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REPORT

An Experimental Investigation of Fission Product Release in SLOWPOKE-2 Reactors — Data Report

by

A.M.C. Harnden
B.J. Lewis and L.G.I. Bennett

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AN EXPERIMENTAL INVESTIGATION OF FISSION PRODUCT RELEASE IN SLOWPOKE-2 REACTORS — DATA REPORT

A report prepared by A.M.C. Harnden, Department of Physics, Queen's University, and B.J. Lewis and L.G.I. Bennett, SLOWPOKE-2 Facility and the Department of Chemistry and Chemical Engineering, Royal Military College of Canada, under contract to the Atomic Energy Control Board.

ABSTRACT

The results of an investigation into the release of fission products from SLOWPOKE-2 reactors fuelled with a highly-enriched uranium alloy core are detailed in Volume 1.

This data report (Volume 2) contains plots of the activity concentrations of the fission products observed in the reactor container at the University of Toronto, Ecole Polytechnique and the Kanata Isotope Production Facility. Release rates from the reactor container water to the gas headspace are also included.

RÉSUMÉ

Le volume 1 décrit en détail les résultats d'une enquête sur le rejet de produits de fission de réacteurs SLOWPOKE-2 alimentés par un cœur en alliage d'uranium hautement enrichi.

Ce rapport de données (volume 2) contient des tracés des concentrations de radioactivité des produits de fission observées dans l'enceinte du réacteur à l'Université de Toronto, à l'École polytechnique et à l'Établissement de production d'isotopes de Kanata. Il contient aussi les taux de rejet à partir de l'eau de l'enceinte du réacteur vers la chambre d'expansion du gaz.

DISCLAIMER

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**AN EXPERIMENTAL INVESTIGATION OF FISSION RELEASE IN SLOWPOKE-2
REACTORS — DATA REPORT**

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APPENDIX C - Release Rates for the Noble Gas Species in the Gas Headspace
for the U of T, EP, and KIPF Reactors C-1

LIST OF ACRONYMS AND SYMBOLS

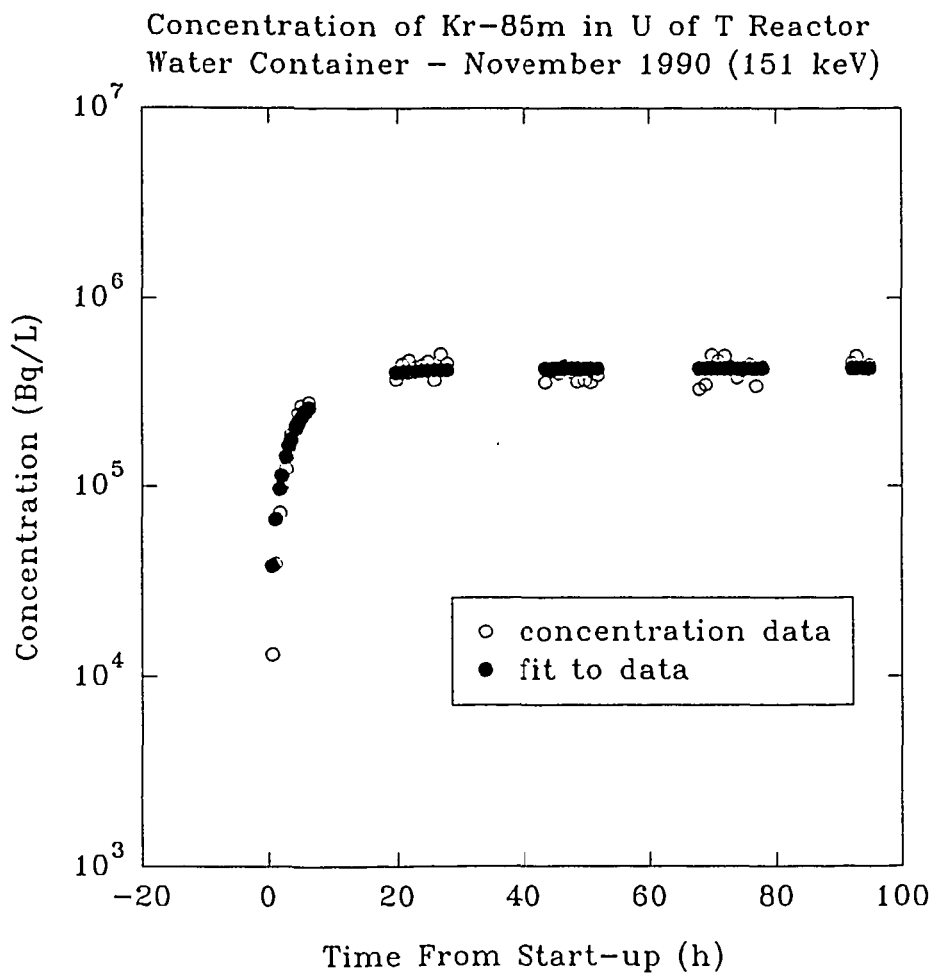
EP	Ecole Polytechnique
KIPF	Kanata Isotope Production Facility
U of T	University of Toronto

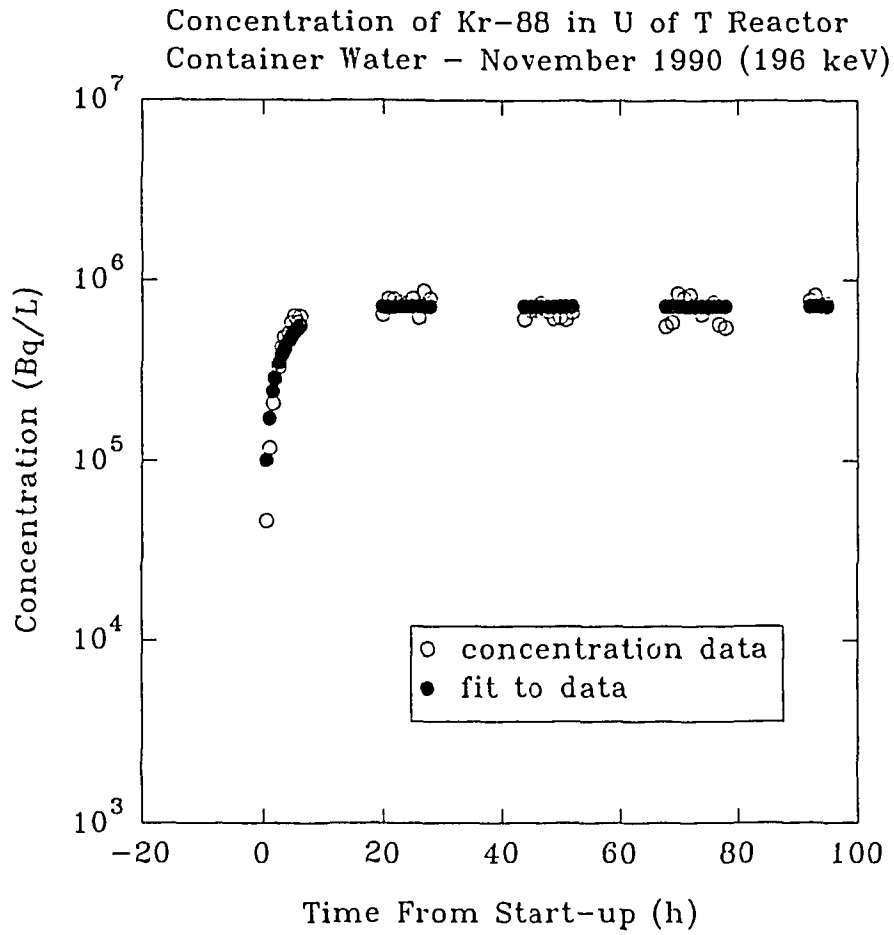
APPENDIX A.

**NOBLE GAS CONCENTRATIONS IN THE REACTOR CONTAINER WATER AND
GAS HEADSPACE FOR THE U OF T, EP, AND KIPF REACTORS**

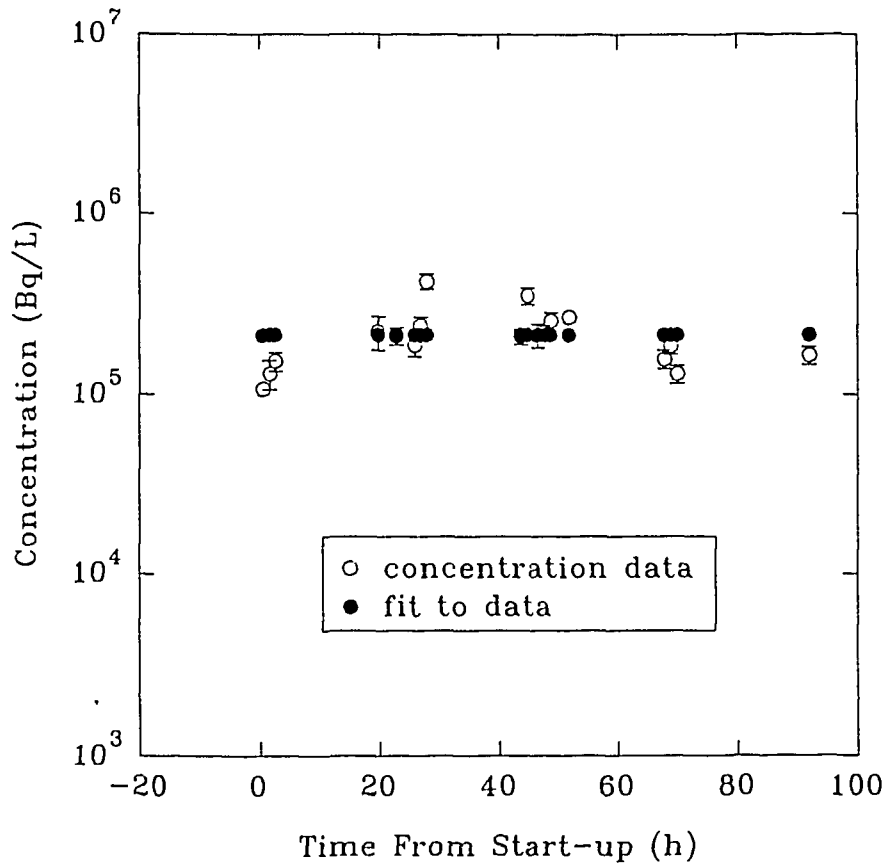
A.1 Reactor Container Water

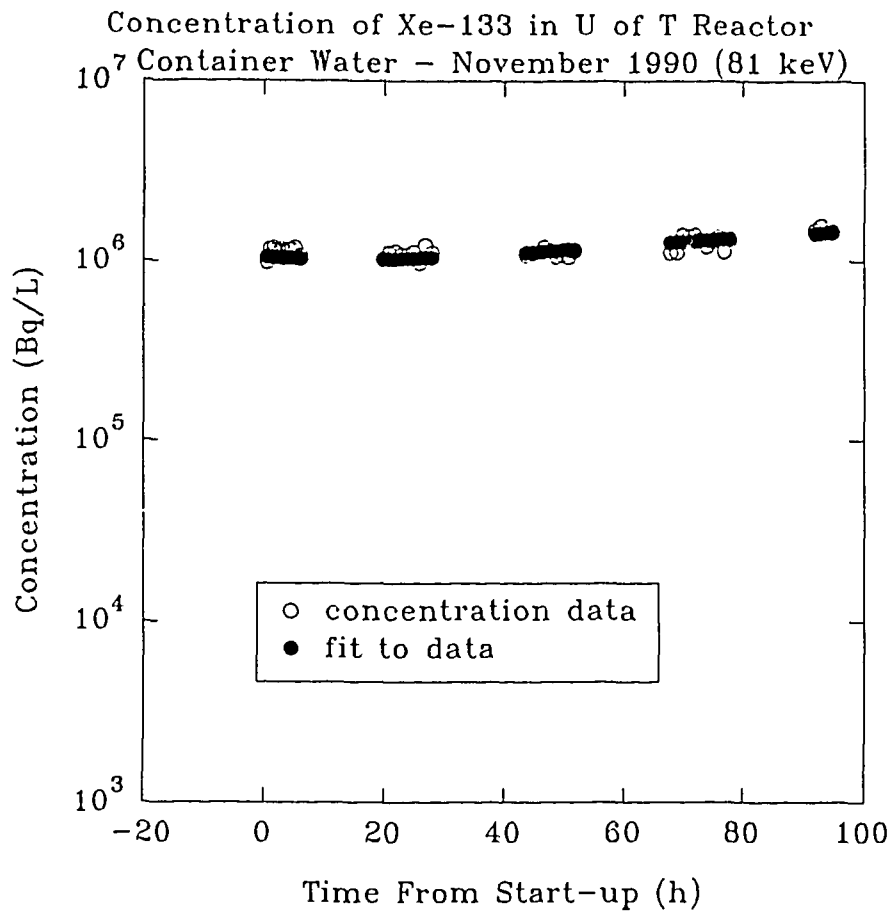
The activity concentrations of the noble gas isotopes measured in the reactor container water of the U of T, EP and KIPF reactors are given in the following plots, with error bars indicating one standard deviation of error. The fit of the concentration model (see Volume 1 Eq. (7) and Appendix) to the data is also shown for those experiments conducted at a steady power level of 5 kW.

