Nuclear Plant Effluents Webinar

March 24, 2015

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Radiation Protection and Consequences Branch
Division of Risk Assessment
Office of Nuclear Reactor Regulation

Effluent Monitoring

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United States Nuclear Regulatory Commission
Protecting People and the Environment

- Each plant monitors discharges of:
  - Noble gas (e.g., krypton, xenon, argon)
  - Tritium - normal discharges
  - Tritium - leaks and spills
  - Carbon-14
  - Iodine and Particulates (e.g., cobalt, cesium, strontium)
- – Effluent Reports – 3 types
  - Individual plant reports (prepared by each plant)
  - Summary reports (prepared by NRC)
  - Tritium reports (plants with groundwater tritium contamination
  - All reports posted on the NRC public web site

NRC's public web site:

http://www.nrc.gov

Click on NUCLEAR REACTORS

Click on “Operating Reactors”

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Click on “Operational Experience”

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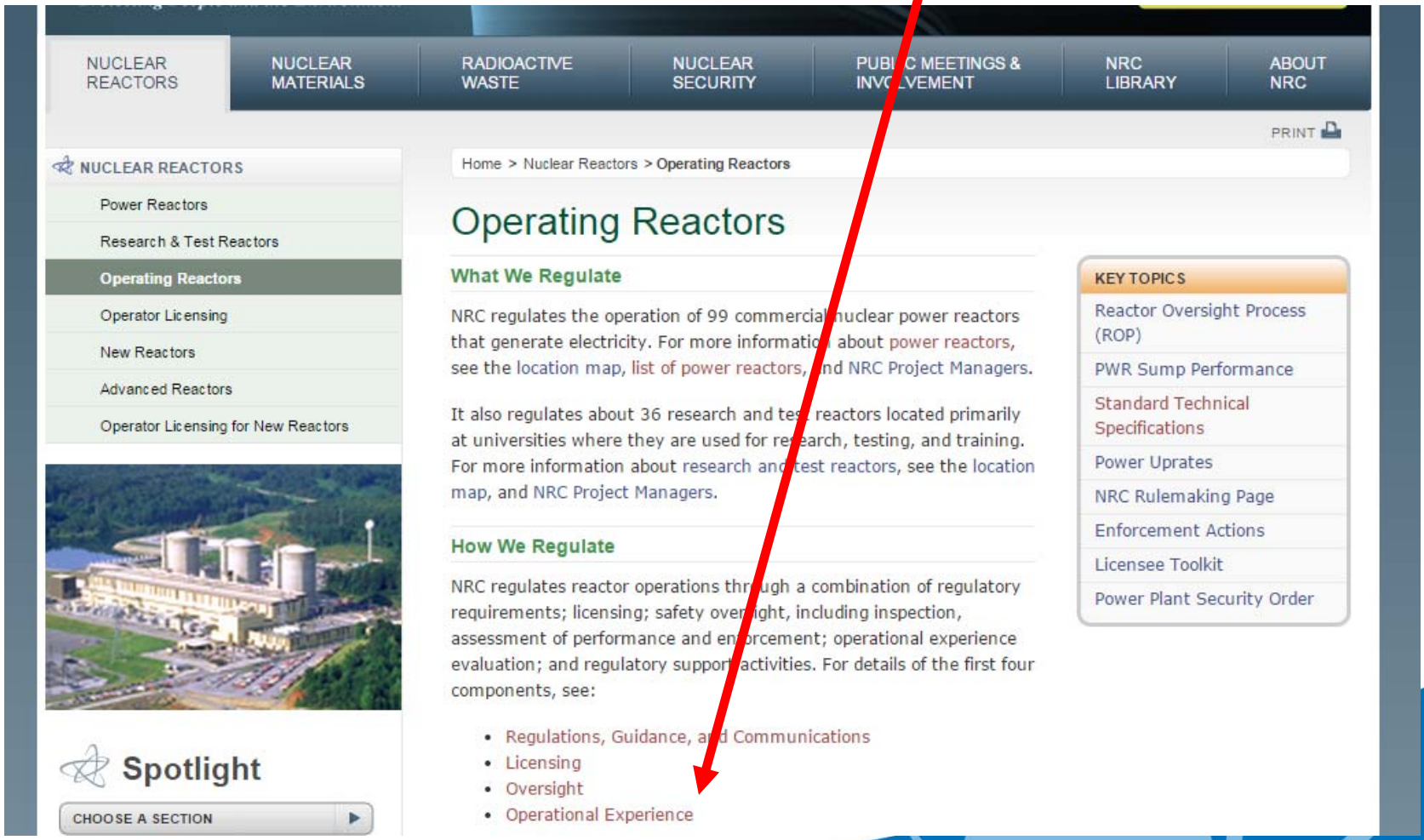
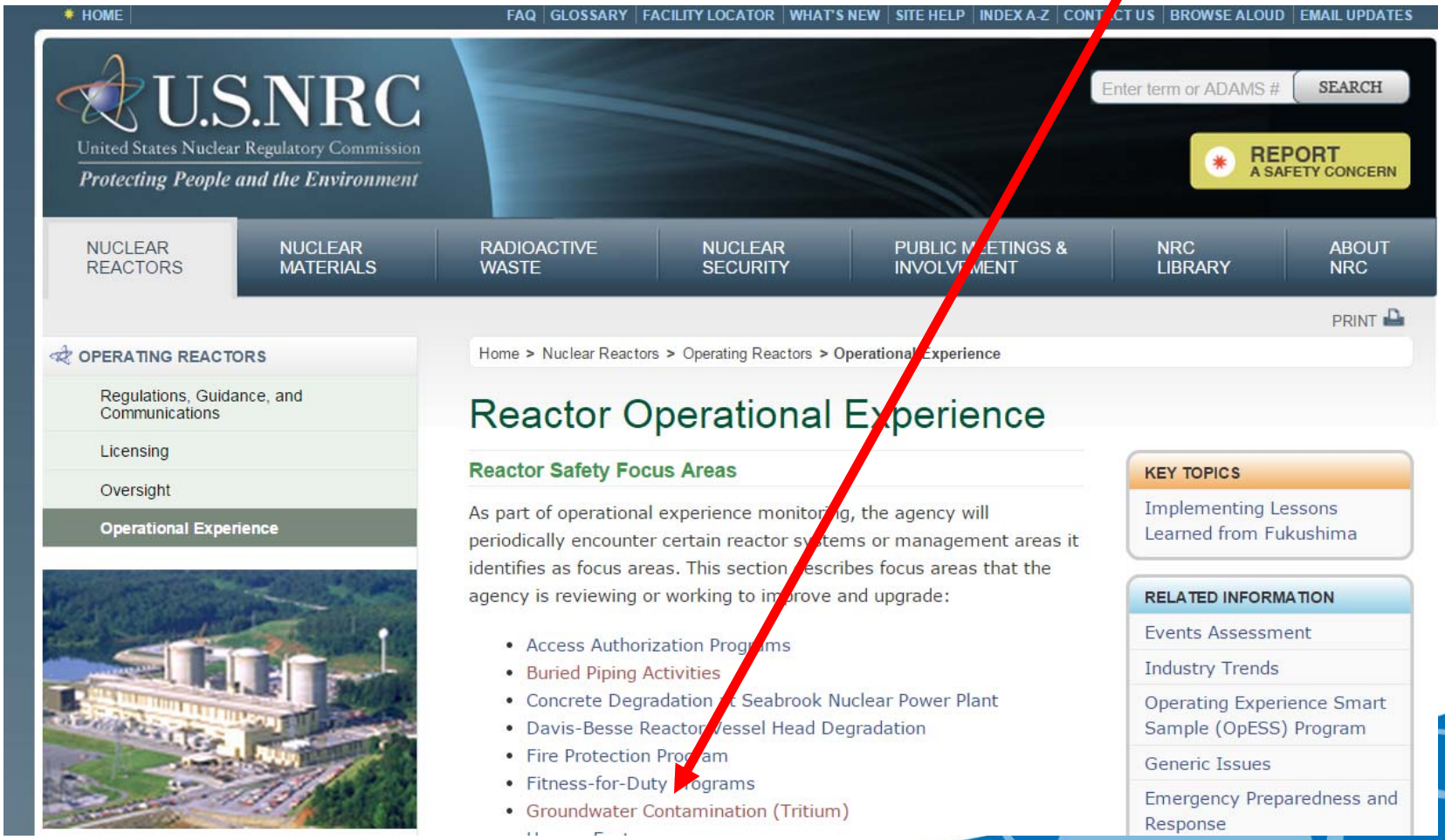


