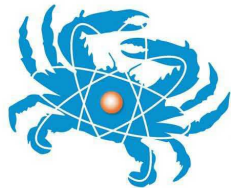


NRC Dose3

J. Stewart Bland, CHP



Chesapeake Nuclear Services

2024 RAMP Virtual Meeting

April 2024

Topics

- NRC Dose3 Overview
- Overview of Features
- XOQDOQ Modeling and Use/Screens
- GASPAR Modeling and Use/Screens
- LADTAP Modeling and Use/Screens
- NRC Dose3 Code Discussions

NRCDOSE3 OVERVIEW

LADTAP
Liquid Pathway Dose Assessment

GASPAR
Gaseous Pathway Dose Assessment

XOQDOQ
**Annual Average Meteorological
Dispersion and Deposition**

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Purpose of Code

- NRC Licensing Evaluation;
- Exposure pathway dose modeling, primarily for reactors to demonstrate compliance with:
 - 10 CFR Part 20
 - Appendix I to 10 CFR Part 50
 - 40 CFR Part 190
- With expanded source term applicable to other fuel cycle facilities
- Not suitable for short term releases; accident dose assessment

NRC Guidance

- NRC guidance on reactor effluent dose calculations is contained in:
 - RG 1.109, *Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I*
 - RG 1.111, *Methods of Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light Water Cooled Reactors*
 - RG 1.113, *Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purposes of Implementing Appendix I*

FORTRAN Codes

LADTAP II

- Liquid effluent doses
- NUREG/CR-4013, RSICC CCC-363

GASPAR II

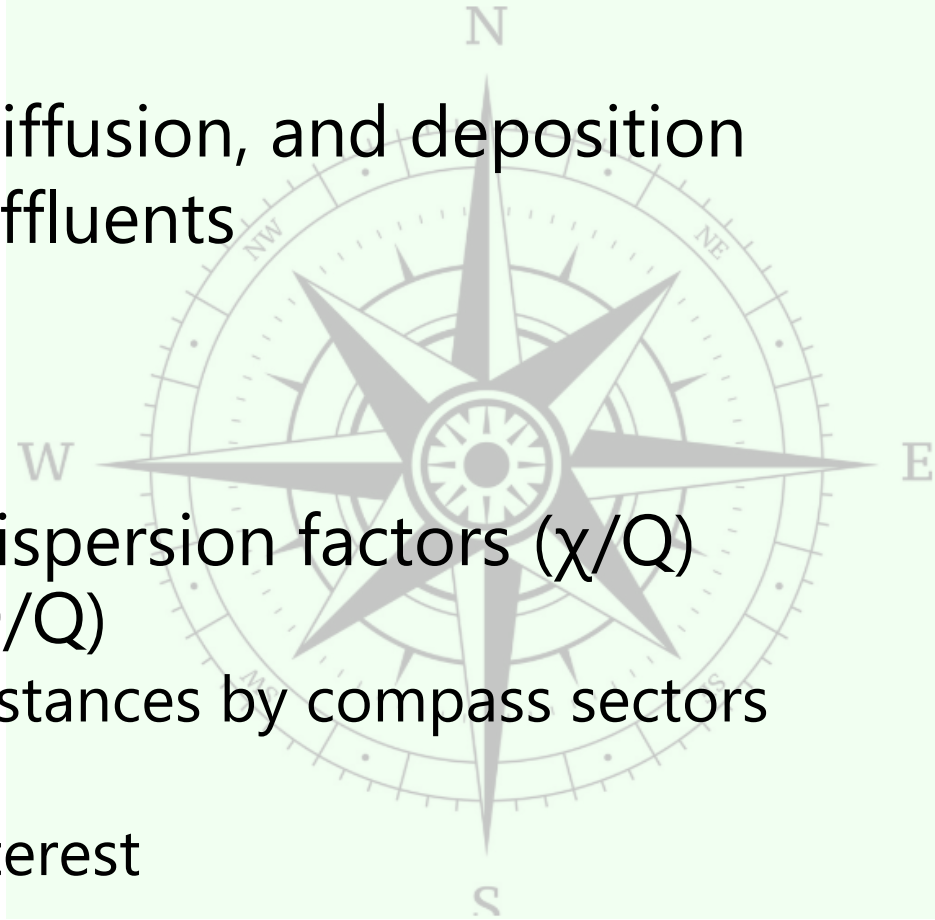
- Gaseous effluent doses
- NUREG/CR-4653, RSICC CCC-463

XOQDOQ

- Atmospheric transport and diffusion
- NUREG/CR-2919, RSICC CCC-316

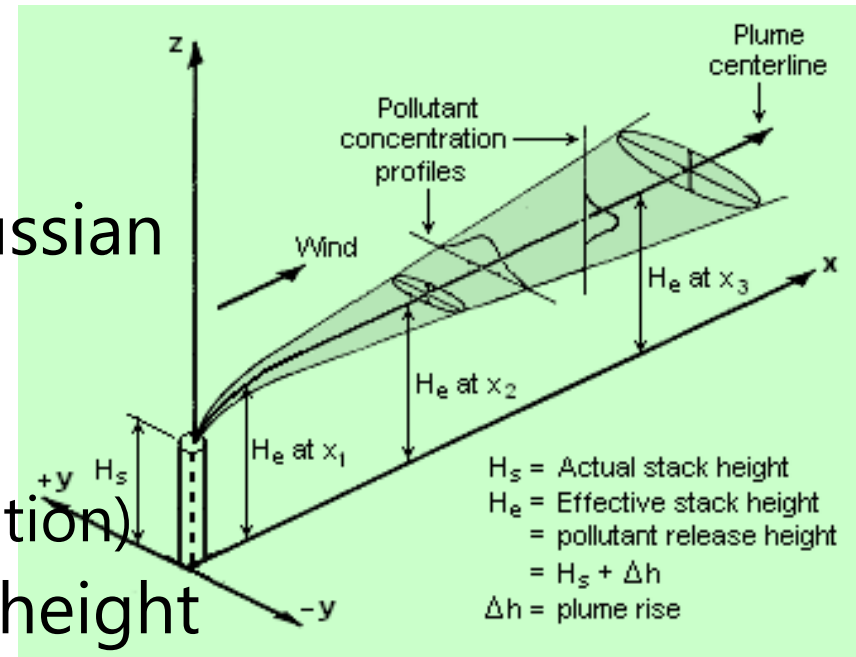
XOQDOQ

- Evaluation of transport, diffusion, and deposition of airborne radiological effluents
 - Routine releases
 - Intermittent releases
 - Non-emergency
- Calculates atmospheric dispersion factors (χ/Q) and deposition factors (D/Q)
 - Predefined segmented distances by compass sectors out to 50 miles
 - User defined points of interest



XOQDOQ

- Straight-line trajectory Gaussian plume model. Considers:
 - Dry deposition
 - Radioactive decay
 - Plume recirculation (stagnation)
- Calculates effective plume height
 - Physical release height
 - aerodynamic downwash
 - plume rise
 - terrain features



GASPAR II

- Estimates airborne effluent doses
 - Routine
 - Non-emergency
 - Individuals or populations
- Requires:
 - Source term released (Ci/yr)
 - Atmospheric dispersion (XOQDOQ)
 - Demographics

GASPAR II

- Internal Exposure Pathways
 - Inhalation (of plume)
 - Ingestion of contaminated food
 - leafy vegetables
 - vegetables and grains
 - meat
 - milk
- External Exposure Pathways
 - Plume
 - Ground Plane

LADTAP II

- Estimates liquid effluent doses
 - Routine
 - Non-emergency
 - Individuals, populations or biota
- Hydrologic model represents mixing in the effluent impoundment system and surface waters

LADTAP II

- Internal Exposure Pathways:
 - Drinking water (freshwater site)
 - Fish
 - Invertebrates
 - Aquatic plants
 - Irrigated crops
- External Exposure Pathways
 - Shoreline
 - Boating
 - Swimming

GASPAR II and LADTAP II

- ICRP-2 DCFs (1950s)
- Four (4) Age Groups
 - Infant
 - Child
 - Teen
 - Adult
- 7 Organs
 - Total Body
 - Bone
 - Liver
 - Thyroid
 - Kidneys
 - Lungs
 - GI-LLI

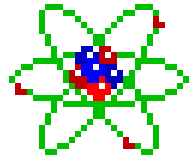
NRC and Industry End Uses

- NRC licensing reviews
 - Design Certification, Combined License, and Early Site Permit Applications
 - License Amendment Requests
- NRC health physics reactor inspections
 - Independent assessment of potential doses from effluent releases
 - Independent assessment of ODCM Dose Conversion Factors and effluent dose calculations

NRC and Industry End Uses (Cont.)

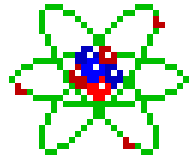
- Calculate doses at locations of interest
- Evaluate Land Use Census
 - Public interest
- Annual dose assessments
 - Actual receiving water body flows and dilutions
 - Meteorology with effluents for evaluated year
- ODCM Dose Conversion Factors

Why Update to NRC Dose3



- Updates the NRC Dose 2.3.20 (CCC-684) code
- Significant increase in flexibility and functionality

Why Update to NRC Dose3



- Need for a licensing tool to support reactor application submittals
- Provides an acceptable method for evaluating exposure pathway doses from reactor effluents
- Improves efficiency in reactor licensing process, and NRC safety and environmental reviews

Overview of Updates

- Improved functionality
 - Updated Windows interface
- Option to select ICRP-2, ICRP-30, or ICRP-72 Dose Conversion Factors (DCFs)
 - Age range
 - Organs
- Expanded license application ready reports

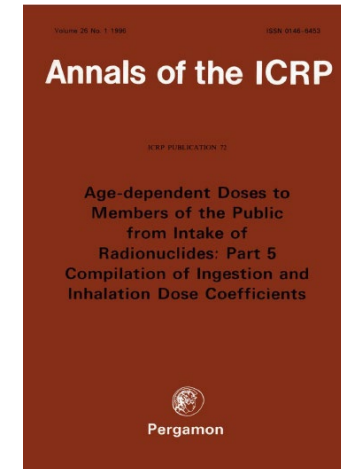
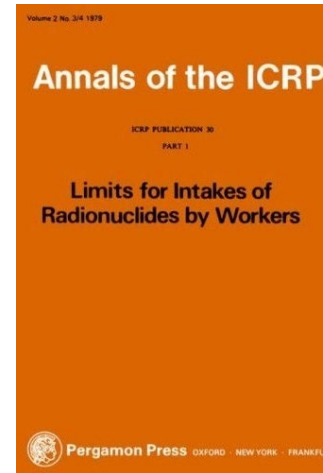
Overview of Updates

- User-modifiable parameter values
 - Bioaccumulation factors
 - Consumption rates
 - Usage factors
 - Other parameters

Previous versions of NRC Dose
(and FORTRAN codes) did not
allow for edits to parameters

Updates (Cont.) – DCFs

- Expanded ICRP-2 DCFs
- ICRP-30 DCFs
- ICRP-72 DCFs
- Ingestion DCFs:
Gastrointestinal Absorption Fractions (f₁)
- Inhalation DCFs: Lung Clearance Classes for Chemical Compounds
 - ICRP-30: D/W/Y
 - ICRP-72: F/M/S



DCFs obtained from Radiological Toolbox, NRC RAMP at <https://ramp.nrc-gateway.gov/>

Updates (Cont.) – Biota Dose

- Biota dose added to GASPAR and expanded in LADTAP
- Biota dose calculated at all user defined special location (GASPAR)
- Biota dose based on species mass, effective radius, primary food eaten (produce or meat) and consumption rate

Updates (Cont.) – Biota Dose

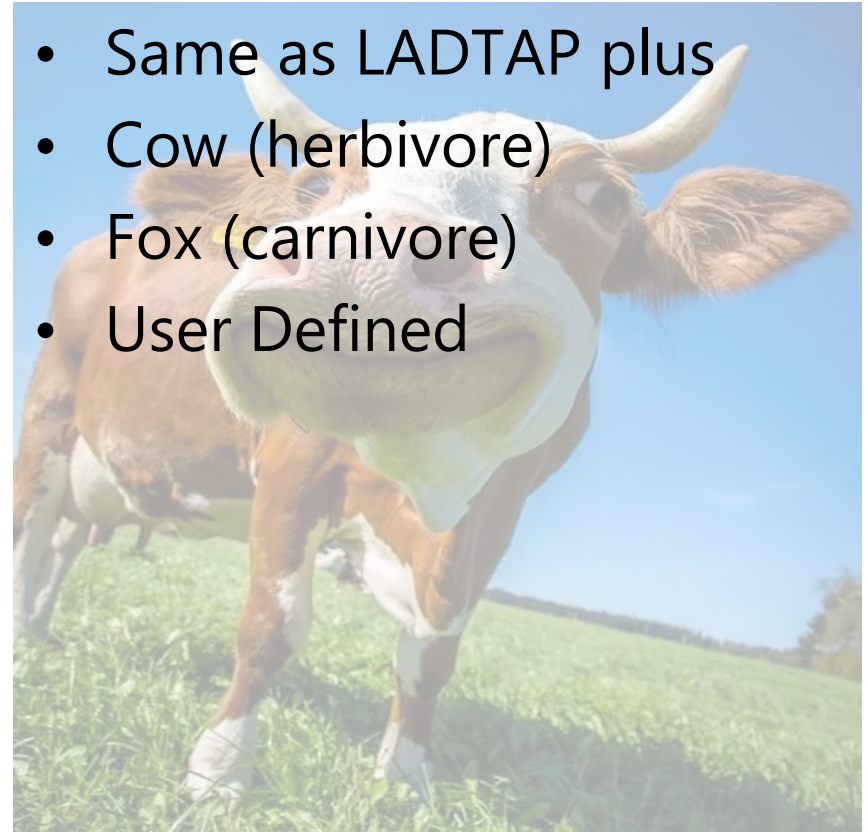
LADTAP

- Algae
- Muskrat
- Raccoon
- Duck
- Heron
- User defined



GASPAR

- Same as LADTAP plus
- Cow (herbivore)
- Fox (carnivore)
- User Defined



Documentation and Release

- NRC Dose3 Quick Start Guide
 - How to install, run, and view output
- DRAFT NUREG on NRC Dose3 Code: User Guide and Technical Manual
 - Technical basis
- Distribution by NRC RAMP

<https://ramp.nrc-gateway.gov/>

OVERVIEW OF FEATURES AND ENHANCEMENTS

NRC Dose3 - Version 1.1.4

Quit About Manuals

LADTAP
Liquid Pathway Dose Assessment

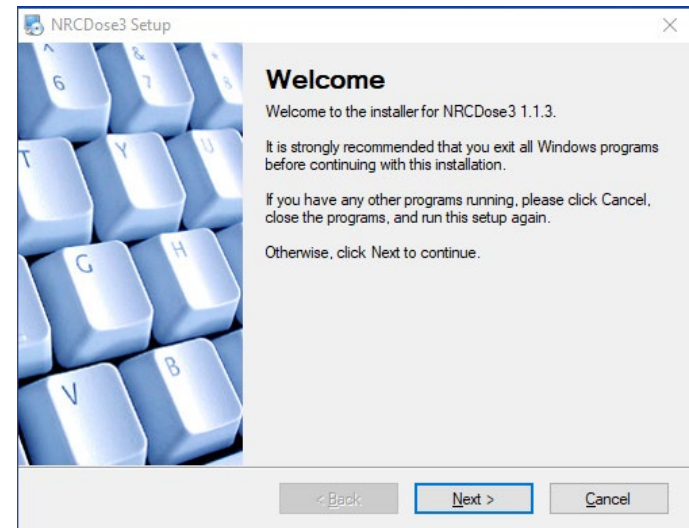
GASPAR
Gaseous Pathway Dose Assessment

XOQDOQ
**Annual Average Meteorological
Dispersion and Deposition**

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Installation and Operation

- Double-click
NRCDose3_v113_Setup.exe
- Follow prompts
- NRCDose3 will install in C:\directory (unless changed by the user)



File Types

.XN3

- XOQDOQ
- Case file saved by XOQDOQ

.GN3

- GASPAR
- Case file saved by GASPAR

.LN3

- LADTAP
- Case file saved by LADTAP

.DAT

- LADTAP and GASPAR
- Data file used in place of manually entered data
- Used to initially test the program (Older DAT files incompatible with NRC Dose3)

File Structure

- When a code is opened, it will be loaded with the last case file from the database
 - When first opened, an example case file will be pre-loaded
- If a different case is desired, select *File->Open LN3 File* from the menu to load a saved case
 - Or "*Open GN3 File*" or "*Open XN3 File*" as applicable
- When saving a case, it will be saved to the database as well as a case file (.xn3, .gn3, .ln3 file type, as applicable)

Hard-Coded Parameters

- Previous versions of codes had many hard-coded parameters that are now user-editable
- Editing may be appropriate for site-specific conditions

CAUTION

Changing parameters from accepted methods (i.e., RGs) or licensing documentation may require evaluation or justification

XOQDOQ Expanded Editable Parameters

- Building wake constant
 - Though not recommended without a sound technical bases
- Essentially all other key modeling parameters (input values to the meteorological model) were already user defined or user controlled

LADTAP Expanded Editable Parameters

- Population age group fractions
- Food and water consumption rates
- Bioaccumulation and transfer factors
- Various environmental exposure times and produce production and storage times

GASPAR Editable Parameters

- Population age group fractions
- Human consumption and inhalation rates
- Bioaccumulation factors
- Various environmental exposure times and produce production and storage times
- Meat and milk animal consumption rates

Dose Conversion Factors

- Expanded ICRP-2 DCFs from:
 - RG 1.109, Revision 1, *Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I* (October 1977)
 - NUREG-0172, *Age Specific Radiation Dose Commitment Factors for One-Year Chronic Intake* (November 1977)
 - NUREG-0172, *Errata* (August 1983)
 - NUREG/CR-2384, *Age Specific Inhalation Radiation Dose Commitment Factors for Selected Radionuclides* (August 1982)
 - EMP-155, *Review and Expansion of USNRC Regulatory Guide 1.109 Models for Computing Dose Conversion Factors* (February 1983)

DCFs

- Some radionuclides in those sources were not included in LADTAP II/GASPAR II
- NRC Dose3 includes ICRP-2 DCFs for ALL radionuclides contained in those sources
- NRC Dose3 includes ICRP-30 and ICRP-60/72 DCFs for ALL radionuclides in those sources
- 203 radionuclides included in NRC Dose3

Additional Radionuclides

S-35	Kr-88	Xe-138
Cl-36	Kr-89	Ba-133
Ar-39	Sr-85	Tm-170
Ar-41	Cd-109	Yb-169
Ca-45	Sn-113	Ta-182
Ga-67	I-125	Ir-192
Se-75	Xe-131m	Au-198
Kr-83m	Xe-133m	Tl-201
Kr-85m	Xe-133	Tl-204
Kr-85	Xe-135m	Rn-22
Kr-87	Xe-137	Pu-236

DCFs

- NRC Dose3 allows only one chemical form, inhalation class or ingestion class for each radionuclide
- Multiple ingestion DCFs based on f1 value
- Multiple inhalation DCFs based on inhalation class
 - D/W/Y for ICRP-30
 - F/M/S for ICRP-72
- Nuclear power plant effluents are assumed to be oxides; other fuel cycle facilities may have different states

