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1.0 MEPAS Receptor and Health Impact Components Update Inhalation Impacts Based on Air Concentration

The following change needs to be made to the User Interfaces for the MEPAS Receptor and Human Health Impact Components. Mark Dortch of WES requested the change.

Background. The estimation of human impacts from the inhalation route for chemicals has traditionally been based on the average daily intake rate, with application of slope factors or reference dose, depending on the health impact endpoint. Recently, EPA has recommended that inhalation impacts be based on comparison to the average air concentration at the exposure location. The changes described here allow the user to select the method for evaluation of chemical health impacts. Because the receptor model generates the input to the health impact model, it is necessary to modify that component also, so the correct input parameter is provided for the health impacts analysis.

1.1 Receptor UI Changes

The change involves adding one parameter to the MEPAS Receptor UI, allowing the user to select the method to be used to determine inhalation health impacts. If “average daily intake” is selected, then the current method is used. The UI currently has just one window. A line could be added with a pull-down menu (like the current option for selecting the Dermal Water Model) as follows:

Method for Inhalation Impact Analysis HE – INHAL	Air concentration
	Daily Intake

The selection flag will be called HE-INHAL on the input screen and will have a tag of HEINHAL for connection to the help file (RCP.HTM). The parameter name for the GID file will be INHALE and will have an integer value of 1 if daily intake is selected and 0 if air concentration is selected (default value). The allowable values are 0 and 1. The parameter has no units. The parameter should not be treated as a stochastic parameter.

1.2 Health Impacts UI Changes

The Health Impacts UI must be modified to allow the user to identify the method to be used to estimate inhalation impacts. If “average daily intake” is selected, then the current method is used. If “air concentration” is selected, then the new method is used. The selection of the inhalation-impact method should be on the tab “chemical” following the two items already on the page. The new item should read as follows:

Method for Inhalation Impact Analysis HE – INHAL	Air concentration
	Daily Intake

The selection flag will be called HE-INHAL on the input screen and will have a tag of HEINHAL for connection to the help file (HEI.HTM). The parameter name for the GID file will be INHALE and will

have an integer value of 1 if daily intake is selected and 0 if air concentration is selected (default value). The allowable values are 0 and 1. The parameter has no units. Note: these names are the same as for the receptor component, but this should not cause a problem because use of the parameters is not connected between the two components. The parameter should not be treated as a stochastic parameter.

1.3 Formulation Changes

Implementation of the above changes involves changing the receptor component to generate air concentrations instead of average daily intake rate. When “daily intake” is selected, the inhalation average daily intake is calculated by the original equation of MEPAS (Streng and Chamberlain 1995, Equation 99) as follows:

$$D_{aii} = C_{ari} U_{ai} F_{ai} \frac{ED_{ai}}{BW_{ai} AT_{aii}} \quad (1)$$

where

D_{aii} = average daily inhalation dose from chemical pollutant I for the air-inhalation pathway (mg/kg/d)

C_{ar} = concentration of pollutant I in air at the point of inhalation (mg/m³)

U_{ai} = inhalation rate (m³/d)

F_{ai} = fraction of year that inhalation exposure occurs (dimensionless)

ED_{ai} = exposure duration for the air-inhalation pathway (yr)

BW_{ai} = body weight of individuals exposed via the air-inhalation pathway (kg)

AT_{aii} = averaging time for air-inhalation exposure to pollutant I (yr).

The above equation illustrates the calculation for the air-inhalation pathway. Similar equations are presented in Streng and Chamberlain (1995) for other inhalation pathways. In the present discussion, the air-inhalation pathway is used to illustrate the changes.

When “air concentration” is selected, the exposure air concentration is calculated instead of the average daily inhalation dose. This calculation is performed very similarly to the above method, except intake rate and body weight are removed from the equation, as follows:

$$C_{aii} = C_{ari} F_{ai} \frac{ED_{ai}}{AT_{aii}} \quad (2)$$

where C_{aii} is the average air concentration at the exposure location (as the basis for the health impact estimate for the exposed individual) for chemical pollutant i for the air inhalation pathway (mg/m³).

1.4 Health Impacts from Carcinogenic Chemicals

Similar changes in formulations have been made to the health impacts component. When “daily intake” is selected, the health impacts are calculated using the inhalation slope factor and the inhalation reference dose as follows. For carcinogenic impacts:

$$R_{aii} = D_{aii} SF_i \quad (3)$$

where

R_{aii} = risk of developing cancer from the lifetime exposure for inhalation pathway ai and chemical pollutant i (risk/lifetime)

D_{aii} = average daily inhalation dose from chemical pollutant I for the air inhalation pathway (mg/kg/d)

SF_i = inhalation slope factor for cancer incidence risk for chemical pollutant i (risk per mg/kg/d inhalation intake).