Click on "Groundwater Contamination (Tritium)



Click on “Radioactive Effluent and Environmental Reports”

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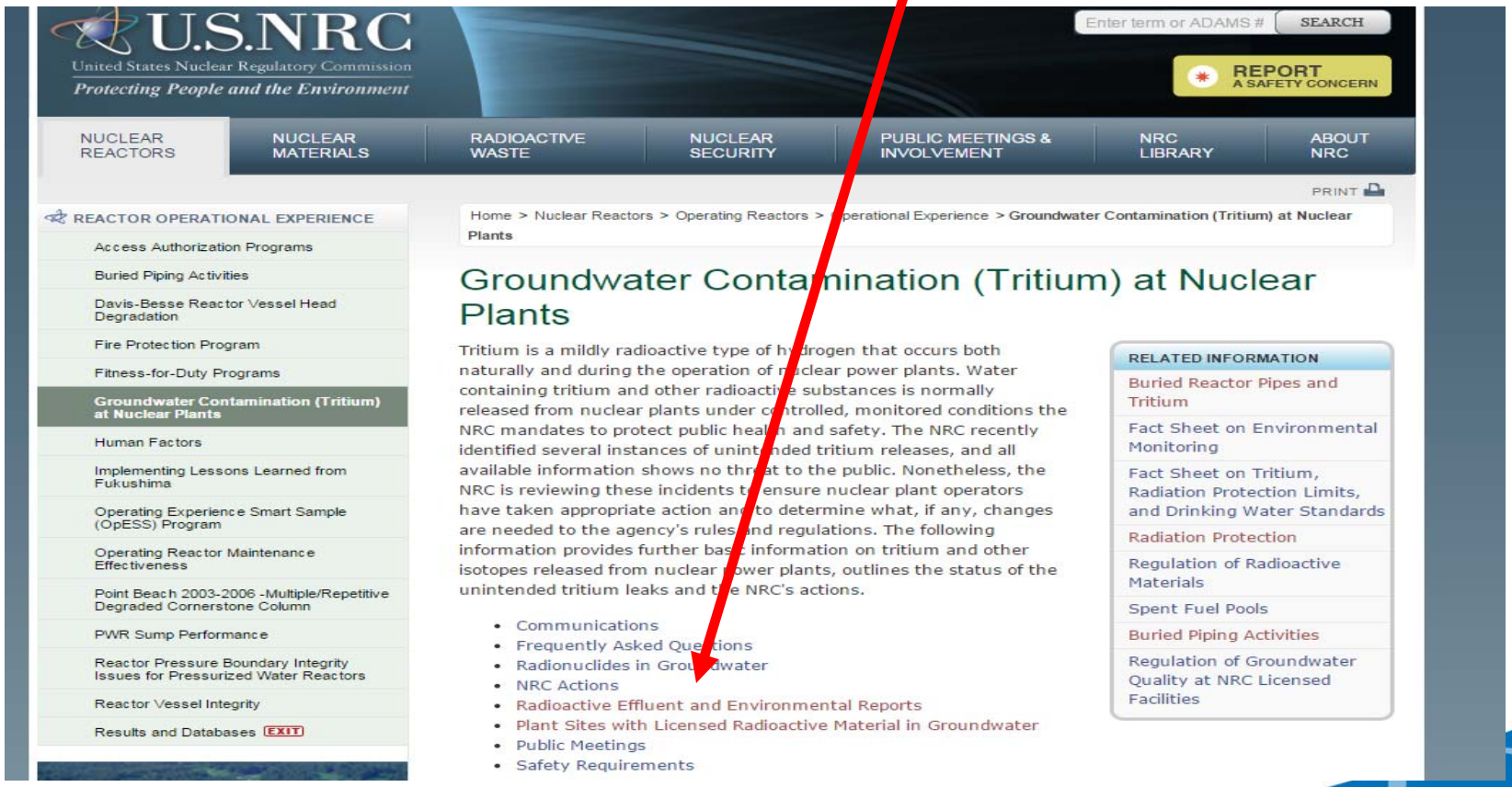