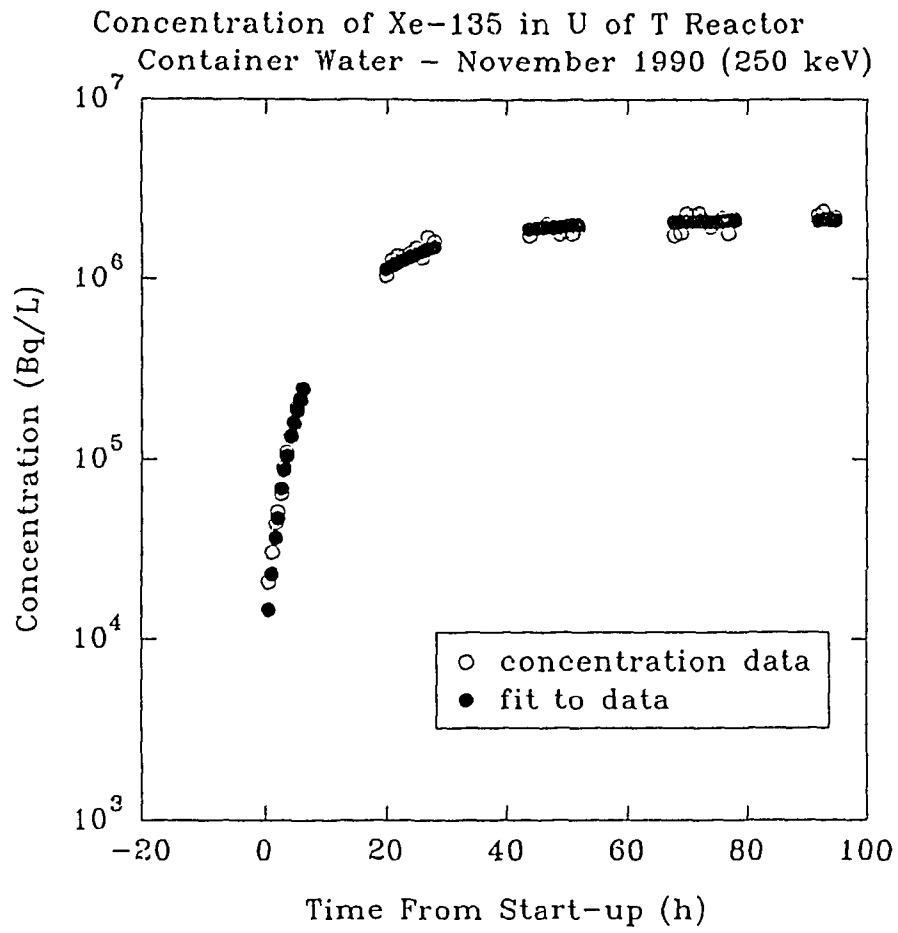


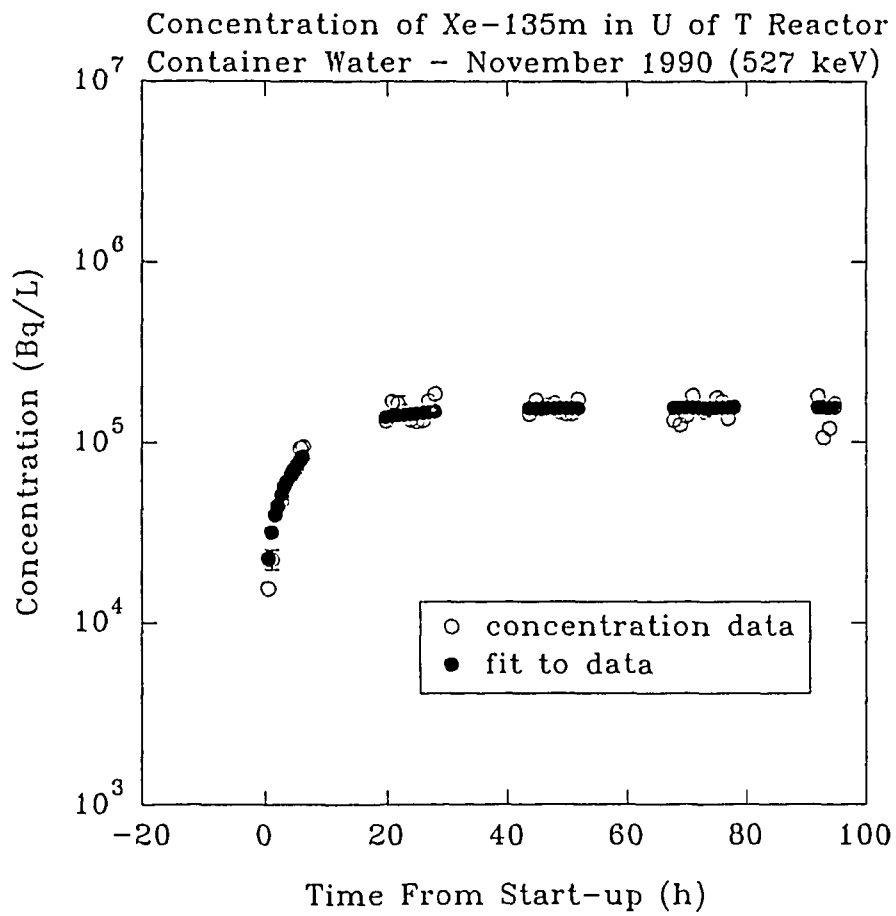


Concentration of Kr-89 in U of T Reactor
Container Water - November 1990 (220 keV)

