About the Contamination

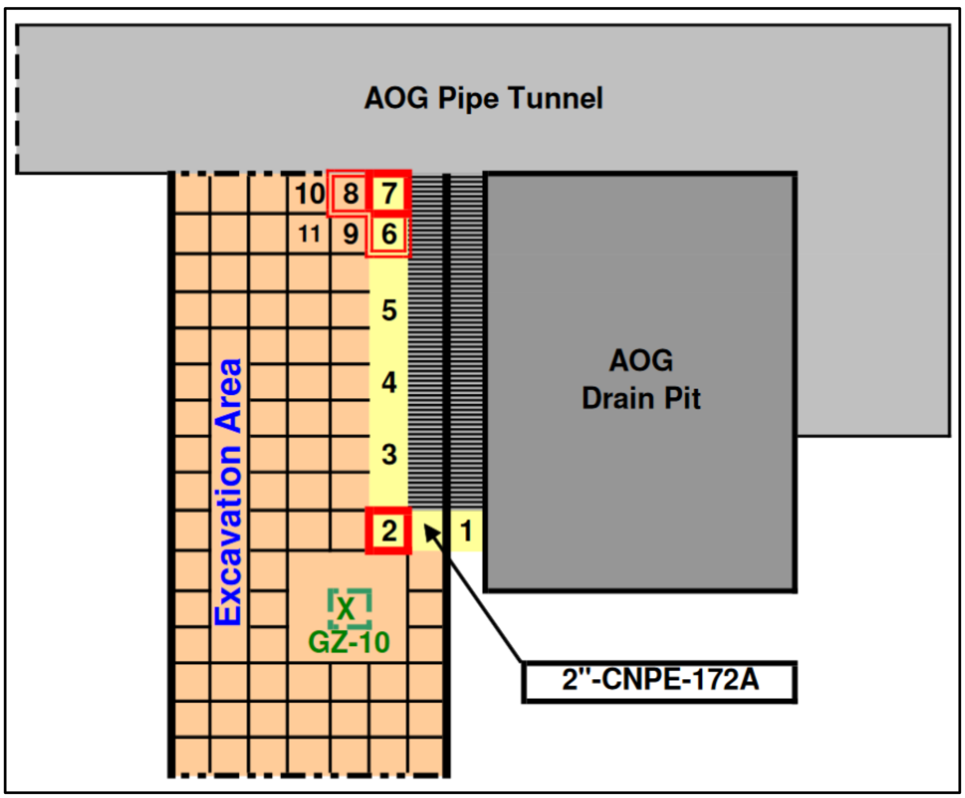
On January 7, 2010, there was a report of tritium in groundwater at Vermont Yankee, which told officials that there was an underground leak of radioactive material. Radioisotopes had contaminated the environment, which was confirmed by soil testing. Although the soil at Vermont Yankee was contaminated with radioactive materials, there is no known exposure or risk to the public.

Soil Analysis

Soil was collected for analysis, and the results showed the following radioisotopes in the soil:

- Strontium-90
- Cesium-137
- Zinc-65
- Manganese-54
- Cobalt-60

The Advanced Off-Gas (AOG) pipe was the source of the leak. The soil samples were taken from various locations and depths below the excavation area outside the Advanced Off-Gas (AOG) pipe tunnel.