- Click on your nuclear plant, or
- click on “Radioactive Effluent Summary Report” (by year)

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Alphabetical List of Operating Nuclear Power Reactors

A - G	H - P	Q - W
Arkansas Nuclear One 1 & 2	H.B. Robinson 2	Quad Cities 1 & 2
Beaver Valley 1 & 2	Haddam Neck	River Bend 1
Braidwood 1 & 2	Hope Creek 1	Salem 1 & 2
Browns Ferry 1, 2, & 3	Indian Point 2 & 3	San Onofre 2 & 3
Brunswick 1 & 2	James A. FitzPatrick	Seabrook 1
Byron Station 1 & 2	Joseph M. Farley 1 & 2	Sequoyah 1 & 2
Callaway	Kewaunee	Shearon Harris 1
Calvert Cliffs 1 & 2	LaSalle County 1 & 2	South Texas Project 1 & 2
Catawba 1 & 2	Limerick 1 & 2	St. Lucie 1 & 2

In accordance with the direction from the Commission, NRC's annual summary radioactive effluent reports are being written for each calendar year. The staff began with the data from calendar year 2007. The currently available NRC summary reports can be found at the links below.

Radioactive Effluent Summary Report by Calendar Year: | 2009 | 2008 | 2007 |

Click on Catawba's "Radioactive Effluent Reports: 2013"

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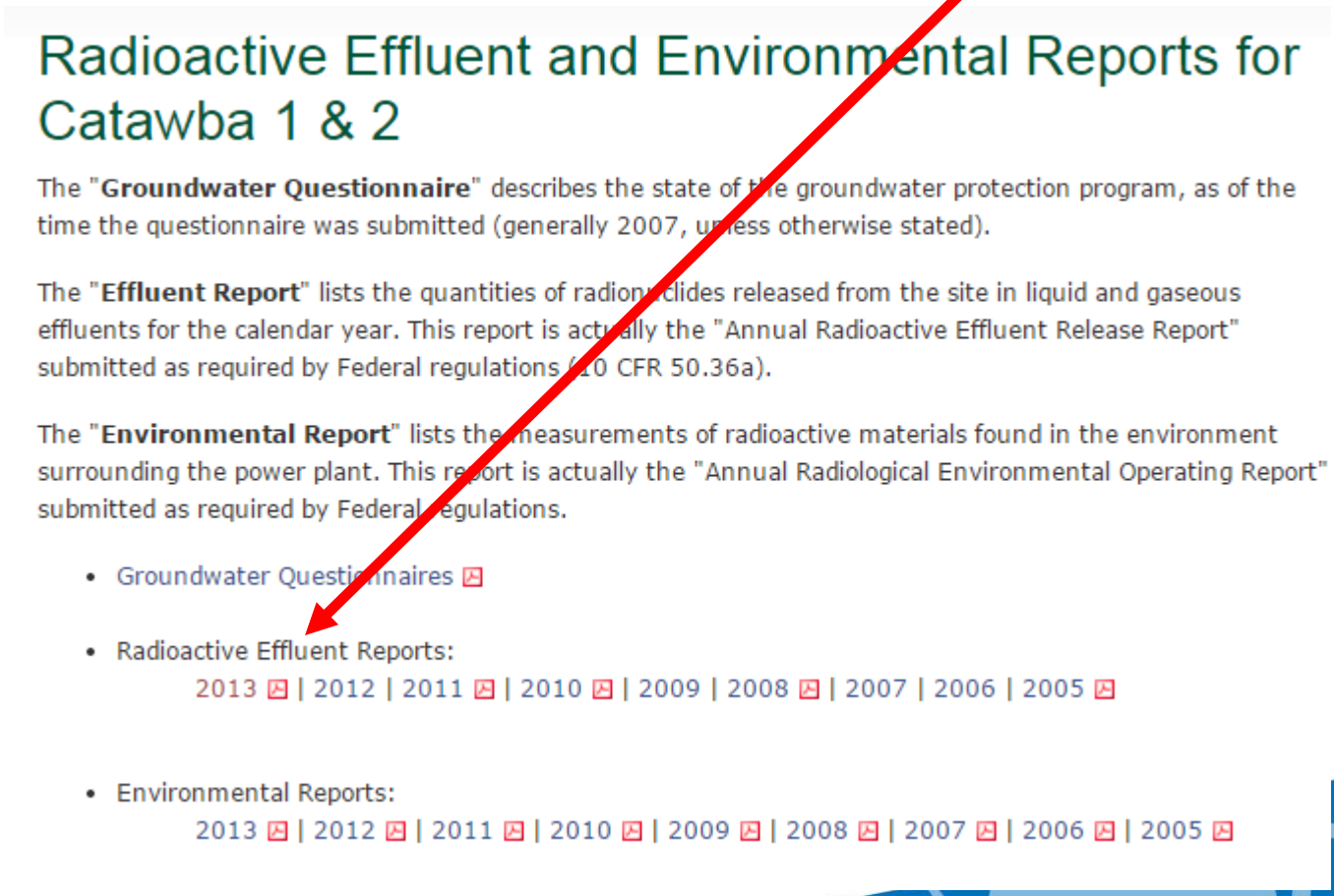

Radioactive Effluent and Environmental Reports for Catawba 1 & 2

The "**Groundwater Questionnaire**" describes the state of the groundwater protection program, as of the time the questionnaire was submitted (generally 2007, unless otherwise stated).

