



EPRI

ELECTRIC POWER
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Summary of Regulatory Guide 1.21 Carbon-14 Reports

H.R. Helmholz, G.F. Palino
NWT Corporation for EPRI

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Regulatory Guide-1.21 Rev. 2

- Revision-2 of Regulatory Guide-1.21. June 2009 requires licensees to evaluate if Carbon-14 is a gaseous release "Principle Radionuclide".
 - A Principle Radionuclide defined as:
 1. Greater than a 1% contributor to the boundary dose, or
 2. Greater than 1% of the activity release.
- If Carbon-14 is a Principle Radionuclide, the dose contribution is required to be included in the ARERR starting with the report due April 2011.
- Quantity of Carbon-14 in gaseous waste discharge can be estimated by:
 1. Sample measurement
 2. Use of Carbon-14 source term normalized to power generation
 3. Use of GALE Code (NUREG-0017) and by inference NUREG-0016

BWR Carbon-14 Release Reported In 2010 ARERR (Values in blue taken from 2010 ARERR)

| <u>Plant</u> | <u>Basis of C-14 Source Term</u> | 2010 Gaseous Release | | | | |
|-------------------|-------------------------------------------------------|-------------------------|---------------------|--------------------------------|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| | | <u>Gaseous Fraction</u> | <u>Total Curies</u> | <u>CO₂ Fraction</u> | <u>CO₂ Curies</u> | |
| Pilgrim | 2-coolant masses, 2-energy groups at BOC, MOC, EOC | 0.99 | 8.54 | 1 | 8.54 | a Adjusted this value for actual EFPD of operation. |
| Brunswick-1 | UFSAR 9.5 Ci/yr at 80% capacity ^a | 1 | 10.5 ^b | 1 | 10.5 | ^b Reported total site Carbon-14 release as 21.0 Curies. |
| Brunswick-2 | UFSAR 9.5 Ci/yr at 80% capacity ^a | 1 | 10.5 ^b | 1 | 10.5 | |
| Fitzpatrick | EPRI 5.1Ci/GW _{th} -EFPY | 0.99 | 9.29 | 0.95 | 8.82 | |
| Nine Mile Point-1 | EPRI 5.1Ci/GW _{th} -EFPY | 0.99 | 9.16 | 0.95 | 8.70 | ^c Annual dose from both reactors. |
| Nine Mile Point-2 | EPRI 5.1Ci/GW _{th} -EFPY | 0.99 | 15.73 | 0.95 | 14.90 | ^d Reported total site Carbon-14 release of 24.5 Curies. NWT proportioned this release to according to thermal power rating. |
| Grand Gulf | FSAR 9.5 Ci/yr | 1 | 9.5 | 0.95 | 9.03 | |
| Susquehanna-1 | EPRI 1021106 Methodology | 0.99 | 12.6 ^d | 1 | 12.6 ^d | |
| Susquehanna-2 | EPRI 1021106 Methodology | 0.99 | 11.9 ^d | 1 | 11.9 ^d | |
| Columbia G. S. | EPRI 1021106 Methodology | | 17.80 | | | |

BWR Carbon-14 Release Reported In 2010 ARERR (Values in blue taken from 2010 ARERR)

| <u>Plant</u> | <u>Basis of C-14 Source Term</u> | 2010 Gaseous Release | | | |
|----------------|-----------------------------------|-------------------------|---------------------|--------------------------------|------------------------------|
| | | <u>Gaseous Fraction</u> | <u>Total Curies</u> | <u>CO₂ Fraction</u> | <u>CO₂ Curies</u> |
| Dresden-2 | EPRI 5.1Ci/GW _{th} -EFPY | | n.f. ^e | | |
| Dresden-3 | EPRI 5.1Ci/GW _{th} -EFPY | | n.f. ^e | | |
| LaSalle-1 | Final Environmental Statement | | 9.20 ^f | | |
| LaSalle-2 | Final Environmental Statement | | 9.20 ^f | | |
| Clinton | EPRI 1021106 Methodology | 0.99 | 15.59 | 0.95 | |
| Cooper | EPRI 5.1Ci/GW _{th} -EFPY | | 11.60 | | |
| Browns Ferry-1 | EPRI 1021106 Methodology | | 11.74 ^g | | 11.15 ^g |
| Browns Ferry-2 | EPRI 1021106 Methodology | | 11.74 ^g | | 11.15 ^g |
| Browns Ferry-3 | EPRI 1021106 Methodology | | 11.74 ^g | | 11.15 ^g |
| Oyster Creek | EPRI 1021106 Methodology | | 10.01 | | |

^e Could not find value in 2010 ARERR

^f Reported total site release as 18.4 Curies.

^g Reported total site and total CO₂ gaseous release as 35.22 and 33.46 Curies, respectively.