Vermont Yankee Nuclear Power Plant Soil Sampling Sites

Laboratory Results & Analyses

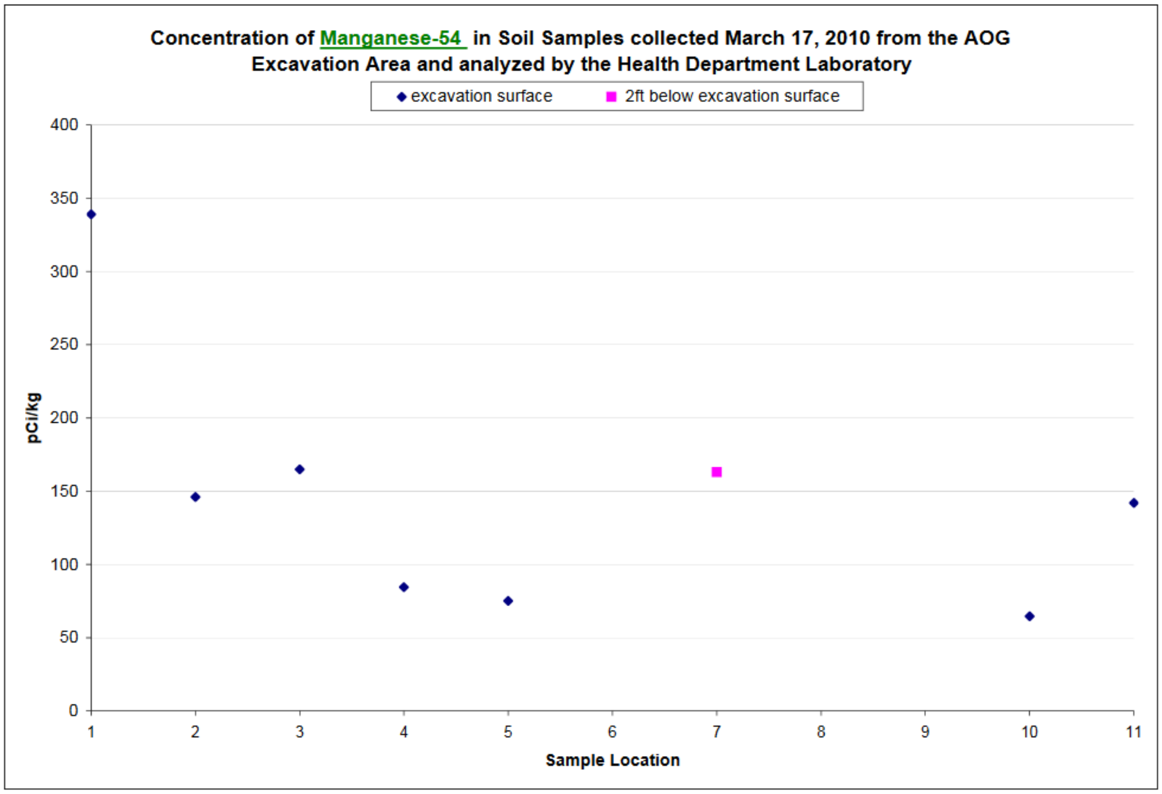
The Vermont Department of Health and Vermont Yankee performed separate laboratory analyses on the soil samples.