Age Ranges

ICRP-30

- Adult only
 - Occupational DCFs

ICRP-72

- Adult
- 15 year old
- 10 year old
- 5 year old
- 1 year old
- Newborn

Organs

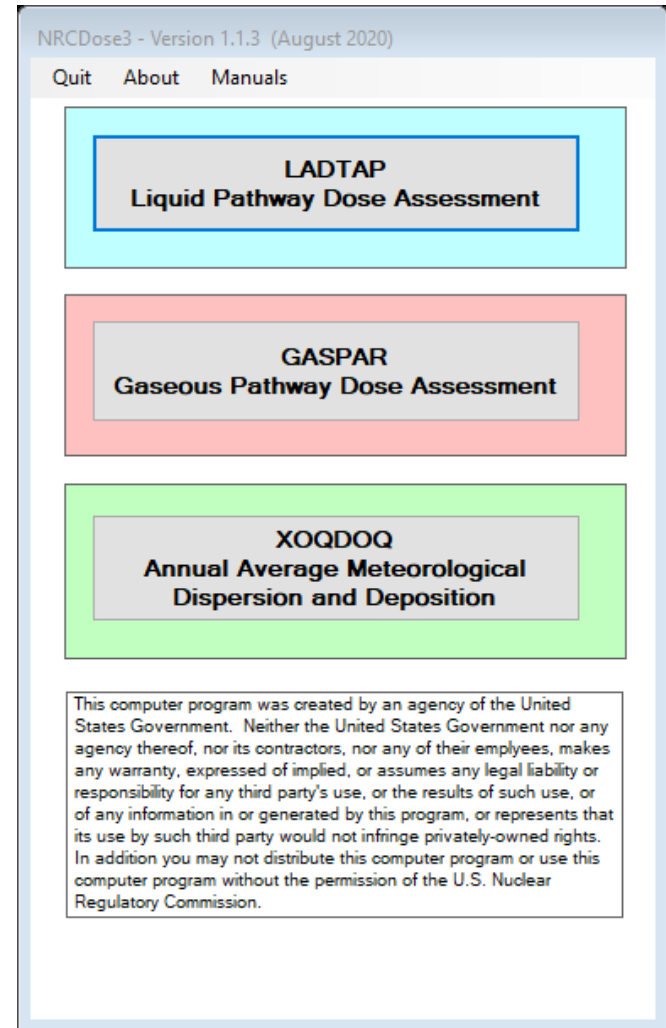
ICRP-30

- 24 organs, including remainder

ICRP-72

- 27 organs, including remainder
 - Colon, ETA, skin(ext)

XOQDOQ MODELING AND USE



XOQDOQ – Atmospheric Transport and Dispersion

- Implements the straight-line Gaussian modeling of RG 1.111
- Calculates ground-level concentrations
- Accounts release points characteristics (height, plume rise)
- Additional plume dispersion due to building wakes
- Plume depletion via dry deposition and radioactive decay

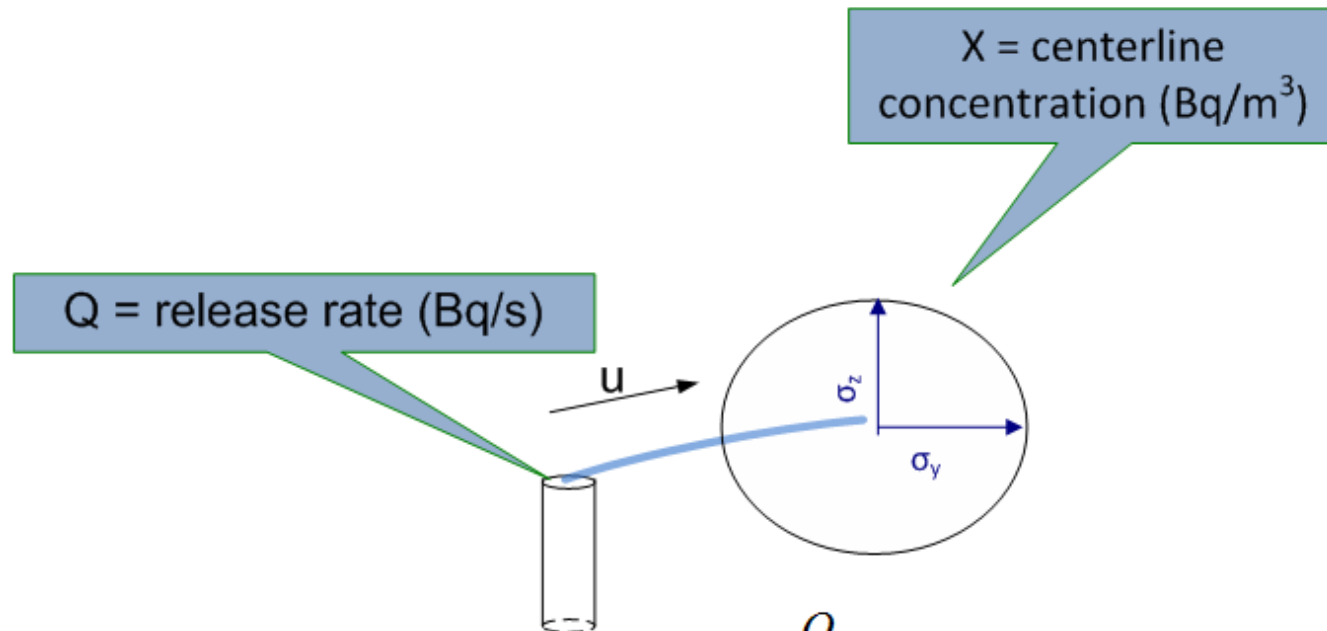
XOQDOQ – Atmospheric Transport and Dispersion

- Annual average relative dispersion (χ/Q) and deposition (D/Q) values at user specified locations (MEI doses) and standard radial distances and segments (population doses) for routine releases
- Intermittent releases (e.g., containment purge, waste gas tank)
- Elevated, ground level, or mixed mode releases
- Meteorological modeling considerations: building wake effects, plume depletion (dry deposition), and radioactive decay

XOQDOQ – Atmospheric Transport and Dispersion

- Wind direction in 16 compass directions (22.5° sectors), 14 wind speed classes, and 7 atmospheric stability classes (A-G)
- Three different dispersion χ/Q values; one deposition D/Q value
 - Undecayed, Undepleted χ/Q
 - Decayed, Undepleted χ/Q (2.26-day half-life)
 - Decayed, Depleted χ/Q (8-day half-life)
 - Deposition D/Q (2.26-day and 8-day half-lives)
- Output used as meteorological data input to GASPAR

Basic Meteorology Dispersion – χ/Q

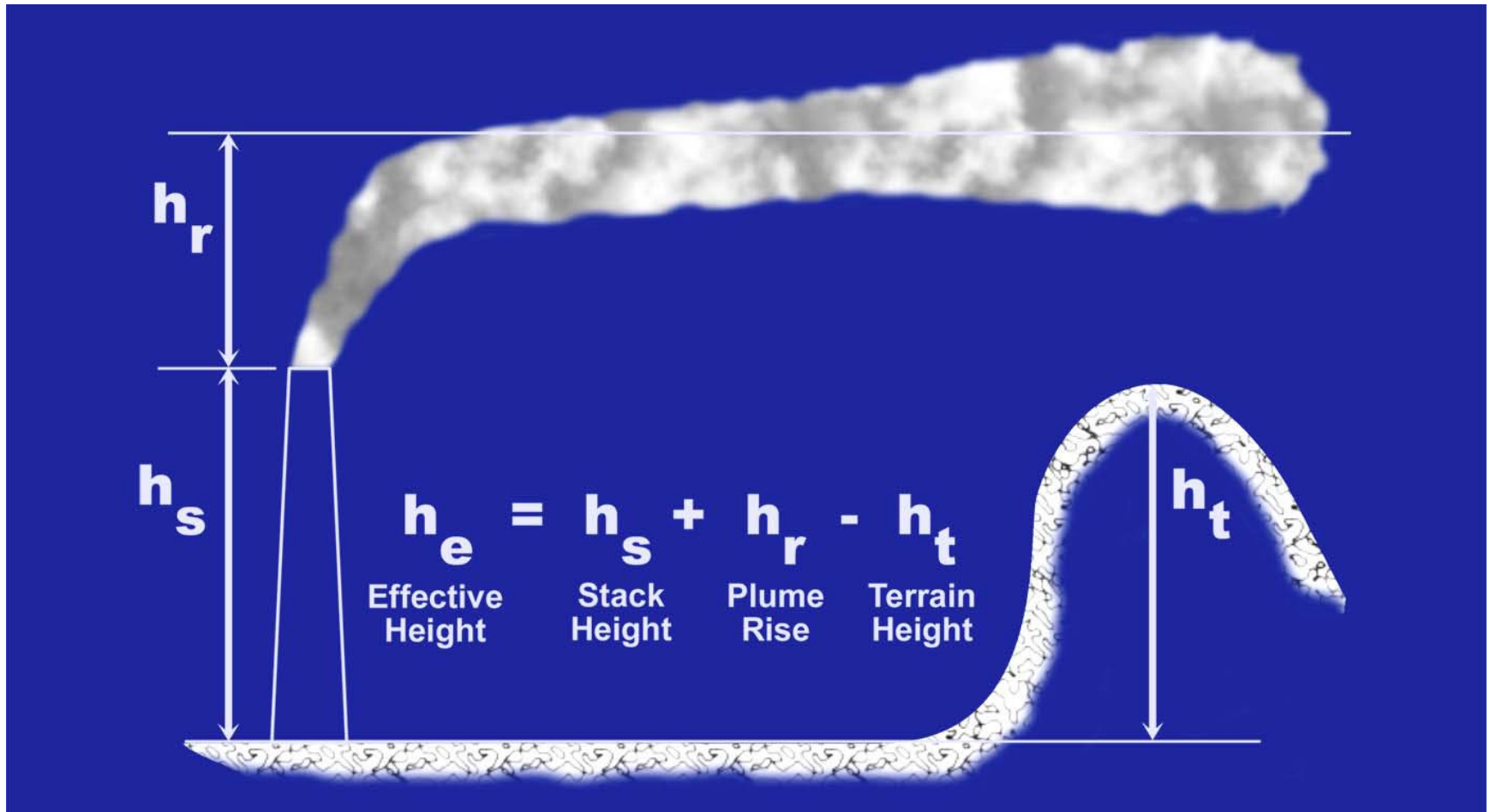


$$X = \frac{Q}{u\pi\sigma_y\sigma_z} \text{ (Bq/m}^3\text{)}$$

then

$$\frac{X}{Q} = \frac{1}{u\pi\sigma_y\sigma_z} \text{ (s/m}^3\text{)}$$

Dispersion – Release and Terrain Characteristics



Gaussian Model – Sector Average

- Dividing the area surrounding a point source into 16 segments gives $360^\circ/16 = 22.5^\circ$ per segment
- For averaging condition (over time), the plume is assumed to meander, spreading uniformly over the 22.5° sector

$$\frac{\chi}{Q} = \frac{2.032}{\sigma_z u x}$$

where

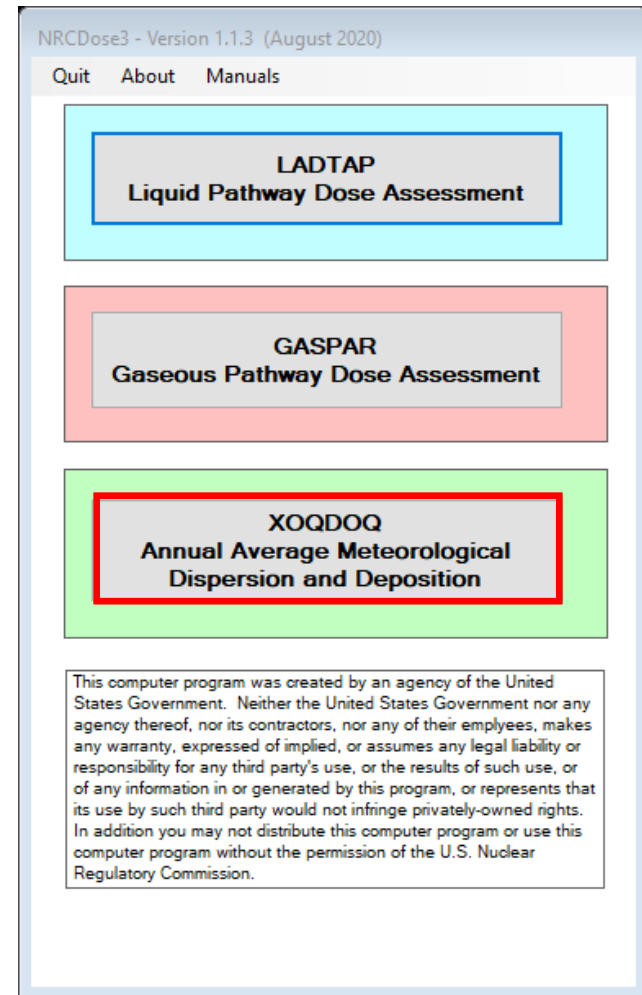
x = the distance from the point of release

u = the wind velocity

$2.032 = \sqrt{2/\pi}$ divided by the width of a 22.5° segment in radians

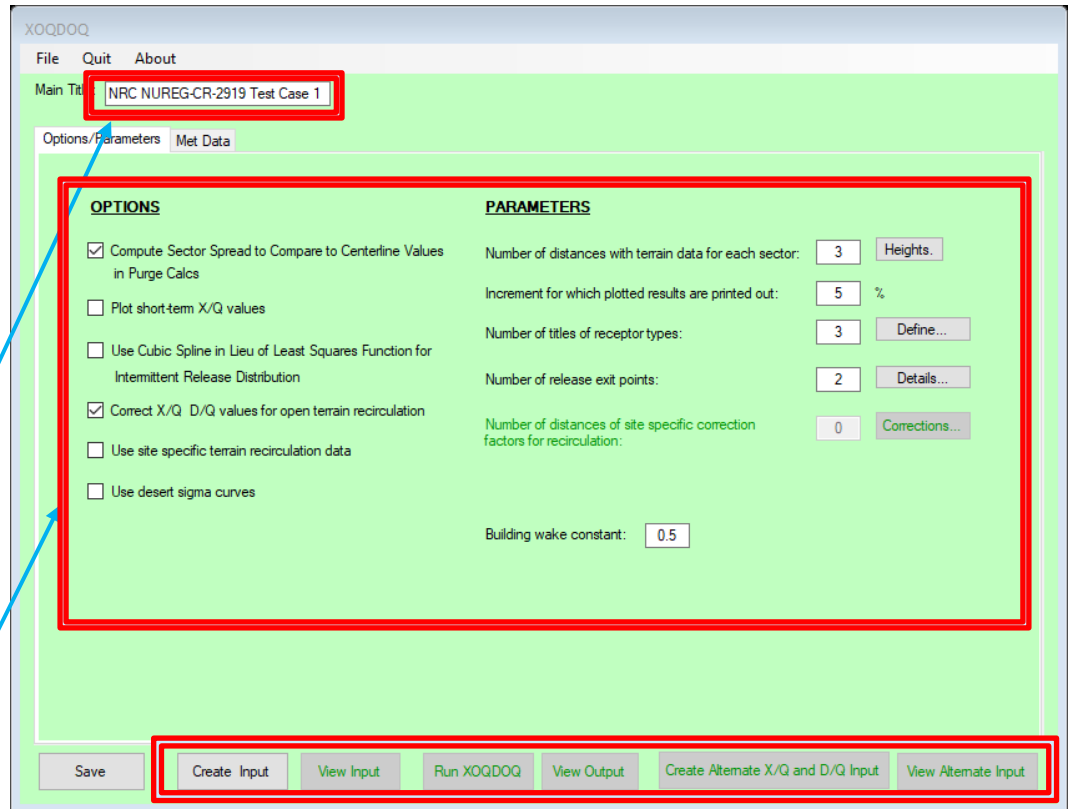
Starting and Running XOQDOQ

- Double click "XOQDOQ"



XOQDOQ Main Screen

- XOQDOQ Module Main Screen opens with case data that is saved in the database
- Contains three main functional areas:
 - toolbar and initial setup area,
 - data input tabs
 - code execution and reports



XOQDOQ – File Management

- New — New XOQDOQ case. Clears the databases.
- Open XN3 File — open an existing “*.XN3” file previously created with NRCDOSE3
- Open Legacy Input File — Opens Windows Explorer; navigate to “*.dat” file
 - Uses a file created with the original XOQDOQ
 - “Create input” not needed; select run XOQDOQ. Input screens and options cannot be used

XOQDOQ – File Management

- Save to Database — Choose this option to save current case to the database. When XOQDOQ is opened with “Current Project” selected, the information in the database, as last saved before exiting, initially populates all XOQDOQ screens and windows.
- Save to XN3 File — Choose this option to save the completed case to a “*.XN3” file
- Delete — Choose this option to open an explorer window that will allow the user to delete any previously saved “*.XN3” files

XOQDOQ Main Screen – Options

- Various options
 - Purge calc (short term releases) printout compares sector spread to centerline values
 - Printout plot of short-term X/Q values (not very useful)
 - Open terrain recirculation: correction is applied uniformly to all directional sectors out to 10 km (NUREG/CR-2919, Figure 3.2)
 - Use site-specific terrain recirc values (user input under Parameters)
 - Desert sigma curves (specialized dispersion values developed for desert environment)

OPTIONS

- Compute Sector Spread to Compare to Centerline Values in Purge Calcs
- Plot short-term X/Q values
- Use Cubic Spline in Lieu of Least Squares Function for Intermittent Release Distribution
- Correct X/Q D/Q values for open terrain recirculation
- Use site specific terrain recirculation data
- Use desert sigma curves

XOQDOQ Options/Parameters

PARAMETERS

Number of distances with terrain data for each sector:

Increment for which plotted results are printed out: %

Number of titles of receptor types:

Number of release exit points:

Number of distances of site specific correction factors for recirculation:

Building wake constant:

Terrain Height Values

DISTANCE:
Range 2
Range 3

Distance: meters
Height: meters

	Distance	Height		Distance	Height
S:	<input type="text" value="100"/>	<input type="text" value="0"/>	N:	<input type="text" value="100"/>	<input type="text" value="0"/>
SSW:	<input type="text" value="100"/>	<input type="text" value="0"/>	NNE:	<input type="text" value="100"/>	<input type="text" value="0"/>
SW:	<input type="text" value="100"/>	<input type="text" value="0"/>	NE:	<input type="text" value="100"/>	<input type="text" value="0"/>
WSW:	<input type="text" value="100"/>	<input type="text" value="0"/>	ENE:	<input type="text" value="100"/>	<input type="text" value="0"/>
W:	<input type="text" value="100"/>	<input type="text" value="0"/>	E:	<input type="text" value="100"/>	<input type="text" value="0"/>
WNW:	<input type="text" value="100"/>	<input type="text" value="0"/>	ESE:	<input type="text" value="100"/>	<input type="text" value="0"/>
NW:	<input type="text" value="100"/>	<input type="text" value="0"/>	SE:	<input type="text" value="100"/>	<input type="text" value="0"/>
NNW:	<input type="text" value="100"/>	<input type="text" value="0"/>	SSE:	<input type="text" value="100"/>	<input type="text" value="0"/>

XOQDOQ Main Screen – Parameters

PARAMETERS

Number of distances with terrain data for each sector: Heights.

Increment for which plotted results are printed out: %

Number of titles of receptor types: Define...

Number of release exit points: Details...

Number of distances of site specific correction factors for recirculation: Corrections...

Building wake constant:

Receptor Types

Type	Title	Locations	
1.	<input type="text" value="Site Boundary"/>	<input type="text" value="3"/>	<input type="button" value="Define.."/>
2.	<input type="text" value="Cows"/>	<input type="text" value="3"/>	<input type="button" value="Define..."/>
3.	<input type="text" value="Residences"/>	<input type="text" value="2"/>	<input type="button" value="Define..."/>

Save Exit

Receptor Locations

LOCATION

Direction: ▾

Distance: meters

Save Exit

XOQDOQ Main Screen – Parameters

PARAMETERS

Number of distances with terrain data for each sector: Heights...