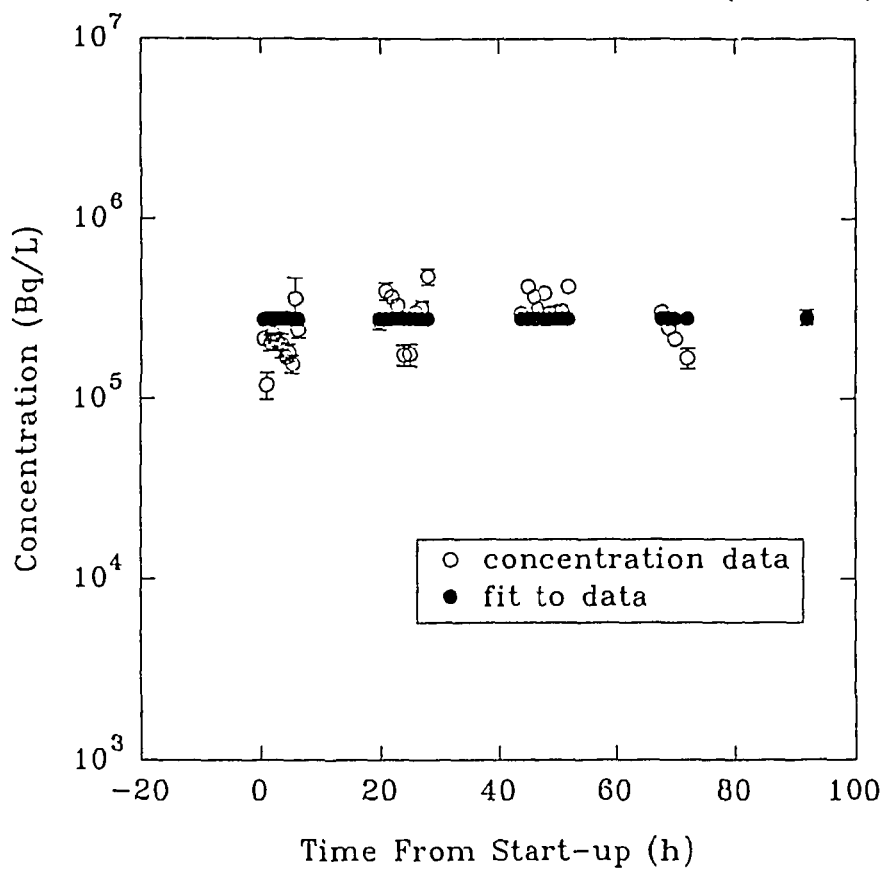


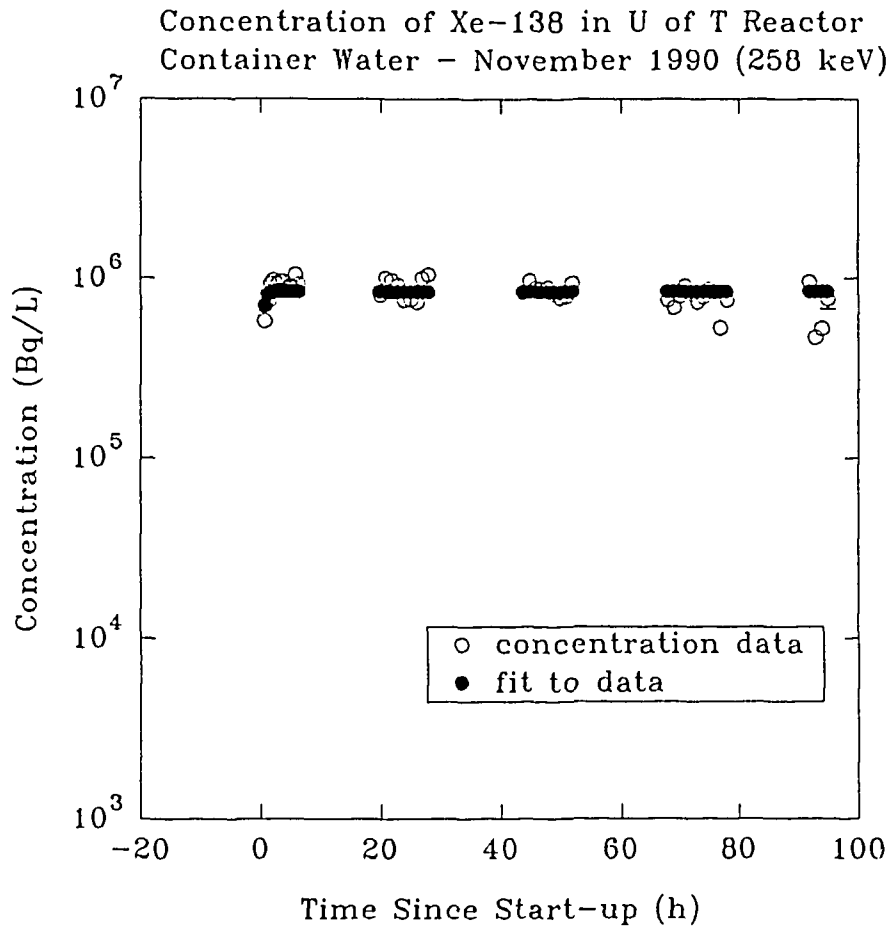


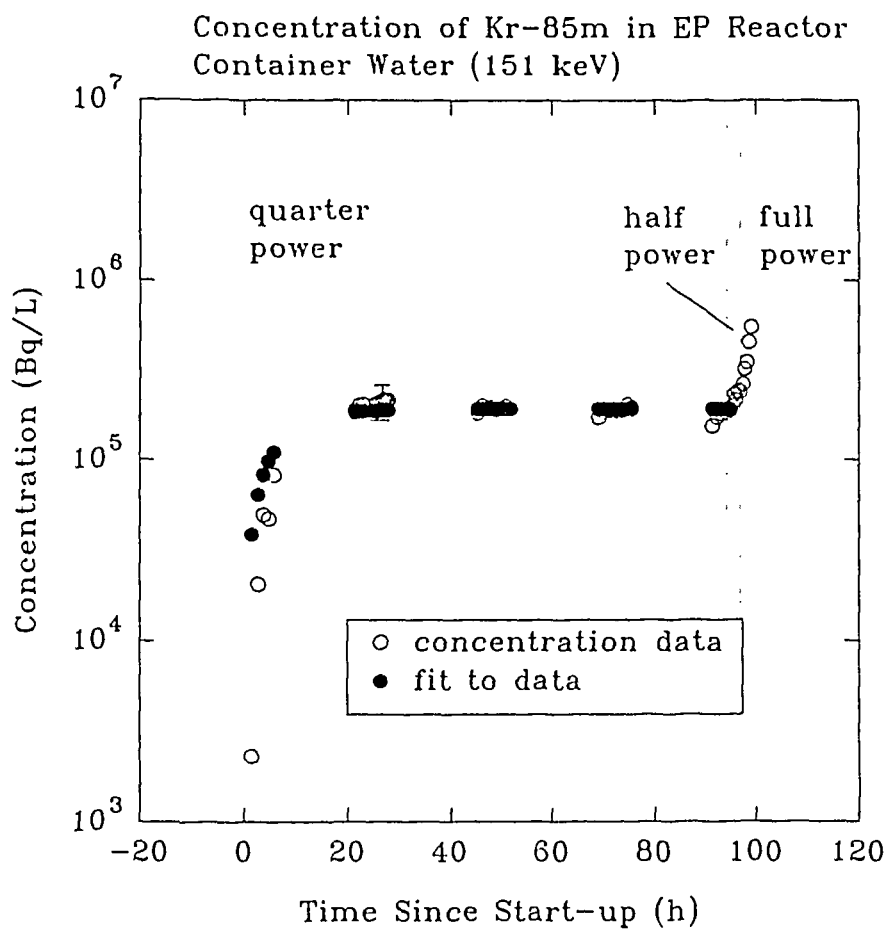


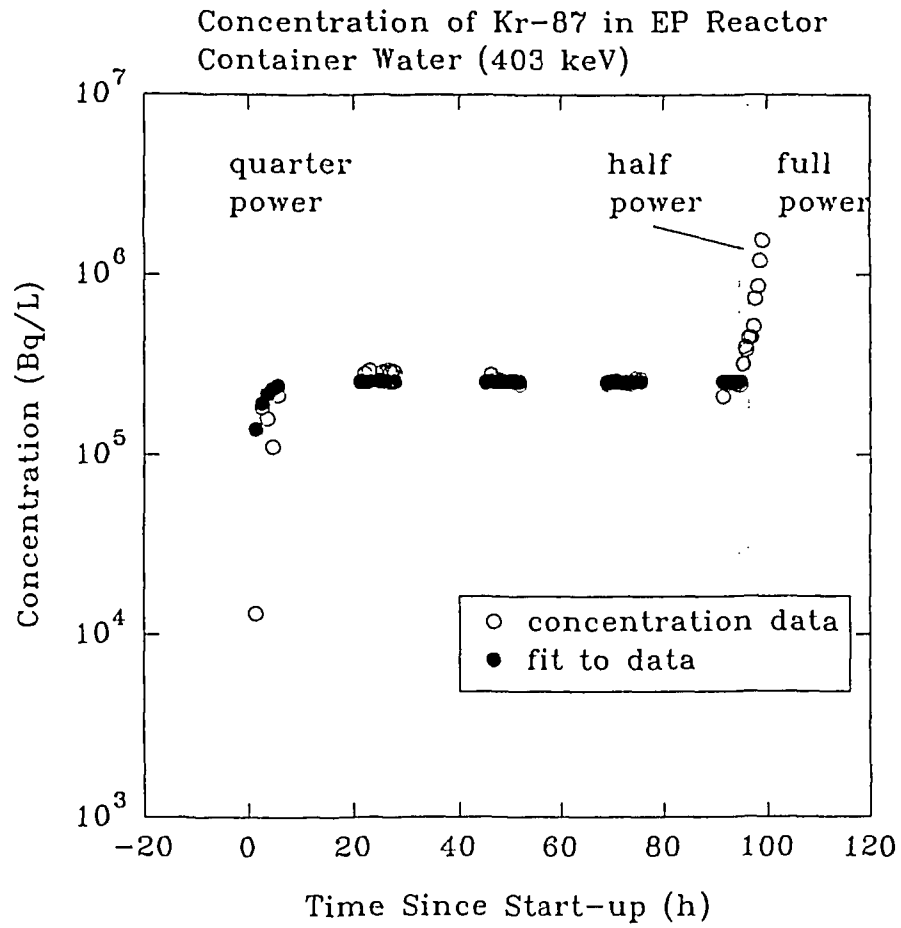


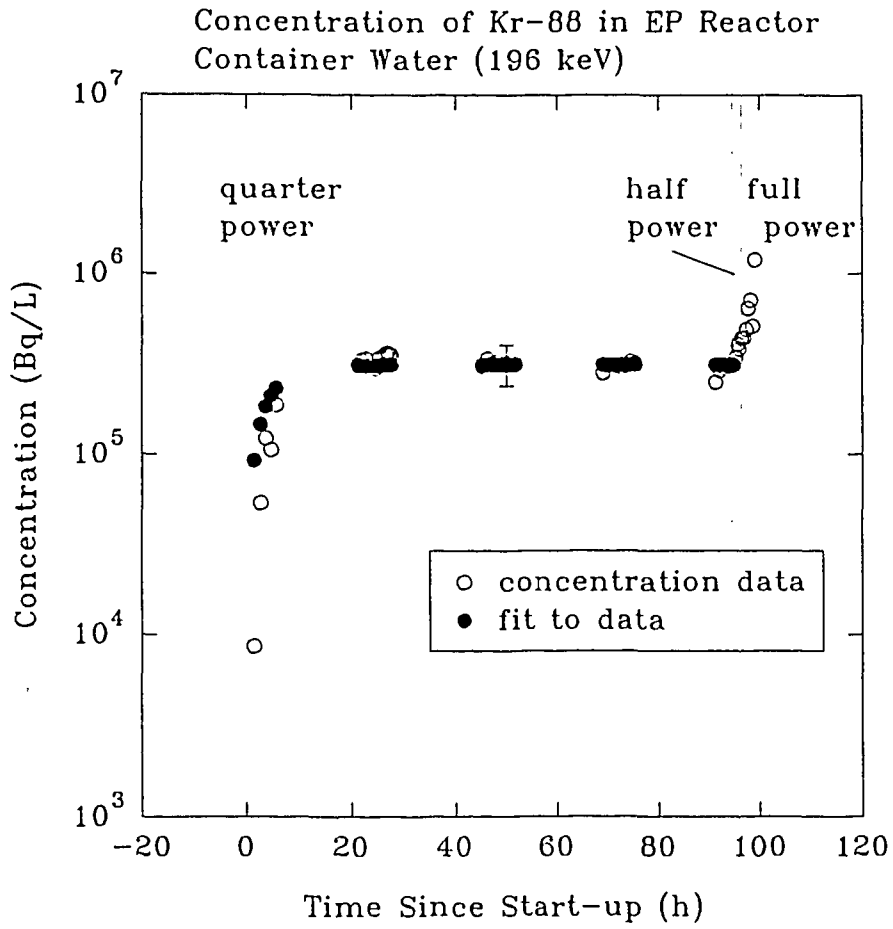
Concentration of Xe-137 in U of T Reactor
Container Water - November 1990 (456 keV)