When “air concentration” is selected, the cancer risk is evaluated using the inhalation unit risk factor in place of the slope factor and the air concentration in place of the average daily intake rate as follows:

$$R_{aii} = C_{aii} URF_i \quad (4)$$

where

C_{aii} = the average air concentration at the exposure location (as the basis for the health impact estimate for the exposed individual) for chemical pollutant i for the air inhalation pathway (mg/m³)

URF_i = the inhalation unit risk factor for pollutant I (risk per mg/m³).

Note that normal units of URF_i are risk per $\mu\text{g}/\text{m}^3$.

1.5 Health Impacts from Non-Carcinogenic Chemicals

The health impact endpoint for non-carcinogenic chemicals is the hazard quotient. When “daily intake” is selected, the hazard quotient is evaluated as follows for inhalation pathways.

$$HQ_{aii} = \frac{D_{aii}}{RfD_{hi}} \quad (5)$$

where

HQ_{aii} = hazard quotient for inhalation pathway ai for non-carcinogenic chemical pollutant i (dimensionless)

D_{aii} = average daily inhalation dose from chemical pollutant I for the air-inhalation pathway (mg/kg/d)

RfD_{hi} = inhalation reference dose for non-carcinogenic chemical pollutant i (mg/kg/d).

When “air concentration” is selected, the hazard quotient is evaluated from the air concentration and the reference concentration as follows:

$$HQ_{aii} = \frac{C_{aii}}{RfC_{hi}} \quad (6)$$

where

C_{aii} = average air concentration at the exposure location (as the basis for the health impact estimate for the exposed individual) for chemical pollutant i for the air inhalation pathway (mg/m^3)

RfC_{hi} = inhalation reference concentration for non-carcinogenic chemical pollutant i (mg/m^3).

The toxicity parameters needed for the “air concentration” option are available with the chemical database supplied with Framework for Analysis of Risk in Multimedia Environmental Systems (FRAMES). However, not many values have been populated at this time. When a value is not present for the inhalation reference concentration, a value can be estimated from the inhalation reference dose as follows:

$$RfC_{hi} = RfD_{hi} \frac{70}{20} \quad (7)$$

where

70 = average body weight for an adult (kg)

20 = average inhalation rate for an adult (m^3/day)

and other terms are as previously defined.

When a value is not present for the inhalation unit risk factor, a value can be estimated from the inhalation slope factor as follows:

$$URF_i = SF_i \frac{20}{70} \quad (8)$$

where terms are as previously defined.

2.0 MEPAS Receptor and Health Impact Components Updates for Inhalation Impacts Based on Air Concentration Test Plan WES - October 2001

The following test cases were designed to test and ensure that the task of updating the MEPAS Receptor Intake and Human Health Impact Components meet all of their requirements. Table 2.1 shows the requirements specified for this task. Table 2.2 lists the test cases along with the requirements addressed by each test.

Table 2.1. Requirements for Testing the MEPAS Intake and Health Impact Modules Updates

Requirement Number	Requirement
1	Modify MEPAS Intake module UI to allow the user to choose between “Average Concentration” or “Daily Intake” for computation of inhalation impacts.
2	Compute intakes correctly when either “Average Concentration” or “Daily Intake” method is selected.
3	Modify MEPAS Health Impact module UI to allow the user to choose between “Average Concentration” or “Daily Intake” for computation of inhalation impacts.
4	Compute health impacts correctly when either “Average Concentration” or “Daily Intake” method is selected.
5	Only compute health impacts for inhalation pathways when the selections made in the Intake UI and Health Impact UI are consistent (i.e., “Air Concentration” is selected in both, or “Daily Intake” is selected in both).

Table 2.2. Relationship Between the MEPAS Exposure Module Update Requirements and Test Cases

		Test Case by Number		
		01	02	03
Requirements	1	X	X	
	2	X	X	
	3	X	X	
	4	X	X	
	5			X

2.1 Test Case Inhale01

2.1.1 Description and Rationale for Test Case

This test case will be used to check that the MEPAS Intake Module and the MEPAS Health Impact Module both allow the user to choose between “Average Concentration” or “Daily Intake” for computation of inhalation impacts. In this case, “Air Concentration” will be selected and a check will be made to ensure that the MEPAS modules are computing the results correctly. Two constituents will be used for this case and they are benzene, and strontium-90 (Sr-90). These constituents provide the range of health impacts associated with radionuclides and chemicals. Only selected benzene and Sr-90 health impacts will be tested in this test plan.

