Here up to two lines or 200 characters

SUMMARY OF DOSE (Rem) FOR DOSE LOCATIONS AS A FUNCTION OF TIME

COMPARTMENT NAME: control rm

TIME	( hours )	THYROID	WHOLE BODY	BETA	TEDE
.0000E+00		.4043E-01	.4489E-03	.7002E-02	X.XXXxE+00
.3900E-01		.2340E+01	.9620E-01	.9176E+00	X.XXXxE+00

COMPARTMENT NAME: eab

TIME	( hours )	THYROID	WHOLE BODY	BETA	TEDE
.0000E+00		.4043E-01	.4489E-03	.7002E-02	X.XXXxE+00
.3900E-01		.2340E+01	.9620E-01	.9176E+00	X.XXXxE+00
X      To      X		X.x	X.x	X.x	X.x

\* WTHD Worst Two Hour Dose

COMPARTMENT NAME: lpz

TIME	( hours )	THYROID	WHOLE BODY	BETA	TEDE
.0000E+00		.4043E-01	.4489E-03	.7002E-02	X.XXXxE+00
.3900E-01		.2340E+01	.9620E-01	.9176E+00	X.XXXxE+00