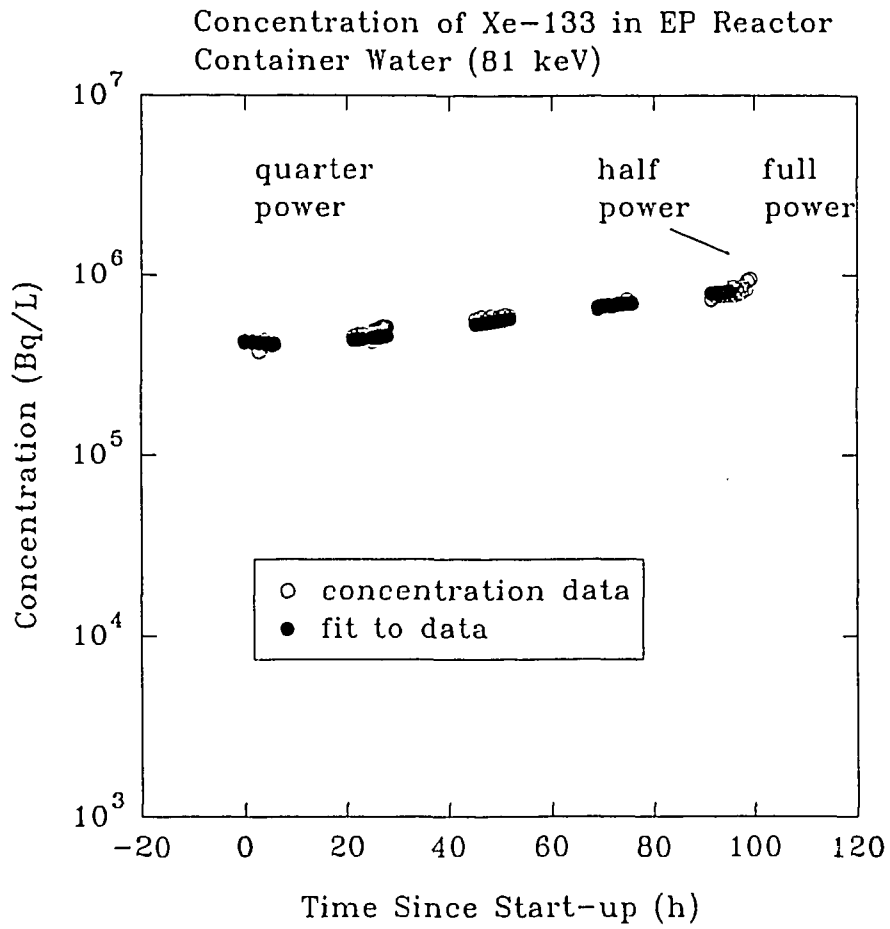


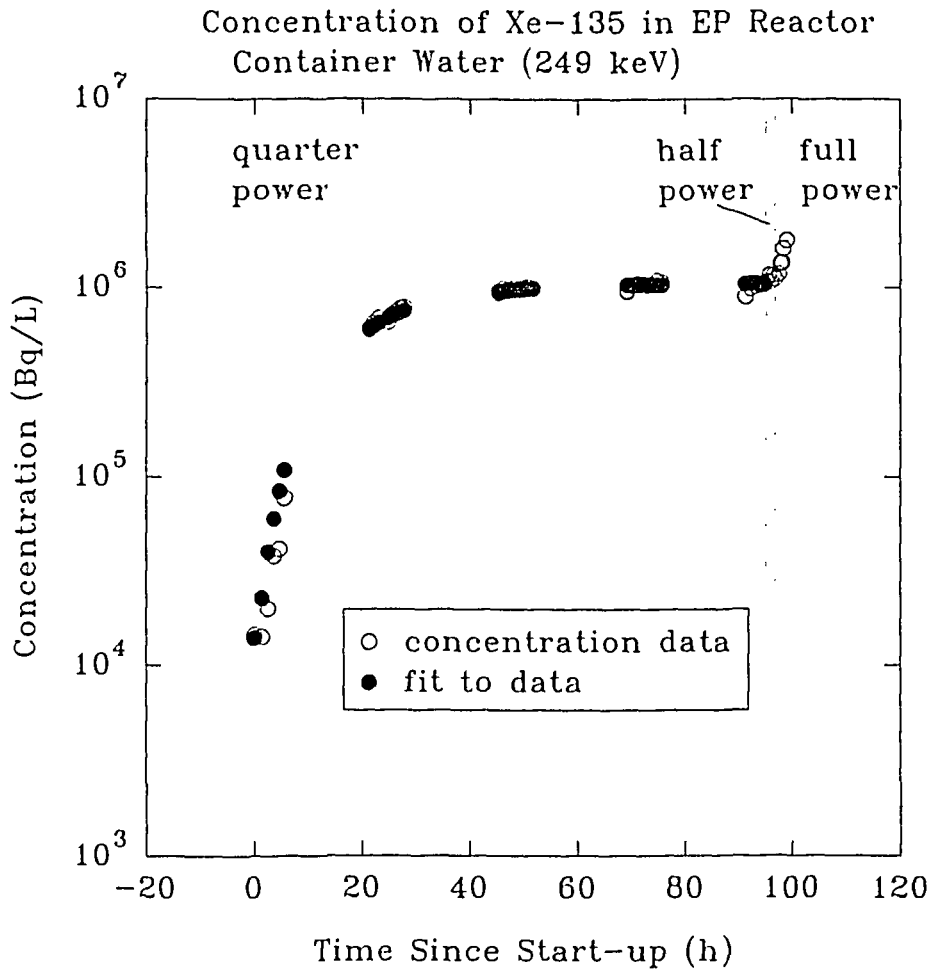


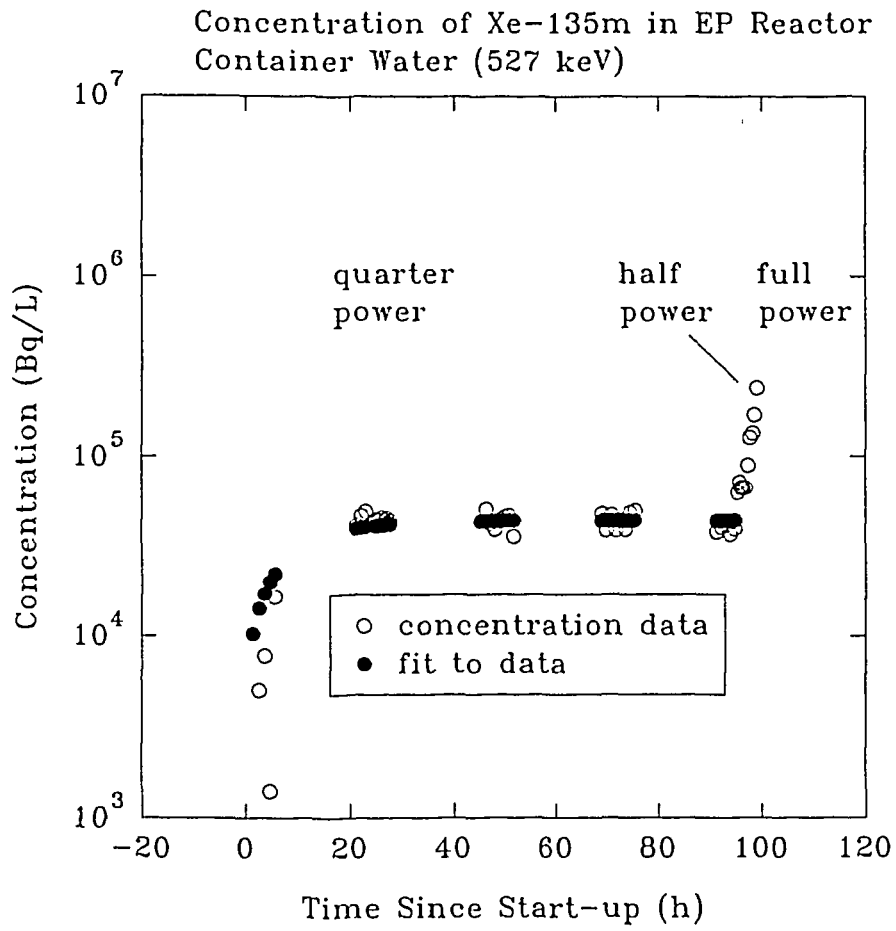


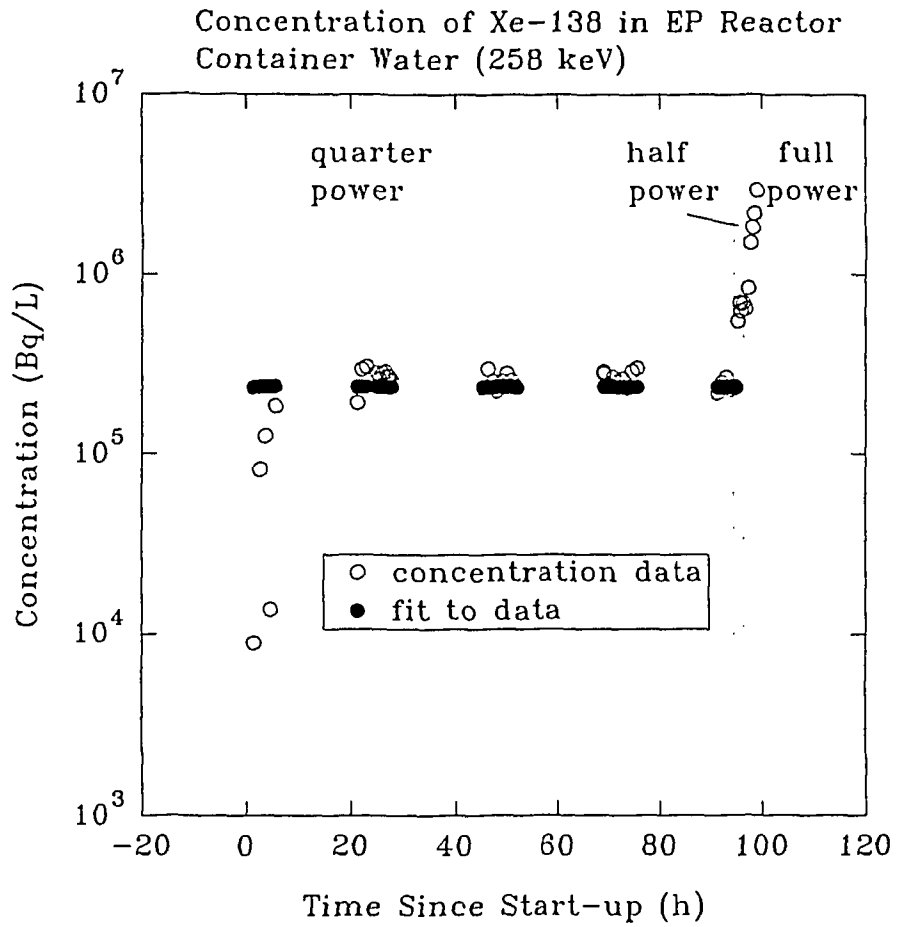


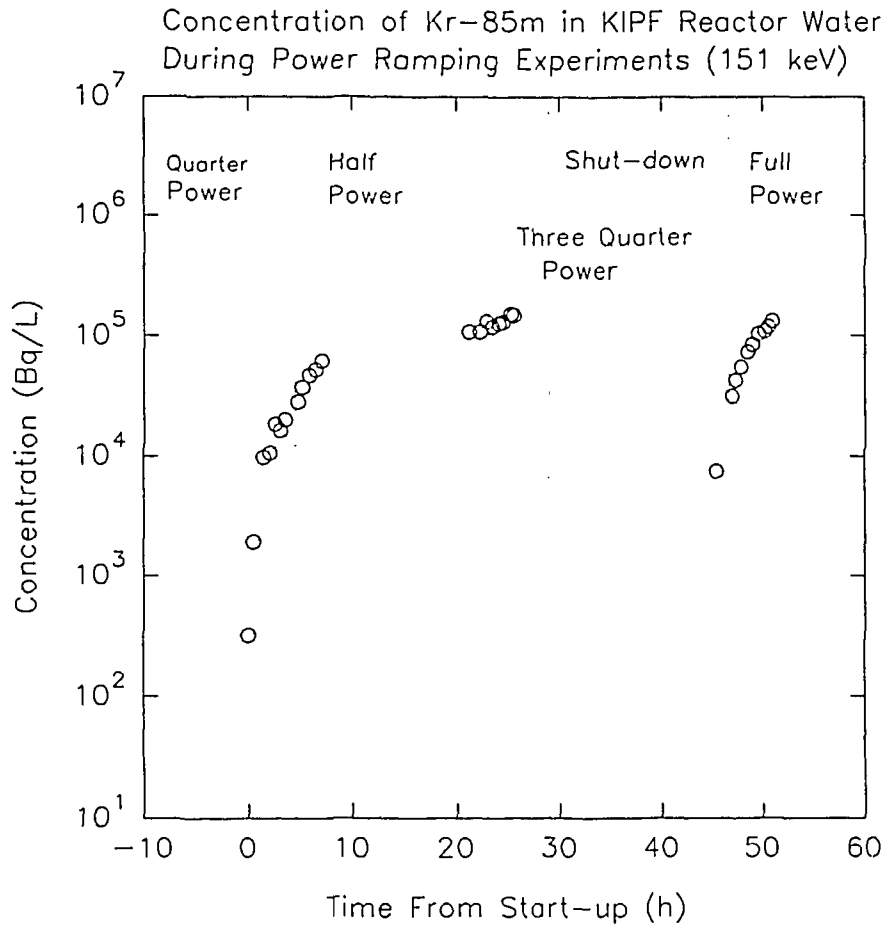


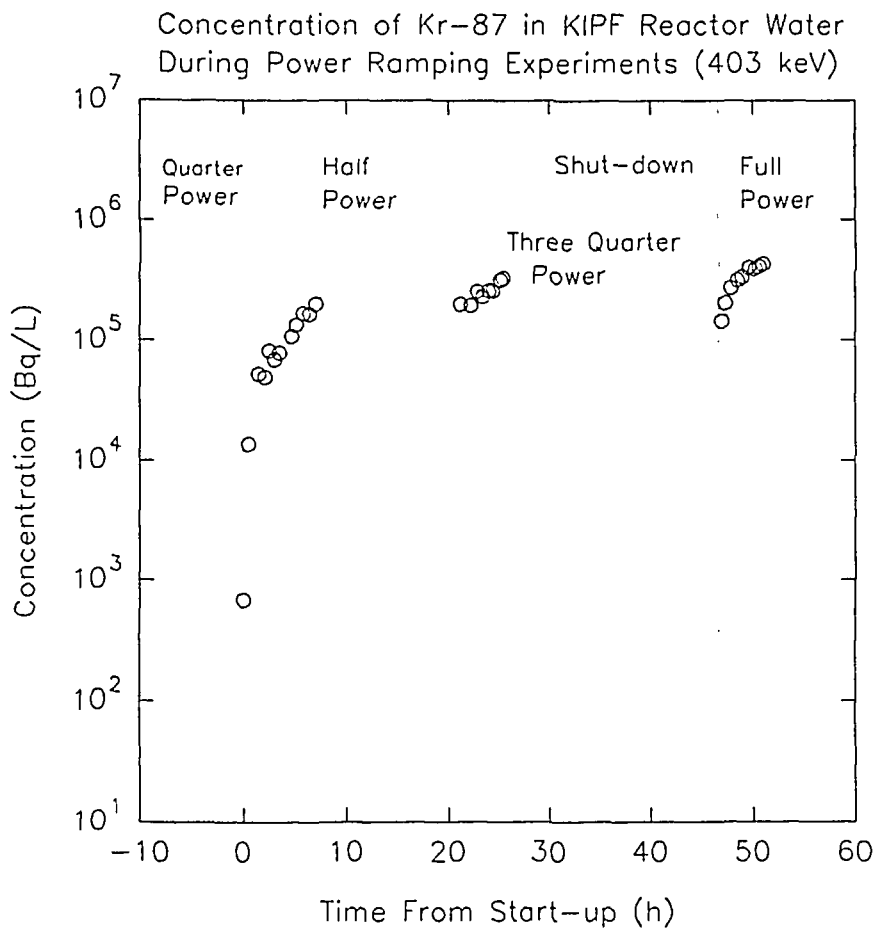


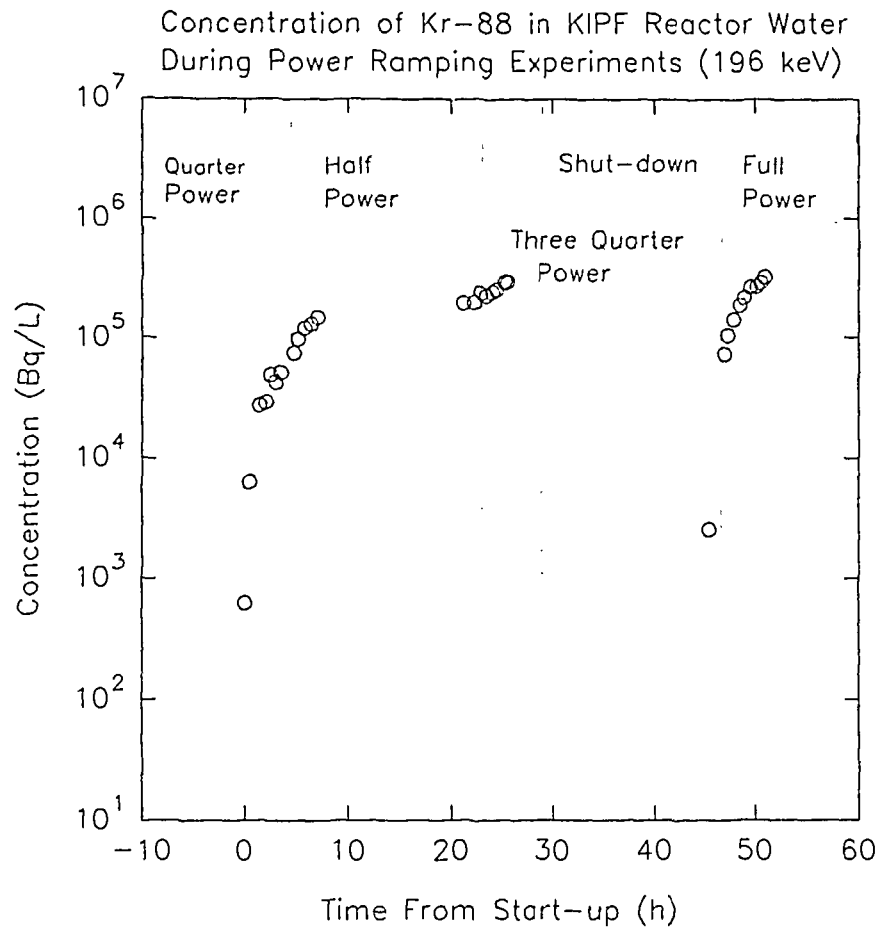


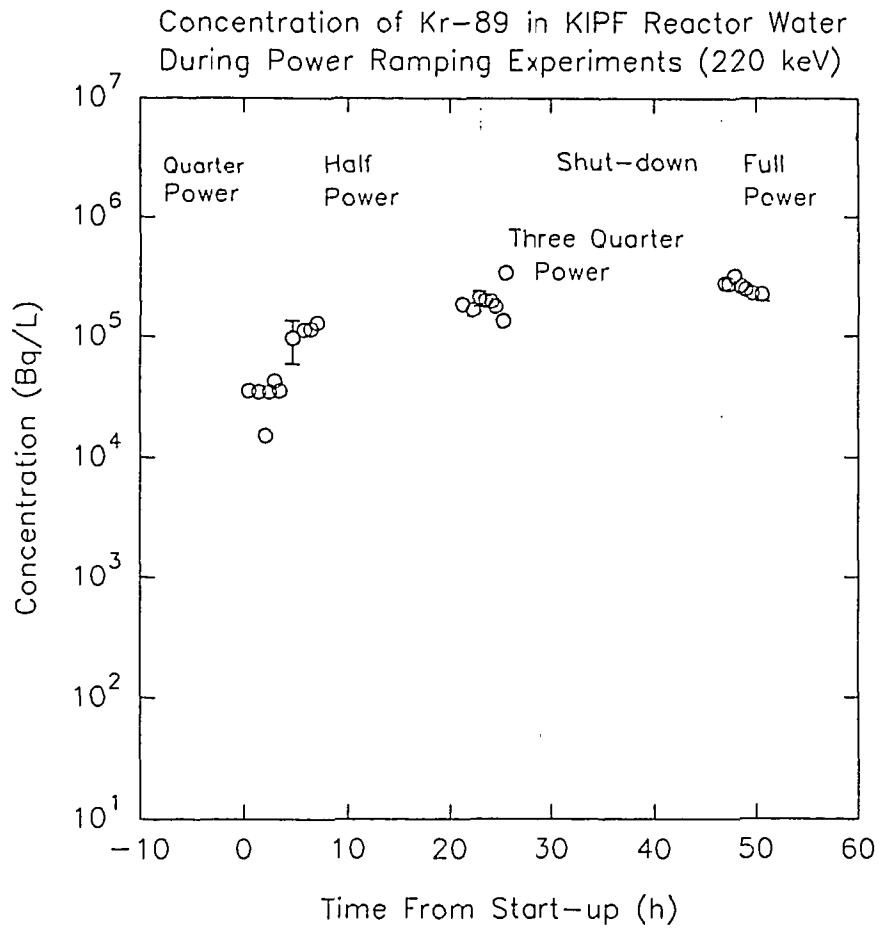


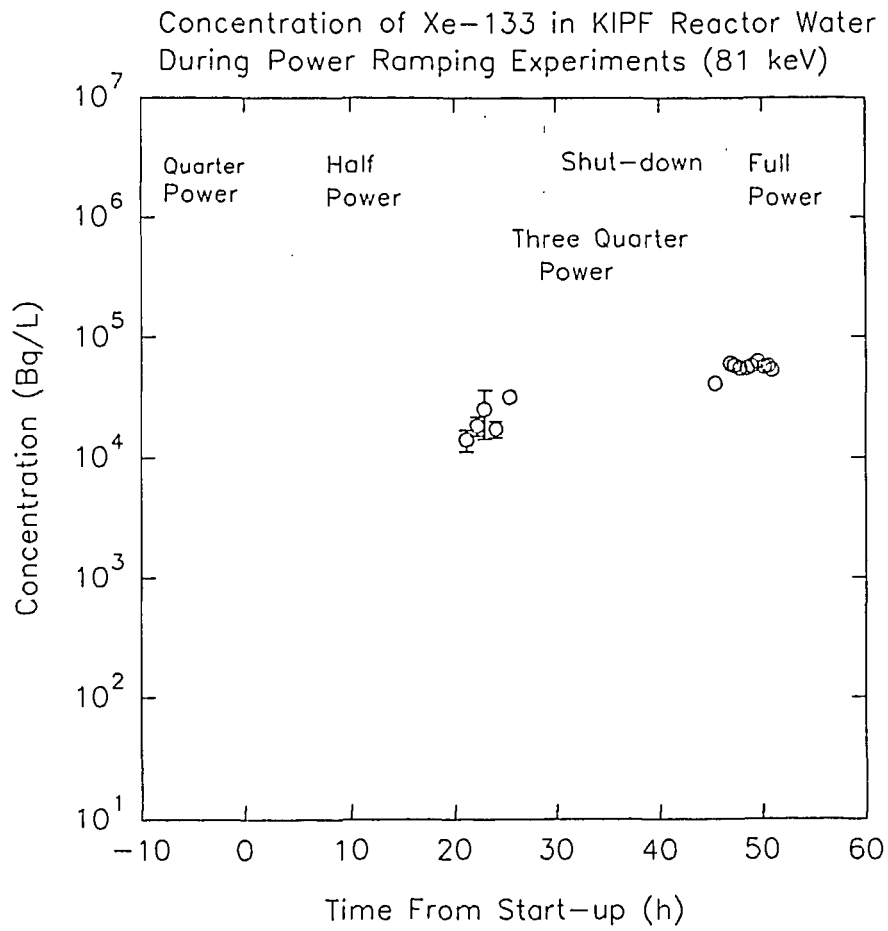