2.1.2 Testing Procedure and Data

1. Create a folder under the main FRAMES folder named “Inhale01.”
2. A GID file titled “Inhale01.GID” is included in this test package. You will need to check to make sure that the file path names in the file match the file path for the FRAMES directory on your computer. The file path on your computer should be C:\frames or something similar. Open the GID file in a text editor. Do a find and replace to change the file paths in the file. Search for ‘ “D:’ and replace with ‘ “C:’ or whatever the path name is on your computer. Save the file as a text format after the changes have been made. Note that the data contained in the file will not be described here. The data can be viewed through the FRAMES User Interface (FUI) when the case is brought up.
3. Copy the GID file into the subfolder you just created named “Inhale01.”
4. Start up FRAMES.
5. Click on the ‘file’ and select “Open.”
6. Find the folder named “Inhale01” and click on it.
7. Select the file “Inhale.GID” and click the “Open” button. The case should come up in the working area screen on the FUI. The icons on the screen represent a scenario where contaminants are transported to the exposure location via air, direct exposure to surface soils, groundwater, and surface water.
8. Right click on the icon entitled “src25” and select “User Input.”
9. Take a look through the input data if you would like and then use the “File” menu to save and exit.
10. The light on the icon should turn to yellow.
11. Right click on the icon and select “Run Model.” The model should run and the light on the icon should turn green. This indicates a successful run.
12. Repeat this process with the icons labeled “src26,” “air23,” and “exp02a.”
13. For the icon labeled “Intake02a,” bring up the “User Input” screen and note the parameter at the bottom of the screen “Method for inhalation impact analysis.” “Air concentration” should be selected.
14. Then use the “File” menu to save and exit.

15. Right click on the icon and select “Run Model.” The model should run and the light on the icon should turn green. This indicates a successful run.
16. For the icon labeled “hei22,” bring up the “User Input” screen and note the parameter at the bottom of the screen “Method for inhalation impact analysis.” “Air concentration” should be selected.
17. Then use the “File” menu to save and exit.
18. Right click on the icon and select “Run Model.” The model should run, and the light on the icon should turn green. This indicates a successful run.
19. After all models have been run, and each icon has a green light, right click on the Intake module and select use the “view/print module output” menu item to select “RIF text view.” This will bring up the results of the Intake module in a text format.
20. Check the selected results in the file to ensure that they match the results in the expected results section.
21. Next right click on the Health Impact module and select use the “view/print module output” menu item to select “HIF text view.” This will bring up the results of the Health Impact module in a text format.
22. Check the selected results in the file to ensure that they match the results in the expected results section.
23. After the checks have been made, use the “File menu” to save and exit the case.

2.1.3 Expected Results

It is expected that the user interfaces for the Intake and Health Impact modules will allow the user to select which method to use in calculating the inhalation health impacts. It is also expected that the modules will calculate their results correctly based on their formulations. As noted previously, selected results for benzene and Sr-90 will be tested in this test plan. The following table includes the results for the Intake module that were computed by hand using the formulations provided for the method used.

Table 2.3. Expected Results for the MEPAS Intake Module

	Benzene	Sr-90
Air Pathway, Inhalation, Carcinogenic	2.85E-12 mg/m ³	N/A
Air Pathway, Inhalation, Non-Carcinogenic	6.66E-12 mg/m ³	N/A
Air Pathway, Inhalation	N/A	5.39E-11 Bq
Surface Soil Pathway, Inhalation	N/A	4.73E-05 Bq

Table 2.4. Expected Results for the MEPAS Health Impact Module

	Benzene	Sr-90
Air Pathway, Indoor Inhalation, Carcinogenic	2.36E-14 risk/lifetime	N/A

Air Pathway, Indoor Inhalation, Non-Carcinogenic	1.119E-9	N/A
Air Pathway, Indoor Inhalation	N/A	1.136E-18 risk/lifetime
Surface Soil Pathway, Indoor Inhalation	N/A	9.971E-13 risk/lifetime

2.1.4. Test Results and Conclusion

The user interfaces for the Intake and Health Impact modules allowed the user to select which method to use in calculating the inhalation health impacts. The modules calculated their results correctly based on their formulations. The results files for the Intake module (RIF file) and Health Impact module (HIF file) are listed below. The results of interest are in bold. The module meets the requirements for this test case.

Inhale01.RIF file:

```
*****
* File: C:\FRAMES\INHALE01\INHALE01.rif
* Section: rcp19
* Date: 10/8/2001 2:48:56 PM
*****
```

```
1,
Receptor Intake File generated by MEPAS 4.0 intake module
2,
"chronic","fcm3","Air", 1, 1, 2,
10.0,"km", 10.0,"km",
0., 70.,"yr",
"Benzene","71432", 0, 3,
0.00,"yr", 30.00,"yr", 2,
1.,"Air","inhalation","mg/m^ 3","noncarcinogenic",
6.66E-12,
1.,"Air","inhalation","mg/m^ 3","carcinogenic",
2.85E-12,
50.00,"yr", 30.00,"yr", 2,
1.,"Air","inhalation","mg/m^ 3","noncarcinogenic",
6.66E-12,
1.,"Air","inhalation","mg/m^ 3","carcinogenic",
2.85E-12,
100.00,"yr", 30.00,"yr", 2,
1.,"Air","inhalation","mg/m^ 3","noncarcinogenic",
0.00E+00,
1.,"Air","inhalation","mg/m^ 3","carcinogenic",
0.00E+00,
"STRONTIUM-90","SR90", 1, 3,
0.00,"yr", 30.00,"yr", 1,
1.,"Air","inhalation","Bq","intake",
5.39E-11,
"YTTRIUM-90","Y90", 1,
1.,"Air","inhalation","Bq","intake",
0.00E+00,
50.00,"yr", 30.00,"yr", 1,
1.,"Air","inhalation","Bq","intake",
5.39E-11,
```