The "**Effluent Report**" lists the quantities of radionuclides released from the site in liquid and gaseous effluents for the calendar year. This report is actually the "Annual Radioactive Effluent Release Report" submitted as required by Federal regulations (10 CFR 50.36a).

The "**Environmental Report**" lists the measurements of radioactive materials found in the environment surrounding the power plant. This report is actually the "Annual Radiological Environmental Operating Report" submitted as required by Federal regulations.

- Groundwater Questionnaires
- Radioactive Effluent Reports:
  2013 | 2012 | 2011 | 2010 | 2009 | 2008 | 2007 | 2006 | 2005
- Environmental Reports:
  2013 | 2012 | 2011 | 2010 | 2009 | 2008 | 2007 | 2006 | 2005

Catawba Letter to NRC

(this is a pdf file, so you scroll instead of clicking)

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United States Nuclear Regulatory Commission
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April 30, 2014

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Subject: Duke Energy Carolinas, LLC
Catawba Nuclear Station, Units 1 and 2
Docket Nos. 50-413 and 50-414
2013 Annual Radioactive Effluent Release Report

Pursuant to Catawba Nuclear Station Technical Specification (TS) 5.6.3 and Selected Licensee Commitment 16.11-16, please find attached the Annual Radioactive Effluent Release Report for the period of January 1, 2013, through December 31, 2013. In accordance with Catawba TS 5.5.1, the Offsite Dose Calculation Manual (ODCM) is included in this submittal.

Attachment 1	Summary of Gaseous and Liquid Effluents Report
Attachment 2	Supplemental Information
Attachment 3	Solid Waste Disposal Report
Attachment 4	Meteorological Data
Attachment 5	Unplanned Offsite Releases
Attachment 6	Assessment of Radiation Dose from Radioactive Effluents to Members of the Public (includes fuel cycle dose calculation results)

Catawba effluent data – 2013

How to read exponential notation?

2.06E+01 is read by moving decimal “1” digit to the right
so 2.06E+1 Ci is really 20.6 Ci,
where “Ci” is curies. “Curies” is 37 million transformations per second.

Catawba Nuclear Station Units 1 & 2

REPORT FOR 2013	Unit	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
A. Fission and Activation Gases						
1. Total Release	Ci	1.13E+00	9.14E-01	7.79E-01	6.54E-01	3.48E+00
2. Avg. Release Rate	µCi/sec	1.46E-01	1.16E-01	9.81E-02	8.22E-02	1.10E-01
B. Iodine-131						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	µCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half Life >= 8 days						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	µCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
1. Total Release	Ci	5.52E+01	4.85E+01	5.30E+01	5.38E+01	2.10E+02
2. Avg. Release Rate	µCi/sec	7.09E+00	6.17E+00	6.67E+00	6.77E+00	6.67E+00
E. Carbon-14						
1. Total Release	Ci	5.42E+00	5.36E+00	4.90E+00	4.87E+00	2.06E+01
2. Avg. Release Rate	µCi/sec	6.97E-01	6.82E-01	6.17E-01	6.13E-01	6.52E-01

NRC Effluent Summary Reports

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- NRC prepares “Radioactive Effluent Summary Reports” for each calendar year
- The link to these annual reports is provided on NRC web site
- So we return to NRC web page for “Radioactive Effluent and Environmental Reports”
- Click on last line, the “Radioactive Effluent Summary Report”

Click on the
Radioactive Effluent Summary Reports
by year

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Radioactive Effluent and Environmental Reports

Each commercial nuclear power plant is required to submit two annual reports, which detail (1) the radioactive effluents discharged from the site, and (2) the effects (if any) on the environment. In addition to these two annual reports, in 2007 each power plant voluntarily submitted answers to a questionnaire related to the voluntary initiative on groundwater protection, initiated by the commercial nuclear power industry.

To see these reports and questionnaires for a particular nuclear power plant, select the plant name from the following table.

Alphabetical List of Operating Nuclear Power Reactors

A - G	H - P	Q - W
Arkansas Nuclear One 1 & 2	H.B. Robinson 2	Quad Cities 1 & 2
Beaver Valley 1 & 2	Haddam Neck	River Bend 1
Braidwood 1 & 2	Hope Creek 1	Salem 1 & 2
Browns Ferry 1, 2, & 3	Indian Point 2 & 3	San Onofre 2 & 3
Brunswick 1 & 2	James A. FitzPatrick	Seabrook 1
Byron Station 1 & 2	Joseph M. Farley 1 & 2	Sequoyah 1 & 2
Callaway	Kewaunee	Shearon Harris 1
Calvert Cliffs 1 & 2	LaSalle County 1 & 2	South Texas Project 1 & 2
Catawba 1 & 2	Limerick 1 & 2	St. Lucie 1 & 2

In accordance with the direction from the Commission, NRC's annual summary radioactive effluent reports are being written for each calendar year. The staff began with the data from calendar year 2007. The currently available NRC summary reports can be found at the links below.