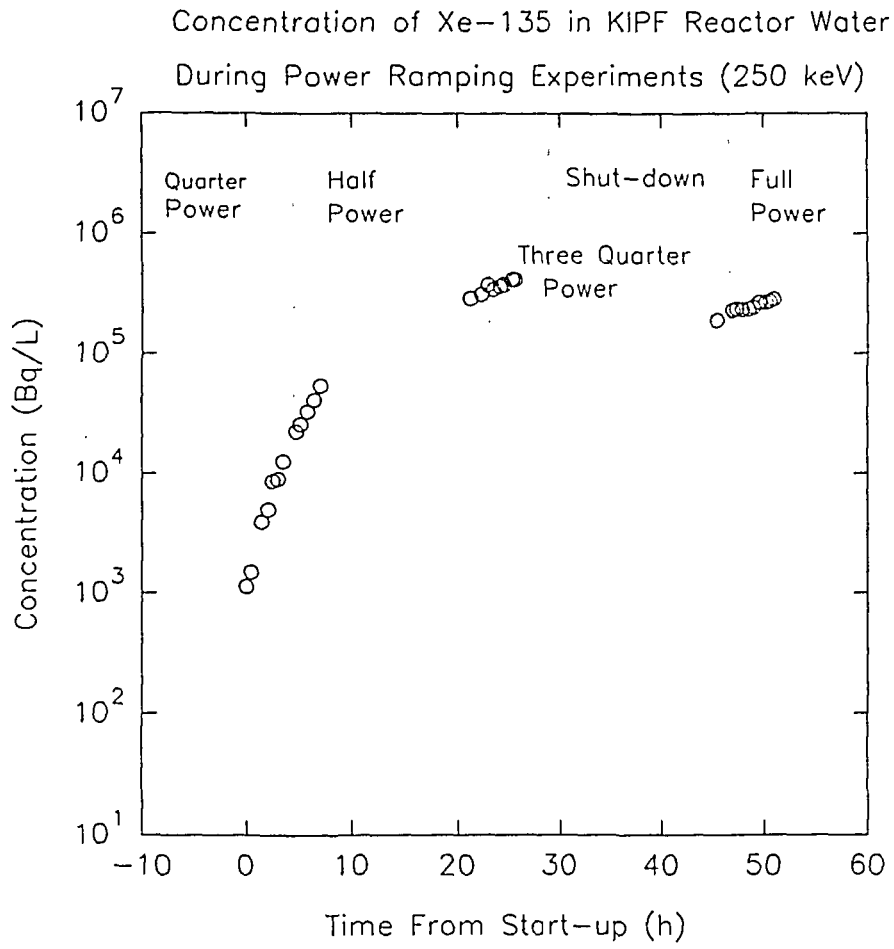


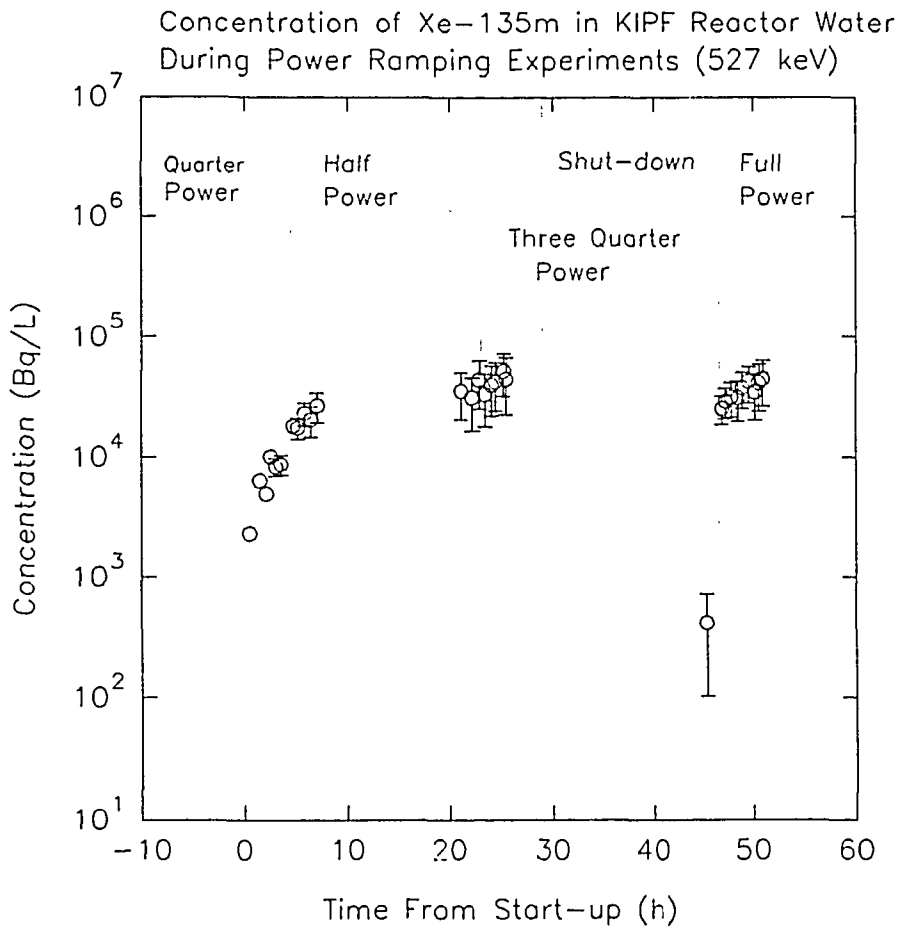


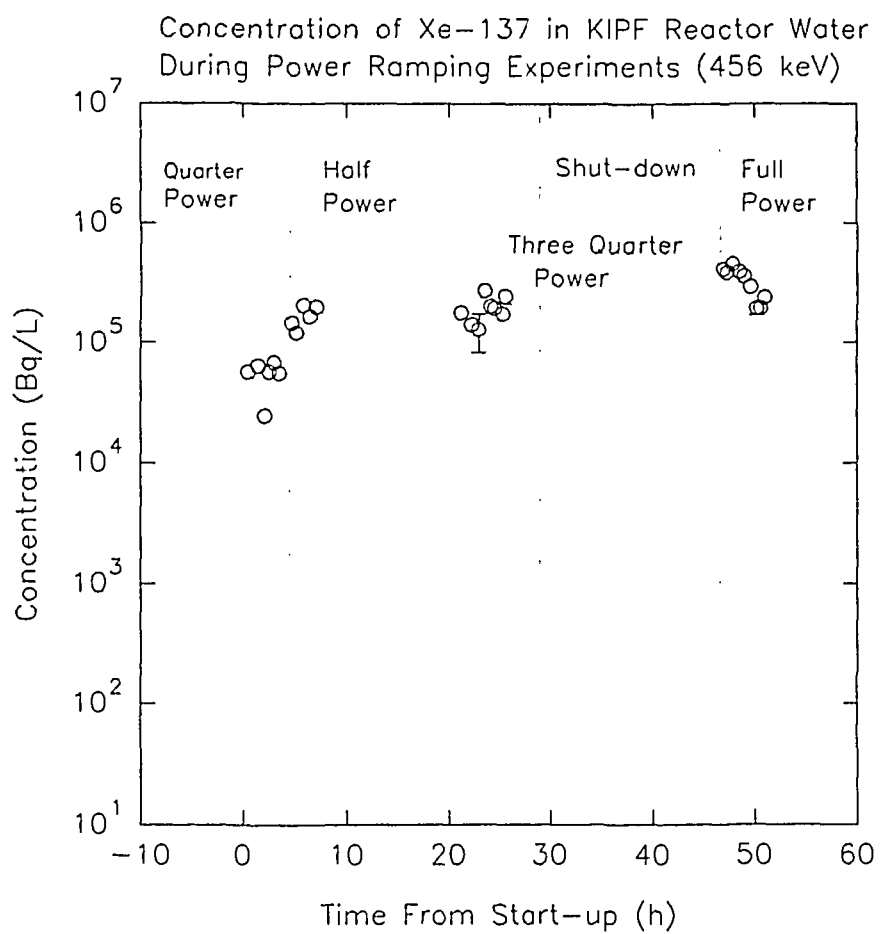


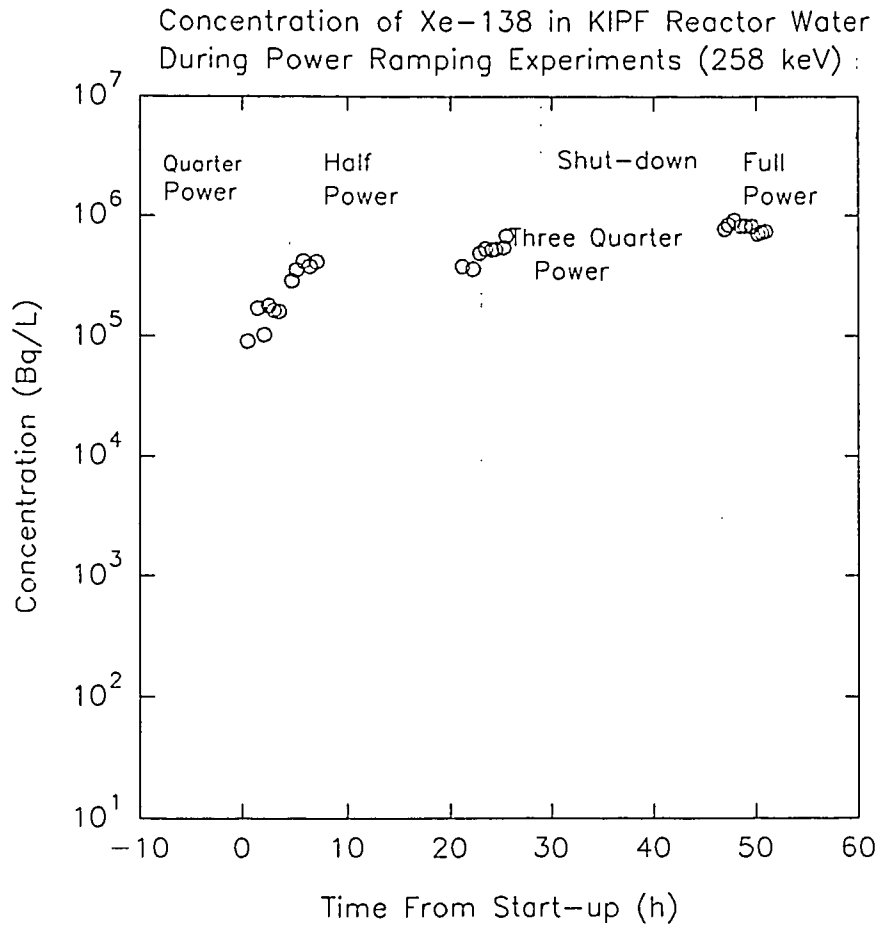


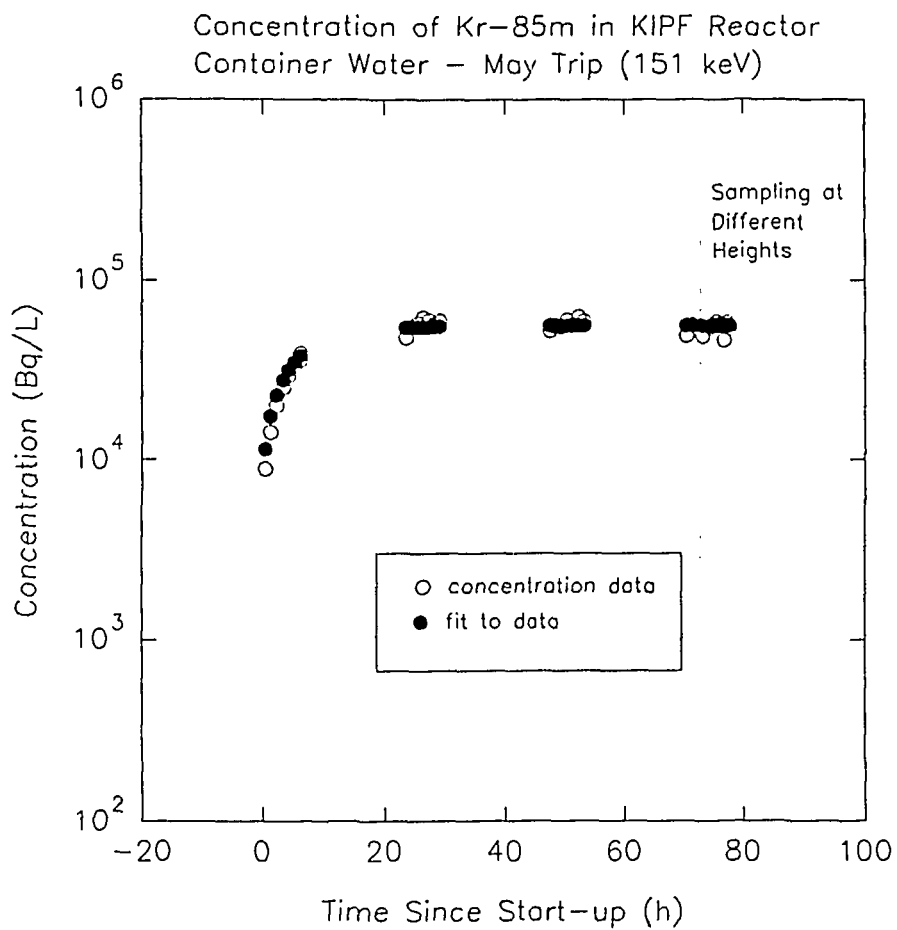


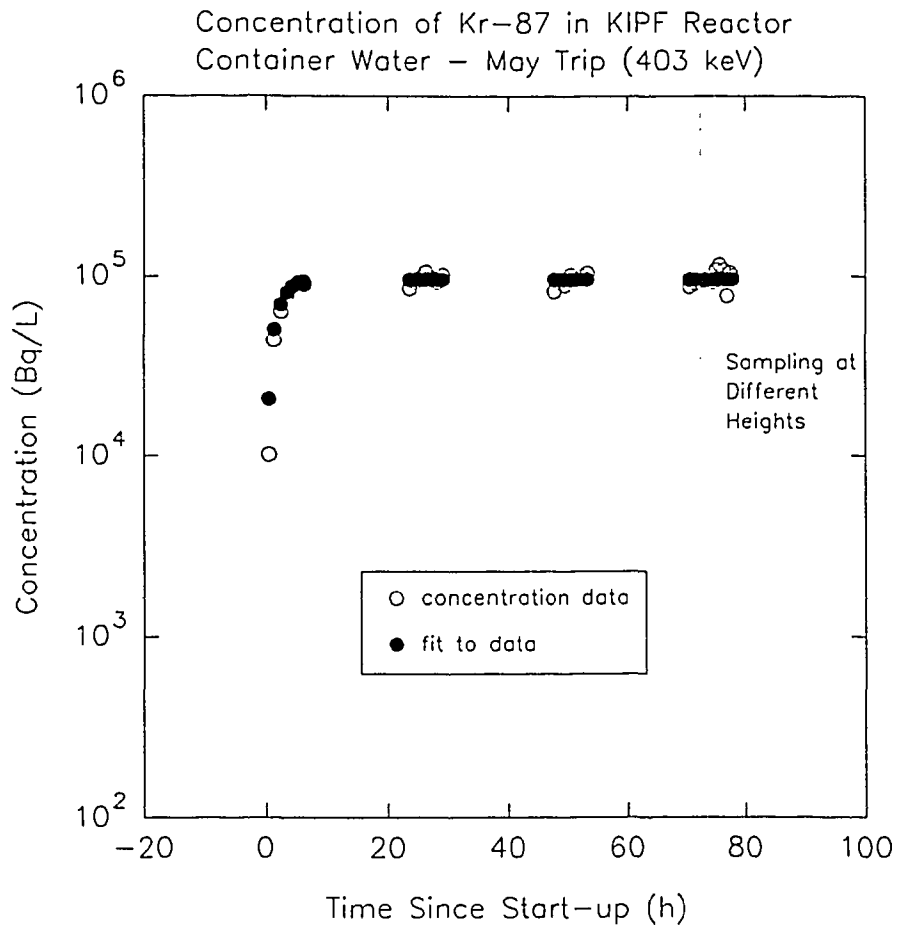


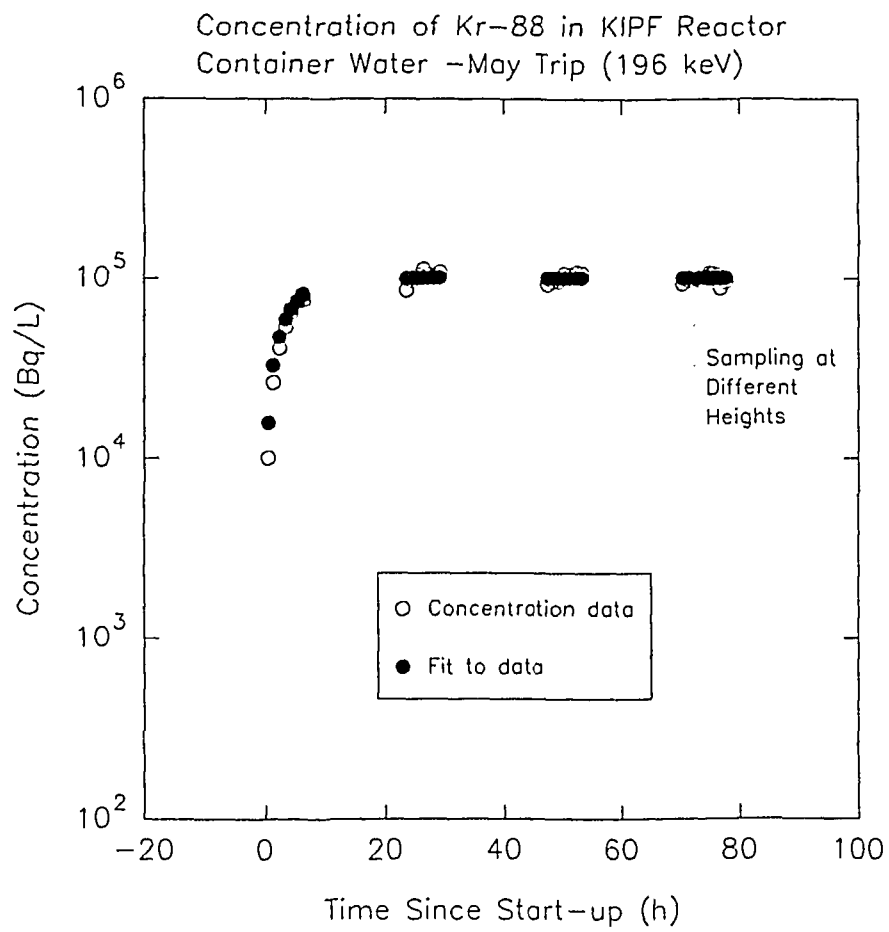


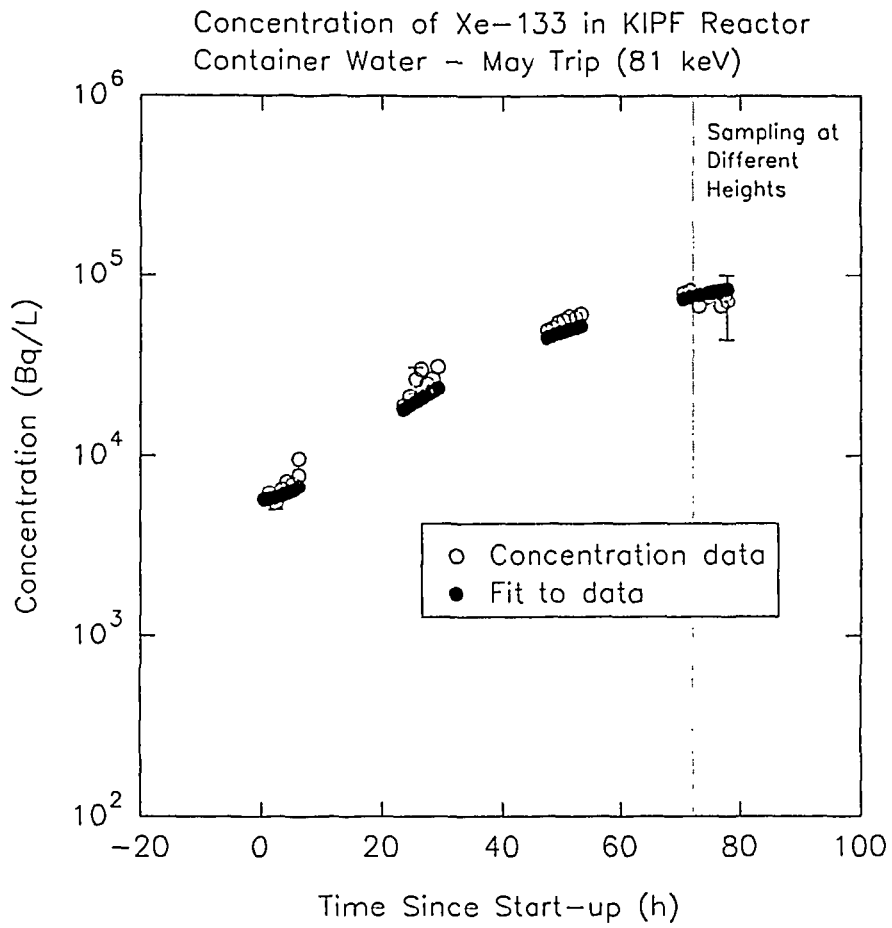


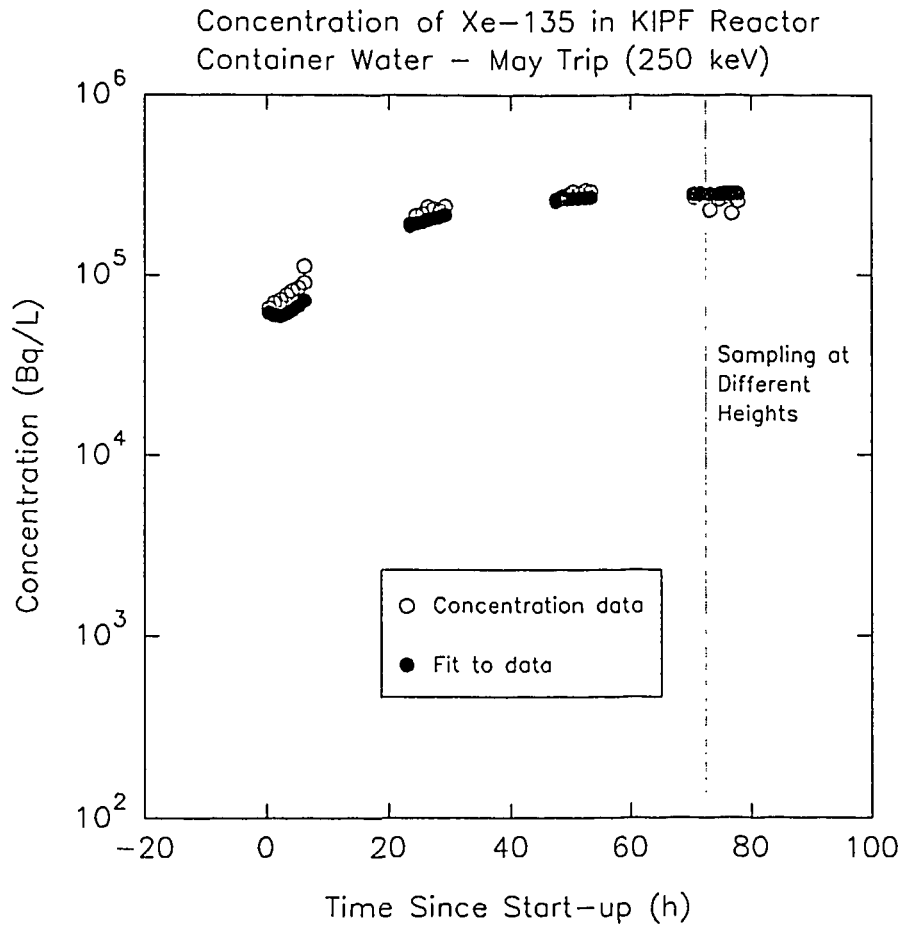