"YTTRIUM-90","Y90", 1,
 1., "Air", "inhalation", "Bq", "intake",
 0.00E+00,
 100.00,"yr", 30.00,"yr", 1,
 1., "Air", "inhalation", "Bq", "intake",
 0.00E+00,
 "YTTRIUM-90","Y90", 1,
 1., "Air", "inhalation", "Bq", "intake",
 0.00E+00,
 "chronic", "fcm3", "Soil", 1, 1, 2,
 0.0,"km", 0.0,"km",
 0., 70., "yr",
 "Benzene", "71432", 0, 3,
 0.00,"yr", 30.00,"yr", 2,
 1., "Soil", "inhalation", "mg/m^3", "noncarcinogenic",
 3.34E-14,
 1., "Soil", "inhalation", "mg/m^3", "carcinogenic",
 1.43E-14,
 50.00,"yr", 30.00,"yr", 0,
 100.00,"yr", 30.00,"yr", 0,
"STRONTIUM-90","SR90", 1, 3,
0.00,"yr", 30.00,"yr", 1,
1., "Soil", "inhalation", "Bq", "intake",
4.73E-05,
 "Y90","Y90", 1,
 1., "Soil", "inhalation", "Bq", "intake",
 4.73E-05,
 50.00,"yr", 30.00,"yr", 1,
 1., "Soil", "inhalation", "Bq", "intake",
 1.43E-05,
 "Y90","Y90", 1,
 1., "Soil", "inhalation", "Bq", "intake",
 1.43E-05,
 100.00,"yr", 30.00,"yr", 1,
 1., "Soil", "inhalation", "Bq", "intake",
 4.34E-06,
 "Y90","Y90", 1,
 1., "Soil", "inhalation", "Bq", "intake",
 4.34E-06,

Inhale01.HIF file:

```

*****
* File: C:\FRAMES\INHALE01\INHALE01.hif
* Section: hei22
* Date: 10/10/2001 11:41:48 AM
*****
  
```

1,
 Health Impacts File generated by MEPAS 4.0 health impacts component
 2,
 "chronic", "fcm3", "Air", 1, 1, 2, 1, 1,
 "all sites",
 "total body",
 10.0,"km", 10.0,"km",
 0., 70., "yr",
"Benzene", "71432", 0, 3,
0.00,"yr", 30.00,"yr", 2,
1., "Air", "inhalation", "HI", "noncarcinogenic",
1.12E-09,
1., "Air", "inhalation", "Risk", "carcinogenic",
2.36E-14,

50.00,"yr", 30.00,"yr", 2,
 1.,"Air","inhalation","HI","noncarcinogenic",
 1.12E-09,
 1.,"Air","inhalation","Risk","carcinogenic",
 2.36E-14,
 100.00,"yr", 30.00,"yr", 2,
 1.,"Air","inhalation","HI","noncarcinogenic",
 0.00E+00,
 1.,"Air","inhalation","Risk","carcinogenic",
 0.00E+00,
"STRONTIUM-90","SR90", 1, 3,
0.00,"yr", 30.00,"yr", 1,
1.,"Air","inhalation","Risk","cancer incidence",
1.14E-18,
 "YTTRIUM-90","Y90", 1,
 1.,"Air","inhalation","Risk","cancer incidence",
 0.00E+00,
 50.00,"yr", 30.00,"yr", 1,
 1.,"Air","inhalation","Risk","cancer incidence",
 1.14E-18,
 "YTTRIUM-90","Y90", 1,
 1.,"Air","inhalation","Risk","cancer incidence",
 0.00E+00,
 100.00,"yr", 30.00,"yr", 1,
 1.,"Air","inhalation","Risk","cancer incidence",
 0.00E+00,
 "YTTRIUM-90","Y90", 1,
 1.,"Air","inhalation","Risk","cancer incidence",
 0.00E+00,
 "chronic","fcm3","Soil", 1, 1, 2, 1, 1,
 "all sites",
 "total body",
 0.0,"km", 0.0,"km",
 0., 70.,"yr",
 "Benzene","71432", 0, 3,
 0.00,"yr", 30.00,"yr", 2,
 1.,"Soil","inhalation","HI","noncarcinogenic",
 5.61E-12,
 1.,"Soil","inhalation","Risk","carcinogenic",
 1.18E-16,
 50.00,"yr", 30.00,"yr", 0,
 100.00,"yr", 30.00,"yr", 0,
"STRONTIUM-90","SR90", 1, 3,
0.00,"yr", 30.00,"yr", 1,
1.,"Soil","inhalation","Risk","cancer incidence",
9.97E-13,
 "Y90","Y90", 1,
 1.,"Soil","inhalation","Risk","cancer incidence",
 6.47E-15,
 50.00,"yr", 30.00,"yr", 1,
 1.,"Soil","inhalation","Risk","cancer incidence",
 3.01E-13,
 "Y90","Y90", 1,
 1.,"Soil","inhalation","Risk","cancer incidence",
 1.96E-15,
 100.00,"yr", 30.00,"yr", 1,
 1.,"Soil","inhalation","Risk","cancer incidence",
 9.15E-14,
 "Y90","Y90", 1,
 1.,"Soil","inhalation","Risk","cancer incidence",
 5.94E-16,