Increment for which plotted results are printed out: %

Number of titles of receptor types: Define...

Number of release exit points: Details...

Number of distances of site specific correction factors for recirculation: Corrections...

Building wake constant:

Location Selection

RELEASE POINTS

Mixed-mode Release - with P...
Ground Level

Edit
Delete
Save
Exit

Release Point Data

Release Point Title:

Vent/Stack Average Velocity: m/sec
Vent/Stack Inside Diameter: meters
Release Point Height: meters
Height of Vent's/Stack's Bldg: meters
Minimal cross-sectional area for Vent's/Stack's Bldg: m sq
Wind Height used for the vent/stack elevated release: meters
Vent/Stack heat emission rate: cal/sec

Purges:
Number of intermittent releases:
Average number of hours per intermittent release:

Save Exit

Met Data Input

- Calms
- Met data: hours or % frequency
- Height of measurement
- Plant grade
- Half-lives (do not change)
- Inputting joint frequency distribution (JFDs)
 - Line-by-line entering for each Stability Class

File Quit About

Main Title: NRC NUREG-CR-2919 Test Case 1

Options/Parameters Met Data

Distribute calms as first wind-speed class Input joint frequency distribution data as percent frequency

Number of velocity categories: 5 Max Wind Speeds... Number of stability categories: 7 Wind speed class units: mph m/sec

Number of hours, or percent, of calm for each stability category:

Class A. 0 hr D. 4 hr G. 4 hr
 B. 0 hr E. 4 hr
 C. 4 hr F. 4 hr

Height (above ground level) of the measured wind presented in the joint frequency data: 10.00 m

Plant grade elevation (above sea level): 0.00 m

Half-lives used in X/Q calculations (days)
 1. 101.00 2. 2.26 3. -8.00

Import JFD Data (METQA) Import JFD Data (EXCEL) (Hours) Total: 16

STABILITY	Wind Speed	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Class A																	
Class B																	
Class C																	
Class D																	
Class E																	
Class F																	
Class G																	
Class 2		1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1
Class 3		1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1
Class 4		1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1
Class 5		1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1

Clear

Save Create Input View Input Run XOQDOQ View Output Create Alternate X/Q and D/Q Input View Alternate Input

Windspeed Input

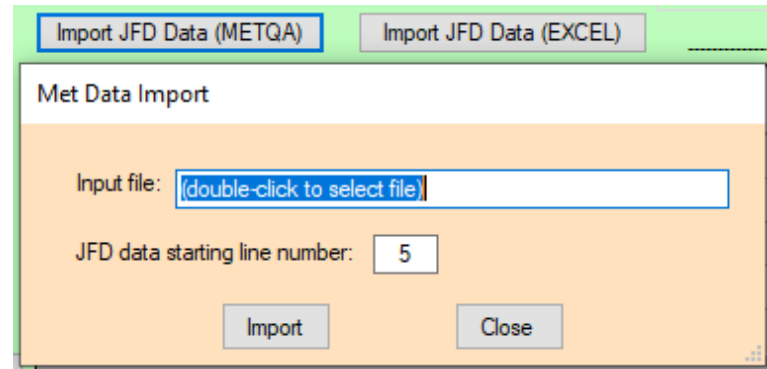
- Enter the “Number of velocity categories” (maximum 13), and then select “Max Wind Speeds...” to enter the maximum wind speed of each category

The screenshot shows a software window titled "Maximum Wind Speeds". At the top, it says "Number of velocity categories: 5" and has a button labeled "Max Wind Speeds...". Below this, the window title is "Maximum Wind Speeds". Underneath, it says "Wind Speed Units: m/sec". There is a section titled "Wind Speed" with a list of classes. Class 1 has a value of 1.00, Class 2 has 2.00, Class 3 has 4.00, Class 4 has 8.00, and Class 5 has 16.00. Classes 6 and 7 are empty. At the bottom of the window, there are two buttons: "Save" and "Exit".

Class	Wind Speed (m/sec)
Class 1.	1.00
2.	2.00
3.	4.00
4.	8.00
5.	16.00
6.	
7.	

Import Met Data

- Met data (JFD) can be imported using 2 standard file formats
 - **MetQA:** file format generated by an internal (NRC) application MetQA (Version 2.0), which represents the NRC staff's implementation of NUREG-0917
 - **EXCEL:** specific data array by wind direction, wind speed range, and atmospheric stability classes ranging, in sequence, from extremely unstable (Class A) thru extremely stable (Class G)



NOTE: Input file examples included in install

Import Met Data – Example File Format

AutoSave OFF Met Data Import Format for XOQDOQ 5 wind speeds

Home Insert Draw Page Layout Formulas Data Review View

U25

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	
1	JFD Data Import																		
2																			
3	This sample file (for use as a template) is configured for 7 Stability Classes and 5 velocity (speed) categories. Edit as appropriate for your case.																		
4																			
5	Stability	Wind Speed																	
6	Class	Category	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	
7	Class 1	Speed 1	0	0	0	0	0	0	0	1	1	3	1	0	0	0	0	0	
8		Speed 2	0	0	0	0	0	0	0	0	3	3	0	0	1	0	0	0	
9		Speed 3	0	1	0	0	0	1	3	5	12	8	5	4	1	5	1	0	
10		Speed 4	1	0	0	1	1	2	7	17	73	39	20	22	16	11	2	0	
11		Speed 5	0	0	2	0	0	0	13	41	55	43	31	33	35	35	1	1	
12	Class 2	Speed 1	0	0	0	0	0	0	0	1	3	0	1	0	0	0	0	0	
13		Speed 2	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	
14		Speed 3	0	0	0	0	0	0	0	0	2	1	0	0	1	1	1	1	
15		Speed 4	1	0	0	1	0	0	2	10	10	7	6	6	8	1	1	0	
16		Speed 5	0	1	1	0	0	1	2	12	11	8	7	8	8	11	1	0	
17	Class 3	Speed 1	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	
18		Speed 2	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	
19		Speed 3	1	0	1	0	0	1	2	3	2	10	4	3	5	0	0	0	
20		Speed 4	0	4	0	0	0	0	2	10	21	15	6	12	17	4	3	1	
21		Speed 5	0	1	0	1	0	2	5	23	10	16	9	7	14	11	2	0	
22	Class 4	Speed 1	6	5	3	2	5	4	9	11	10	6	2	3	2	6	6	4	
23		Speed 2	3	4	4	4	7	7	15	12	18	20	5	13	5	4	3	1	
24		Speed 3	19	25	20	15	29	38	55	74	92	44	45	31	34	33	24	9	
25		Speed 4	81	63	58	52	59	82	132	160	171	110	83	75	110	120	100	65	
26		Speed 5	104	97	95	56	38	92	174	203	87	44	55	53	104	201	172	145	
27	Class 5	Speed 1	3	5	8	4	10	11	12	2	3	4	4	0	1	0	2	1	
28		Speed 2	4	5	14	16	18	23	23	18	17	9	9	8	3	8	4	7	
29		Speed 3	26	28	35	39	78	96	95	55	43	23	26	28	22	24	21	16	
30		Speed 4	46	72	83	92	133	181	191	119	66	38	35	34	40	67	105	52	
31		Speed 5	96	132	95	70	57	139	220	132	36	27	24	21	26	95	133	84	
32	Class 6	Speed 1	1	1	0	0	1	3	2	5	2	1	0	2	0	3	1	0	
33		Speed 2	1	1	1	1	3	8	8	8	5	3	3	1	4	2	1	2	
34		Speed 3	4	6	9	9	21	33	36	33	16	21	12	13	11	10	12	3	
35		Speed 4	17	12	22	18	27	63	101	47	20	15	13	6	17	43	48	23	
36		Speed 5	14	9	14	7	15	44	86	29	13	5	5	9	10	40	69	23	
37	Class 7	Speed 1	0	0	0	0	1	0	3	2	1	0	1	1	0	2	0	0	
38		Speed 2	1	2	1	1	4	3	3	5	2	2	1	3	6	1	2	4	
39		Speed 3	5	4	4	4	6	17	25	22	25	13	10	7	15	13	12	4	
40		Speed 4	2	3	9	6	9	29	52	39	16	10	9	11	15	31	45	16	
41		Speed 5	2	3	9	1	6	24	65	25	9	8	6	1	9	26	70	13	
42																			
43																			

XOQDOQ – Save, Create Input and Run

XOQDOQ

File Quit About

Main Title: NRC NUREG-CR-2919 Test Case 1

Options/Parameters Met Data

Distribute calms as first wind-speed class Input joint frequency distribution data as percent frequency

Number of velocity categories: 5 Max Wind Speeds... Number of stability categories: 7 Wind speed class units: mph m/sec

Number of hours, or percent, of calm for each stability category:

Class A: 0 hr D: 4 hr G: 4 hr
 Class B: 0 hr E: 4 hr
 Class C: 4 hr F: 4 hr

Height (above ground level) of the measured wind presented in the joint frequency data: 10.00 m

Plant grade elevation (above sea level): 0.00 m

Half-lives used in X/Q calculations (days):
 1. 101.00 2. 2.26 3. -8.00

Import JFD Data (METGA) Import JFD Data (EXCEL) (Hours) Total: 16

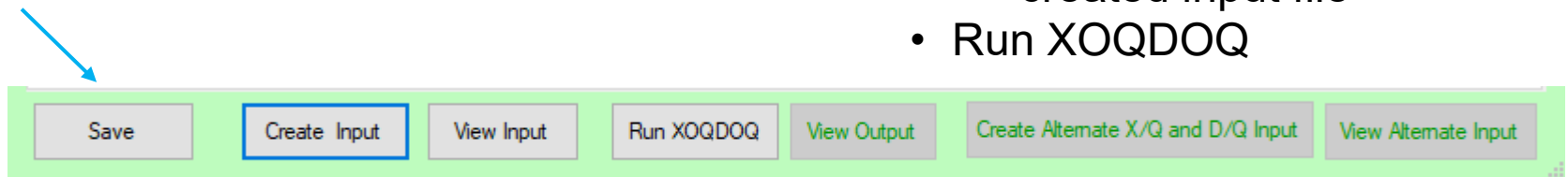
STABILITY

Wind Speed	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Class 2	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1
Class 3	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1
Class 4	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1
Class 5	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1

Save Create Input View Input Run XOQDOQ View Output Create Alternate X/Q and D/Q Input View Alternate Input

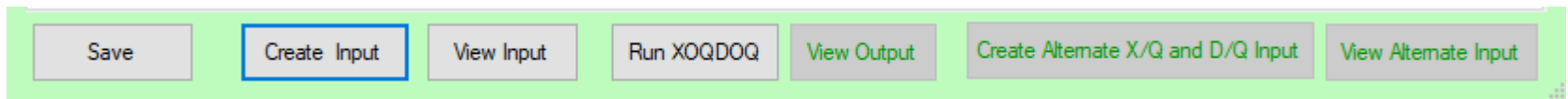
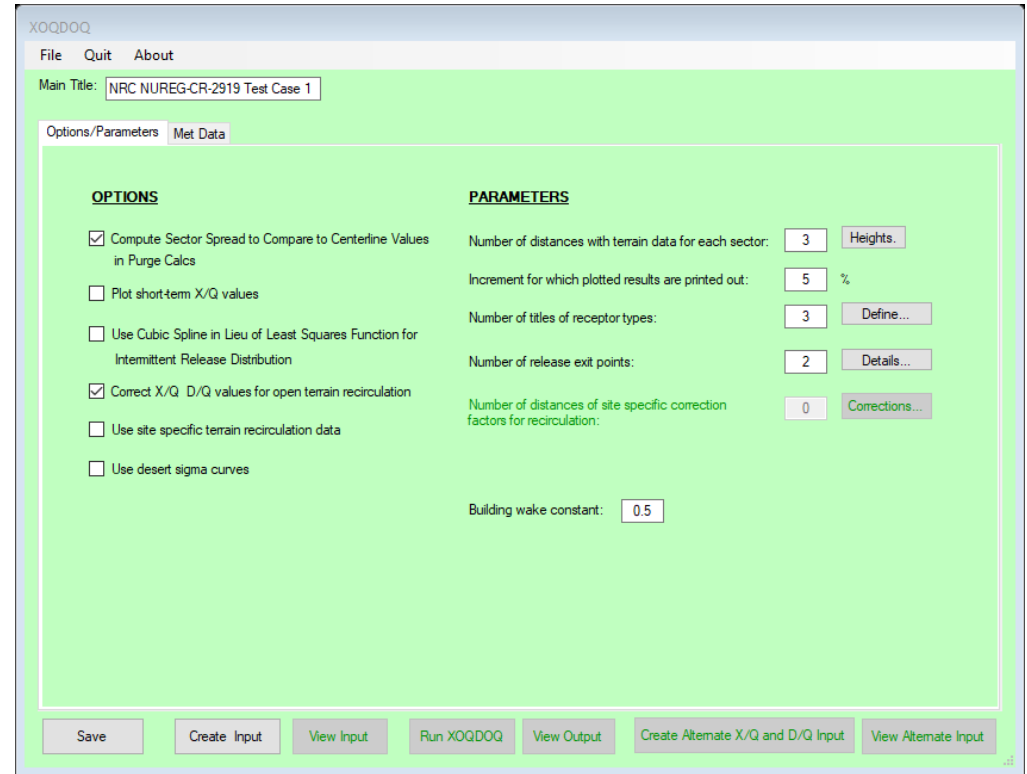
After inputting JDFs,

- Save
 - This will save to the dataset as well as to any file name as being used.
- Create Input
 - This creates the dataset in the format required by the FORTRAN code
- View Input
 - Allows user to view he created input file
- Run XOQDOQ



XOQDOQ – Save, Create, Input and Run

- **Save** to save the dataset to any file name as being used.
- **Create Input** to create the dataset in the format required by the FORTRAN code
- **View Input** to view created input file
- **Run XOQDOQ**



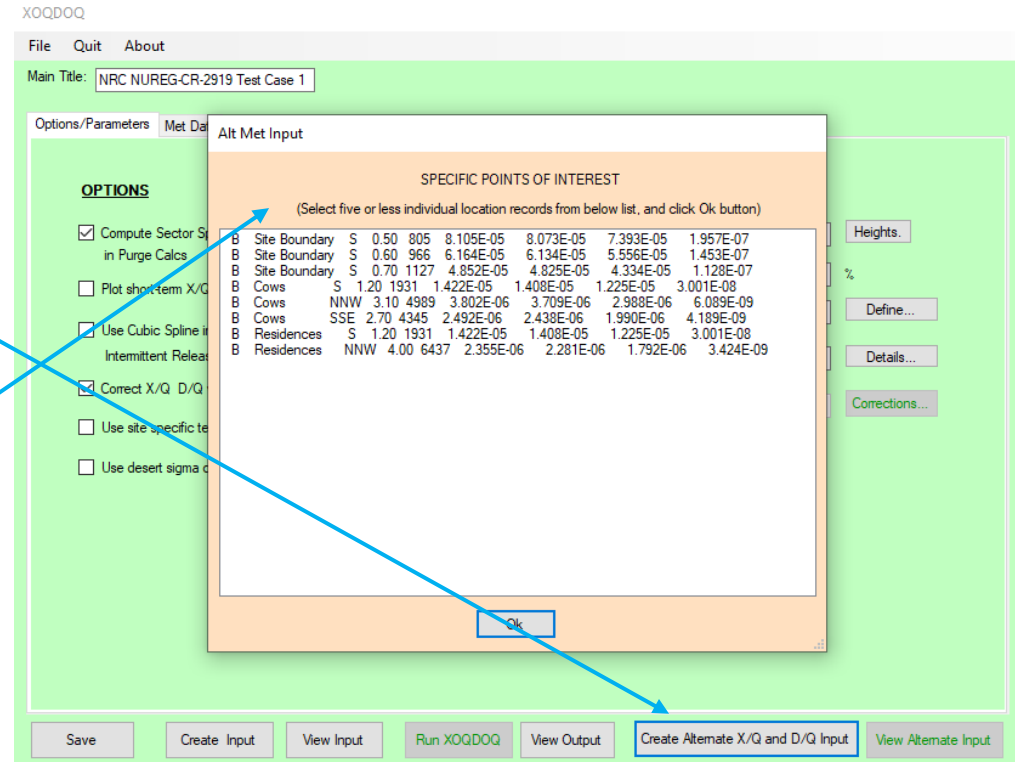
View Input

- Shows the input deck as used by the FORTRAN code
- Follows the card format as described in NUREG/CR-2919

```
1010011100
NRC NUREG-CR-2919 Test Case 1
  5 7 3 5 3 2 0
 10 101 2.26 -8 0
  0 0 4 4 4 4 4
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
  1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 1
  1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 1
  1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 1
  1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 1
  1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 1
  1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 1
  1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 1
  1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 1
  1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 1
  1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 1
  1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 1
  1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 1
  1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 1
  1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 1
  1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 1
  1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 1
  1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 1
  0.5 -100 1 2 4 8 16
 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 800 800 800 800 800 800 800 800 800 800 800 800 800 800 800
 16 16 16 16 16 16 16 16 16 16 16 16 16 16 16
10000100001000010000100001000010000100001000010000100001000010000
 200 200 200 200 200 200 200 200 200 200 200 200 200 200 200
  3 3 2
Site Boundary
  1 805 1 966 1 1127
Cows
  1 1931 8 4989 16 4345
Residences
  1 1931 8 6437
Mixed-mode Release - with Purge
 10 2 45 40 2000 45 0
A 1 25 4
Ground Level
  0 0 30 25 900 10 0
B 0 0 0
|
```

Create Alt. Input – For GASPAR

- A meteorological dataset suitable for import by GASPAR can be created
 - Select **Create Alternate X/Q and D/Q Input**
- Pop-up screen to select up to 5 locations
- An input file will be created internal which may be referenced during the GASPAR run
- Only applicable to XOQDOQ for single release point runs



LADTAP
Liquid Pathway Dose Assessment

GASPAR
Gaseous Pathway Dose Assessment

XOQDOQ
**Annual Average Meteorological
Dispersion and Deposition**

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GASPAR MODELING AND USE

GASPAR

- Performs dose assessments for gaseous radioactive effluents released into the atmosphere
- Implements dose assessment methods described in RG 1.109
- Calculates the radiation dose to individuals, population groups, and biota from:
 - inhalation of contaminated air,
 - direct exposure from contaminated ground and
 - consumption of contaminated foods
- Basic calculation methods are described in NUREG/CR-4653

GASPAR

- Calculated doses support
 - NEPA evaluations
 - Compliance with the NRC public dose limits in 10 CFR Part 20
 - EPA public dose limits in 40 CFR Part 190
 - NRC ALARA design objectives and numerical guides in 10 CFR Part 50, Appendix I

Starting and Running GASPAR

- Double click "GASPAR"