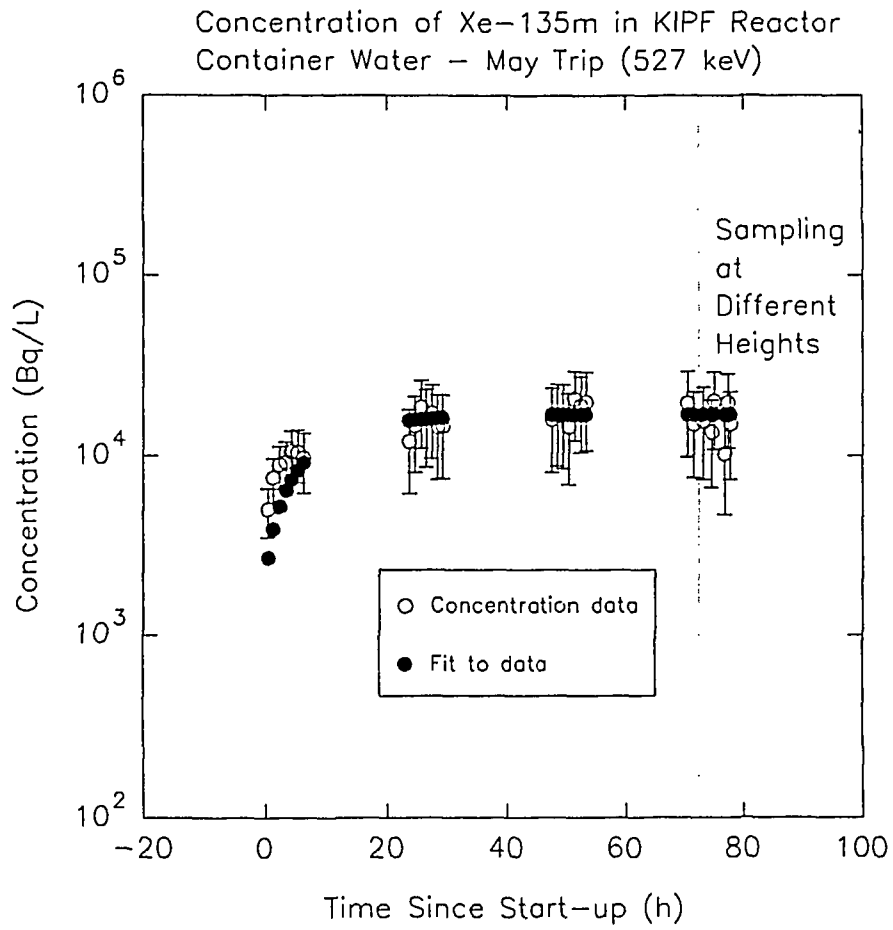


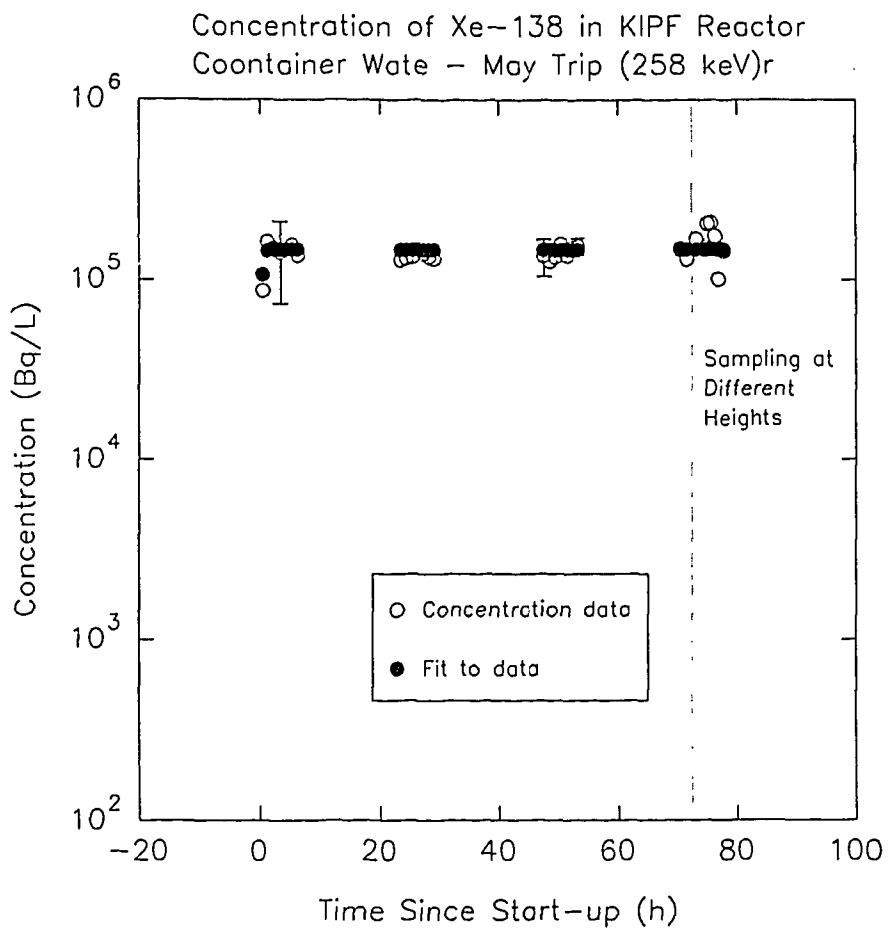








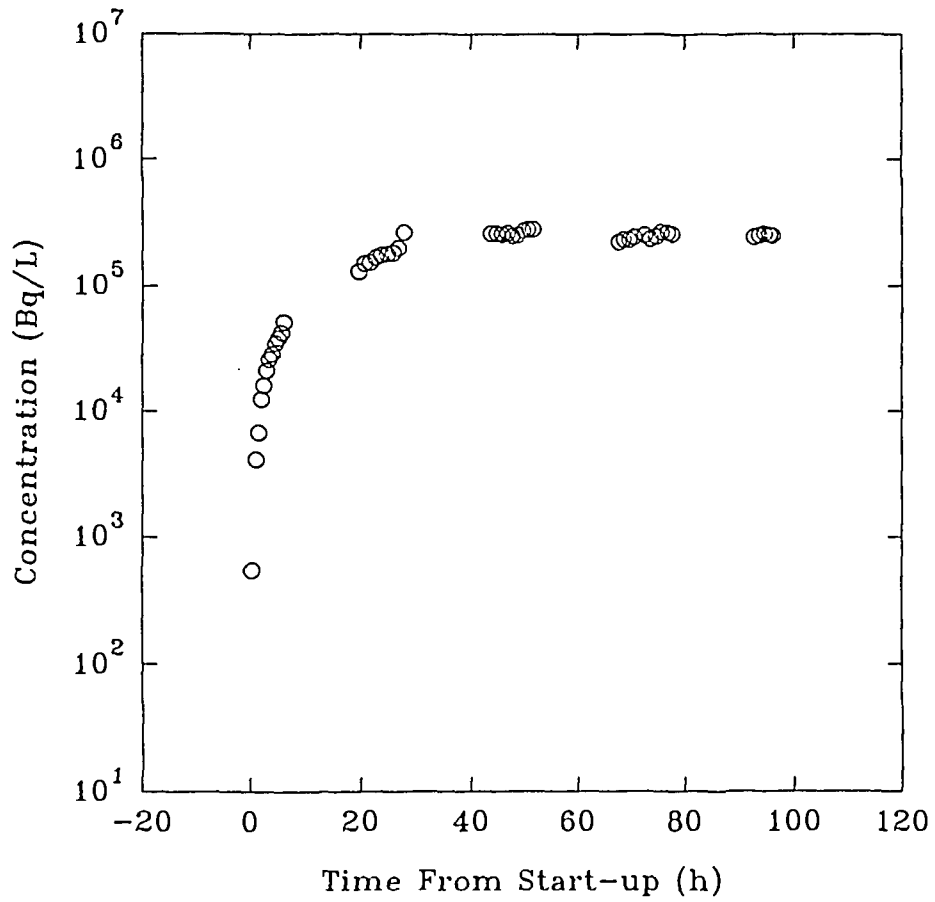


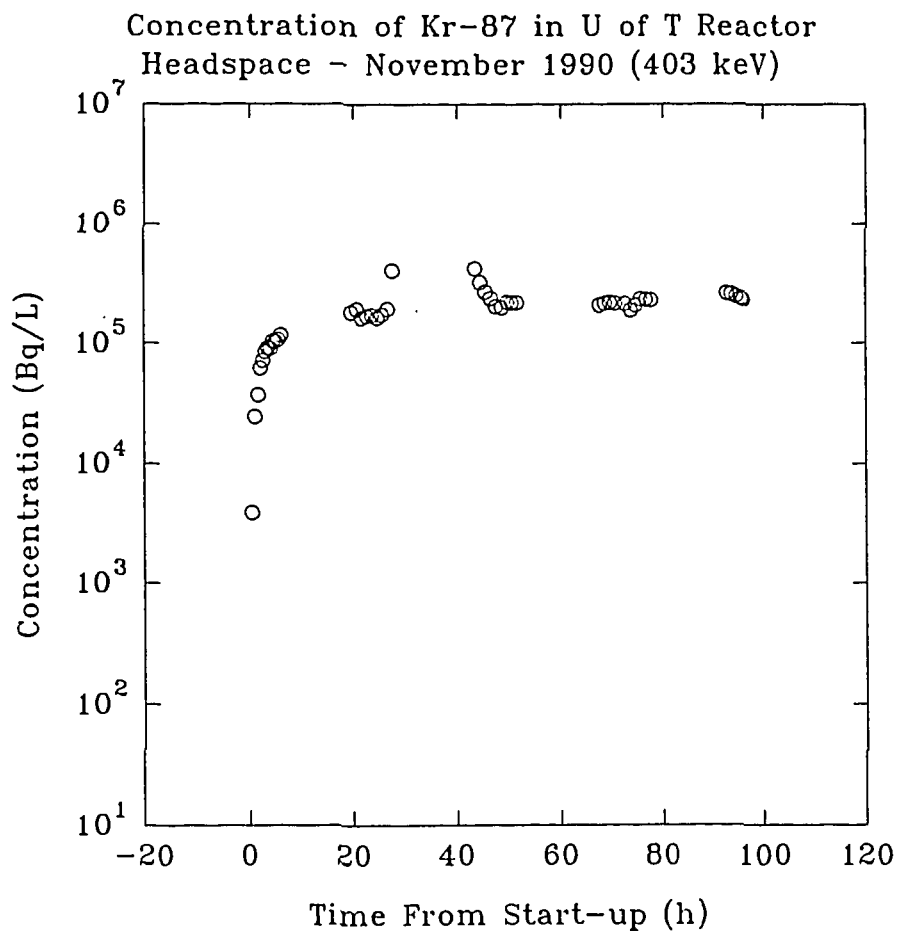


A.2 Gas Headspace

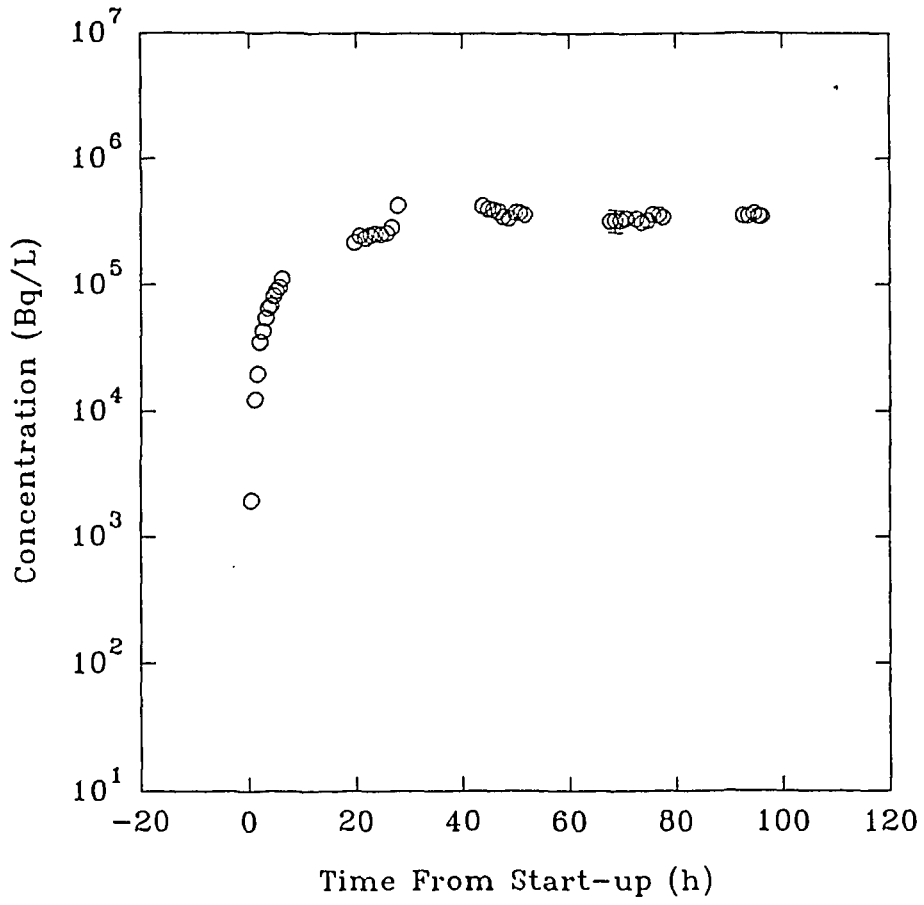
The activity concentrations of the noble gas isotopes measured in the gas headspace of the U of T, EP and KIPF reactors