2.2. Test Case Inhale02

2.2.1. Description and Rationale for Test Case

This test case will be used to check that the MEPAS Intake Module and the MEPAS Health Impact Module both allow the user to choose between “Average Concentration” or “Daily Intake” for computation of inhalation impacts. In this case, “Daily Intake” will be selected, and a check will be made to ensure that the MEPAS modules are computing the results correctly. Two constituents, benzene and Sr-90, will be used for this case. These constituents provide the range of health impacts associated with radionuclides and chemicals. Only selected benzene and Sr-90 health impacts will be tested in this test plan.

2.2.2. Testing Procedure and Data

1. Create a folder under the main FRAMES folder named ‘Inhale01.’
2. A GID file titled “Inhale01.GID” is included in this test package. You will need to check to make sure that the file path names in the file match the file path for the FRAMES directory on your computer. The file path on your computer should be C:\frames or something similar. Open the GID file in a text editor. Do a find and replace to change the file paths in the file. Search for ‘D:’ and replace with ‘C:’ or whatever the path name is on your computer. Save the file as a text format after the changes have been made. Note that the data contained in the file will not be described here. The data can be viewed through the FRAMES User Interface (FUI) when the case is brought up.
3. Copy the GID file into the subfolder you just created named “Inhale01.”
4. Start up FRAMES.
5. Click on the “file” and select “Open.”
6. Find the folder named “Inhale01” and click on it.
7. Select the file “Inhale.GID” and click the “Open” button. The case should come up in the working area screen on the FUI. The icons on the screen represent a scenario where contaminants are transported to the exposure location via air, direct exposure to surface soils, groundwater, and surface water.
8. Right click on the icon entitled “src25” and select “User Input.”
9. Take a look through the input data if you would like and then use the “File” menu to save and exit.
10. The light on the icon should turn to yellow.
11. Right click on the icon and select “Run Model.” The model should run and the light on the icon should turn green. This indicates a successful run.
12. Repeat this process with the icons labeled “src26,” “air23,” and “exp02a.”
13. For the icon labeled “Intake02a,” bring up the “User Input” screen and note the parameter at the bottom of the screen “Method for inhalation impact analysis.” “Daily Intake” should be selected.
14. Then use the “File” menu to save and exit.

15. Right click on the icon and select “Run Model.” The model should run, and the light on the icon should turn green. This indicates a successful run.
16. For the icon labeled “hei22,” bring up the “User Input” screen and note the parameter at the bottom of the screen “Method for inhalation impact analysis.” “Daily Intake” should be selected.
17. Then use the “File” menu to save and exit.
18. Right click on the icon and select “Run Model.” The model should run, and the light on the icon should turn green. This indicates a successful run.
19. After all models have been run and each icon has a green light, right click on the Intake module and select use the “view/print module output” menu item to select “RIF text view.” This will bring up the results of the Intake module in a text format.
20. Check the selected results in the file to ensure that they match the results in the expected results section.
21. Next right click on the Health Impact module and select use the “view/print module output” menu item to select “HIF text view.” This will bring up the results of the Health Impact module in a text format.
22. Check the selected results in the file to ensure that they match the results in the expected results section
23. After the checks have been made, use the “File menu” to save and exit the case.

2.2.3. Expected Results

It is expected that the user interfaces for the Intake and Health Impact modules will allow the user to select which method to use in calculating the inhalation health impacts. It is also expected that the modules will calculate their results correctly based on their formulations. As noted previously, selected results for benzene and Sr-90 will be tested in this test plan. The following table includes the results for the Intake module that were computed by hand using the formulations provided for the method used.