NRC Dose3 - Version 1.1.4

Quit About Manuals

LADTAP
Liquid Pathway Dose Assessment

GASPAR
Gaseous Pathway Dose Assessment

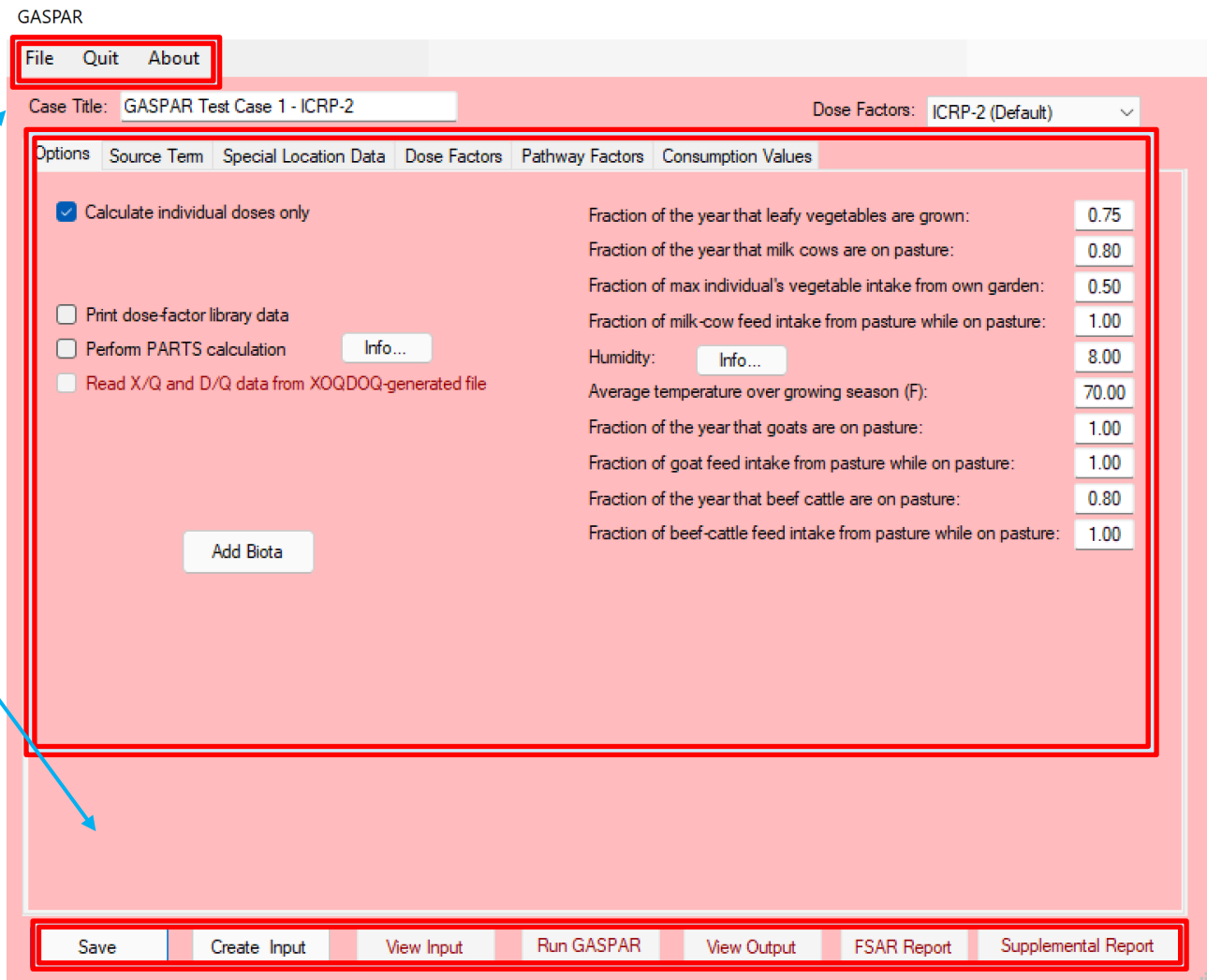
XOQDOQ
**Annual Average Meteorological
Dispersion and Deposition**

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GASPAR Main Screen

- Contains three main functional areas:
 - the toolbar and initial setup area,
 - data input tabs area and
 - code execution and reports area

NOTE:
GASPAR opens with the last saved database



GASPAR Start-up

- New — Select this option to begin a new GASPAR case. This will clear the database from any previously input information.
- Open GN3 File — Select this option to access and open a "*.GN3" file that was previously created with NRC Dose3.
- Save to Database — Choose this option to save the current case to the database. When GASPAR starts, it loads the data that was last saved (typically from the last, previous run), populating all GASPAR screens and windows.
- Save to GN3 File — Choose this option to save the completed case to a "*.GN3" file. This allows the file to be saved for later use, or for sharing with others.
- Delete — Choose this option to open an explorer window that will allow the user to delete any previously saved "*.GN3" files.

GASPAR – Options

- Enter a Case Title
- Select dose factors:
 - ICRP-2 (Default)
 - ICRP-30
 - ICRP-72
- Option for individual doses only
- Printing cumulative or detailed reports
- Printing dose factor library
- PARTS calculations (dose conversion factors for site-specific modeling; used in ODCM)

GASPAR

File Quit About

Case Title: **GASPAR Test Case 1 - ICRP-2** Dose Factors: **ICRP-2 (Default)**

Options Source Term Special Location Data Dose Factors Pathway Factors Consumption Values

Calculate individual doses only

Print dose-factor library data

Perform PARTS calculation **Info...**

Read X/Q and D/Q data from XOQDOQ-generated file

Add Biota

Fraction of the year that leafy vegetables are grown:	0.75
Fraction of the year that milk cows are on pasture:	0.80
Fraction of max individual's vegetable intake from own garden:	0.50
Fraction of milk-cow feed intake from pasture while on pasture:	1.00
Humidity: Info...	8.00
Average temperature over growing season (F):	70.00
Fraction of the year that goats are on pasture:	1.00
Fraction of goat feed intake from pasture while on pasture:	1.00
Fraction of the year that beef cattle are on pasture:	0.80
Fraction of beef-cattle feed intake from pasture while on pasture:	1.00

Save **Create Input** **View Input** **Run GASPAR** **View Output** **FSAR Report** **Supplemental Report**

NOTE: Changing DCFs will re-initialize the source term

GASPAR Main Screen

- Seven data input tabs:
 - Options
 - Source Term
 - Pop/Prod Data
 - Special Locations
 - Dose Factors
 - Pathway Factors
 - Consumption Values

The screenshot shows the GASPAR Main Screen interface. The title bar reads "GASPAR" and the menu bar includes "File", "Quit", and "About". The "Case Title" field contains "GASPAR Test Case 1 - ICRP-2" and the "Dose Factors" dropdown is set to "ICRP-2 (Default)". A red box highlights the "Options" tab, which is currently selected. The "Options" tab contains several checkboxes and a list of parameters with input fields. The "Calculate individual doses only" checkbox is checked. Other checkboxes include "Print dose-factor library data", "Perform PARTS calculation", and "Read X/Q and D/Q data from XOQDOQ-generated file". The "Perform PARTS calculation" checkbox has an "Info..." button next to it. The "Add Biota" button is located at the bottom left of the main area. The right side of the screen displays a list of parameters with their corresponding values in input fields:

Fraction of the year that leafy vegetables are grown:	0.75
Fraction of the year that milk cows are on pasture:	0.80
Fraction of max individual's vegetable intake from own garden:	0.50
Fraction of milk-cow feed intake from pasture while on pasture:	1.00
Humidity:	8.00
Average temperature over growing season (F):	70.00
Fraction of the year that goats are on pasture:	1.00
Fraction of goat feed intake from pasture while on pasture:	1.00
Fraction of the year that beef cattle are on pasture:	0.80
Fraction of beef-cattle feed intake from pasture while on pasture:	1.00

At the bottom of the screen, there is a row of buttons: "Save", "Create Input", "View Input", "Run GASPAR", "View Output", "FSAR Report", and "Supplemental Report".

GASPAR – Options

- Input site-specific for pathway modeling assumptions

Dose Factors: ICRP-2 (Default)

Way Factors Consumption Values

Fraction of the year that leafy vegetables are grown:	<input type="text" value="0.75"/>
Fraction of the year that milk cows are on pasture:	<input type="text" value="0.80"/>
Fraction of max individual's vegetable intake from own garden:	<input type="text" value="0.50"/>
Fraction of milk-cow feed intake from pasture while on pasture:	<input type="text" value="1.00"/>
Humidity: <input type="button" value="Info..."/>	<input type="text" value="8.00"/>
Average temperature over growing season (F):	<input type="text" value="70.00"/>
Fraction of the year that goats are on pasture:	<input type="text" value="1.00"/>
Fraction of goat feed intake from pasture while on pasture:	<input type="text" value="1.00"/>
Fraction of the year that beef cattle are on pasture:	<input type="text" value="0.80"/>
Fraction of beef-cattle feed intake from pasture while on pasture:	<input type="text" value="1.00"/>

GASPAR – Biota

- Modeling based on BNWL-1754 (same as LADTAP)
- Six (6) biota types automatically included
 - muskrat, racoon, duck, heron, cow, and fox
- Option for User defined biota
 - Food type (limited to either herbivore or carnivore)

Additional Biota Types

The screenshot shows a software interface for defining biota types. It features a table with the following data:

Name	Food Type	Mass (g)	Effective Radius (cm)	Consumption Rate (g/day)
Bear	Herbivore	200000	30.0	10000

Below the table is a form for editing the selected biota type. The form contains the following fields:

- Name:
- Primary Food:
- Mass: g
- Effective Radius: cm
- Consumption Rate: g/day

Buttons for 'Add Biota Type', 'Delete Biota Type', 'Clear', 'Save', and 'Close' are also visible.

GASPAR – Source Term

- Title
- Source term multiplication
- Add, delete or clear options

Options Source Term Pop/Prod Data Special Location Data Dose Factors Pathway Factors Consumption Values

Source Term:

Title:

Source Multiplication Factor:

Release time for purges: hr

Nuclide	Quantity (Ci)
CS-137	1.00E+00
H-3	1.00E+02
I-131	1.00E-01
KR-85	3.00E+02
XE-135	2.00E+02

Add Nuclide

Delete Nuclide

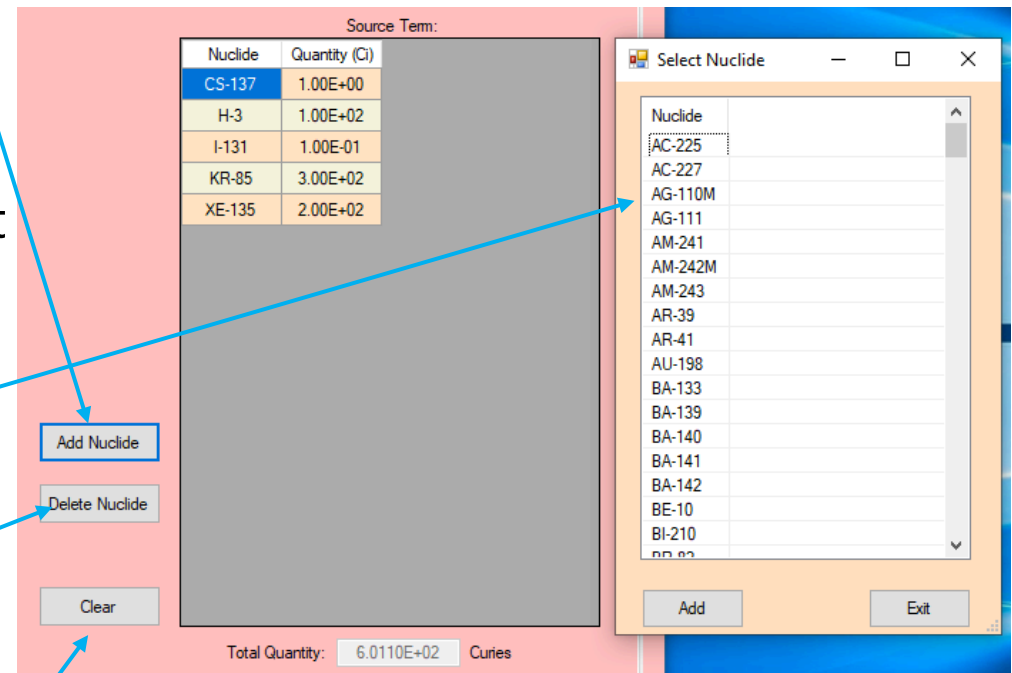
Clear

Total Quantity: Curies

NOTE: Only a single source term may be used for each case

GASPAR – Source Term

- Select: Add Nuclide
 - Pop-up menus with nuclide list
 - Highlight desired nuclide; use "control" key to select multiple nuclides
- Selecting "Add" will add them to list
- "Delete Nuclide" will delete selected nuclide
- "Clear" will clear all nuclides in the source term



GASPAR – Source Term – ICRP-30 and ICRP-72 DCFs

- ICRP-30 and ICRP-72 DCFs, select the applicable solubility (f1) or lung clearance type (F, M, S) for each radionuclide

The screenshot displays the 'Source Term' window in the GASPAR software. It features a table with columns for Nuclide, Default, Class, f1, and Quantity (Ci). The 'Add Nuclide' button is highlighted with a red box. A 'Select Nuclide' dialog box is open, showing a list of radionuclides with their respective Default, Class, and f1 values. A blue arrow points from the 'Add Nuclide' button to the 'Select Nuclide' dialog box.

Nuclide	Default	Class	f1	Quantity (Ci)
CS-137	Yes	F		1.00E+00
H-3	Yes	V		1.00E+02
I-131	Yes	F		1.00E-01
KR-85	Yes			3.00E+02
XE-135	Yes			2.00E+02

Total Quantity: 6.0110E+02 Curies

Nuclide	Default	Class	f1
AC-225		F	0.0005
AC-225		M	0.0005
AC-225	Yes	S	0.0005
AC-227		F	0.0005
AC-227		M	0.0005
AC-227	Yes	S	0.0005
AG-110M		F	0.05
AG-110M		M	0.05
AG-110M	Yes	S	0.01
AG-111		F	0.05
AG-111		M	0.05
AG-111	Yes	S	0.01
AM-241		F	0.0005
AM-241	Yes	M	0.0005
AM-241		S	0.0005
AM-242M			

NOTE: Only one solubility or inhalation class allowed per radionuclide

GASPAR – Population/Production Data

- Used for population dose calculations only
- Dropdown menu for data type
 - Population
 - Milk
 - Meat
 - Vegetable
 - Meteorology
- Except for meteorology, 50 mile data may be entered rather than sector segmented data

The screenshot shows the GASPAR software interface. The title bar reads 'GASPAR'. The menu bar includes 'File', 'Quit', and 'About'. The main window has a 'Case Title' field containing 'GASPAR Test Case 1 - ICRP-2' and a 'Dose Factors' dropdown menu set to 'ICRP-2 (Default)'. Below this is a tabbed interface with tabs for 'Options', 'Source Term', 'Pop/Prod Data', 'Special Location Data', 'Dose Factors', 'Pathway Factors', and 'Consumption Values'. The 'Pop/Prod Data' tab is active. It features a 'Data Type' dropdown menu with a list of options: 'Population', 'Milk Production', 'Meat Production', 'Vegetable Production', and 'Meteorology'. The 'Population' option is selected. To the right of the dropdown is a 'Total 50 Mile Population' field with the value '1000000'. Below this field is a checkbox labeled 'Input by distance and direction' which is unchecked. There are 'Clear' and 'Update' buttons to the right of the checkbox. At the bottom of the window, there is a row of buttons: 'Save', 'Create Input', 'View Input', 'Run GASPAR', 'View Output', 'FSAR Report', and 'Supplemental Report'.

GASPAR – Input Population/Production Data

- Applies for population, milk, meat, and vegetable production
- Input population or production data by meteorological sector and distance (data typically found in applicant's SAR or Environmental Report)

GASPAR

File Quit About

Case Title: GASPAR Test Case 1 - ICRP-2 Dose Factors: ICRP-2 (Default)

Options Source Tem Pop/Prod Data Special Location Data Dose Factors Pathway Factors Consumption Values

Data Type:
Population
Milk Production
Meat Production
Vegetable Production
Meteorological

Input by distance and direction

Title: Clear Update

	1 mi	2 mi	3 mi	4 mi	5 mi	10 mi	20 mi	30 mi	40 mi
N	0	0	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0	0	0

Save Create Input View Input Run GASPAR View Output FSAR Report Supplemental Report

NOTE: Select "UPDATE" before exiting input

GASPAR – Special Location Data

- Select Add to add new location (will clear fields)
 - Identified the location where individual doses will be calculated
- Location data
 - Name
 - Distance/Direction (information use only)
- Atmospheric dispersion factors
- Detailed Reports
- Save

GASPAR

File Quit About

Case Title: GASPAR Test Case 1 - ICRP-2 Dose Factors: ICRP-2 (Default)

Options Source Term Pop/Prod Data Special Location Data Dose Factors Pathway Factors Consumption Values

Special Locations

Test Loc #1
Test Loc #2

Add

Remove

Number of Locations: 2

Location for Individual Doses

Name of Location: Test Loc #1

Direction from site: N

Distance from site: 1000.00 m

Atmospheric Dispersion Factors

Undecayed, Undepleted: 1.000E-06

Decayed, Undepleted: 1.000E-06

Decayed, Depleted: 1.000E-06

Ground Deposition Factor: 1.000E-07

Don't print any detailed reports

Report Control

Omit printing detailed reports for:

Plume exposure

Ground exposure

Vegetable ingestion

Cow Meat ingestion

Cow-milk ingestion

Goat-milk ingestion

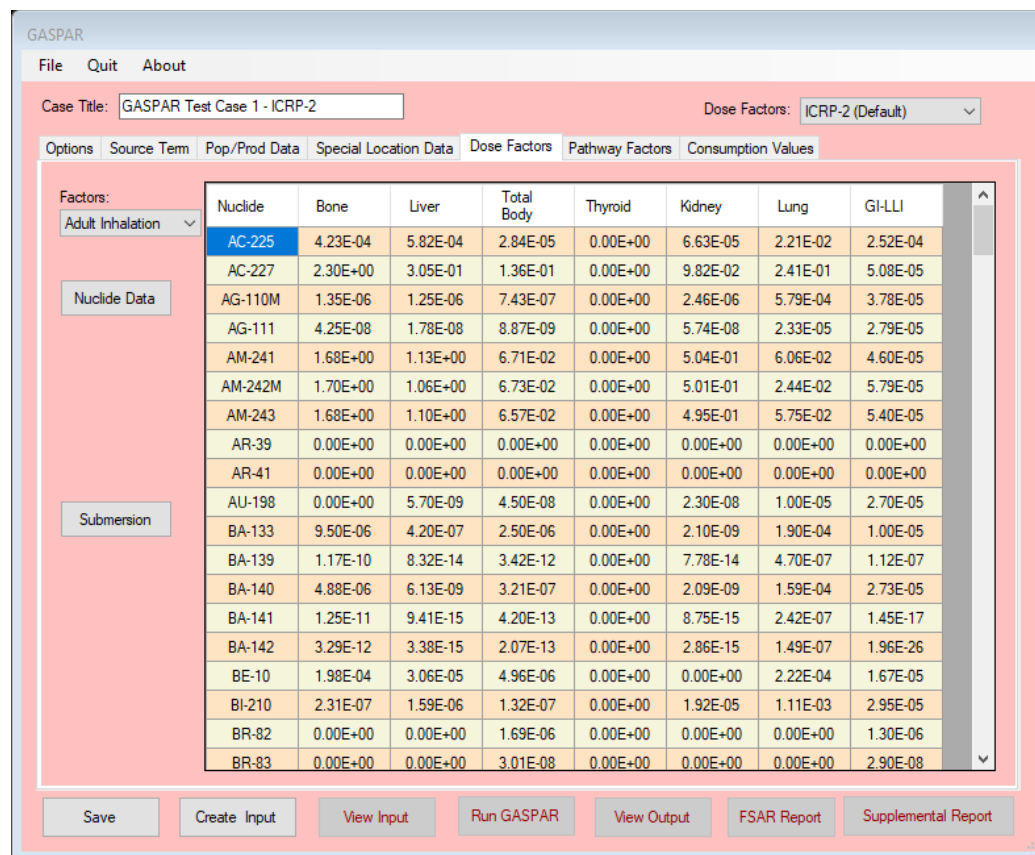
Inhalation

Save

Save Create Input View Input Run GASPAR View Output FSAR Report Supplemental Report

GASPAR – Dose Factors

- Dropdown menu for displaying dose factors
 - Inhalation
 - Ingestion
 - By age group
- Values for the Dose Factors being used (mrem per pCi, inhaled or ingested)
 - ICRP-2
 - ICRP-30
 - ICRP-72



The screenshot shows the GASPAR software interface. The 'Case Title' is 'GASPAR Test Case 1 - ICRP-2' and the 'Dose Factors' are set to 'ICRP-2 (Default)'. The 'Dose Factors' dropdown menu is open, showing 'Adult Inhalation' selected. The 'Nuclide Data' and 'Submersion' buttons are visible. The main table displays dose factors for various nuclides across different organs and the total body.