are given in the following plots with error bars indicating one standard deviation of error.

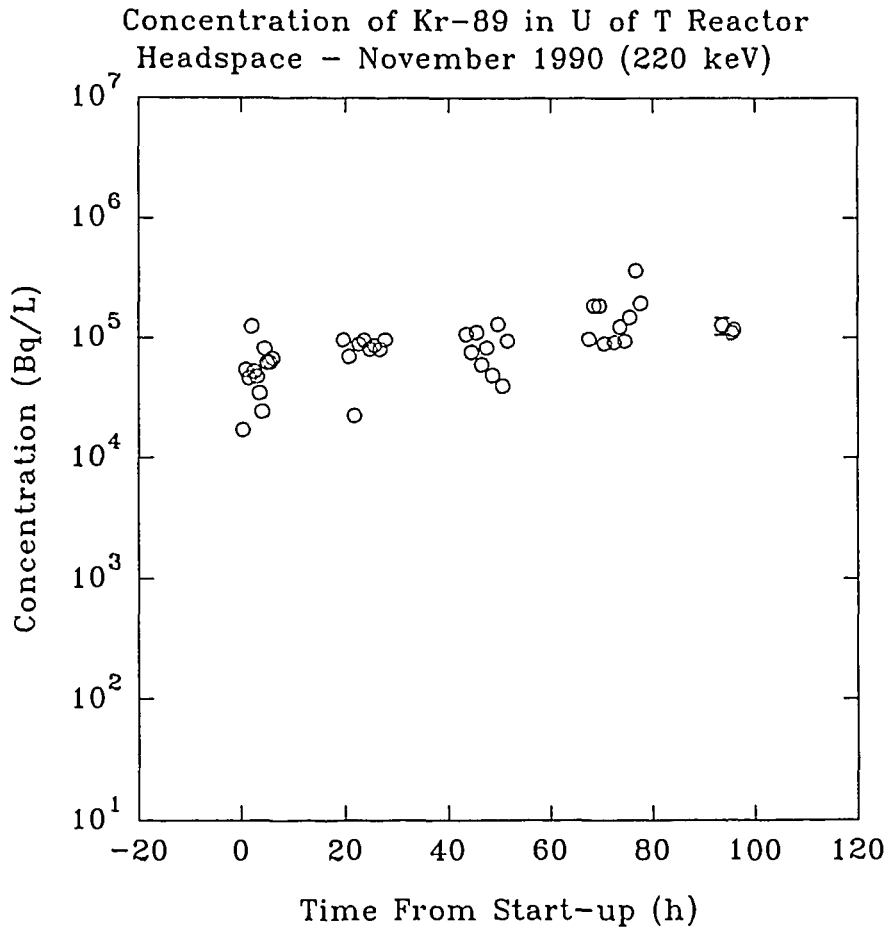
Concentration of Kr-85m in U of T Reactor
Headspace - November 1990 (151 keV)

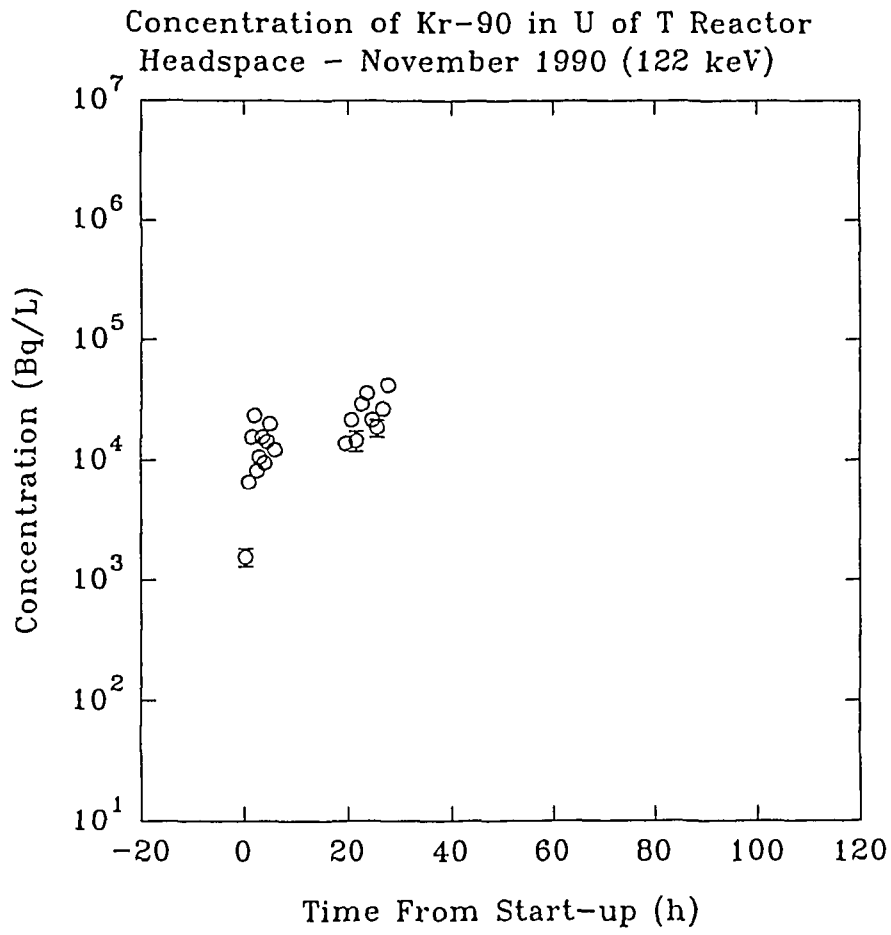




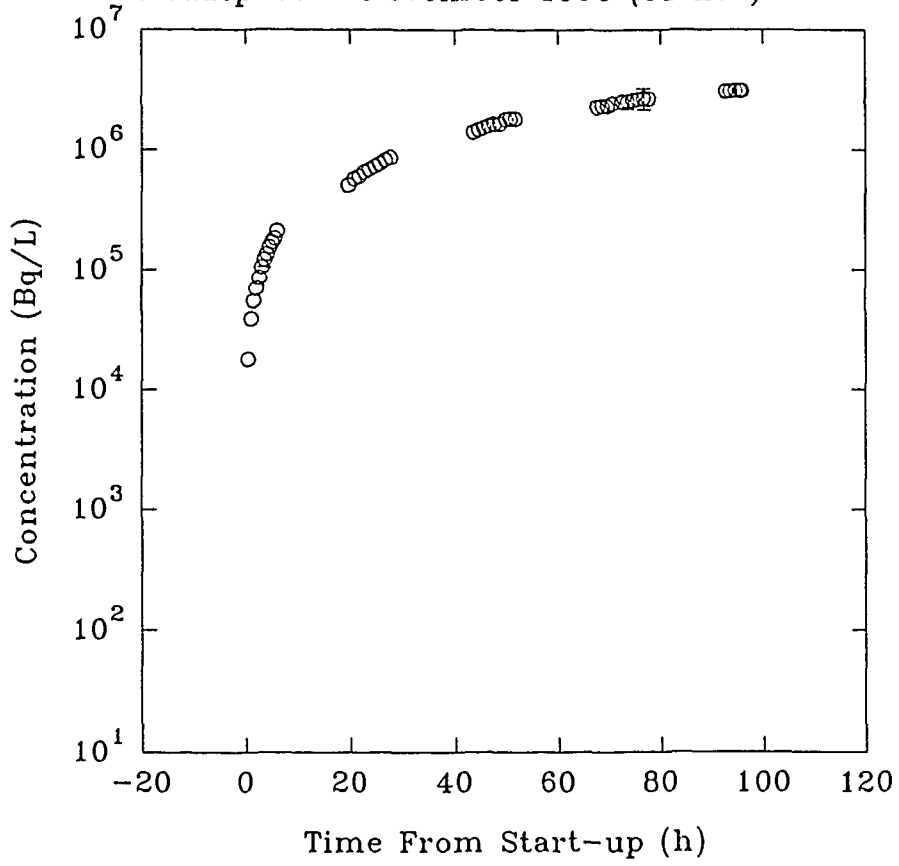
Concentration of Kr-88 in U of T Reactor
Headspace - November 1990 (196 keV)