Table 2.5. Expected Results for the MEPAS Intake Module

	Benzene	Sr-90
Air Pathway, Inhalation, Carcinogenic	8.155E-13 mg/m ³	N/A
Air Pathway, Inhalation, Non-Carcinogenic	1.903E-12 mg/m ³	N/A
Air Pathway, Inhalation	N/A	5.39E-11 Bq
Surface Soil Pathway, Inhalation	N/A	4.73E-05 Bq

Table 2.6. Expected Results for the MEPAS Health Impact Module

	Benzene	Sr-90
--	----------------	--------------

Air Pathway, Indoor Inhalation, Carcinogenic	2.36E-14 risk/lifetime	N/A
Air Pathway, Indoor Inhalation, Non-Carcinogenic	1.119E-9	N/A
Air Pathway, Indoor Inhalation	N/A	1.136E-18 risk/lifetime
Surface Soil Pathway, Indoor Inhalation	N/A	9.971E-13 risk/lifetime

2.2.4. Test Results and Conclusion

The user interfaces for the Intake and Health Impact modules allowed the user to select which method to use in calculating the inhalation health impacts. The modules calculated their results correctly based on their formulations. The results files for the Intake module (RIF file) and Health Impact module (HIF file) are listed below. The results of interest are in bold. The module meets the requirements for this test case.

Inhale02.RIF file:

```
*****
* File: C:\FRAMES\Inhale02\Inhale02.rif
* Section: rcp19
* Date: 10/9/2001 11:24:12 AM
*****
```

```
1,
Receptor Intake File generated by MEPAS 4.0 intake module
2,
"chronic","fcm3","Air", 1, 1, 2,
10.0,"km", 10.0,"km",
0., 70.,"yr",
"Benzene","71432", 0, 3,
0.00,"yr", 30.00,"yr", 2,
1.,"Air","inhalation","mg/kg/day","noncarcinogenic",
1.90E-12,
1.,"Air","inhalation","mg/kg/day","carcinogenic",
8.16E-13,
50.00,"yr", 30.00,"yr", 2,
1.,"Air","inhalation","mg/kg/day","noncarcinogenic",
1.90E-12,
1.,"Air","inhalation","mg/kg/day","carcinogenic",
8.16E-13,
100.00,"yr", 30.00,"yr", 2,
1.,"Air","inhalation","mg/kg/day","noncarcinogenic",
0.00E+00,
1.,"Air","inhalation","mg/kg/day","carcinogenic",
0.00E+00,
"STRONTIUM-90","SR90", 1, 3,
0.00,"yr", 30.00,"yr", 1,
1.,"Air","inhalation","Bq","intake",
5.39E-11,
"YTTRIUM-90","Y90", 1,
1.,"Air","inhalation","Bq","intake",
0.00E+00,
50.00,"yr", 30.00,"yr", 1,
1.,"Air","inhalation","Bq","intake",
5.39E-11,
"YTTRIUM-90","Y90", 1,
```

1., "Air", "inhalation", "Bq", "intake",
0.00E+00,
100.00,"yr", 30.00,"yr", 1,
1., "Air", "inhalation", "Bq", "intake",
0.00E+00,
"YTTRIUM-90", "Y90", 1,
1., "Air", "inhalation", "Bq", "intake",
0.00E+00,
"chronic", "fcm3", "Soil", 1, 1, 2,
0.0,"km", 0.0,"km",
0., 70., "yr",
"Benzene", "71432", 0, 3,
0.00,"yr", 30.00,"yr", 2,
1., "Soil", "inhalation", "mg/kg/day", "noncarcinogenic",
9.53E-15,
1., "Soil", "inhalation", "mg/kg/day", "carcinogenic",
4.09E-15,
50.00,"yr", 30.00,"yr", 0,
100.00,"yr", 30.00,"yr", 0,
"STRONTIUM-90", "SR90", 1, 3,
0.00,"yr", 30.00,"yr", 1,
1., "Soil", "inhalation", "Bq", "intake",
4.73E-05,
"Y90", "Y90", 1,
1., "Soil", "inhalation", "Bq", "intake",
4.73E-05,
50.00,"yr", 30.00,"yr", 1,
1., "Soil", "inhalation", "Bq", "intake",
1.43E-05,
"Y90", "Y90", 1,
1., "Soil", "inhalation", "Bq", "intake",
1.43E-05,
100.00,"yr", 30.00,"yr", 1,
1., "Soil", "inhalation", "Bq", "intake",
4.34E-06,
"Y90", "Y90", 1,
1., "Soil", "inhalation", "Bq", "intake",
4.34E-06,

Inhale02.HIF file:

```
*****
* File: C:\FRAMES\Inhale02\Inhale02.hif
* Section: hei22
* Date: 10/9/2001 11:35:34 AM
*****
```

1,
Health Impacts File generated by MEPAS 4.0 health impacts component
2,
"chronic", "fcm3", "Air", 1, 1, 2, 1, 1,
"all sites",
"total body",
10.0,"km", 10.0,"km",
0., 70., "yr",
"Benzene", "71432", 0, 3,
0.00,"yr", 30.00,"yr", 2,
1., "Air", "inhalation", "HI", "noncarcinogenic",
1.12E-09,
1., "Air", "inhalation", "Risk", "carcinogenic",
2.37E-14,
50.00,"yr", 30.00,"yr", 2,

