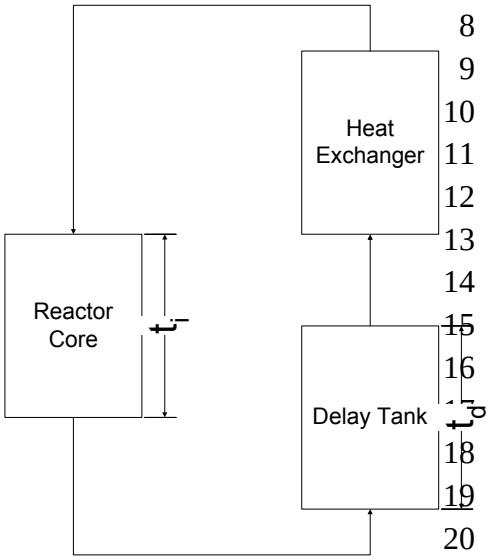
Appendix A

Nitrogen-16

The Nitrogen-16 activity acquired by the coolant depends upon the flow pattern of the coolant and its residence times within and without the neutron flux. The figure shows a simplified coolant flow loop. The residence time within the neutron flux is denoted as t_i. The residence time without the neutron flux is dominated by the stay time in the delay tank and is denoted t_d.



Consider a unit volume of water leaving the reactor. If its Nitrogen-16 activity at this point is α, then at time t_d later, when it re-enters the reactor, its activity will have decayed to $\alpha e^{-\lambda t}$ where λ is the radionuclide's decay constant and t is equal to t_d. In passing through the reactor, the Nitrogen-16 continues to decay, (i.e. $\alpha e^{-\lambda t}$) where λ is the radionuclide's decay constant and t is equal to t_i.

In the reactor, the unit volume is exposed to an average flux Φ_{av} and acquires in the time t_i the additional activity $\Sigma_{act}\ \Phi_{av}(1- e^{-\lambda t})$, where Σ_{act} is the average macroscopic activation cross section in the flux Φ_{av}. If T is the total of t_i and t_d, the total activity leaving the reactor is $\alpha e^{-\lambda T}+ \Sigma_{act}\ \Phi_{av}(1- e^{-\lambda t})$.

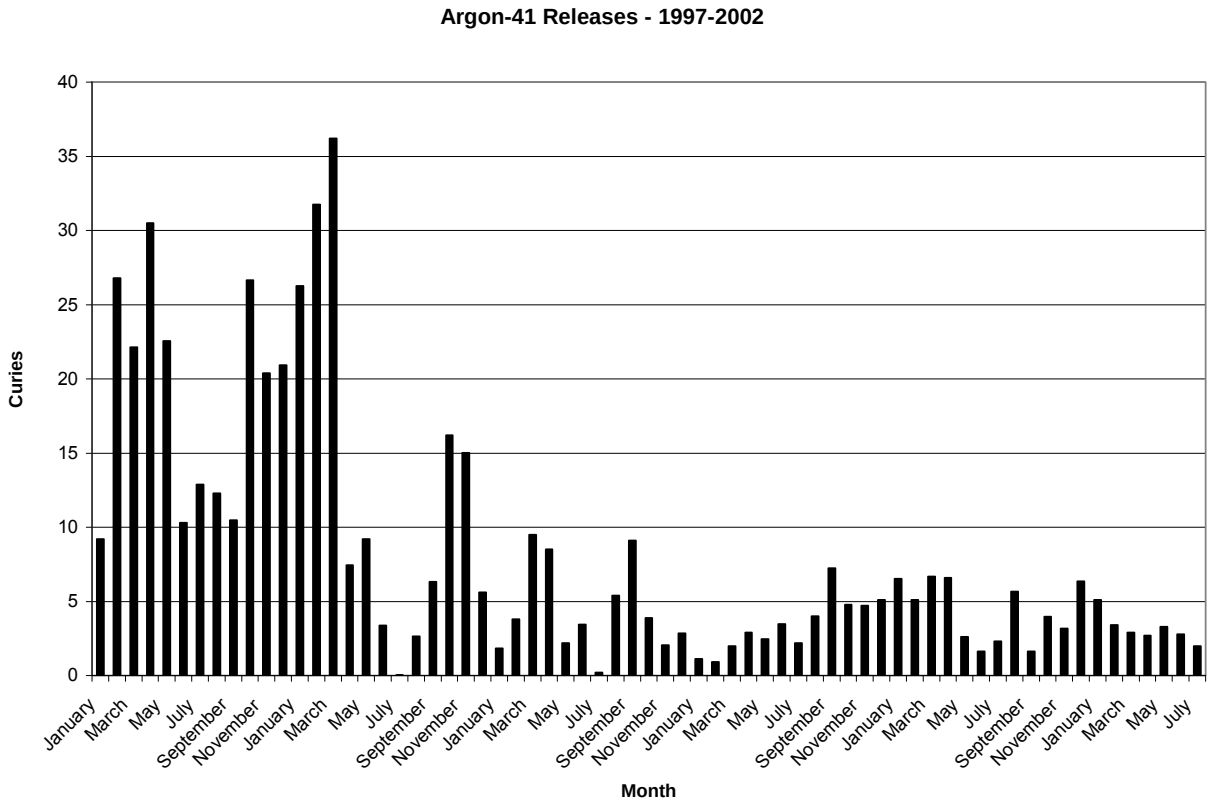
At equilibrium, after the coolant has made many passes around the circuit, the total activity is equal to α or $\alpha = \alpha e^{-\lambda T}+ \Sigma_{act}\ \Phi_{av}(1- e^{-\lambda t})$.