Radioactive Effluent Summary Report by Calendar Year: | 2009 | 2008 | 2007 |

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NUREG/CR-2907, Vol. 15

Radioactive Effluents from Nuclear Power Plants

Annual Report 2009

NUREG/CR-2907

(now in a pdf file, so clicking doesn't work)

Table 1.1
Nuclear Power Plants, 2009

Plant Name	Type	Full Plant Name	Location
Arkansas 1, 2	PWR	Arkansas Nuclear One (ANO), Units 1, 2	Russellville, AR
Beaver Valley 1, 2	PWR	Beaver Valley, Units 1, 2	Shippingport, PA
Braidwood 1, 2	PWR	Braidwood Generating Station, Units 1, 2	Braceville, IL
Browns Ferry 1, 2, 3	BWR	Browns Ferry Nuclear Plant, Units 1, 2, 3	Decatur, AL
Brunswick 1, 2	BWR	Brunswick Steam Electric Plant, Units 1, 2	Southport, NC
Byron 1, 2	PWR	Byron Generating Station, Units 1, 2	Byron, IL
Callaway	PWR	Callaway Plant, Unit 1	Callaway, MO
Calvert Cliffs 1, 2	PWR	Calvert Cliffs Nuclear Power Plant, Units 1, 2	Lusby, MD
Catawba 1, 2	PWR	Catawba Nuclear Station, Units 1, 2	York, SC

Long-term Trend in Gases

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Figure 3.15
Historical Trend in Noble Gas Effluents

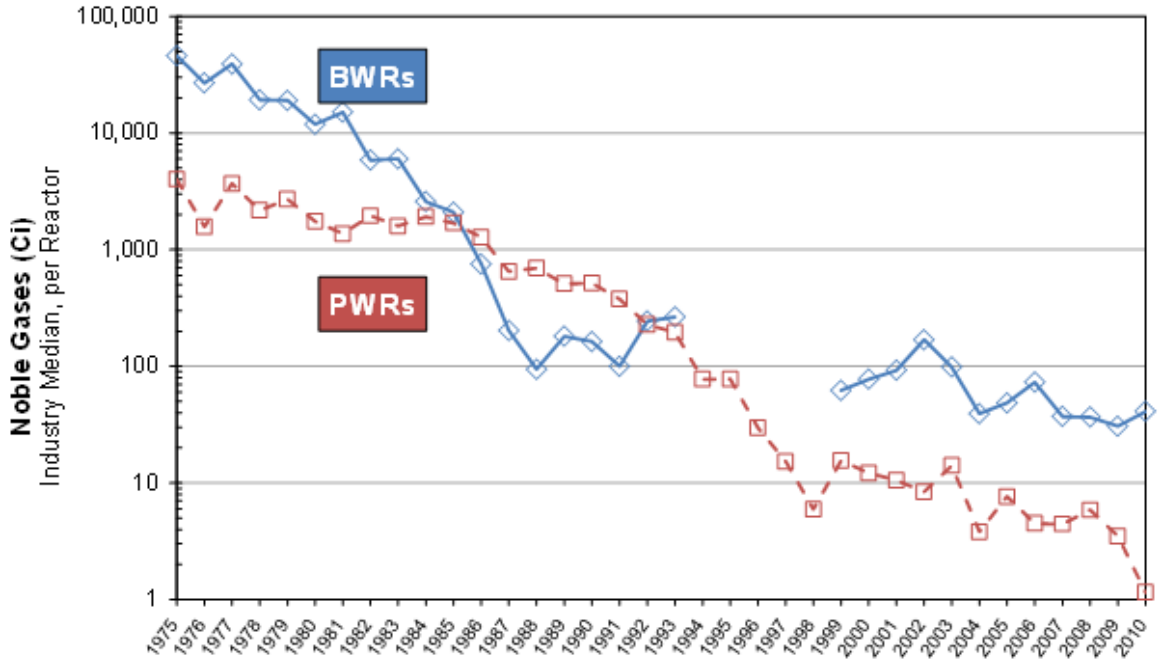

Figure 3.15 shows a significant downward trend in the amount of noble gases in gaseous effluents from both BWRs and PWRs. The magnitude of the reduction is a 99.9% reduction in noble gas effluents over the last 35 years. For example, in 1975, the median release for BWRs was greater than 40,000 curies; however, in 2010, the median was 41.09 curies.

Long-term Trends in Liquids

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Figure 3.16
Historical Trend of Particulates in Liquid Effluents