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
AC-225	4.23E-04	5.82E-04	2.84E-05	0.00E+00	6.63E-05	2.21E-02	2.52E-04
AC-227	2.30E+00	3.05E-01	1.36E-01	0.00E+00	9.82E-02	2.41E-01	5.08E-05
AG-110M	1.35E-06	1.25E-06	7.43E-07	0.00E+00	2.46E-06	5.79E-04	3.78E-05
AG-111	4.25E-08	1.78E-08	8.87E-09	0.00E+00	5.74E-08	2.33E-05	2.79E-05
AM-241	1.68E+00	1.13E+00	6.71E-02	0.00E+00	5.04E-01	6.06E-02	4.60E-05
AM-242M	1.70E+00	1.06E+00	6.73E-02	0.00E+00	5.01E-01	2.44E-02	5.79E-05
AM-243	1.68E+00	1.10E+00	6.57E-02	0.00E+00	4.95E-01	5.75E-02	5.40E-05
AR-39	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AR-41	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AU-198	0.00E+00	5.70E-09	4.50E-08	0.00E+00	2.30E-08	1.00E-05	2.70E-05
BA-133	9.50E-06	4.20E-07	2.50E-06	0.00E+00	2.10E-09	1.90E-04	1.00E-05
BA-139	1.17E-10	8.32E-14	3.42E-12	0.00E+00	7.78E-14	4.70E-07	1.12E-07
BA-140	4.88E-06	6.13E-09	3.21E-07	0.00E+00	2.09E-09	1.59E-04	2.73E-05
BA-141	1.25E-11	9.41E-15	4.20E-13	0.00E+00	8.75E-15	2.42E-07	1.45E-17
BA-142	3.29E-12	3.38E-15	2.07E-13	0.00E+00	2.86E-15	1.49E-07	1.96E-26
BE-10	1.98E-04	3.06E-05	4.96E-06	0.00E+00	0.00E+00	2.22E-04	1.67E-05
BI-210	2.31E-07	1.59E-06	1.32E-07	0.00E+00	1.92E-05	1.11E-03	2.95E-05
BR-82	0.00E+00	0.00E+00	1.69E-06	0.00E+00	0.00E+00	0.00E+00	1.30E-06
BR-83	0.00E+00	0.00E+00	3.01E-08	0.00E+00	0.00E+00	0.00E+00	2.90E-08

NOTE: Dose factor data is not editable

GASPAR – Dose Factors – Nuclide Data

- Nuclide decay data
- External dose factors
- Absorbed Energies
 - For biota calculations
 - Effective radii
 - Units (MeV/Bq s)

Nuclide Data

Nuclide	Atomic Number	Atomic Weight	Isomeric State	Decay Constant	EXG TB Factor (mrem/hr per pCi/m ²)
H-3	1	3		1.78E-09	0.00E+00
BE-10	4	10		1.37E-14	0.00E+00
C-14	6	14		3.84E-12	0.00E+00
N-13	7	13		1.16E-03	7.60E-09
F-18	9	18		1.05E-04	6.80E-09
NA-22	11	22		8.44E-09	1.60E-08

Effective Energies

Nuclide	1 cm	1.5 cm	2.5 cm	3.5 cm	5 cm
Ac-225	5.92E+00	5.92E+00	5.92E+00	5.92E+00	5.92E+00
Ac-227	8.50E-02	8.50E-02	8.51E-02	8.52E-02	8.52E-02
Ag-110	1.18E+00	1.18E+00	1.18E+00	1.18E+00	1.18E+00
Ag-110m	1.49E-01	1.82E-01	2.42E-01	3.03E-01	3.96E-01
Ag-111	3.55E-01	3.55E-01	3.55E-01	3.56E-01	3.57E-01
Am-241	5.61E+00	5.61E+00	5.62E+00	5.62E+00	5.62E+00
Am-242m	7.03E-02	7.08E-02	7.14E-02	7.18E-02	7.22E-02

Exit

NOTE: Dose factor data is not editable

GASPAR – Dose Factors Submersion

- Submersion (semi-infinite plume) dose factors for noble gases (mrad or mrem per year per pCi/m³)

Noble Gas Submersion DFs - Default

Type	AR-41	KR-83M	KR-85M	KR-85	KR-87	KR-88	KR-89	XE-131M	XE-133M
Gamma Air	9.30E-03	1.93E-05	1.23E-03	1.72E-05	6.17E-03	1.52E-02	1.73E-02	1.56E-04	3.27E-04
Beta Air	3.28E-03	2.88E-04	1.97E-03	1.95E-03	1.03E-02	2.93E-03	1.06E-02	1.11E-03	1.48E-03
Gamma T-Body	8.84E-03	7.56E-08	1.17E-03	1.61E-05	5.92E-03	1.47E-02	1.66E-02	9.15E-05	2.51E-04
Beta Skin	2.69E-03	0.00E+00	1.46E-03	1.34E-03	9.73E-03	2.37E-03	1.01E-02	4.76E-04	9.94E-04
Beta Lung	0.00E+00	2.91E-06	1.95E-05	1.87E-05	1.02E-04	3.38E-05	1.09E-04	1.10E-05	1.46E-05
Tau	1.05E-04	1.04E-04	4.38E-05	2.05E-09	1.51E-04	6.78E-05	3.61E-03	6.80E-07	3.55E-06

Close

NOTE: GASPAR calculates airborne submersion dose only from noble gas

GASPAR – Pathway Factors

- Default values included for various environmental pathway modeling parameters
- Goat milk transfer factors
- Hold-up and Transport Times
- Physical parameters
- Option to reset to default values

GASPAR

File Quit About

Case Title: GASPAR Test Case 1 - ICRP-2 Dose Factors: ICRP-2 (Default)

Options Source Term Pop./Prod Data Special Location Data Dose Factors Pathway Factors Consumption Values

Growing period for vegetables consumed by human:

Growing period for vegetables consumed by human:	60.0	days
Cow feed ingestion rate:	50.0	kg/day
Goat feed ingestion rate:	6.0	kg/day
Vegetables retention for particulates other than iodine:	0.2	
Weather removal constant:	5.73E-7	1/sec
Soil surface density:	240.0	kg/m ²
Iodine retention:	1.0	
Pasture grass yield:	0.7	kg/m ²
Feed crop yield:	2.0	kg/m ²
Garden vegetable crop yield:	2.0	kg/m ²

Goat Feed to Milk Transfer Factors (D/L)

Hydrogen:	0.17	Calcium:	0.47
Boron:	0.012	Iron:	0.0013
Carbon:	0.10	Copper:	0.013
Magnesium:	0.042	Strontium:	0.014
Phosphorus:	0.25	Iodine:	0.06
Chlorine:	0.50	Cesium:	0.30
Potassium:	0.057	Polonium:	0.0018

Holdup and Transport Times (sec)

Meat to consumption:	1.73E6
Milk to population:	3.46E5
Vegetables to population:	1.21E6
Vegetables to individual:	5.18E6
Milk to individual:	1.73E5
Leafy vegetables to individual:	8.64E4
Pasture grazing period:	2.59E6
Feed storage time:	7.78E6

Physical Parameters

Midpoint of plant life:	6.31E8	sec
Shielding factor for individuals:	0.7	
Shielding factor for populations:	0.5	
Hydrosphere water volume:	2.7E19	L
Volume of the atmosphere:	3.8E18	m ³
Iodine deposit fraction:	0.5	

Transfer Factors

Page Defaults

Save Create Input View Input Run GASPAR View Output FSAR Report Supplemental Report

GASPAR – Transfer Factors

- By element
 - Feed-to-meat (cow, day/kg)
 - Soil-to-vegetation
 - Grass-to-milk (cow, day/liter)
- Can be edited to address site-characteristic data
- Tab to reset to Default values
- Save – any changed

Transfer Factors

Element	Item	Value
H	Meat	1.2E-02
H	Soil	4.8E+00
H	Milk	1.0E-02
HE	Meat	2.0E-02
HE	Soil	5.0E-02
HE	Milk	2.0E-02
LI	Meat	1.0E-02
LI	Soil	8.3E-04
LI	Milk	5.0E-02
BE	Meat	1.0E-03
BE	Soil	4.2E-04
BE	Milk	1.0E-04
B	Meat	8.0E-04
B	Soil	1.2E-01
B	Milk	2.7E-03
C	Meat	3.1E-02
C	Soil	5.5E+00
C	Milk	1.2E-02

Get Defaults Save

Close

GASPAR – Consumption Values

- U.S. (country) population
 - Artifact of FORTRAN code; required input but not used
- Population fractions
- Maximum and average individual consumption values; by age group
- Get Defaults to reset
- Save changes

The screenshot displays the GASPAR software interface. At the top, there is a menu bar with 'File', 'Quit', and 'About'. Below the menu bar, the 'Case Title' is 'GASPAR Test Case 1 - ICRP-2' and the 'Dose Factors' are set to 'ICRP-2 (Default)'. The 'Consumption Values' tab is selected, showing 'Usage Parameters' and 'Intake Consumption Data'.

Usage Parameters

2000 US population: Fraction of population:

Intake Consumption Data

Intake Type -->	Inhalation (m3/yr)	Vegetables (kg/yr)	Leafy Vegetables (kg/yr)	Milk (kg/yr)	Meat (kg/yr)
Max Adult Consumption	8000.00	520.00	64.00	310.00	110.00
Max Teen Consumption	8000.00	630.00	42.00	400.00	65.00
Max Child Consumption	3700.00	520.00	26.00	330.00	41.00
Max Infant Consumption	1400.00	0.00	0.00	330.00	0.00
Avg Adult Consumption	8000.00	190.00	30.00	110.00	95.00
Avg Teen Consumption	8000.00	240.00	20.00	200.00	59.00
Avg Child Consumption	3700.00	200.00	10.00	170.00	37.00

Buttons: Save, Create Input, View Input, Run GASPAR, View Output, FSAR Report, Supplemental Report, Get Defaults, Usage Defaults, Save

Running GASPAR – Outputs/Reports

- Can be Saved and Run from any screen
 - Save
 - Create Input
 - View Input
 - Run GASPAR
 - View Output
 - FSAR Report
 - Supplemental Report

GASPAR

File Quit About

Case Title: Dose Factors:

Options Source Tem Pop/Prod Data Special Location Data Dose Factors Pathway Factors Consumption Values

Usage Parameters

2000 US population: Fraction of population:

Intake Consumption Data

Intake Type -->	Inhalation (m3/yr)	Vegetables (kg/yr)	Leafy Vegetables (kg/yr)	Milk (kg/yr)	Meat (kg/yr)	<input type="button" value="Get Defaults"/>
Max Adult Consumption	8000.00	520.00	64.00	310.00	110.00	<input type="button" value="Save"/>
Max Teen Consumption	8000.00	630.00	42.00	400.00	65.00	
Max Child Consumption	3700.00	520.00	26.00	330.00	41.00	
Max Infant Consumption	1400.00	0.00	0.00	330.00	0.00	
Avg Adult Consumption	8000.00	190.00	30.00	110.00	95.00	
Avg Teen Consumption	8000.00	240.00	20.00	200.00	59.00	
Avg Child Consumption	3700.00	200.00	10.00	170.00	37.00	



View Input

- Input follows the format of the “card deck” as described in NUREG/CR-4653
- The datasets reflect testing modeling under the “Pathway factors” tab, such as transfer factors, exposure and transfer assumptions.
- The bottom section is the standard format for GASPARG input (individual doses only), containing the Selections inputs, source term, Special Location assumptions
- If population doses performed, would also include the population, production and meteorological data

```

| 1.20E-2 2.00E-2 1.00E-2 1.00E-3 8.00E-4 3.10E-2 7.70E-2 1.60E-2 1.50E-1 2.00E-2 3.00E-2 5.00E-3
1.50E-3 4.00E-5 4.60E-2 1.00E-1 8.00E-2 2.00E-2 1.20E-2 4.00E-3 1.60E-2 3.10E-2 2.30E-3 2.40E-3
8.00E-4 4.00E-2 1.30E-2 5.30E-3 8.00E-3 3.00E-2 1.30E+0 2.00E+1 2.00E-3 1.50E-2 2.60E-2 2.00E-2
3.10E-2 6.00E-4 4.60E-3 3.40E-2 2.80E-1 8.00E-3 4.00E-1 4.00E-1 1.50E-3 4.00E-3 1.70E-2 5.30E-4
8.00E-3 8.00E-2 4.00E-3 7.70E-2 2.90E-3 2.00E-2 4.00E-3 3.20E-3 2.00E-4 1.20E-3 4.70E-3 3.30E-3
4.80E-3 5.00E-3 4.80E-3 1.60E-3 4.40E-3 5.30E-3 4.40E-3 4.00E-3 4.40E-3 4.40E-3 4.40E-3 4.00E-1
1.60E+0 1.30E-3 8.00E-3 4.00E-1 1.50E-3 4.00E-3 8.00E-3 2.60E-1 4.00E-2 2.90E-4 1.30E-2 1.20E-2
8.00E+0 2.00E-2 2.00E-2 3.40E-2 6.00E-2 2.00E-4 8.00E+2 3.40E-4 2.00E-4 1.40E-5 2.00E-4 2.00E-4
2.00E-4 2.00E-4 2.00E-4 2.00E-4
4.80E+0 5.00E-2 8.30E-4 4.20E-4 1.20E-1 5.50E+0 7.50E+0 1.60E+0 6.50E-4 1.40E-1 5.20E-2 1.30E-1
1.80E-4 1.50E-4 1.10E+0 5.90E-1 5.00E+0 6.00E-1 3.70E-1 3.60E-2 1.10E-3 5.40E-5 1.30E-3 2.50E-4
2.90E-2 6.60E-4 9.40E-3 1.90E-2 1.20E-1 4.00E-1 2.50E-4 1.00E-1 1.00E-2 1.30E+0 7.60E-1 3.00E+0
1.30E-1 1.70E-2 2.60E-3 1.70E-4 9.40E-3 1.20E-1 2.50E-1 5.00E-2 1.30E+1 5.00E+0 1.50E-1 3.00E-1
2.50E-1 2.50E-3 1.10E-2 1.30E+0 2.00E-2 1.00E+1 1.00E-2 5.00E-3 2.50E-3 2.50E-3 2.50E-3 2.40E-3
2.50E-3 2.50E-3 2.50E-3 2.60E-3 2.60E-3 2.50E-3 2.60E-3 2.50E-3 2.60E-3 2.50E-3 2.60E-3 1.70E-4
6.30E-3 1.80E-2 2.50E-1 5.00E-2 1.30E+1 5.00E-1 2.50E-3 3.80E-1 2.50E-1 6.80E-2 1.50E-1 1.50E-1
2.50E-1 3.50E+0 1.00E-2 3.10E-4 2.50E-3 4.20E-3 2.50E-3 2.50E-3 2.50E-3 2.50E-4 2.50E-4 2.50E-3
2.50E-3 2.50E-3 2.50E-3 2.50E-3
1.00E-2 2.00E-2 5.00E-2 1.00E-4 2.70E-3 1.20E-2 2.20E-2 2.00E-2 1.40E-2 2.00E-2 4.00E-2 1.00E-2
5.00E-4 1.00E-4 2.50E-2 1.80E-2 5.00E-2 2.00E-2 1.00E-2 8.00E-3 5.00E-6 5.00E-6 1.00E-3 2.20E-3
2.50E-4 1.20E-3 1.00E-3 6.70E-3 1.40E-2 3.90E-2 5.00E-5 5.00E-4 6.00E-3 4.50E-2 5.00E-2 2.00E-2
3.80E-2 8.00E-4 1.00E-3 5.00E-6 2.50E-7 7.50E-3 2.50E-2 1.00E-6 1.00E-2 1.00E-2 5.00E-2 1.20E-4
1.00E-4 2.50E-3 1.50E-3 1.00E-3 6.00E-3 2.00E-2 1.20E-2 4.00E-4 5.00E-6 1.00E-4 5.00E-6 5.00E-6
5.00E-6 5.00E-6 5.00E-6 5.00E-6 5.00E-6 5.00E-6 5.00E-6 5.00E-6 5.00E-6 5.00E-6 5.00E-6 5.00E-6
2.50E-2 5.00E-4 2.50E-2 5.00E-3 5.00E-3 5.00E-3 8.00E-2 2.20E-2 6.20E-4 5.00E-4 3.00E-4
5.00E-2 2.00E-2 5.00E-2 8.00E-3 5.00E-6 5.00E-6 5.00E-6 5.00E-4 5.00E-6 2.00E-6 5.00E-6 5.00E-6
5.00E-6 5.00E-6 5.00E-6 5.00E-6
2.80E+08 3
9.30E-03 1.93E-05 1.23E-03 1.72E-05 6.17E-03 1.52E-02 1.73E-02 1.56E-04 3.27E-04 3.53E-04 3.36E-03
1.92E-03 1.51E-03 9.21E-03
3.28E-03 2.88E-04 1.97E-03
2.46E-03 1.27E-02 4.17E-03 1.95E-03 1.03E-02 2.93E-03 1.06E-02 1.11E-03 1.48E-03 1.05E-03 7.39E-04
7.18E-03 1.40E-07 8.03E-04 2.81E-05 4.64E-03 1.13E-02 1.12E-02 4.08E-05 1.50E-04 1.55E-04 2.22E-03
1.29E-03 1.21E-03 6.41E-03
1.18E-02 4.16E-06 2.62E-03 1.54E-03 1.60E-02 1.58E-02 2.43E-02 5.63E-04 1.22E-03 5.81E-04 3.47E-03
3.65E-03 1.58E-02 1.25E-02
0.00E+00 2.91E-06 1.95E-05 1.87E-05 1.02E-04 3.38E-05 1.09E-04 1.10E-05 1.46E-05 1.05E-05 8.79E-06
2.46E-05 1.23E-04 4.93E-05
1.05E-04 1.04E-04 4.38E-05 2.05E-09 1.51E-04 6.78E-05 3.61E-03 6.80E-07 3.55E-06 1.53E-06 7.41E-04
2.12E-05 2.96E-03 8.15E-04
60.0 50.0 6.0 0.2 5.73E-7
240.0 1.0 0.7 2.0 2.0
1.73E+06 3.46E+05 1.21E+06 5.18E+06 1.73E+05 8.64E+04 2.59E+06 7.78E+06
1.70E-01 1.20E-02 1.00E-01 4.20E-02 2.50E-01 5.00E-01 5.70E-02 4.70E-01 1.30E-03 1.30E-02
1.40E-02 6.00E-02 3.00E-01 1.80E-03
0.18 0.11 0.71
3760.0 5548.0 5950.0
111.0 120.0 175.0
4.8 8.1 17.0
141.0 83.0 70.0
22.0 35.0 47.0
3360.0 5000.0 5040.0 6060.0 8000.0 8980.0
182.0 249.0 269.0 323.0 296.0 429.0
4.8 10.1 11.5 14.6 19.9 42.2
150.0 477.0 347.0 369.0 340.0 301.0
27.0 51.0 58.0 74.0 97.0 120.0
0.7 0.5 0.5 5.0
6.31E8 2.7E19 3.8E18
0
GASPARG Test Case 1 - ICRP-72
1 1 1 0 1 0 0
1000 0.75 0.8 0.5 1 8 70 1 1 0.8 1
Source Term 1
1 1 0 0
CS-137 1.000E+00
H -3 1.000E+02
I -131 1.000E-01
KR-85 3.000E+02
XE-135 2.000E+02
1Test Loc #1 N 1000 1.000E-06 1.000E-06 1.000E-06 1.000E-070000000
1Test Loc #2 NE 1200 2.200E-07 2.100E-07 2.000E-07 3.400E-090000000