Argon-41

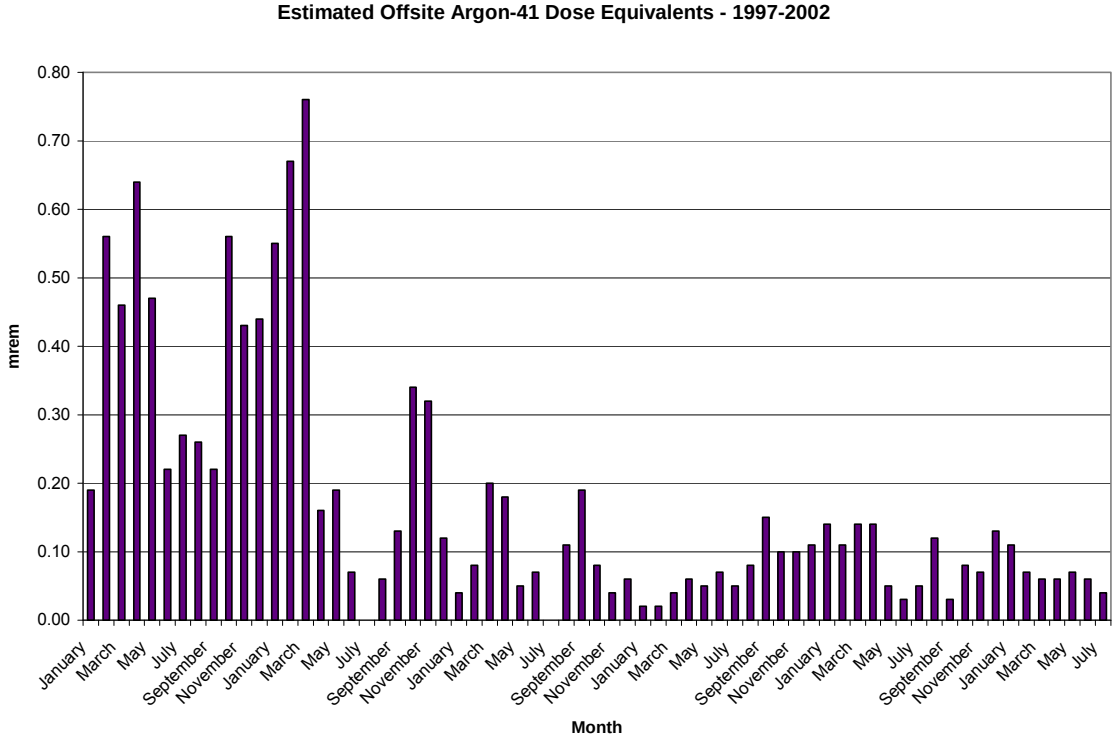
Argon-41 is produced by activation of natural argon (a normal trace element in atmospheric air). Argon-41 decays to Potassium-41 with a half-life of 100 minutes (0.076 days) by the emission of a 1.2-MeV beta particle and a 1.3-MeV gamma ray.

Argon-41 production is dependent upon the dissolved air in the reactor coolant. Since the amount of dissolved air in the coolant is variable depending upon the air influx from the various beam tubes, empirical data was selected over calculations. We used historic Argon-41 release rates and the Comply Code to determine off-site dose equivalents associated with its release.

1


Argon-41 Releases - 1997-2002
Curies
Month
0
5
10
15
20
25
30
35
40
January
March
May
July
September
November

2
3


Estimated Offsite Argon-41 Dose Equivalents - 1997-2002
mrem
Month
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
January
March
May
July
September
November

4