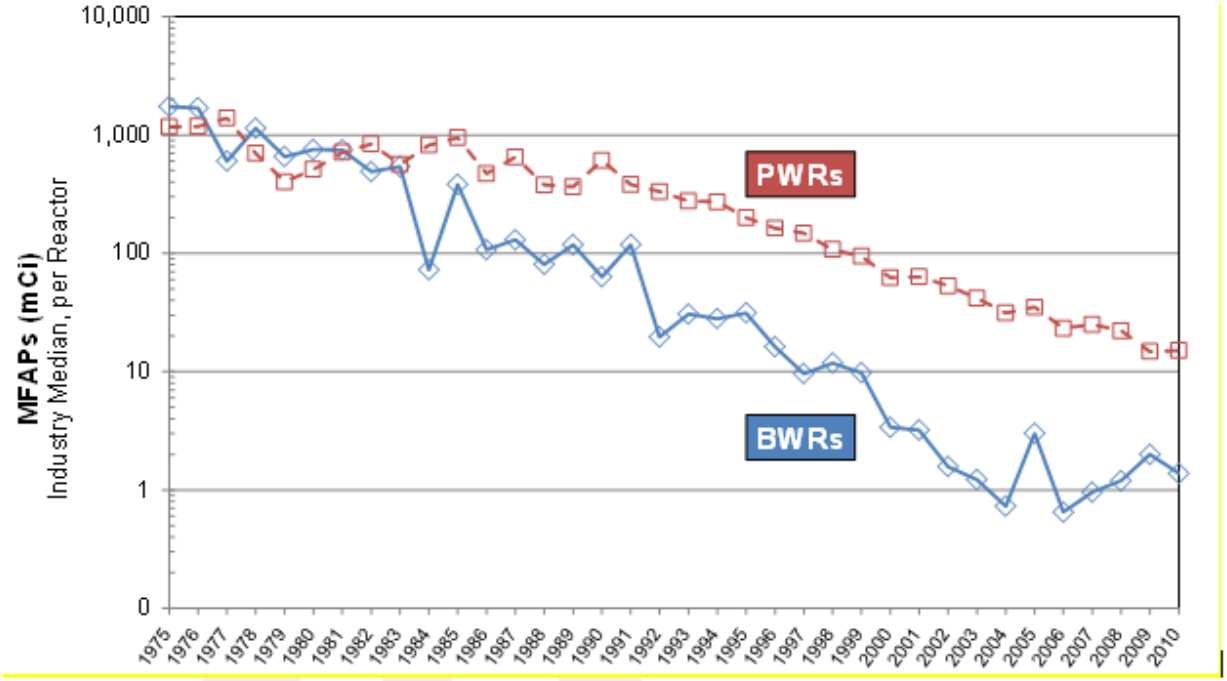

Figure 3.16 indicates a downward trend in the amount of particulate activity in liquid effluents from both BWRs and PWRs. The magnitude of the reduction is significant, i.e., a 99.9% reduction over the last 35 years.. For example, in 1978, the median activity of liquid effluents from BWRs was greater than 1,100 millicuries; and in 2010, the median was 1.4 millicuries.

Catawba Noble Gas Effluents

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Table 3.5
PWR Gaseous Releases — Selected Fission and Activation Gases, 2009

PWR Facility	Kr-85 (Ci)	Xe-133 (Ci)	Xe-135 (Ci)
Farley 2		3.52E-04	2.35E-04
Seabrook		3.21E-02	4.34E-03
Beaver Valley 2		4.71E-02	4.44E-03
Point Beach 1	4.33E-03	2.72E-02	2.15E-02
Point Beach 2	4.33E-03	2.72E-02	2.15E-02
Beaver Valley 1		7.14E-02	3.11E-03
McGuire 1	1.47E-02	5.15E-02	1.65E-02
McGuire 2	1.47E-02	5.15E-02	1.65E-02
Crystal River 3		9.13E-02	
Kewaunee		1.12E-01	6.32E-03
Robinson 2	3.06E-02	9.53E-02	6.99E-05
St. Lucie 1		2.53E-03	3.27E-01
Wolf Creek	1.94E-02	2.70E-01	4.83E-02
Diablo Canyon 1	2.02E-01	1.52E-01	2.37E-05
Diablo Canyon 2	2.02E-01	1.52E-01	2.37E-05
Catawba 1	4.05E-03	3.77E-01	3.32E-02
Catawba 2	4.05E-03	3.77E-01	3.32E-02

Catawba Liquid Effluents
- Routine, planned tritium releases

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Table 5.14
PWR Liquid Effluents — Tritium (Ci)

PWR Facility	H-3
Watts Bar	1.70E+03
South Texas 2	1.35E+03
Callaway	1.16E+03
Wolf Creek	1.11E+03
Diablo Canyon 1	1.09E+03
Diablo Canyon 2	1.09E+03
Byron 1	1.02E+03

PWR Facility	H-3
PWR Median Release	**5.68E+02**
Arkansas 2	5.68E+02
Surry 1	4.93E+02
Surry 2	4.93E+02
Davis-Besse	4.71E+02
Catawba 1	4.61E+02
Catawba 2	4.61E+02

Typical Nuclear Plant Effluents
(2010 Data)

United States Nuclear Regulatory Commission
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	BWRs	PWRs
Gases Effluents		
– Tritium	25 Ci (191 max)	32 Ci (1190 max)
– Noble gas	11 Ci (450 max)	Ci (207 max)
– C-14	12 Ci (18 max)	8.5 Ci (13 max)
– Iodine	1 mCi (20 max)	mCi (2 max)
– Particulates	mCi (6.6 max)	mCi (0.4 max)
Liquid Effluents		
– Tritium	5 Ci (150 max)	568 Ci (1700 max)
– Iodine	mCi (0.4 max)	mCi (10 max)
– Particulates	mCi (40 max)	mCi (0.12 max)
– Noble gas	None	None
– C-14	None	None

Radiation Dose to the Public

National Council on Radiation Protection

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NCRP Report No. 160, *Ionizing Radiation Exposure of the Population of the United States*

Purchase

In 2006, Americans were exposed to more than seven times as much ionizing radiation from medical procedures as was the case in the early 1980s, according to a new report on population exposure released March 3rd by the National Council on Radiation Protection and Measurements (NCRP) at its annual meeting in Bethesda, Maryland. In 2006, medical exposure constituted nearly half of the total radiation exposure of the U.S. population from all sources.

The increase was primarily a result of the growth in the use of medical imaging procedures, explained Dr. Kenneth R. Kase, senior vice president of NCRP and chairman of the scientific committee that produced the report. "The increase was due mostly to the higher utilization of computed tomography (CT) and nuclear medicine. These two imaging modalities alone contributed 36 percent of the total radiation exposure and 75 percent of the medical radiation exposure of the U.S. population." The number of CT scans and nuclear medicine procedures performed in the United States during 2006 was estimated to be 67 million and 18 million, respectively.