PWR Carbon-14 Releases Reported In 2010 ARERR

(Values in blue taken from 2010 ARERR)

| <u>Plant</u> | <u>Basis of C-14 Source Term</u> | 2010 C-14 Production | | 2010 Gaseous Release | | |
|-----------------|----------------------------------------|----------------------|-------------------------|----------------------|-------------------------|--------------------------------|
| | | <u>Total Curies</u> | <u>Gaseous Fraction</u> | <u>Total Curies</u> | <u>Organic Fraction</u> | <u>CO₂ Fraction</u> |
| McGuire-1 | 9.4 Ci/GW _e -yr | | | 10.1 ^a | 0.80 | 0.20 |
| McGuire-2 | 9.4 Ci/GW _e -yr | | | 10.1 ^a | 0.80 | 0.20 |
| Catawba-1 | 9.4 Ci/GW _e -yr | | | 10.2 ^b | 0.80 | 0.20 |
| Catawba-2 | 9.4 Ci/GW _e -yr | | | 10.2 ^b | 0.80 | 0.20 |
| Oconee-1 | 9.4 Ci/GW _e -yr | | | 7.50 ^c | 0.80 | 0.20 |
| Oconee-2 | 9.4 Ci/GW _e -yr | | | 7.50 ^c | 0.80 | 0.20 |
| Oconee-3 | 9.4 Ci/GW _e -yr | | | 7.50 ^c | 0.80 | 0.20 |
| Diablo Canyon-1 | EPRI 3.4 - 3.9 Ci/GW _{th} -yr | 10.8 | 0.98 | 10.5 | 0.70 | 0.30 |
| Diablo Canyon-2 | EPRI 3.4 - 3.9 Ci/GW _{th} -yr | 12.0 | 0.98 | 11.8 | 0.70 | 0.30 |
| Callaway | EPRI TR-1021106 | | | 11.1 | | |
| Palisades | neutron flux and coolant mass | | | 7.69 | 0.70 | 0.30 |

^a Based on a total site release of 20.2 Ci and assuming equal release from each reactor.

^b Based on a total site release of 20.4 Ci and assuming equal release from each reactor.

^c Based on a total site release of 22.5 Ci and assuming equal release from each reactor.

PWR Carbon-14 Releases Reported In 2010 ARERR

(Values in blue taken from 2010 ARERR)

| | | | | | | | |
|-----------------------|----------------------------------|------------------|------|--------------------|------|------------------|---------------------------------------------------------------------------------------------------------------------------------|
| Beaver Valley-1 | EPRI 3.9 Ci/GW _{th} -yr | | | 11 ^e | 0.60 | 0.4 ^e | |
| Beaver Valley-2 | EPRI 3.9 Ci/GW _{th} -yr | | | 11 ^e | 0.60 | 0.4 ^e | |
| H.B. Robinson-2 | NUREG-0017 (GALE Code) | | | 5.04 ^f | | | ^e Based on Scenario-5 of 9 scenarios presented by Key Solutions Inc. |
| South Texas Project-1 | NUREG-0017 (GALE Code) | 7.3 | | 7.29 | 0.80 | 0.20 | |
| South Texas Project-2 | NUREG-0017 (GALE Code) | 7.3 | | 7.27 | 0.80 | 0.20 | |
| Virgil C. Summer | neutron flux and coolant mass | | | 10.1 | 0.80 | 0.20 | ^f Corrected the NUREG-0017 value of 7.3 Ci/yr for actual plant availability. |
| Wolf Creek | Referenced EPRI Report | | | ? | 0.70 | 0.30 | |
| San Onofre-1 | ? | | | 10.95 ^g | | | ^g Based on a total site release of 21.9 Ci and assuming equal release from each reactor. |
| San Onofre-2 | ? | | | 10.95 ^g | | | |
| Sequoyah-1 | EPRI 3.4 Ci/GW _{th} -yr | 9.9 ^h | 0.98 | 9.6 ^h | 0.80 | 0.20 | ^h Based on total site production of 19.8 Ci and 98% release and assuming equal production release from each reactor. |
| Sequoyah-2 | EPRI 3.4 Ci/GW _{th} -yr | 9.9 ^h | 0.98 | 9.6 ^h | 0.80 | 0.20 | |
| Waterford-3 | FSAR | | | 10.12 | | | |
| Wolf Creek | Referenced EPRI report | | | | 0.70 | 0.30 | |

Summary of 2010 C-14 Release Reporting

- BWR

- Number of site reviewed: 13

- Basis of C-14 source term and release

| | |
|-------------------------------|---------|
| EPRI 5.1 Ci/GWth - EFPY | 4 sites |
| EPRI Neutronic calculation | 1 site |
| EPRI 1021106 Methodology* | 5 sites |
| FSAR 9.5 Ci/yr | 2 sites |
| Final Environmental Statement | 1 site |

* EPRI 1021106 could not determine if used proxy value or neutronic calculation

- Separately reported C-14 Dose: 7 sites

Summary of 2010 C-14 Release Reporting

- PWR

- Number of site reviewed: 13

- Basis of C-14 source term and release

| | |
|-----------------------------|---------|
| 9.4 Ci/GWe-EFPY | 3 sites |
| EPRI 3.4 - 3.9 Ci/GWth-EFPY | 2 sites |
| EPRI Neutronic Calculation | 2 sites |
| EPRI 1021106 Methodology* | 4 sites |
| GALE Code 7.3 Ci/yr | 2 sites |
| FSAR | 1 site |
| Unstated | 1 site |

* EPRI 1021106 could not determine if used proxy value or neutronic calculation

- Separately reported C-14 Dose: 6 sites