```

Run GASPAR – View Output

- Basic assumptions used for calculations
- Lists the Source Term
- Followed by Doses
 - Population (if performed)
 - Individual by Special Locations
- If selected “Print Dose Factor Library,” output will include all nuclides

```
*****
*
*
*                               NRC Dose3
*
*                               GASPAR Test Case 1 - ICRP-2
*
*                               U.S. NUCLEAR REGULATORY COMMISSION
*                               WASHINGTON, D.C. 20555
*
*                               DATE OF RUN:10-23-2019
*
*                               CALCULATIONS PERFORMED USING THE ICRP-2
*                               BASED DOSE CONVERSION FACTORS
*
*****

GASPAR Test Case 1 - ICRP-2

JOB CONTROL PARAMETERS

JC(1) = 1 :POPULATION/INDIVIDUAL DOSE SELECTION
JC(2) = 1 :NUMBER OF SOURCE RELEASE POINTS
JC(3) = 1 :PRINT CONTROL FOR DOSE ACCUMULATION
JC(4) = 0 :READ CONTROL FOR BLOCK DATA CHANGE RECORDS
JC(5) = 0 :PRINT CONTROL FOR DOSE FACTOR TABLE
JC(6) = 0 :CALCULATION CONTROL FOR UNIT DOSE FACTORS
JC(7) = 0 :READ CONTROL FOR DISPERSION DATA INPUT FILE
JC(8) = 0
JC(9) = 0
JC(10)= 0

EXPOSURE PATHWAY FRACTIONS

PARAMETER DESCRIPTION(FRACTION) VALUE
-----
FV LEAFY VEGETABLE FROM GARDEN 0.75
FG OTHER EDIBLES FROM GARDEN 0.50
FP TIME MILK COWS ON PASTURE 0.80
FB TIME BEEF ON PASTURE 0.80
FGT TIME MILK GOATS ON PASTURE 1.00
FPF MILK COW INTAKE FROM PASTURE 1.00
FBF BEEF INTAKE FROM PASTURE 1.00
FPG MILK GOAT INTAKE FROM PASTURE 1.00

HUMIDITY(G/M**3) 1.42

SOURCE TERM RELEASE NUMBER 1

RELEASE POINT Source Term 1
UML = 1.00E+00 SOURCE TERM MULTIPLICATION FACTOR
JC1 = 0 NEW OR PREVIOUS MET DATA PARAMETER
JC2 = 0 NEW OR PREVIOUS SOURCE TERM RELEASE DATA PARAMETER

NUCLIDE CI/YR
-----
55CS137 1.00E+00
1H 3 1.00E+02
53I 131 1.00E-01
36KR 85 3.00E+02
54XE135 2.00E+02

6.011E+02 TOTAL CURIES FOR 5 RADIONUCLIDES
```

GASPAR FSAR Report

- Provides a summary report of assumptions and doses
- Suitable for use in creating input for safety analyses and licensing support

FSAR Input Report - GASPAR Test Case 1 - ICRP-2 - 22-Oct-2019 18:07

Input Parameters for the GASPAR Code

```

-----
X/Q (sec/m3)
For maximum individual dose calculation
Undecayed, Undepleted: 1.00E-06
Decayed, Undepleted: 1.00E-06
Decayed, Depleted: 1.00E-06

D/Q (1/m2)
For maximum individual dose calculation 1.00E-07

Distance to residence (mi) 0.62
Midpoint of plant life (yr) 20.0
Fraction of the year that leafy vegetables are grown: 0.75
Fraction of the year that milk cows are on pasture: 0.80
Fraction of milk-cow feed intake that is from pasture while on pasture: 1.00
Fraction of the year that goats are on pasture: 1.00
Fraction of goat feed intake that is from pasture while on pasture: 1.00
Fraction of the maximum individual's vegetable intake that is from garden: 0.50
Average absolute humidity over the growing season (g/m3): 1.00
Fraction of the year that beef cattle cows are on pasture: 0.80
Fraction of beef-cattle feed intake that is from pasture while on pasture: 1.00
Animal considered for milk pathway Cow and Goat
Annual milk production for all distances and directions within 50 miles (L) 1000
Annual meat production for all distances and directions within 50 miles (kg) 1000
Annual vegetable production for all distances and directions within 50 miles (kg) 1000
    
```

Gaseous Source Term for the GASPAR Code

Isotope	Release Rate (Ci/yr)
CS-137	1.00E+00
H-3	1.00E+02
I-131	1.00E-01
KR-85	3.00E+02
XE-135	2.00E+02

Calculated Doses from Gaseous Effluents (Plume Exposure due to Noble Gases)

Type of Dose	Dose
Gamma dose in air (mrad/yr)	1.22E-02
Beta dose in air (mrad/yr)	3.41E-02
Dose to total body (mrem/yr)	8.14E-03
Dose to skin (mrem/yr)	3.41E-02

Note: 1. Doses due to noble gases, including AR-41

Calculated Doses from Gaseous Effluents (mrem/yr)

Age Group	Effective	GI-LLI	Bone	Liver	Kidney	Thyroid	Lung
Ground	4.13E+01	4.13E+01	4.13E+01	4.13E+01	4.13E+01	4.13E+01	4.13E+01
Vegetable							
Adult	1.30E+01	4.09E-01	1.45E+01	1.99E+01	6.81E+00	1.20E+01	2.25E+00
Teen	1.07E+01	4.62E-01	2.30E+01	3.06E+01	1.05E+01	1.49E+01	4.05E+00
Child	7.70E+00	3.58E-01	5.41E+01	5.18E+01	1.70E+01	2.76E+01	6.09E+00
Meat							
Adult	1.81E+00	5.71E-02	2.01E+00	2.76E+00	9.40E-01	6.30E-01	3.14E-01
Teen	7.76E-01	3.39E-02	1.67E+00	2.22E+00	7.60E-01	4.56E-01	2.96E-01
Child	4.38E-01	2.10E-02	3.08E+00	2.95E+00	9.65E-01	6.88E-01	3.47E-01
Cow Milk							
Adult	1.53E+01	4.72E-01	1.71E+01	2.33E+01	8.00E+00	1.73E+01	2.63E+00
Teen	1.44E+01	6.13E-01	3.09E+01	4.12E+01	1.41E+01	2.74E+01	5.44E+00
Child	1.06E+01	4.76E-01	7.45E+01	7.13E+01	2.35E+01	5.40E+01	8.36E+00

GASPAR Supplemental Report

- Provides additional information that may not be included in the GASPAR output or the FSAR Report

Supplemental FSAR Input - GASPAR Test Case 1 - ICRP-2 - 22-Oct-2019 18:10

Program Constants for GASPAR

Intake Product Parameters

Growing period for vegetables consumed by human:	60.0	days
Cow feed ingestion rate:	50.0	kg/day
Goat feed ingestion rate:	6.0	kg/day
Vegetables retention for particulates other than iodine:	0.2	
Weather removal constant:	5.73E-7	1/sec
Soil surface density:	240.0	1/sec
Iodine retention:	1.0	
Pasture grass yield:	0.7	kg/m2
Feed crop yield:	2.0	kg/m2
Garden vegetable crop yield:	2.0	kg/m2

Holdup & Transport Times (sec)

Meat to consumption:	1.73E6
Milk to population:	3.46E5
Vegetables to population:	1.21E6
Vegetables to individual:	5.18E6
Milk to individual:	1.73E5
Leafy vegetables to individual:	8.64E4
Pasture grazing period:	2.59E6
Feed storage time:	7.78E6

Physical Parameters

Midpoint of plant life:	6.31E8	sec
Shielding factor for individuals:	0.7	
Shielding factor for populations:	0.5	
Hydrosphere water volume:	2.7E19	m3
Volume of the atmosphere:	3.8E18	m3
Iodine deposit fraction:	0.5	
Bone correction factor:	5.0	

Goat Feed to Milk Transfer Factors (D/L)

Hydrogen:	0.17	Calcium:	0.47
Boron:	0.012	Iron:	0.0013
Carbon:	0.10	Copper:	0.013
Magnesium:	0.042	Strontium:	0.014
Phosphorus:	0.25	Iodine:	0.06
Chlorine:	0.50	Cesium:	0.30
Potassium:	0.057	Polonium:	0.0018

Usage Parameters

2000 US Population:	2.80E+08		
	Children	Teenagers	Adults
Fraction of population:	0.18	0.11	0.71
Average inhalation rate:	8000.0	8000.0	3700.0
Average vegetable intake:	190.0	240.0	200.0
Average leafy vegetable intake:	30.0	20.0	10.0
Average milk intake:	110.0	200.0	170.0
Average meat intake:	95.0	59.0	37.0

Transfer Coefficients for the LADTAP and GASPAR Codes

Units: Veg (veg/soil); Milk (d/l); Meat (d/kg)

Element	Item	Value
H	Meat	1.20E-02
H	Veg/Soil	4.80E+00
H	Milk	1.00E-02
KR	Meat	2.00E-02
KR	Veg/Soil	3.00E+00
KR	Milk	2.00E-02
I	Meat	2.90E-03
I	Veg/Soil	2.00E-02
I	Milk	6.00E-03

LADTAP

LADTAP
Liquid Pathway Dose Assessment

GASPAR
Gaseous Pathway Dose Assessment

XOQDOQ
**Annual Average Meteorological
Dispersion and Deposition**

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LADTAP Dose Modeling

- Routine liquid effluent releases – not for short-term accident
- Modeling assumes annual average conditions
 - Average dispersion in receiving water body
 - Average radioactive effluents over time
- RG 1.109, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I, Rev. 1, October 1977

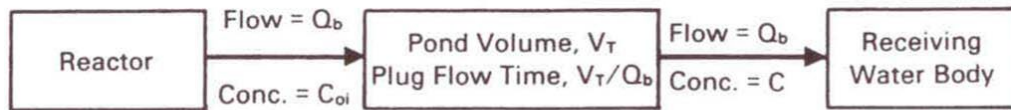
LADTAP Dose Modeling

- Exposure pathways to maximum exposed individual and to population:
 - potable water (downstream supply),
 - aquatic foods (fresh and saltwater water fish, invertebrate (crustacea and shellfish), and aquatic plants (seaweed)
 - shoreline deposits (build-up to mid-point of plant life (assumed 40-year life)
 - Swimming and boating from direct exposure,
 - irrigated foods, and
 - non-human biota (7 surrogate species)

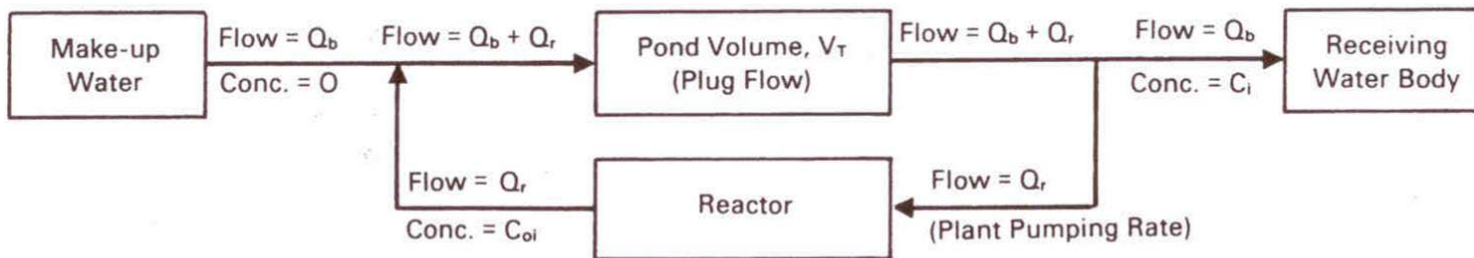
LADTAP – Reconcentration models

- Models from RG 1.113:
 - **Plug-Flow Model** - uniform, constant flow through pond; negligible evaporation
 - **Partially Mixed Model** - applicable where blowdown and plant pumping significant
 - **Completely Mixed Model** - estimates effluent concentration at midpoint of plant life
- Refer to NUREG/CR-4013, Section 3.1.1 for more detail

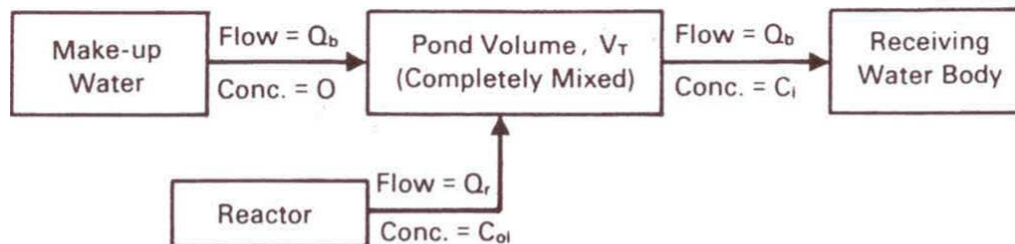
LADTAP – Reconcentration Models



(a) Plug-Flow Model



(b) Partially Mixed Model



(c) Completely Mixed Model

FIGURE 3.2. Schematic Representations of Impoundment Models

Starting and Running LADTAP

- Double click "LADTAP"

LADTAP
Liquid Pathway Dose Assessment

GASPAR
Gaseous Pathway Dose Assessment

XOQDOQ
**Annual Average Meteorological
Dispersion and Deposition**

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LADTAP Main Screen

- LADTAP opens with data saved in the database
- Contains three main functional areas:
 - the toolbar and initial setup area,
 - data input tabs area and
 - code execution and reports area

LADTAP

File Quit About

Scenario: NUREG/CR-4013 Sample Problem 1 Source Term: Test #1 Dose Factors: ICRP-2 (Default)

Selections ALARA Locations Fish/Population/Biota Irrigation Food Data Dose Factors Pathway Factors

Discharge Flow Rate: 3150.00 CFS Site Type
 Fresh water
 Salt water

Source Term Multiplier: 1

50 mi Population: 2200000

Print dose factors

Population Fractions
Modify defaults?
 No Yes Edit

Dose Contributions
Print by radionuclide %
 No Yes

Reconciliation
Model: Partially-Mixed

Effluent discharge rate from impoundment system to the receiving water body:
200 CFS

Impoundment Total Volume:
50000 ft³

Add Nuclide
Delete Nuclide
Clear

Source Term:		
Nuclide	Quantity (Ci)	R-Factor
I-133	1.20E-03	
I-135	1.30E-03	
CS-134	3.90E-04	
CS-138	2.80E-02	
CS-137	5.50E-03	
H-3	1.80E+01	
I-131	5.20E-04	

Total Quantity: 1.8037E+01 Curies

Save Create Input View Input Run LADTAP View Output FSAR Report Supplemental Report

LADTAP Start-up

- New — Select this option to begin a new LADTAP case. This will clear the database from any previously input information.
- Open LN3 File — Select this option to access and open a “*.LN3” file that was previously created with NRC Dose3.
- Save to Database — Choose this option to save the current case to the database. When LADTAP starts, it loads the data that was last saved (typically from the last, previous run), populating all LADTAP screens and windows.
- Save to LN3 File — Choose this option to save the completed case to a “*.LN3” file. This allows the file to be saved for later use, or for sharing with others.
- Delete — Choose this option to open an explorer window that will allow the user to delete any previously saved “*.LN3” files.

LADTAP – Basic Information

- Scenario Name
- Source Term Identifier
- Dose Factor Library
 - ICRP-2 (Default)
 - ICRP-30
 - ICRP-72

The screenshot shows the LADTAP software interface. At the top, there is a menu bar with 'File', 'Quit', and 'About'. Below the menu bar, there are three input fields: 'Scenario: NUREG/CR-4013 Sample Problem 1', 'Source Term: Test #1', and 'Dose Factors: ICRP-2 (Default)'. Below these fields, there is a tabbed interface with tabs for 'Selections', 'ALARA Locations', 'Fish/Population/Biota', 'Imigation Food Data', 'Dose Factors', and 'Pathway Factors'. The 'Selections' tab is active. In the center, there are several input fields and checkboxes: 'Discharge Flow Rate: 3150.00 CFS', 'Source Term Multiplier: 1', '50 mi Population: 2200000', 'Print dose factors' (checkbox), 'Population Fractions' (radio buttons for 'No' and 'Yes'), 'Dose Contributions' (radio buttons for 'No' and 'Yes'), 'Reconcentration' (dropdown menu for 'Partially-Mixed'), 'Effluent discharge rate from impoundment system to the receiving water body: 200 CFS', and 'Impoundment Total Volume: 50000 ft³'. On the right side, there is a table titled 'Source Term:' with columns 'Nuclide', 'Quantity (Ci)', and 'R-Factor'. The table contains the following data:

Nuclide	Quantity (Ci)	R-Factor
I-133	1.20E-03	
I-135	1.30E-03	
CS-134	3.90E-04	
CS-138	2.80E-02	
CS-137	5.50E-03	
H-3	1.80E+01	
I-131	5.20E-04	

Below the table, there are buttons for 'Add Nuclide', 'Delete Nuclide', and 'Clear'. At the bottom right, there is a 'Total Quantity: 1.8037E+01 Curies' field. At the bottom of the window, there is a row of buttons: 'Save', 'Create Input', 'View Input', 'Run LADTAP', 'View Output', 'FSAR Report', and 'Supplemental Report'.

NOTE: Changing DCF Library will cause other entries to reset

LADTAP – Selections

- Release/site information
- Fresh or Saltwater
- Print Dose Factors
- Dose contribution by nuclide
- Modify Population Fractions
 - (ICRP-2/ICRP-72)
 - Adult (71%)
 - Teen (11%)
 - Child (18%)
 - ICRP-30
 - Adult (100%)

The screenshot shows the LADTAP software interface. At the top, there is a menu bar with 'File', 'Quit', and 'About'. Below the menu bar, there are input fields for 'Scenario: NUREG/CR-4013 Sample Problem 1', 'Source Tem: Test #1', and 'Dose Factors: ICRP-2 (Default)'. The main window has several tabs: 'Selections', 'ALARA Locations', 'Fish/Population/Biota', 'Irigation Food Data', 'Dose Factors', and 'Pathway Factors'. The 'Selections' tab is active. In the center, there is a 'Site Type' section with two radio buttons: 'Fresh water' (selected) and 'Salt water'. To the left, there are input fields for 'Discharge Flow Rate: 3150.00 CFS', 'Source Tem Multiplier: 1', and '50 mi Population: 2200000'. Below these are checkboxes for 'Print dose factors' and 'Population Fractions' (with 'No' selected). To the right, there is a 'Dose Contributions' section with 'Print by radionuclide %' (with 'No' selected). At the bottom left, there is a 'Reconcentration' section with a 'Model' dropdown set to 'Partially-Mixed', and input fields for 'Effluent discharge rate from impoundment system to the receiving water body: 200 CFS' and 'Impoundment Total Volume: 50000 ft³'. On the right side, there is a table titled 'Source Tem:' with columns 'Nuclide', 'Quantity (Ci)', and 'R-Factor'. The table contains the following data:

Nuclide	Quantity (Ci)	R-Factor
I-133	1.20E-03	
I-135	1.30E-03	
CS-134	3.90E-04	
CS-138	2.80E-02	
CS-137	5.50E-03	
H-3	1.80E+01	
I-131	5.20E-04	

At the bottom right, there is a 'Total Quantity: 1.8037E+01 Curies' field. At the very bottom, there are several buttons: 'Save', 'Create Input', 'View Input', 'Run LADTAP', 'View Output', 'FSAR Report', and 'Supplemental Report'.