1., "Air", "inhalation", "HI", "noncarcinogenic",
 1.12E-09,
 1., "Air", "inhalation", "Risk", "carcinogenic",
 2.37E-14,
 100.00,"yr", 30.00,"yr", 2,
 1., "Air", "inhalation", "HI", "noncarcinogenic",
 0.00E+00,
 1., "Air", "inhalation", "Risk", "carcinogenic",
 0.00E+00,
"STRONTIUM-90", "SR90", 1, 3,
0.00,"yr", 30.00,"yr", 1,
1., "Air", "inhalation", "Risk", "cancer incidence",
1.14E-18,
 "YTTRIUM-90", "Y90", 1,
 1., "Air", "inhalation", "Risk", "cancer incidence",
 0.00E+00,
 50.00,"yr", 30.00,"yr", 1,
 1., "Air", "inhalation", "Risk", "cancer incidence",
 1.14E-18,
 "YTTRIUM-90", "Y90", 1,
 1., "Air", "inhalation", "Risk", "cancer incidence",
 0.00E+00,
 100.00,"yr", 30.00,"yr", 1,
 1., "Air", "inhalation", "Risk", "cancer incidence",
 0.00E+00,
 "YTTRIUM-90", "Y90", 1,
 1., "Air", "inhalation", "Risk", "cancer incidence",
 0.00E+00,
 "chronic", "fcm3", "Soil", 1, 1, 2, 1, 1,
 "all sites",
 "total body",
 0.0,"km", 0.0,"km",
 0., 70., "yr",
 "Benzene", "71432", 0, 3,
 0.00,"yr", 30.00,"yr", 2,
 1., "Soil", "inhalation", "HI", "noncarcinogenic",
 5.61E-12,
 1., "Soil", "inhalation", "Risk", "carcinogenic",
 1.19E-16,
 50.00,"yr", 30.00,"yr", 0,
 100.00,"yr", 30.00,"yr", 0,
"STRONTIUM-90", "SR90", 1, 3,
0.00,"yr", 30.00,"yr", 1,
1., "Soil", "inhalation", "Risk", "cancer incidence",
9.97E-13,
 "Y90", "Y90", 1,
 1., "Soil", "inhalation", "Risk", "cancer incidence",
 6.47E-15,
 50.00,"yr", 30.00,"yr", 1,
 1., "Soil", "inhalation", "Risk", "cancer incidence",
 3.01E-13,
 "Y90", "Y90", 1,
 1., "Soil", "inhalation", "Risk", "cancer incidence",
 1.96E-15,
 100.00,"yr", 30.00,"yr", 1,
 1., "Soil", "inhalation", "Risk", "cancer incidence",
 9.15E-14,
 "Y90", "Y90", 1,
 1., "Soil", "inhalation", "Risk", "cancer incidence",
 5.94E-16,

2.3. Test Case Inhale03

2.3.1. Description and Rationale for Test Case

This test case will be used to check that the MEPAS Health Impact Module will only compute health impacts for inhalation pathways when the selections made in the Intake UI and Health Impact UI are consistent (i.e., “Average Concentration” is selected in both or “Daily Intake” is selected in both). In this case, “Daily Intake” will be selected in the Intake module and “Air Concentration” will be selected in the Health Impact module. Two constituents, benzene and Sr-90, will be used for this case. These constituents provide the range of health impacts associated with radionuclides and chemicals. Only selected benzene and Sr-90 health impacts will be tested in this test plan.

2.3.2. Testing Procedure and Data

1. Create a folder under the main FRAMES folder named “Inhale03.”
2. A GID file titled “Inhale03.GID” is included in this test package. You will need to check to make sure that the file path names in the file match the file path for the FRAMES directory on your computer. The file path on your computer should be C:\frames or something similar. Open the GID file in a text editor. Do a find and replace to change the file paths in the file. Search for ‘ “D:’ and replace with ‘ ”C:’ or whatever the path name is on your computer. Save the file as a text format after the changes have been made. Note that the data contained in the file will not be described here. The data can be viewed through the FRAMES User Interface (FUI) when the case is brought up.
3. Copy the GID file into the subfolder you just created named “Inhale01.”
4. Start up FRAMES.
5. Click on the ‘file’ and select “Open.”
6. Find the folder named “Inhale03” and click on it.
7. Select the file “Inhale.GID” and click the “Open” button. The case should come up in the working area screen on the FUI. The icons on the screen represent a scenario where contaminants are transported to the exposure location via air, direct exposure to surface soils, groundwater, and surface water.
8. Right click on the icon entitled “src25” and select “User Input.”
9. Take a look through the input data if you would like and then use the “File” menu to save and exit.
10. The light on the icon should turn to yellow.
11. Right click on the icon and select “Run Model.” The model should run, and the light on the icon should turn green. This indicates a successful run.
12. Repeat this process with the icons labeled “src26,” “air23,” and “exp02a.”
13. For the icon labeled “Intake02a,” bring up the “User Input” screen and note the parameter at the bottom of the screen “Method for inhalation impact analysis.” “Daily Intake” should be selected.
14. Then use the “File” menu to save and exit.