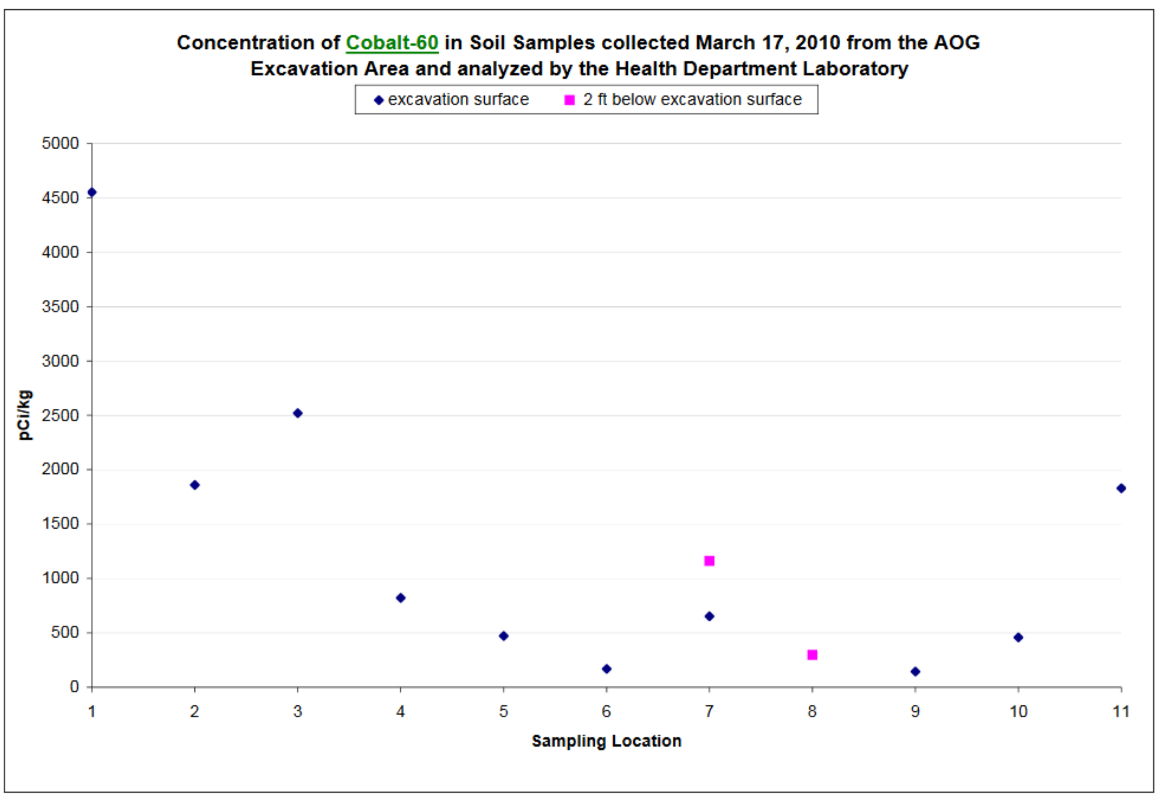
Laboratory analyses for soil samples collected March 17, 2010 at locations along the Vermont Yankee Advanced Off-Gas Pipe Tunnel leak pathway						
Sample Location		VT Department of Health Results (pCi/kg)				VDH-contracted Lab Results (pCi/kg)
AOG Reference Site Number	**Depth**	**Mn-54**	**Co-60**	**Zn-65**	**Cs-137**	**Sr-90**
1	surface	339	4550	884	980	TBD
	2ft below surface	<LLD	<LLD	<LLD	173	TBD
2	surface	146	1860	401	1030	TBD
	2ft below surface	<LLD	<LLD	<LLD	<LLD	TBD
3	surface	165	2520	615	4080	TBD
	2ft below surface	<LLD	<LLD	<LLD	<LLD	TBD
4	surface	85	821	382	628	TBD
	2ft below surface	<LLD	<LLD	<LLD	<LLD	TBD
5	surface	75	472	139	446	TBD
	2ft below surface	<LLD	<LLD	<LLD	<LLD	TBD
6	surface	<LLD	170	<LLD	326	TBD
	2ft below surface	<LLD	<LLD	<LLD	884	TBD
7	surface	<LLD	652	315	1080	TBD
	2ft below surface	163	1160	535	733	TBD
8	surface	<LLD	<LLD	<LLD	544	TBD
	2ft below surface	<LLD	298	<LLD	951	TBD
9	surface	<LLD	145	<LLD	1020	TBD
	2ft below surface	<LLD	<LLD	<LLD	149	TBD
10	surface	65	458	137	326	TBD
	2ft below surface	<LLD	<LLD	<LLD	<LLD	TBD
11	surface	142	1830	499	1670	TBD
	2ft below surface	<LLD	<LLD	<LLD	38	TBD