LADTAP – Reconcentration

- Drop down menus for the three (3) models

LADTAP

File Quit About

Scenario: NUREG/CR-4013 Sample Problem 1 Source Term: Test #1 Dose Factors: ICRP-2 (Default)

Selections ALARA Locations Fish/Population/Biota Irrigation Food Data Dose Factors Pathway Factors

Source Term:

Nuclide	Quantity (Ci)	R-Factor
I-133	1.20E-03	
I-135	1.30E-03	
CS-134	3.90E-04	
CS-138	2.80E-02	
CS-137	5.50E-03	
H-3	1.80E+01	
I-131	5.20E-04	

Discharge Flow Rate: 3150.00 CFS

Source Term Multiplier: 1

50 mi Population: 2200000

Site Type

Fresh water

Salt water

Print dose factors

Population Fractions

Modify defaults?

No Yes

Dose Contributions

Print by radionuclide %

No Yes

Reconcentration

Model: Partially-Mixed

Effluent discharge rate from impoundment system to the receiving water body: 200 CFS

Impoundment Total Volume: 50000 ft³

Add Nuclide

Delete Nuclide

Clear

Total Quantity: 1.8037E+01 Curies

Save Create Input View Input Run LADTAP View Output FSAR Report Supplemental Report

Alternatively, user can put in a nuclide specific reconcentration factor manually.

LADTAP – Reconcentration Models

- Plug-Flow Model

$$C_i = C_{0i} * \exp[-2.788 \times 10^{-4} \lambda_i \frac{V_T}{Q_B}]$$

- Partially Mixed Model

$$C_i = C_0 * \frac{R}{(R+1) * \exp[\frac{V_T * \lambda_i}{3600 * Q_r (R+1)} - 1]}$$

where:

$$R = \frac{\text{reactor effluent discharge rate}}{\text{pond flow-through rate}}$$

- Completely Mixed Model

$$C_i = C_0 * \frac{Q_b}{(Q_b + V_T * \lambda_i / 3600) \left\{ 1 - \exp \left[-3.15 \times 10^7 (Q_b + \frac{\lambda_i V_T}{3600}) (\frac{T_{PL}}{V_T}) \right] \right\}}$$

LADTAP – Source Term

- Select: Add Nuclide
- Pop-up menus with nuclide list
- Highlight desired nuclide; use "control" key to select multiple nuclides
 - Select "Add" to add to list
- "Delete Nuclide" will delete selected nuclide
- "Clear" will clear all nuclides in the Source Term

The screenshot displays the LADTAP Source Term interface. It features a table with columns for Nuclide, Quantity (Ci), and R-Factor. A 'Select Nuclide' pop-up menu is open, showing a list of nuclides with 'AC-225' selected. The interface includes buttons for 'Add Nuclide', 'Delete Nuclide', and 'Clear', as well as 'Run LADTAP' and 'View Output' buttons at the bottom. A 'Site Type' section has radio buttons for 'Fresh water' (selected) and 'Salt water'. A 'Contributions' section has radio buttons for 'No' and 'Yes'. A 'Total Quantity' label is visible at the bottom right of the table area.

Nuclide	Quantity (Ci)	R-Factor
I-133	1.20E-03	
I-135	1.30E-03	
CS-134	3	
CS-138	2	
CS-137	5	
H-3	1	
I-131	5	

Source Term:

Nuclide	Quantity (Ci)	R-Factor
AC-225		
AC-227		
AG-110M		
AG-111		
AM-241		
AM-242M		
AM-243		
AR-39		
AR-41		
AU-198		
BA-133		
BA-139		
BA-140		
BA-141		
BA-142		
BE-10		
BI-210		
BR-82		

Site Type

Fresh water
 Salt water

Contributions

No
 Yes

Add Nuclide

Delete Nuclide

Clear

Run LADTAP

View Output

Add

Exit

Total Quantity

LADTAP – Source Term

- ICRP-30 and ICRP-72 DCFs
 - For radionuclides with more than one solubility class, select the applicable one
 - The same nuclide with more than one solubility class is not allowed

The screenshot displays the 'Source Term' configuration window in LADTAP. It features a table of nuclides with columns for Nuclide, Default, f1, Quantity (Ci), and R-Factor. A 'Select Nuclide' dialog box is open, showing a list of nuclides with columns for Nuclide, Default, and f1. The dialog box also includes 'Add' and 'Exit' buttons.

Nuclide	Default	f1	Quantity (Ci)	R-Factor
CS-134	Yes	1	3.90E-04	
CS-137	Yes	1	5.50E-03	
CS-138	Yes			
H-3	Yes			
I-131	Yes			
I-133	Yes			
I-135	Yes			

Nuclide	Default	f1
AC-225	Yes	0.001
AC-227	Yes	0.001
AG-110M	Yes	0.05
AG-111	Yes	0.05
AM-241	Yes	0.001
AM-242M	Yes	0.001
AM-243	Yes	0.001
AR-39	Yes	
AR-41	Yes	
AU-198	Yes	0.1
BA-133	Yes	0.1
BA-139	Yes	0.1
BA-140	Yes	0.1
BA-141	Yes	0.1
BA-142	Yes	0.1
BE-10	Yes	0.005
BI-210	Yes	0.05

LADTAP – ALARA Locations (Individual Doses)

- Defines the exposure assumptions for individual dose calculations
- Enter data
 - Shore width factor defines the geometry for the shoreline exposure
 - Dilution factors by pathway
 - Transit time by pathways

LADTAP Input: C:\NRC\Dose3\NUREG-CR-4013 Sample Problem 1 - ICRP-2.In3

File Quit About

Scenario: NUREG/CR-4013 Sample Problem 1 Source Term: Test #1 Dose Factors: ICRP-2 (Default)

Selections ALARA Locations Fish/Population/Biota Irrigation Food Data Dose Factors Pathway Factors

ALARA - Max. Individual

Shore-width factor: River Shoreline (0.2)

Dilution Factor

Aquatic food and boating:	1	Calc
Shoreline and swimming:	1	Calc
Drinking water:	4	Calc

Transit Time (hrs)

Drinking water:	3
Other pathways:	0.1

Change default usage and consumption data

No Yes Edit

Additional Usage Locations

At outfall	Add
Downstream	

Remove

Number of Records: 2

ALARA - Additional Location

Location: At outfall

Dilution Factor

All pathways:	1	Calc
---------------	---	------

Transit Time (hrs)

All pathways:	1
---------------	---

Shore-width factor: River Shoreline (0.2)

Change default usage and consumption data

No Yes Edit Cancel Save

Save Create Input View Input Run LADTAP View Output FSAR Report Supplemental Report

LADTAP – Dilution Factor Calculation

- Using the “Calc” options, a dilution factor will be calculated based on receiving water body parameters
 - Based on RG 1.113
 - For nontidal uniform flow and steady-state conditions, diffusive transport in the flow direction negligible compared with advective transport

Dilution Factor Calculation

Surface water model

River
 Lake

Surface Water Velocity (ft/sec):

Surface Water Depth (ft):

Downstream Distance (ft):

Offshore Distance (ft):

River Width/Lake Discharge Depth (ft):

Save Exit

LADTAP Dilution Calculation

- Surface Water Model — Select the appropriate hydrological model by clicking on either River or Lake model option
- Surface Water Velocity — surface water velocity in units of feet per second (ft/s)
- Surface Water Depth — surface water depth in units of ft
- Downstream Distance — downstream distance in units of ft
- Offshore Distance — offshore distance in units of ft
- River Width/Lake Discharge Depth — either the river width or lake discharge depth depending on the model selected in units of ft

LADTAP – Individual Age Group Exposure Assumptions

- Drop down menu to select age group
 - ICRP-2 DCFs: four age groups: Adult, Teen, Child, Infant
 - ICRP-30 DCFs: Adult age group only
 - ICRP-72 DCFs: Adult, 15-year, 10-year, 5-year, 1-year and newborn
- Remember to Save before Exit

Max Individual Consumption

Age Group: Adults

Consumption (kg/yr)

Fish:	21.00
Fresh Water Invertebrate:	0.00
Salt Water Invertebrate:	0.00
Aquatic Plant:	0.00
Drinking Water:	730.00

Usage/Exposure Time (hr/yr)

Shoreline:	12.00
Swimming:	12.00
Boating:	12.00

Save

Defaults

Exit

LADTAP – Additional Locations (Individual Doses)

- Add/remove additional locations of interest – by name
- Define exposure assumptions
 - Dilution
 - Transit time
 - Shore width factor
- Ability to change exposure times and consumption rates

Additional Usage Locations

At outfall
Downstream

Add

Remove

Number of Records: 2

ALARA - Additional Location

Location: At outfall

Dilution Factor

All pathways: 1 Calc

Transit Time (hrs)

All pathways: 1

Shore-width factor: River Shoreline (0.2) v

Change default usage and consumption data

No Yes Edit

Cancel Save

LADTAP Population Doses: Fish and Shellfish

- Select pathway from dropdown menu
- Add location
- Define harvest, dilution and transit time

LADTAP Input: C:\NRC\Dose3\NUREG-CR-4013 Sample Problem 1 - ICRP-72.In3

File Quit About

Scenario: NUREG/CR-4013 Sample Problem 1 Source Term: Test #1 Dose Factors: ICRP-72

Selections ALARA Locations Fish/Population/Biota Irrigation Food Data Dose Factors Pathway Factors

Fish Usage: Sport Fishing
Commercial Fishing
Sport Invertebrate Harvest
Commercial Invertebrate Harvest

Sport Fishing

Fish Downstream Add

Remove

Number of Records: 1

Sport Fishing Location

Location: Fish Downstream

Annual harvest: 70000 kg/yr

Dilution factor: 4 Calc

Transit Time: 1 hrs

Cancel Save

Population Usage: Drinking Water
Shoreline
Swimming
Boating

Drinking Water Usage

Water at 16 mi downstream Add

Remove

Number of Records: 1

Drinking Water Usage Location

Location: Water at 16 mi downstream

Total Population: 2200000

Dilution factor: 4 Calc

Transit Time: 1 hrs

Supply rate: 0 gpd

Avg Ind Usage: 0 gpd

Cancel Save

Biota Locations

Fish at outfall Add

Fish Downstream Remove

Number of Records: 2

Biota Exposure

Location: Fish at outfall

Dilution factor: 1 Calc

Transit Time: 0.1 hrs

Cancel Save

Add Biota

Save Create Input View Input Run LADTAP View Output FSAR Report Supplemental Report

LADTAP Population Usages

- From drop down, select:
 - drinking water,
 - shoreline,
 - swimming or
 - boating
- Add location
- For drinking water, define the population served or the supply rate
- For others, define person-hours annual usage
- Define dilution and transit time
- Add additional locations as needed

LADTAP Input: C:\NRC\dose3\NUREG-CR-4013 Sample Problem 1 - ICRP-72.In3

File Quit About

Scenario: NUREG/CR-4013 Sample Problem 1 Source Term: Test #1 Dose Factors: ICRP-72

Selections ALARA Locations Fish/Population/Biota Irrigation Food Data Dose Factors Pathway Factors

Fish Usage: Sport Fishing
Commercial Fishing
Sport Invertebrate Harvest
Commercial Invertebrate Harvest

Sport Fishing

Fish Downstream Add Remove

Number of Records: 1

Sport Fishing Location

Location: Fish Downstream

Annual harvest: 70000 kg/yr
Dilution factor: 4 Calc
Transit Time: 1 hrs
Cancel Save

Population Usage: Drinking Water
Shoreline
Swimming
Boating

Drinking Water Usage

Water at 16 mi downstream Add Remove

Number of Records: 1

Drinking Water Usage Location

Location: Water at 16 mi downstream

Total Population: 2200000
Dilution factor: 4 Calc
Transit Time: 1 hrs
Supply rate: 0 gpd
Avg Ind Usage: 0 gpd
Cancel Save

Biota Locations

Fish at outfall Add Remove
Fish Downstream

Number of Records: 2

Biota Exposure

Location: Fish at outfall

Dilution factor: 1 Calc
Transit Time: 0.1 hrs
Cancel Save

Add Biota

Save Create Input View Input Run LADTAP View Output FSAR Report Supplemental Report

LADTAP – Biota Doses

- Add locations for calculating doses to biota
- Define dilution and transit time
- Add additional locations as needed
- A “new” biota can be defined and added

LADTAP Input: C:\NRC\Dose3\NUREG-CR-4013 Sample Problem 1 - ICRP-72.In3

File Quit About

Scenario: NUREG/CR-4013 Sample Problem 1 Source Term: Test #1 Dose Factors: ICRP-72

Selections ALARA Locations Fish/Population/Biota Irrigation Food Data Dose Factors Pathway Factors

Fish Usage: Sport Fishing
Commercial Fishing
Sport Invertebrate Harvest
Commercial Invertebrate Harvest

Population Usage: Drinking Water
Shoreline
Swimming
Boating

Sport Fishing

Fish Downstream Add Remove

Number of Records: 1

Sport Fishing Location

Location: Fish Downstream

Annual harvest: 70000 kg/yr
Dilution factor: 4 Calc
Transit Time: 1 hrs
Cancel Save

Drinking Water Usage

Water at 16 mi downstream Add Remove

Number of Records: 1

Drinking Water Usage Location

Location: Water at 16 mi downstream

Total Population: 2200000
Dilution factor: 4 Calc
Transit Time: 1 hrs
Supply rate: 0 gpd
Avg Ind Usage: 0 gpd
Cancel Save

Biota Locations

Fish at outfall Add Remove
Fish Downstream

Number of Records: 2

Biota Exposure

Location: Fish at outfall

Dilution factor: 1 Calc
Transit Time: 0.1 hrs
Cancel Save

Add Biota

Save Create Input View Input Run LADTAP View Output FSAR Report Supplemental Report

LADTAP – Biota Doses

- Select the “Add Biota” button
- Enter the name and exposure assumptions for the new biota type.
- Select the “Save” button
- Up to five (5) new biota may be added

Additional Biota Types

Additional Biota Types

Name	Food Type	Mass (g)	Effective Radius (cm)	Consumption Rate (g/day)	Shoreline Exposure (hrs/yr)	Swimming Exposure (hrs/yr)
Bear	Fish	300	15	1E+04	4000	2000

Name: Consumption Rate: g/day

Food Type: Shoreline Exposure: hrs/yr

Mass: g Swimming Exposure: hrs/yr

Effective Radius: cm

LADTAP – Irrigated Foods

LADTAP Input: C:\NRC\Dose3\NUREG-CR-4013 Sample Problem 1 - ICRP-72.In3

File Quit About

Scenario: Source Term: Dose Factors: ICRP-2 (Default) ▾

Selections ALARA Locations Fish/Population/Biota **Irrigation Food Data** Dose Factors Pathway Factors

Irrigated Food Pathways

Number of Records:

Irrigated Food Data

Food type:

Irrigation rate: L/m²/mon

Total production rate within 50-mi radius: kg/yr or L/yr

Change default usage and consumption data

No Yes

LADTAP – Irrigated Foods

- From dropdown menu select food type
- Total production within 50 miles
- Add irrigation rate
- Option to change default consumption rates
- For milk and meat, add non-contaminated water fractions
- Save: adds Food type to list.

Irrigated Food Data

Food type:

Irrigation rate: L/m²/mon

Vegetables
Leafy Vegetables
Milk
Meat

Irrigated Food Data

Food type:

Irrigation rate: L/m²/mon

Total production rate within 50-mi radius: kg/yr or L/yr

No Yes

Irrigated Food Data

Food type:

Irrigation rate: L/m²/mon

Total production rate within 50-mi radius: kg/yr or L/yr

Non-contaminated Irrigation Water:

Fraction of animal feed production:

Fraction of animal drinking water:

No Yes

LADTAP – Irrigated Foods

ICRP-2

Irrigated Food Type Consumption Data

Food Type -->	Vegetables	Leafy Vegetables	Milk	Meat
Max Adult Consumption (kg/yr)	520.00	64.00	310.00	110.00
Max Teen Consumption (kg/yr)	630.00	42.00	400.00	65.00
Max Child Consumption (kg/yr)	520.00	26.00	330.00	41.00
Max Infant Consumption (kg/yr)	0.00	0.00	330.00	0.00
Avg Adult Consumption (kg/yr)	190.00	30.00	110.00	95.00
Avg Teen Consumption (kg/yr)	240.00	20.00	200.00	59.00
Avg Child Consumption (kg/yr)	200.00	10.00	170.00	37.00
Max Individual Holdup Time (hr)	336.00	24.00	48.00	480.00
Avg Individual Holdup Time (hr)	1440.00	48.00	96.00	480.00

Get Defaults

Save

ICRP-72

Irrigated Food Type Consumption Data

Food Type -->	Vegetables	Leafy Vegetables	Milk	Meat
Max Adult Consumption (kg/yr)	429.00	42.20	301.00	120.00
Max 15 Yr Old Consumption (k...	296.00	19.90	340.00	97.00
Max 10 Yr Old Consumption (k...	323.00	14.60	369.00	74.00
Max 5 Yr Old Consumption (kg...	269.00	11.50	347.00	58.00
Max 1 Yr Old Consumption (kg...	249.00	10.10	477.00	51.00
Max Newborn Consumption (k...	182.00	4.80	150.00	27.00
Avg Adult Consumption (kg/yr)	175.00	17.00	70.00	47.00
Avg 15 Yr Old Consumption (k...	120.00	8.10	83.00	35.00
Avg 10 Yr Old Consumption (k...	123.00	5.60	125.00	29.00

Get Defaults

Save

LADTAP – Irrigated Foods, Farm Data

- For each farm location:
 - Dilution, Production and Transit Time

The image shows two side-by-side panels from the LADTAP software interface. The left panel, titled 'Water Usage Locations', has a 'Food type' dropdown menu set to 'Vegetables'. Below it is a large empty rectangular box. To the right of this box are 'Add' and 'Remove' buttons. At the bottom, it says 'Number of Records: 2'. The right panel, titled 'Water Usage Data', also has 'Food type' set to 'Vegetables'. The 'Location' dropdown is set to 'Test Location'. Below this are three input fields: 'Dilution factor' with '1.0', 'Production rate' with '1.0' (units 'kg/yr or L/yr'), and 'Transit Time' with '1.00' (units 'hrs'). A 'Calc' button is to the right of the 'Dilution factor' field. At the bottom of this panel are 'Cancel' and 'Save' buttons.