Radiation Dose

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The NCRP estimated that the average person in the United States receives about 620 mrem (rounded value) of radiation dose each year from all sources, as follows:

- 311 mrem from natural background
- 300 mrem from medical sources
- 13 mrem from consumer products
- Average person from nuclear power plants – None (as reported by NCRP)
- Average person living next to plants is less than 1 mrem (based on plant reports)

NUREG-CR/2907
Catawba - Gaseous Doses
Maximum Exposed Individual

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7.70E-1 is 0.77 mrem (compared to 620 mrem from all sources)

Table 3.18
PWR Gaseous Effluents — Maximum Annual Organ Dose, 2009

PWR Facility	Annual Organ Dose (mrem)
Salem 2	4.08E-05
Salem 1	1.04E-04
Vogtle 2	3.56E-04
Sequoyah 2	1.30E-02
Prairie Island 1	1.32E-02
Prairie Island 2	1.32E-02
Ft. Calhoun	1.48E-02
PWR Median Dose	**1.48E-02**

PWR Facility	Annual Organ Dose (mrem)
North Anna 1	1.55E-02
North Anna 2	1.55E-02
Point Beach 1	1.61E-02
Catawba 1	7.70E-01
Catawba 2	7.70E-01
Harris	8.47E-01
System Operational Limit	**15**

Catawba - Liquid Doses
Maximum Exposed Individual

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2.51E-02 is 0.0251 mrem (compared to 620 mrem from all sources)

Table 3.20
PWR Liquid Effluents — Maximum Annual Total Body and Organ Dose, 2009

PWR Facility	Annual Total Body Dose (mrem)	Annual Organ Dose (mrem)	PWR Facility	Annual Total Body Dose (mrem)	Annual Organ Dose (mrem)
Palo Verde 1			Farley 1	6.10E-03	9.13E-03
Palo Verde 2			South Texas 1	8.19E-03	8.25E-03
Palo Verde 3			Davis-Besse	7.81E-03	9.67E-03
Robinson 2	4.23E-05	4.76E-05	Harris	5.87E-03	1.27E-02
Salem 2	2.72E-05	8.89E-05	Ginna	9.57E-03	9.62E-03
Salem 1	3.22E-05	8.60E-05	Farley 2	6.42E-03	1.61E-02
Crystal River 3	5.53E-05	1.14E-04	Watts Bar	1.13E-02	1.40E-02
Turkey Point 3	3.93E-04		Vogtle 1	1.18E-02	1.49E-02
Turkey Point 4	3.93E-04		Cook 1	2.22E-02	2.23E-02
Surry 1	1.55E-04	2.52E-04	Cook 2	2.22E-02	2.23E-02
Surry 2	1.55E-04	2.52E-04	Three Mile Island 1	2.77E-02	2.86E-02
Diablo Canyon 1	1.67E-04	4.20E-04	Ft. Calhoun	2.80E-02	3.06E-02
Diablo Canyon 2	1.67E-04	4.20E-04	Catawba 1	2.51E-02	3.54E-02
Indian Point 3	2.49E-04	4.59E-04	Catawba 2	2.51E-02	3.54E-02

Tritium Leaks

Many plants have had leaks – see list below

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- Nuclear plants monitor for tritium leaks into ground water
- Each plant's groundwater tritium results are provided in their annual effluent or environmental reports
- NRC publishes the historical and current maximum values for each plant on the NRC public web page

List of Leaks and Spills

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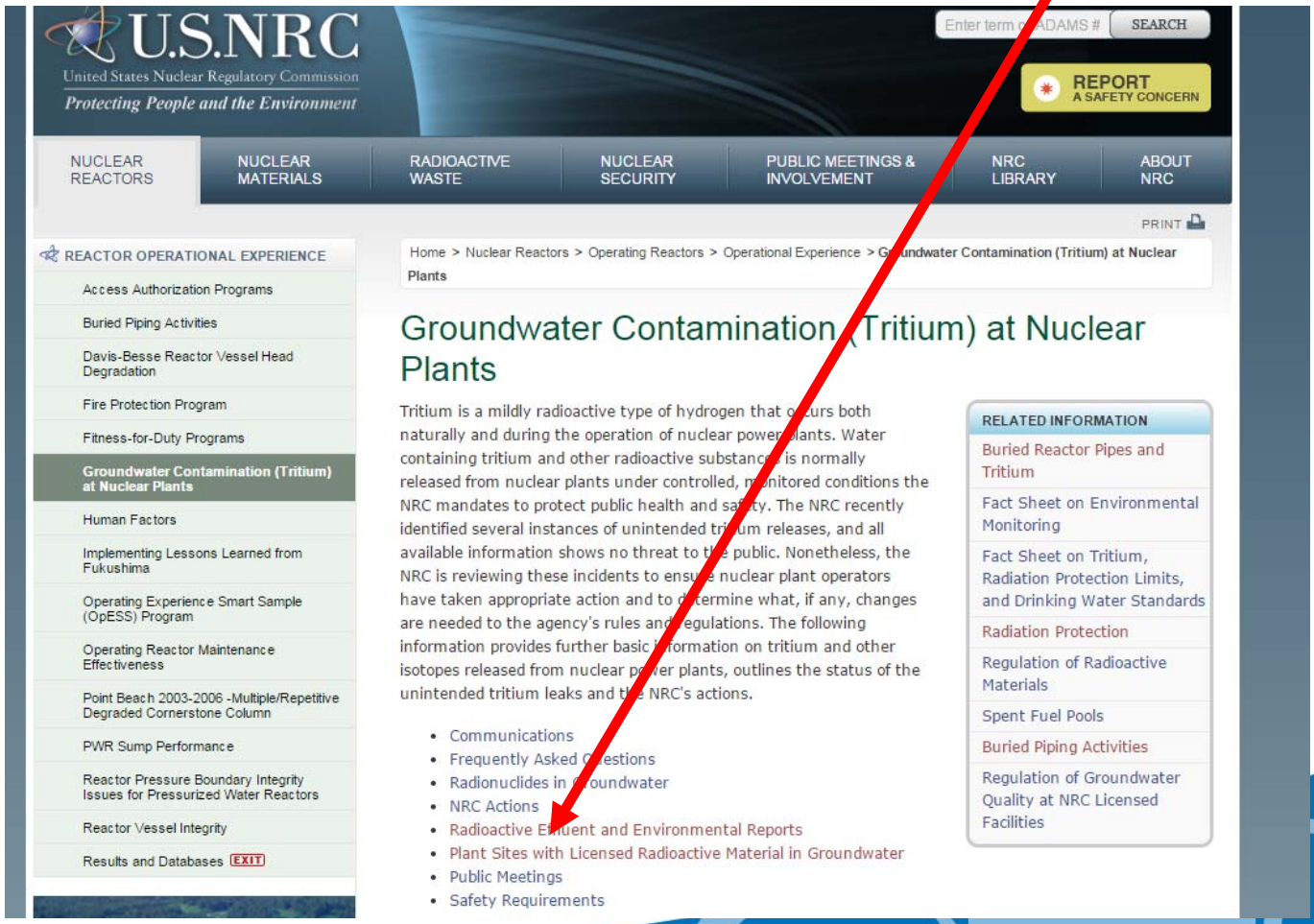
- 6 month updates published on NRC web site
- 45 sites have had > 20,000 pCi/L
- 15 sites currently have > 20,000 pCi/L