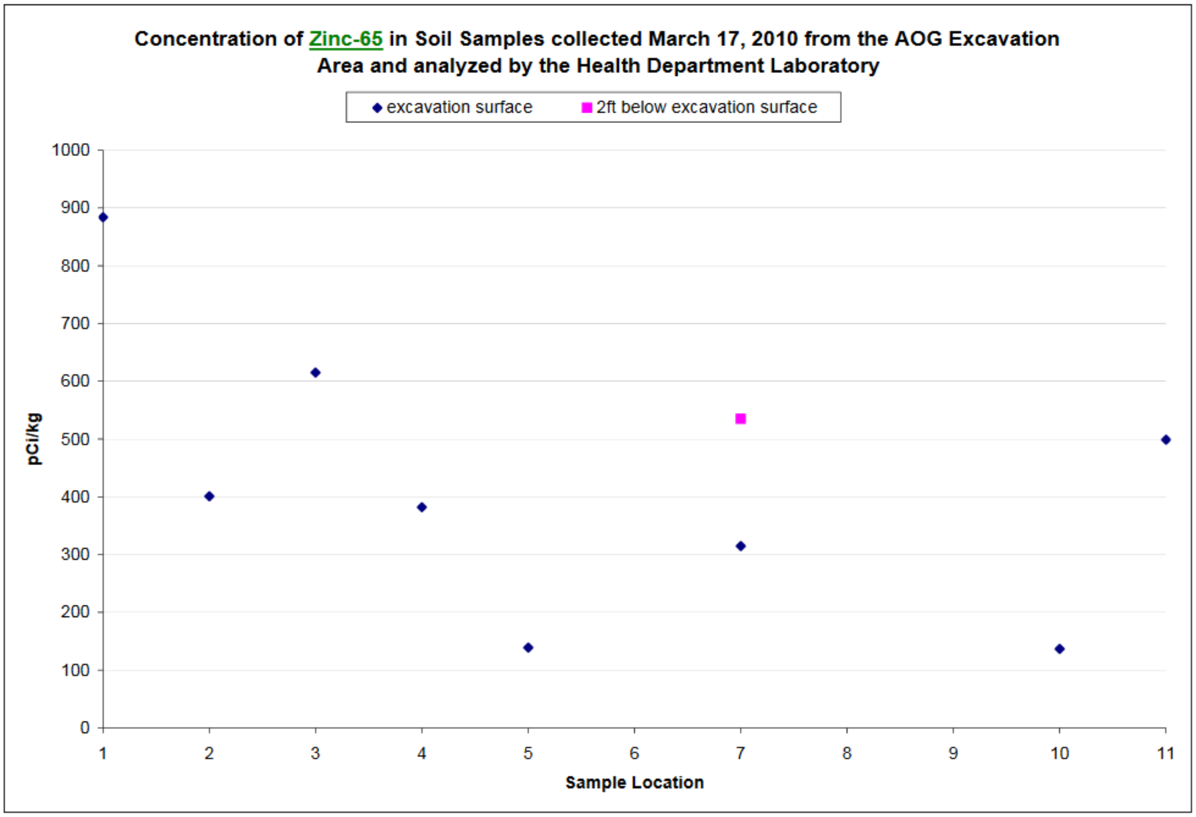
Note: <LLD = Below the Lower Limit of Detection

Laboratory analyses for soil samples collected March 17, 2010 at locations along the Vermont Yankee Advanced Off-Gas Pipe Tunnel leak pathway						
Sample Location		Vermont Yankee Results (pCi/kg)				VY-contractor Results (pCi/kg)
AOG Reference Site Number	**Depth**	**Mn-54**	**Co-60**	**Zn-65**	**Cs-137**	**Sr-90 (*only sites 1, 2 and 7 were analyzed)**
1	surface	553	5974	1308	1830	8290
		4743	48710	13760	11300	
	2ft below surface	< LLD	103	< LLD	< LLD	4740
		< LLD	448	< LLD	51	
2	surface	181	1698	411	1066	5170
		618	6840	1503	2635	
	2ft below surface	62	1706	300	397	2370
		< LLD	< LLD	< LLD	< LLD	
3	surface	< LLD	2667	897	4015	
		329	3014	642	10260	
	2ft below surface	< LLD	< LLD	< LLD	< LLD	
		< LLD	< LLD	< LLD	< LLD	
4	surface	133	1087	366	656	
		131	959	405	838	
	2ft below surface	< LLD	< LLD	< LLD	< LLD	
		< LLD	< LLD	< LLD	< LLD	
5	surface	53	579	284	505	
		87	456	< LLD	529	
		196	2958	702	10000	
	2ft below surface	< LLD	< LLD	< LLD	< LLD	
		< LLD	< LLD	< LLD	< LLD	
6	surface	< LLD	248	214	336	
		< LLD	192	< LLD	312	
	2ft below surface	< LLD	< LLD	< LLD	694	
		< LLD	< LLD	< LLD	983	
7	surface	158	799	670	1238	161
		425	2071	968	1084	
	2ft below surface	251	1311	578	774	152
		126	597	227	340	
8	surface	< LLD	< LLD	< LLD	455	
		< LLD	< LLD	< LLD	1395	
	2ft below surface	< LLD	317	159	1135	
		< LLD	423	< LLD	929	
9	surface	< LLD	151	< LLD	1082	
		< LLD	165	< LLD	1089	
	2ft below surface	< LLD	< LLD	< LLD	135	
		< LLD	< LLD	< LLD	<LLD	
10	surface	< LLD	586	< LLD	392	
		< LLD	485	< LLD	362	
	2ft below surface	< LLD	< LLD	< LLD	< LLD	
		< LLD	< LLD	< LLD	< LLD	
11	surface	428	2450	925	2077	
		256	1722	649	3750	
	2ft below surface	< LLD	< LLD	< LLD	65	
		< LLD	258	< LLD	31	