- Save: adds Food type to list
- Add locations for selected farms for production
- Option to change default consumption rates

LADTAP – Dose Factors

LADTAP Input: C:\NRC\Dose3\NUREG-CR-4013 Sample Problem 1 - ICRP-72.In3

File Quit About

Scenario: Source Term: Dose Factors: ICRP-2 (Default) ▼

Selections ALARA Locations Fish/Population/Biota Irrigation Food Data **Dose Factors** Pathway Factors

Factors:

- Adult Ingestion ▼
- Adult Ingestion
- Teen Ingestion
- Child Ingestion
- Infant Ingestion
- Adult Inhalation
- Teen Inhalation
- Child Inhalation
- Infant Inhalation

Nuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
AC-225	4.40E-06	6.06E-06	2.96E-07	0.00E+00	6.90E-07	0.00E+00	4.07E-04
AC-227	1.87E-03	2.48E-04	1.11E-04	0.00E+00	8.00E-05	0.00E+00	8.19E-05
AG-110M	1.60E-07	1.48E-07	8.79E-08	0.00E+00	2.91E-07	0.00E+00	6.04E-05
AG-111	5.81E-08	2.43E-08	1.21E-08	0.00E+00	7.84E-08	0.00E+00	4.46E-05
AM-241	7.55E-04	7.05E-04	5.41E-05	0.00E+00	4.07E-04	0.00E+00	7.42E-05
AM-242M	7.61E-04	6.63E-04	5.43E-05	0.00E+00	4.05E-04	0.00E+00	9.34E-05
AM-243	7.54E-04	6.90E-04	5.30E-05	0.00E+00	3.99E-04	0.00E+00	8.70E-05
AR-39	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AR-41	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AU-198	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA-139	9.70E-08	6.91E-11	2.84E-09	0.00E+00	6.46E-11	3.92E-11	1.72E-07
BA-140	2.03E-05	2.55E-08	1.33E-06	0.00E+00	8.67E-09	1.46E-08	4.18E-05
BA-141	4.71E-08	3.56E-11	1.59E-09	0.00E+00	3.31E-11	2.02E-11	2.22E-17
BA-142	2.13E-08	2.19E-11	1.34E-09	0.00E+00	1.85E-11	1.24E-11	3.00E-26
BE-10	3.18E-06	4.91E-07	7.94E-08	0.00E+00	3.71E-07	0.00E+00	2.68E-05
BI-210	4.61E-07	3.18E-06	2.64E-07	0.00E+00	3.83E-05	0.00E+00	4.75E-05
BR-82	0.00E+00	0.00E+00	2.26E-06	0.00E+00	0.00E+00	0.00E+00	2.59E-06
BR-83	0.00E+00	0.00E+00	4.02E-08	0.00E+00	0.00E+00	0.00E+00	5.79E-08

Save Create Input View Input Run LADTAP View Output FSAR Report Supplemental Report

LADTAP – Dose Factors

- Nuclide Data
 - External TB and skin DFs from
 - Ground Surface
 - Water Submersion
 - Absorbed Energies
 - For biota calculations
 - Effective radii

NOTE: Nuclide Data is non-editable

LADTAP Input: C:\NRC\Dose3\NUREG-CR-4013 Sample Problem 1 - ICRP-72.In3

File Quit About

Scenario:

Selections ALARA Loc

Factors:
Adult Ingestion

Nuclide Data

Nuclide	Atomic Number	Atomic Weight	Isomeric State	Decay Constant	EXG TB Factor (mrem/hr per pCi/m2)
H-3	1	3		1.78E-09	0.00E+00
BE-10	4	10		1.37E-14	0.00E+00
C-14	6	14		3.84E-12	0.00E+00
N-13	7	13		1.16E-03	7.60E-09
F-18	9	18		1.05E-04	6.80E-09
NA-22	11	22		8.44E-09	1.60E-08

Effective Energies

Nuclide	1 cm	1.5 cm	2.5 cm	3.5 cm	5 cm
Ac-225	5.92E+00	5.92E+00	5.92E+00	5.92E+00	5.92E+00
Ac-227	8.50E-02	8.50E-02	8.51E-02	8.52E-02	8.52E-02
Ag-110	1.18E+00	1.18E+00	1.18E+00	1.18E+00	1.18E+00
Ag-110m	1.49E-01	1.82E-01	2.42E-01	3.03E-01	3.96E-01
Ag-111	3.55E-01	3.55E-01	3.55E-01	3.56E-01	3.57E-01
Am-241	5.61E+00	5.61E+00	5.62E+00	5.62E+00	5.62E+00
Am-242m	7.03E-02	7.08E-02	7.14E-02	7.18E-02	7.22E-02

Exit

Save Create Input View Input Run LADTAP View Output FSAR Report Supplemental Report

LADTAP Pathway Factors

LADTAP Input: C:\NRC\Dose3\NUREG-CR-4013 Sample Problem 1 - ICRP-72.In3

File Quit About

Scenario: Source Term: Dose Factors: ICRP-2 (Default)

Selections ALARA Locations Fish/Population/Biota Irrigation Food Data Dose Factors **Pathway Factors**

<input type="button" value="Bioaccumulation Factors"/>	Processing time for aquatic foods:	<input type="text" value="24.0"/>	hrs	Total US Population:	<input type="text" value="2.60E+08"/>	
	Processing time for water supply systems:	<input type="text" value="12.0"/>	hrs	Midpoint of plant life:	<input type="text" value="20.0"/>	years
<input type="button" value="Usage/Consumption"/>	Milk animals pasture grass consumption rate:	<input type="text" value="50.00"/>	kg/d	Plant Weathering Half-life:	<input type="text" value="14.0"/>	days
	Milk animals water consumption rate:	<input type="text" value="60.00"/>	L/d	Density Thickness of Root Zone:	<input type="text" value="240.0"/>	kg/m ²
<input type="button" value="Page Defaults"/>	Beef animals pasture grass consumption rate:	<input type="text" value="50.00"/>	kg/d			
	Beef animals water consumption rate:	<input type="text" value="50.00"/>	L/d			
	Fraction of deposition captured by vegetation:	<input type="text" value="0.25"/>				

<u>Default Age Group Fractions</u>		<u>Growing Period (days)</u>	<u>Crop Yield (kg/m²)</u>	<u>(U.S. Commercial Harvests)</u>			
Adult:	<input type="text" value="0.71"/>	Vegetables:	<input type="text" value="60"/>	<input type="text" value="2.0"/>	<u>Sport and Commercial Aquatic Food Harvest Parameters</u>		
Teen:	<input type="text" value="0.11"/>	Leafy Vegetables:	<input type="text" value="60"/>	<input type="text" value="2.0"/>	Sport Harvest Processing Time:	<input type="text" value="168"/>	hrs
Child:	<input type="text" value="0.18"/>	Milk:	<input type="text" value="30"/>	<input type="text" value="0.7"/>	Commercial Harvest Processing Time:	<input type="text" value="240"/>	hrs
		Meat:	<input type="text" value="45"/>	<input type="text" value="0.7"/>	Freshwater Fish Harvest:	<input type="text" value="4.40E+07"/>	kg/yr
					Freshwater Invertebrates Harvest:	<input type="text" value="2.30E+06"/>	kg/yr
					Saltwater Fish Harvest:	<input type="text" value="6.58E+08"/>	kg/yr
					Saltwater Invertebrates Harvest:	<input type="text" value="4.10E+08"/>	kg/yr

LADTAP Pathway Factors – Bioaccumulation Factors

- Bioaccumulation factors (fresh and saltwater):
 - Fish
 - Invertebrate
 - Plants
- Transfer factors:
 - Soil-to-vegetables
 - Grass-to-meat
 - Grass-to-milk

NOTE: All bioaccumulation factors are editable for site-specific data

Bioaccumulation Factors & Transfer Coefficients

Bioaccumulation Factors (L/kg)

Element	Item	Value
H	Freshwater Plants	9.0E-01
H	Freshwater Fish	9.0E-01
H	Freshwater Invertebrates	9.0E-01
H	Saltwater Plants	9.3E-01
H	Saltwater Fish	9.0E-01
H	Saltwater Invertebrates	9.3E-01
HE	Freshwater Plants	1.0E+00
HE	Freshwater Fish	1.0E+00
HE	Freshwater Invertebrates	1.0E+00
HE	Saltwater Plants	1.0E+00
HE	Saltwater Fish	1.0E+00
HE	Saltwater Invertebrates	1.0E+00
LI	Freshwater Plants	3.0E+00
LI	Freshwater Fish	5.0E-01
LI	Freshwater Invertebrates	4.0E+01
LI	Saltwater Plants	3.0E+00
LI	Saltwater Fish	5.0E-01
LI	Saltwater Invertebrates	5.0E-01

Get Defaults Save

Transfer Coefficients

Element	Item	Value
H	Meat	1.2E-02
H	Soil	4.8E+00
H	Milk	1.0E-02
HE	Meat	2.0E-02
HE	Soil	5.0E-02
HE	Milk	2.0E-02
LI	Meat	1.0E-02
LI	Soil	8.3E-04
LI	Milk	5.0E-02
BE	Meat	1.0E-03
BE	Soil	4.2E-04
BE	Milk	1.0E-04
B	Meat	8.0E-04
B	Soil	1.2E-01
B	Milk	2.7E-03
C	Meat	3.1E-02
C	Soil	5.5E+00
C	Milk	1.2E-02

Get Defaults Save

Close

Pathway Factors -Usage/Consumption

- Consumption Rates
 - Fish
 - Invertebrate
 - Plants
 - Drinking water
 - Shoreline
 - Swimming
 - Boating
- Irrigated Food Consumption:
 - Vegetables
 - Leafy vegetables
 - Milk
 - Meat
 - Transit and hold-up times

NOTE: All consumption rates are editable for site-specific data

Usage/Consumption Data

Maximum Individual Exposure Consumption Data for selected Dose Factors

Age Group	Fish (kg/yr)	Freshwater Invertebrates (kg/yr)	Aquatic Plants (kg/yr)	Drinking Water (kg/yr)
Adults	21.00	0.00	0.00	730.00
Teens	16.00	0.00	0.00	510.00
Children	6.90	0.00	0.00	510.00
Infants	0.00	0.00	0.00	330.00

Get Defaults Save

Irrigated Food Type Consumption Data

Food Type -->	Vegetables	Leafy Vegetables	Milk	Meat
Max Adult Consumption (kg/yr)	520.00	64.00	310.00	110.00
Max Teen Consumption (kg/yr)	630.00	42.00	400.00	65.00
Max Child Consumption (kg/yr)	520.00	26.00	330.00	41.00
Max Infant Consumption (kg/yr)	0.00	0.00	330.00	0.00
Avg Adult Consumption (kg/yr)	190.00	30.00	110.00	95.00
Avg Teen Consumption (kg/yr)	240.00	20.00	200.00	59.00
Avg Child Consumption (kg/yr)	200.00	10.00	170.00	37.00
Max Individual Holdup Time (hr)	336.00	24.00	48.00	480.00
Avg Individual Holdup Time (hr)	1440.00	48.00	96.00	480.00

Get Defaults Save

Average Individual Consumption Data (kg/yr)

Age Group	Fish (kg/yr)	Invertebrates (kg/yr)	Drinking Water (kg/yr)
Adults	6.90	1.00	370.00
Teens	5.20	0.75	260.00
Children	2.20	0.33	260.00

Get Defaults Save

Close

Running LADTAP – Viewing Outputs/Reports

- Save
- Create Input
- View Input
- Run LADTAP
- View Output
- FSAR Report
- Supplemental Report

The screenshot shows the LADTAP software interface. At the top, there is a menu bar with 'File', 'Quit', and 'About'. Below that, the 'Scenario' is set to 'NUREG/CR-4013 Sample Problem 1', 'Source Term' is 'Test #1', and 'Dose Factors' is 'ICRP-2 (Default)'. There are tabs for 'Selections', 'ALARA Locations', 'Fish/Population/Biota', 'Irrigation Food Data', 'Dose Factors', and 'Pathway Factors'. The 'Dose Factors' tab is active.

Input parameters include:

- Discharge Flow Rate: 3150.00 CFS
- Source Term Multiplier: 1
- 50 mi Population: 2200000
- Print dose factors:
- Population Fractions: No, Yes, with an 'Edit' button.
- Dose Contributions: No, Yes.
- Reconcentration: Model: Partially-Mixed, Effluent discharge rate: 200 CFS, Impoundment Total Volume: 50000 ft³.
- Site Type: Fresh water, Salt water.

A table titled 'Source Term:' is displayed on the right:

Nuclide	Quantity (Ci)	R-Factor
I-133	1.20E-03	
I-135	1.30E-03	
CS-134	3.90E-04	
CS-138	2.80E-02	
CS-137	5.50E-03	
H-3	1.80E+01	
I-131	5.20E-04	

Buttons at the bottom include 'Save', 'Create Input', 'View Input', 'Run LADTAP', 'View Output', 'FSAR Report', and 'Supplemental Report'. A 'Total Quantity' of 1.8037E+01 Curies is shown at the bottom right.



Save Create Input View Input Run LADTAP View Output FSAR Report Supplemental Report

LADTAP FSAR Report

- Provides a summary report of assumptions and doses
- Suitable for use in creating input for safety analyses and licensing support

Parameters:

Midpoint of Plant Life (yr):	20.00
Circulating Water System discharge rate (cfs):	3150.00
Water type selection:	Freshwater
Reconcentration model index:	3 Partially-Mixed
Discharge rate to receiving water (ft3/sec):	200
Total impoundment volume (ft3):	50000
Shore-width factor:	0.2 River Shoreline
Dilution factor for aquatic foods and boating:	1.00
Dilution factor for shoreline and swimming exposure:	1.00
Dilution factor for drinking water:	4.00
Transit time for drinking water (hr):	3.00
Transit time for other pathways (hr):	0.10
Source term multiplier:	1.00
50-mile population:	2200000
Total shoreline usage time (person-hr/yr):	83000
Total swimming usage time (person-hr/yr):	120000
Total boating usage time (person-hr/yr):	520000

Irrigated Foods

Food Type	Irrigation Rate (L/m2-month)	Fraction not contaminated	Animal Water	Total Production within 50-miles (kg/yr.,L/yr)
Vegetables	5000	0.00	0.00	20000
Leafy Vegetables	6000	0.00	0.00	5000
Milk	2000	0.20	0.60	40000
Meat	200	0.20	0.60	300

Population using water-supply system:	2200000
Annual local harvest for sports fishing (kg/yr):	70000
Annual local harvest for commercial fishing (kg/yr):	5000
Annual local harvest for sports invertebrates (kg/yr):	200
Annual local harvest for commercial invertebrates (kg/yr):	300

Liquid Source Term for the LADTAP Code

Isotope	Release Rate (Ci/yr)
CS-134	3.90E-04
CS-137	5.50E-03
CS-138	2.80E-02
H-3	1.80E+01
I-131	5.20E-04
I-133	1.20E-03
I-135	1.30E-03

Individual ALARA Doses (mrem/yr)

Age Group	Skin	Bone	Liver	IBody	Thyroid	Kidney	Lung	GI-LLI
Fish								
Adult	0.00E+00	1.09E-01	1.55E-01	1.03E-01	2.11E-03	5.23E-02	1.75E-02	3.08E-03
Teen	0.00E+00	1.16E-01	1.61E-01	1.61E-01	5.76E-02	1.97E-03	5.44E-02	2.35E-03
Child	0.00E+00	1.46E-01	1.45E-01	2.21E-02	2.09E-03	4.70E-02	1.69E-02	9.69E-04
Infant	0.00E+00	3.38E-02	4.07E-02	2.99E-03	7.27E-04	1.09E-02	4.43E-03	1.42E-04
Plant								
Teen	0.00E+00	3.63E-02	5.03E-02	1.81E-02	6.40E-03	1.71E-02	6.69E-03	8.26E-04
Drinking								
Adult	0.00E+00	4.76E-04	1.70E-03	1.55E-03	2.37E-03	1.34E-03	1.18E-03	1.12E-03
Teen	0.00E+00	4.66E-04	1.42E-03	1.01E-03	1.88E-03	1.00E-03	8.59E-04	7.87E-04
Child	0.00E+00	1.36E-03	2.83E-03	1.70E-03	4.26E-03	1.94E-03	1.65E-03	1.50E-03
Infant	0.00E+00	1.41E-03	3.16E-03	1.59E-03	5.81E-03	1.93E-03	1.64E-03	1.47E-03
Shoreline								
Adult	1.52E-04	1.31E-04	1.31E-04	1.31E-04	1.31E-04	1.31E-04	1.31E-04	1.31E-04
Teen	8.50E-04	7.29E-04	7.29E-04	7.29E-04	7.29E-04	7.29E-04	7.29E-04	7.29E-04
Child	1.78E-04	1.52E-04	1.52E-04	1.52E-04	1.52E-04	1.52E-04	1.52E-04	1.52E-04
Infant	1.27E-05	1.09E-05	1.09E-05	1.09E-05	1.09E-05	1.09E-05	1.09E-05	1.09E-05
Swimming								
Adult	9.90E-06	6.90E-06	6.90E-06	6.90E-06	6.90E-06	6.90E-06	6.90E-06	6.90E-06
Child	1.65E-06	1.15E-06	1.15E-06	1.15E-06	1.15E-06	1.15E-06	1.15E-06	1.15E-06
Boating								
Adult	4.95E-06	3.45E-06	3.45E-06	3.45E-06	3.45E-06	3.45E-06	3.45E-06	3.45E-06
Teen	4.12E-06	2.87E-06	2.87E-06	2.87E-06	2.87E-06	2.87E-06	2.87E-06	2.87E-06

LADTAP Supplemental Report

- Provides additional information on inputs and exposure assumptions that may not be included in the LADTAP output or the FSAR

Supplemental FSAR Input - NUREG/CR-4013 Sample Problem 1 - 22-Oct-2019 06:52

Program Constants for LADTAP

Processing time for aquatic foods (hrs):	24.0	Total US Population:	2.60E+0
Processing time for water supply systems (hrs):	12.0	Midpoint of plant life (yrs):	20.0
Milk animals pasture grass consumption rate (kg/d):	50.00	Plant Weathering Half-life (yrs):	14.0
Milk animals water consumption rate (L/d):	60.00	Root Zone Thickness of Root Zone (kg/m2):	240.0
Beef animals pasture grass consumption rate (kg/d):	50.00		
Beef animals water consumption rate (L/d):	50.00		
Fraction of deposition captured by vegetation:	0.25		

Default Age Group Fractions

Adult: 0.71
 Teen: 0.11
 Child: 0.18

(U.S. Commercial Harvests)
 Sport and Commercial Aquatic Food Harvest Parameters

Sport Harvest Processing Time (hrs): 168
 Commercial Harvest Processing Time (hrs): 240
 Freshwater Fish Harvest (kg/yr): 4.40E+0
 Freshwater Invertebrates Harvest (kg/yr): 2.30E+0
 Saltwater Fish Harvest (kg/yr): 6.58E+0
 Saltwater Invertebrates Harvest (kg/yr): 4.10E+0

	Growing Period (days)	Crop Yield (kg/m2)
Vegetables	60	2.0
Leafy Vegetables	60	2.0
Milk	30	0.7
Meat	45	0.7

Average Individual Consumption Data

	Water Consumption (L/yr)	Fish Consumption (kg/yr)	Invertebrate Consumption (kg/yr)
Adult:	370	6.9	1
Teen:	260	5.2	0.75
Child:	260	2.2	0.33

Bioaccumulation Factors for the LADTAP Code

Element	Item	Value
H	Freshwater Plants	9.00E-01
H	Freshwater Fish	9.00E-01
H	Freshwater Invertebrates	9.00E-01
H	Saltwater Plants	9.30E-01
H	Saltwater Fish	9.00E-01
H	Saltwater Invertebrates	9.30E-01
I	Freshwater Plants	4.00E+01
I	Freshwater Fish	1.50E+01
I	Freshwater Invertebrates	5.00E+00
I	Saltwater Plants	1.00E+03
I	Saltwater Fish	1.00E+01
I	Saltwater Invertebrates	5.00E+01
CS	Freshwater Plants	5.00E+02
CS	Freshwater Fish	2.00E+03
CS	Freshwater Invertebrates	1.00E+03
CS	Saltwater Plants	5.00E+01
CS	Saltwater Fish	4.00E+01
CS	Saltwater Invertebrates	2.50E+01

Transfer Coefficients for the LADTAP and GASPAR Codes

Element	Item	Value
H	Meat	1.20E-02
H	Veg/Soil	4.80E+00
I	Milk	1.00E+00

Questions?