15. Right click on the icon and select "Run Model." The model should run and the light on the icon should turn green. This indicates a successful run.
16. For the icon labeled "hei22," bring up the "User Input" screen and note the parameter at the bottom of the screen "Method for inhalation impact analysis." "Air Concentration" should be selected.
17. Then use the "File" menu to save and exit.
18. Right click on the icon and select "Run Model." The model should run and the light on the icon should turn green. This indicates a successful run.
19. Next right click on the Health Impact module and select use the "view/print module output" menu item to select "HIF text view." This will bring up the results of the Health Impact module in a text format.
20. Check the selected results in the file to ensure that they match the results in the expected results section
21. After the checks have been made, use the "File menu" to save and exit the case.

2.3.3. Expected Results

It is expected that the Health Impact module will produce "0"s as results associated with the inhalation pathway for benzene because the methods selected in the Intake and Health Impact modules are inconsistent. The method selected should not affect the Sr-90 method used.

2.3.4. Test Results and Conclusion

As can be seen below in the HIF file, the results associated with the benzene inhalation results are all zeros.

The module meets the requirements for this test case.

Inhale03.HIF file:

```
*****
* File: C:\FRAMES\INHALE03\INHALE03.hif
* Section: hei22
* Date: 10/10/2001 2:35:43 PM
*****

1,
Health Impacts File generated by MEPAS 4.0 health impacts component
2,
"chronic","fcm3","Air", 1, 1, 2, 1, 1,
"all sites",
"total body",
10.0,"km", 10.0,"km",
0., 70.,"yr",
"Benzene","71432", 0, 3,
0.00,"yr", 30.00,"yr", 2,
1.,"Air","inhalation","HI","noncarcinogenic",
0.00E+ 00,
1.,"Air","inhalation","Risk","carcinogenic",
```

0.00E+00,
50.00,"yr", 30.00,"yr", 2,
1.,"Air","inhalation","HI","noncarcinogenic",
0.00E+00,
1.,"Air","inhalation","Risk","carcinogenic",
0.00E+00,
100.00,"yr", 30.00,"yr", 2,
1.,"Air","inhalation","HI","noncarcinogenic",
0.00E+00,
1.,"Air","inhalation","Risk","carcinogenic",
0.00E+00,
 "STRONTIUM-90","SR90", 1, 3,
 0.00,"yr", 30.00,"yr", 1,
 1.,"Air","inhalation","Risk","cancer incidence",
 1.14E-18,
 "YTTRIUM-90","Y90", 1,
 1.,"Air","inhalation","Risk","cancer incidence",
 0.00E+00,
 50.00,"yr", 30.00,"yr", 1,
 1.,"Air","inhalation","Risk","cancer incidence",
 1.14E-18,
 "YTTRIUM-90","Y90", 1,
 1.,"Air","inhalation","Risk","cancer incidence",
 0.00E+00,
 100.00,"yr", 30.00,"yr", 1,
 1.,"Air","inhalation","Risk","cancer incidence",
 0.00E+00,
 "YTTRIUM-90","Y90", 1,
 1.,"Air","inhalation","Risk","cancer incidence",
 0.00E+00,
 "chronic","fcm3","Soil", 1, 1, 2, 1, 1,
 "all sites",
 "total body",
 0.0,"km", 0.0,"km",
 0., 70., "yr",
"Benzene","71432", 0, 3,
0.00,"yr", 30.00,"yr", 2,
1.,"Soil","inhalation","HI","noncarcinogenic",
0.00E+00,
1.,"Soil","inhalation","Risk","carcinogenic",
0.00E+00,
50.00,"yr", 30.00,"yr", 0,
100.00,"yr", 30.00,"yr", 0,
 "STRONTIUM-90","SR90", 1, 3,
 0.00,"yr", 30.00,"yr", 1,
 1.,"Soil","inhalation","Risk","cancer incidence",
 9.97E-13,
 "Y90","Y90", 1,
 1.,"Soil","inhalation","Risk","cancer incidence",
 6.47E-15,
 50.00,"yr", 30.00,"yr", 1,
 1.,"Soil","inhalation","Risk","cancer incidence",
 3.01E-13,
 "Y90","Y90", 1,
 1.,"Soil","inhalation","Risk","cancer incidence",
 1.96E-15,
 100.00,"yr", 30.00,"yr", 1,
 1.,"Soil","inhalation","Risk","cancer incidence",
 9.15E-14,
 "Y90","Y90", 1,
 1.,"Soil","inhalation","Risk","cancer incidence",
 5.94E-16,

3.0 Reference

Streng, D. L., and P. J. Chamberlain, Jr. 1995. Multimedia Environmental Pollutant Assessment system (MEPAS): Exposure Pathway and Human Health Impact Assessment Models.