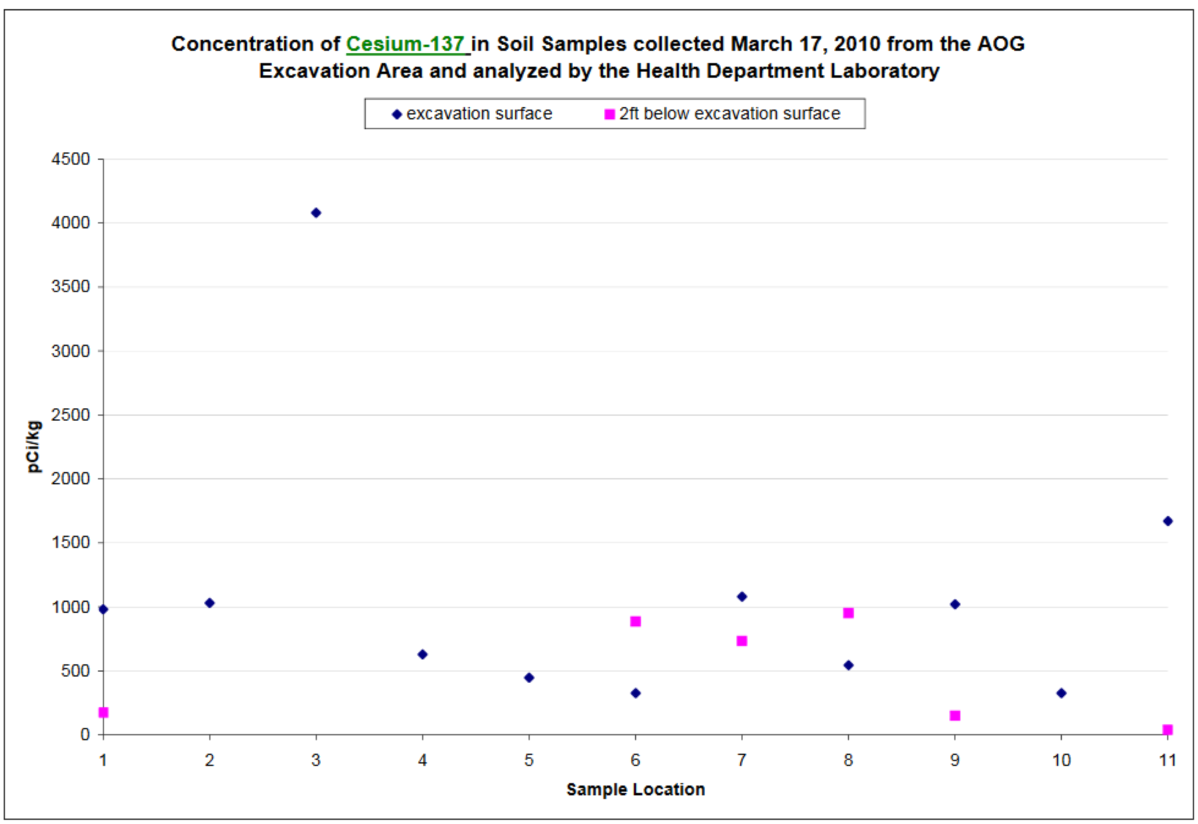
Note: <LLD = Below the Lower Limit of Detection