List of Tritium Leaks:

Click on “Plant Sites with Licensed Radioactive Material in Groundwater” (i.e., list of plants with tritium leaks)



Plant Sites with Licensed Radioactive Material in Groundwater

The U.S. Nuclear Regulatory Commission (NRC) regulations require nuclear power plants to check for the presence of radioactive materials on site property and in the environment. Licensees routinely check their site and the environment for the presence of radioactive materials. The instruments used to perform these checks can detect extremely small concentrations of radioactive materials. As a result of one or more of the causes listed below, radioactive materials (most notably tritium) have been identified in ground moisture or ground water at several commercial nuclear power plants:

1. system leaks (e.g., pipes, valves, tanks)
2. evaporation of liquids
3. condensation of vapors
4. as the result of routine, approved releases

The NRC has prepared the following list of reactor sites where tritium has been detected in ground moisture or groundwater on facility property:

- List of Leaks and Spills at Nuclear Power Plants

Groundwater Tritium

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List of Historical Leaks and Spills At U.S. Commercial Nuclear Power Plants

It is imperative that the preceding paragraphs accompany any reproduction of this list so that the information is communicated in the proper context.

Plant	Historical Maximum Tritium Concentration, pCi/l	Date of Historical Maximum Tritium	Current Concentration of Tritium, pCi/l
Beaver Valley	25,583	September, 2010	19,200
Braidwood	247,000	1998	2,430
Browns Ferry	2,050,000	April, 2010	1,013
Brunswick	19,000,000	December, 2010	3,539,000
Byron	82,000	February, 2006	911
Callaway	1,600,000	July, 2014	1,600,000
Catawba	47,500	October, 2007	11,300

- Comparison Values
  - EPA drinking water at faucet (tap): 20,000 pCi/L = 4 mrem
  - EPA 40 CFR 190 public dose limit: = 25 mrem
  - NRC in surface waters: = 50 mrem

Catawba effluent report

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ATTACHMENT 9

Information to Support the Nuclear Energy Institute (NEI)

2013 Catawba ARERR Groundwater Well Data Section

Duke Energy implemented a Ground Water Protection program in 2007. This initiative was developed to ensure timely and effective management of situations involving inadvertent releases of licensed material to ground water. As part of this program, Catawba Nuclear Station monitored forty-six wells in 2013.

Wells are typically sampled quarterly or semi-annually. Ground water samples are regularly analyzed for tritium and gamma emitters, select wells being analyzed for difficult to detect radionuclides. No gamma or difficult to detect radionuclides (other than naturally occurring radionuclides) were identified in well samples during 2013. Results from sampling during 2013 confirmed existing knowledge of tritium concentrations in site ground water.

Two leak events meeting the criteria for voluntary notification to NEI occurred at Catawba in 2013. On May 15, 2013 Conventional Waste Water piping used to transfer Turbine Building Sump water to the Conventional Waste Ponds leaked greater than 100 gallons of water containing tritium above the station critical level to the ground. The second notification event occurred on October 19, 2013. During planned maintenance activities for draining of secondary condenser water to the conventional waste ponds, water levels in the conventional waste pond rose to a level which caused the settling pond valve pit to overflow more than 100 gallons of water containing tritium above the station critical limits. Neither event was determined to pose a risk to the public because the EPA Drinking Water Limit, 20,000 pCi/L, was not exceeded, and both leaks were contained within the site boundaries. Remediation of both events has been completed.

Catawba tritium data

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1 pCi/L is extremely small, 1 part in a million **times** a million
or
1 part in 1,000,000,000,000
2.35E+02 is 235 pCi/L
1.05E+03 is 1,050 pCi/L
EPA drinking water is 20,000 pCi/L

Well Name	Location	Tritium Concentration (pCi/l) 1st QTR	2nd QTR	3rd QTR	4th QTR	# of Samples
C100R	U-1 SFP	NS	NS	NS	NS	0
C100DR	U-1 SFP	2.35E+02	1.98E+02	2.58E+02	<MDA	4
C101R	U-1 SFP	1.05E+03	1.03E+03	5.45E+02	3.80E+02	4
C101DR	U-1 SFP	6.23E+02	7.95E+02	8.68E+02	6.81E+02	4

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Questions and Discussion

?