Concentration of Manganese-54 in Soil Samples collected March 17, 2010 from the AOG Excavation Area and analyzed by the Health Department Laboratory
excavation surface
2ft below excavation surface
pCi/kg
400
350
300
250
200
150
100
50
0
1
2
3
4
5
6
7
8
9
10
11
Sample Location


Concentration of Cobalt-60 in Soil Samples collected March 17, 2010 from the AOG Excavation Area and analyzed by the Health Department Laboratory
excavation surface
2 ft below excavation surface
pCi/kg
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1
2
3
4
5
6
7
8
9
10
11
Sampling Location



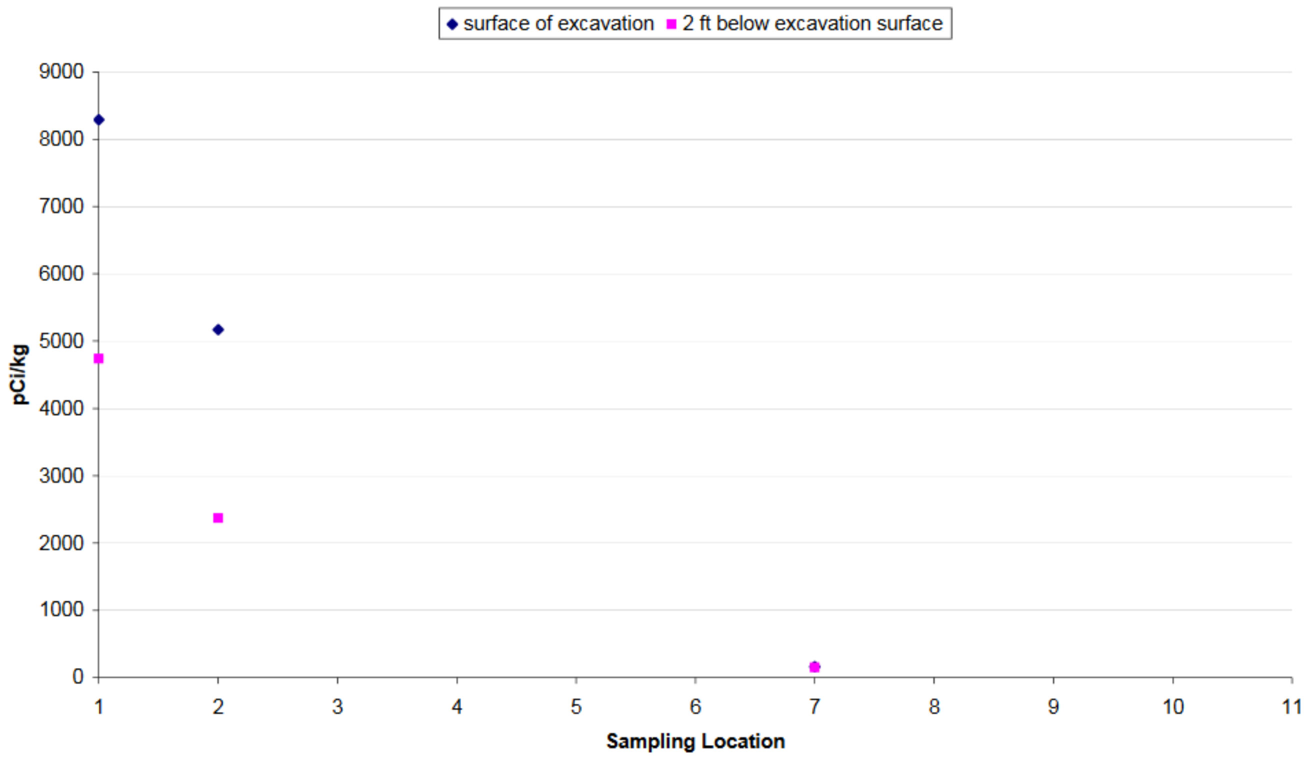
Concentration of Zinc-65 in Soil Samples collected March 17, 2010 from the AOG Excavation Area and analyzed by the Health Department Laboratory
excavation surface
2ft below excavation surface
1000
900
800
700
600
500
400
300
200
100
0
pCi/kg
1
2
3
4
5
6
7
8
9
10
11
Sample Location



Concentration of Cesium-137 in Soil Samples collected March 17, 2010 from the AOG Excavation Area and analyzed by the Health Department Laboratory
excavation surface
2ft below excavation surface
4500
4000
3500
3000
2500
2000
1500
1000
500
0
pCi/kg
1
2
3
4
5
6
7
8
9
10
11
Sample Location

Concentration of Strontium-90 in Soil Samples collected March 17, 2010 from the AOG Excavation Area and analyzed by VY-contracted Lab

(*only sites 1, 2, and 7 were sent to for hard-to-detects)



Laboratory analyses for soil samples collected February 26, 2010 at locations along the Vermont Yankee Advanced Off Gas Pipe Tunnel leak pathway										
Sample Location		VT Department of Health Results (pCi/kg)				VDH contracted Lab Results (pCi/kg)	Vermont Yankee Results (pCi/Kg)			
AOG Reference Site Number	Depth	Mn 54	Co 60	Zn 65	Cs 137	Sr 90	Mn 54	Co 60	Zn 65	Cs 137
1 (*approx*)	surface	< LLD	< LLD	< LLD	< LLD	TBD	< LLD	< LLD	< LLD	< LLD
	2ft below surface	< LLD	< LLD	< LLD	< LLD	TBD	< LLD	< LLD	< LLD	< LLD
	4ft below surface	< LLD	< LLD	< LLD	< LLD	TBD	< LLD	< LLD	< LLD	< LLD
	6ft below surface	< LLD	< LLD	< LLD	< LLD	TBD	< LLD	88.8	< LLD	< LLD
2 (*approx*)	surface	54.5	295	86.0	292	TBD	78.6	294	< LLD	280
	2ft below surface	< LLD	< LLD	< LLD	< LLD	TBD	< LLD	< LLD	< LLD	56.3
	4ft below surface	< LLD	< LLD	< LLD	< LLD	TBD	< LLD	< LLD	< LLD	< LLD
	6ft below surface	< LLD	< LLD	< LLD	< LLD	TBD	< LLD	< LLD	< LLD	< LLD
7 (*approx*)	surface	170	757	455	778	TBD	149	876	394	748
	2ft below surface	164	881	379	669	TBD	206	962	619	611
	4ft below surface	< LLD	183	< LLD	190	TBD	< LLD	< LLD	< LLD	1062
	6ft below surface	< LLD	< LLD	< LLD	1270	TBD	< LLD	308.0	231	311
SW Corner of area	4ft below surface	< LLD	< LLD	< LLD	< LLD	TBD	< LLD	< LLD	< LLD	< LLD
	6ft below surface	< LLD	< LLD	< LLD	< LLD	TBD	< LLD	< LLD	< LLD	< LLD
NW corner of area	4ft below surface	< LLD	< LLD	< LLD	692	TBD	< LLD	< LLD	< LLD	589
	6ft below surface	< LLD	< LLD	< LLD	1110	TBD	< LLD	< LLD	< LLD	843
Note: <LLD = Below the Lower Limit of Detection										

About the sampling and analyses

If nuclear fallout or weapons testing had been the cause of the radioisotope contamination, they would not have been found as deep in the ground as the sampling results showed. The radioisotopes were detected in higher amounts, deeper in the ground than what we would expect from either nuclear fallout or weapons testing. This is evidence that radioisotopes in addition to tritium washed out of the AOG pipe tunnel into the environment with the leaking nuclear reactor water.

Another leak was discovered by Vermont Yankee on May 28, 2010. Soil testing that was done immediately after the discovery detected the strontium-90, cesium-137, zinc-65, manganese-54, and cobalt-60, as well as a number of other radioisotopes that decay quickly and are no longer detectable within hours or days: chromium-51, cobalt-58, zinc-69, niobium-95, rhodium-105, barium-140, lanthanum-140 (all metals), and xenon-131 (a noble gas).

The results of the May 28th sample analysis showed that the concentrations of strontium-90 and cesium-137 found in soil samples taken from the excavation area near the AOG pipe tunnel were much higher than would be expected from fallout.

On March 17 and 18, soil was sampled and cesium-137 was found at as much as 75 times higher than what would be expected in surface soils.

Analysis by Vermont Yankee of concrete mud and construction debris in the AOG pipe tunnel also confirmed the presence of cesium-137.

As part of its ongoing environmental surveillance, the Vermont Department of Health tested soil samples from two sites in the state that were not associated with Vermont Yankee. The results of the analysis confirmed cesium-137 at concentrations consistent with past nuclear fallout. In 2008, cesium-137 was measured at 86 and at 168 picocuries per kilogram (pCi/kg).

More testing is underway. At the request of the Health Department, samples of mud and construction debris from within the tunnel were also taken for analysis. Samples are being analyzed by the Department of Health Laboratory. Samples will also be analyzed by an independent laboratory hired under contract with the Health Department for “hard to detect” radionuclides such as strontium-90, iron-55 and nickel-63.

About Strontium-90 and Cesium-137

Strontium-90 and cesium-137 are both radioactive isotopes, which means they have an unstable nucleus that give off radiation in the form of alpha, beta, and gamma rays when they break down. They are products of nuclear fission and do not occur naturally in the environment.

The “half-life” is the length of time it takes for a substance to reduce to one-half of its original concentration by decaying. Strontium-90 has a half-life of 29 years, and cesium-137 has a half-life of 30 years. This means in 29 years, the concentration of strontium-90 will be half of what it was originally, and in 30 years the concentration of cesium-137 will reduce by half.

Strontium-90 is considered one of the more hazardous radionuclides associated with nuclear reactors. It is a moderately strong beta emitter. Its radiation can pass through the human body, but can be stopped by a layer of wood, aluminum, or thick clothing. In the body, strontium-90 behaves much like calcium, and tends to concentrate in the bones, teeth, and bone marrow. Strontium-90 is linked to bone cancer, cancer of the soft tissue near bone, and leukemia.

Cesium-137 is a strong gamma emitter. Its radiation can pass through the human body and will be stopped only by a lead shield or several feet of concrete.

About Zinc-65, Manganese-54, Cobalt-60

Zinc-65, manganese-54 and cobalt-60 are all corrosion products that are produced when steel components in the nuclear reactor corrode. Tiny amounts of the corroded metals circulate in the reactor water, and may be released during re-fueling or maintenance operations.

All three of these isotopes give off radiation and decay over time. The “half life” is the length of time it takes to reduce to one-half of its original concentration by decaying. Zinc-65 has a half life of 244 days. Manganese-54 has a half life of 313 days. Cobalt-60 has a half life of 5.3 years.

Cobalt-60 is a strong gamma emitter. Its radiation can pass through the human body, and can only be stopped only by a lead shield or several feet of concrete.

For More Information:

Contact the Department of Health
Environmental Health Division
Call: 800 439-8550 OR 802 863-7220
http://www.healthvermont.gov/environment/radiological.com

About Radionuclides
Agency for Toxic Substances & Disease Registry (ATSDR)

About Strontium:
Radioisotope Brief – Strontium-90
ATSDR
Radionuclide Basics – Strontium-90
Environmental Protection Agency

About Cesium:
Radioisotope Brief – Cesium-137
ATSDR
Radionuclide Basics – Cesium-137
Environmental Protection Agency

About Cobalt:
Radioisotope Brief – Cobalt-60
ATSDR
Radionuclide Basics – Cobalt-60
Environmental Protection Agency