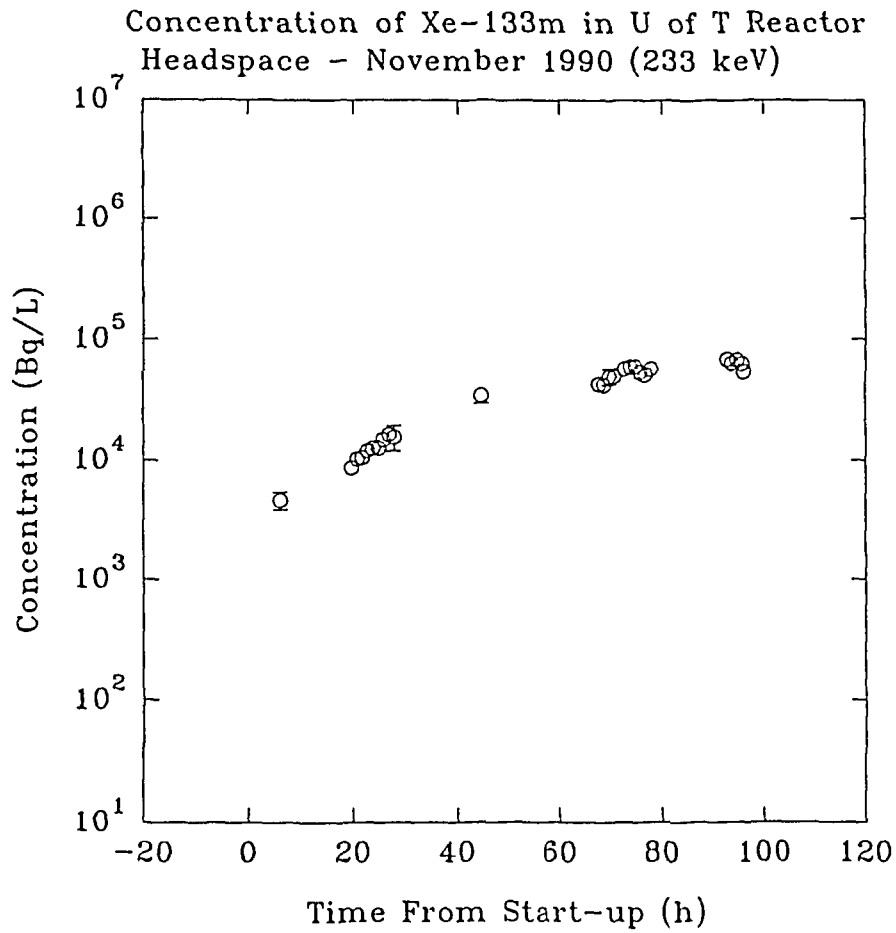


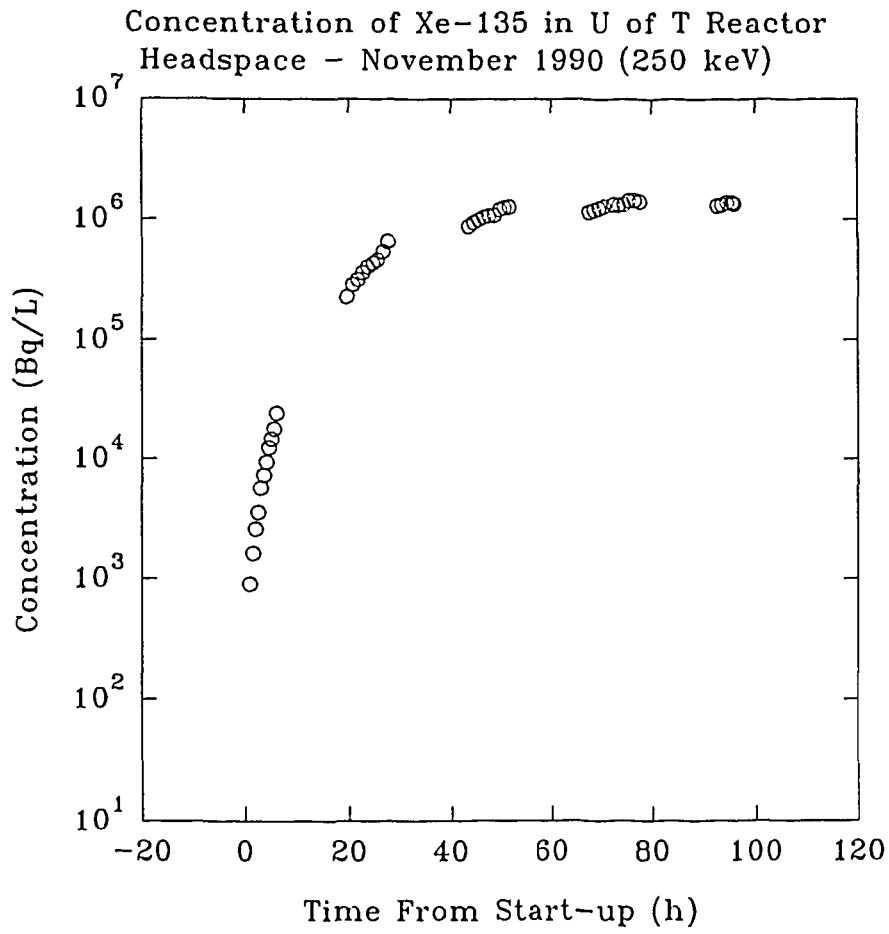




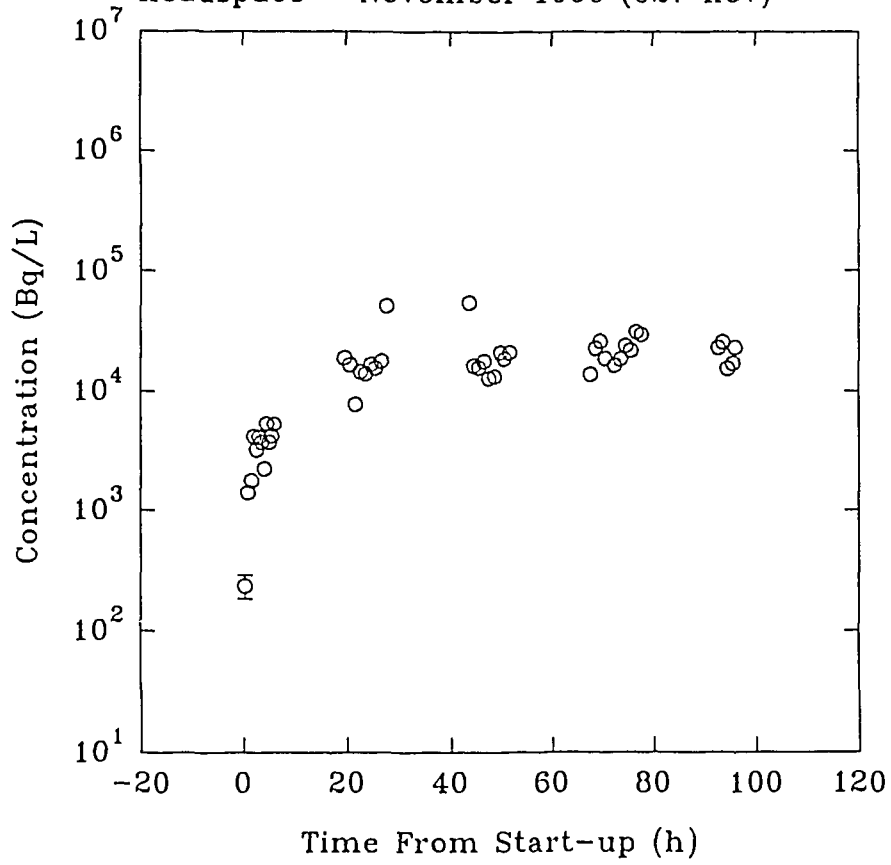
Concentration of Xe-133 in U of T Reactor
Headspace - November 1990 (81 keV)

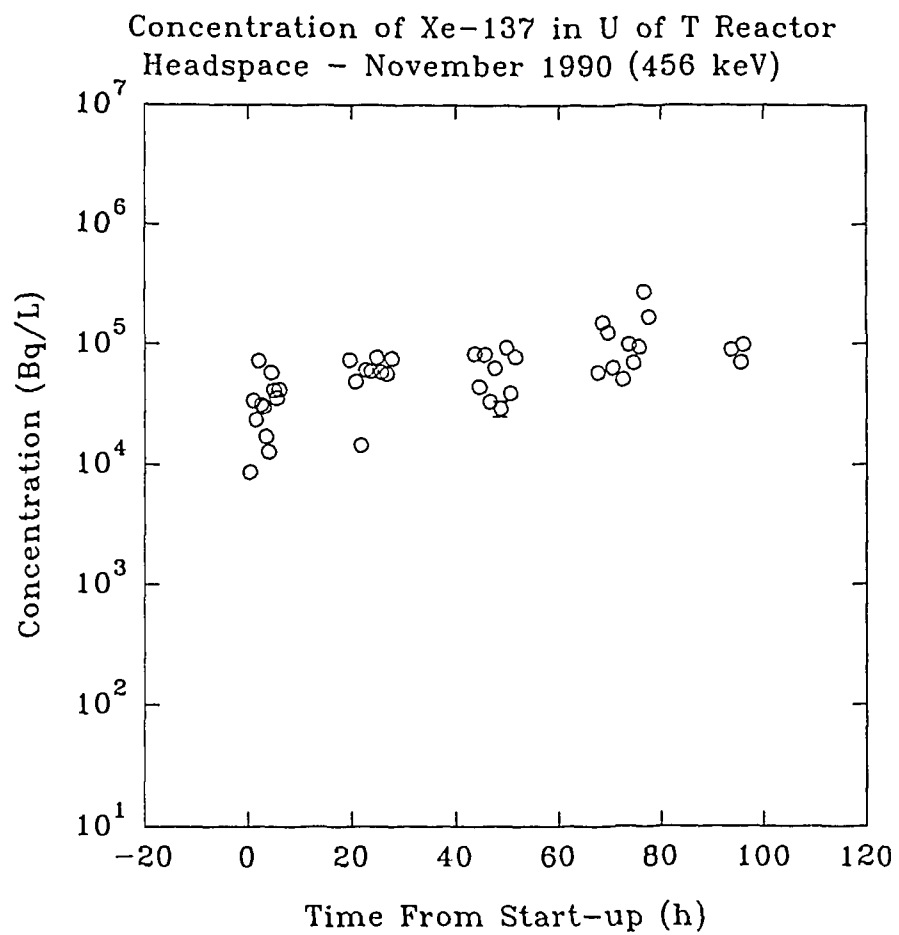


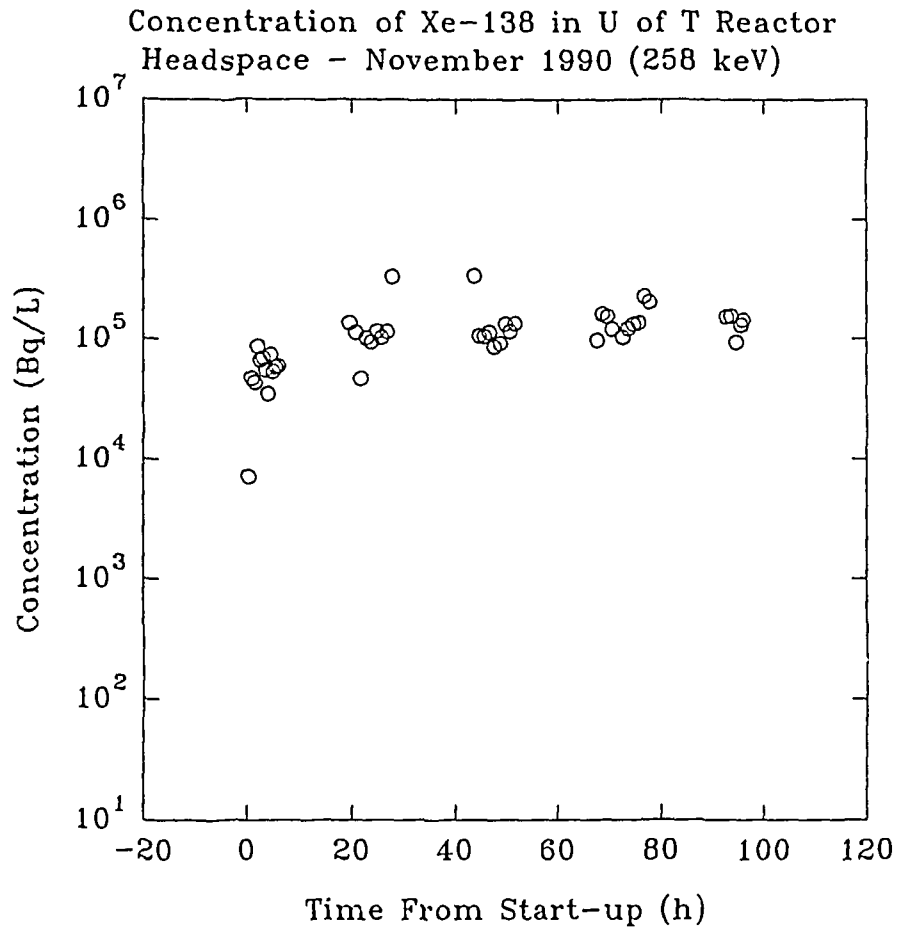


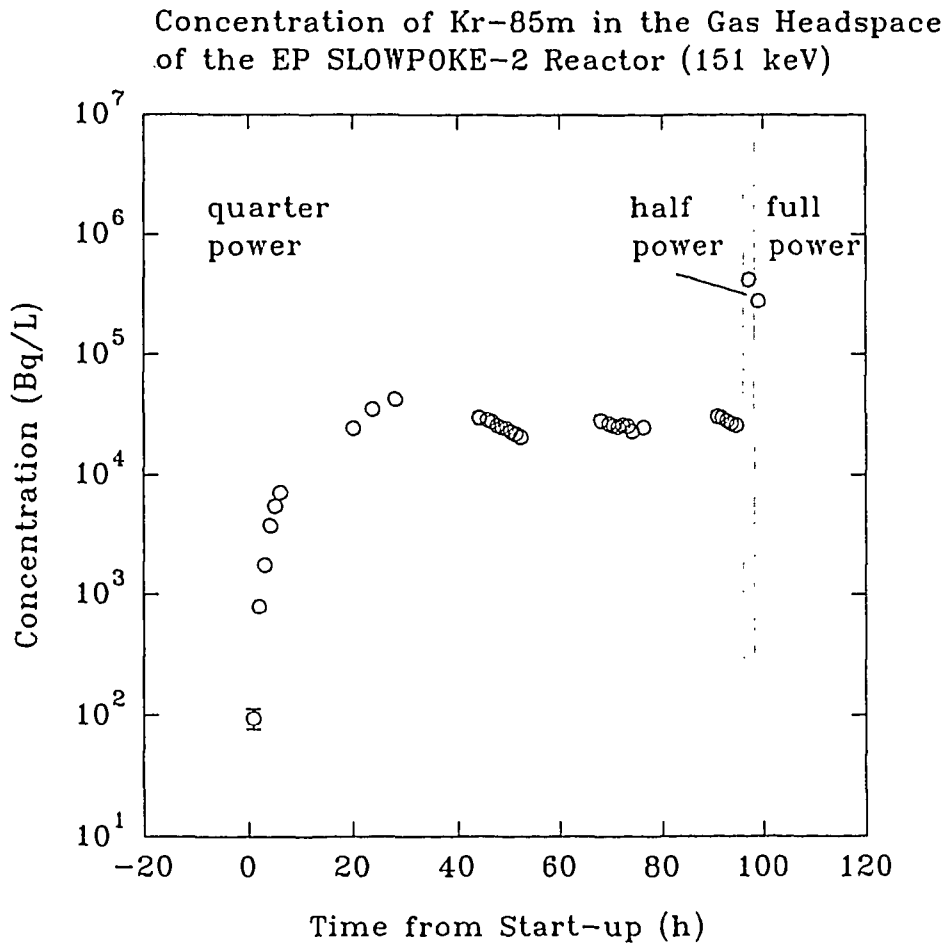


Concentration of Xe-135m in U of T Reactor
Headspace - November 1990 (527 keV)

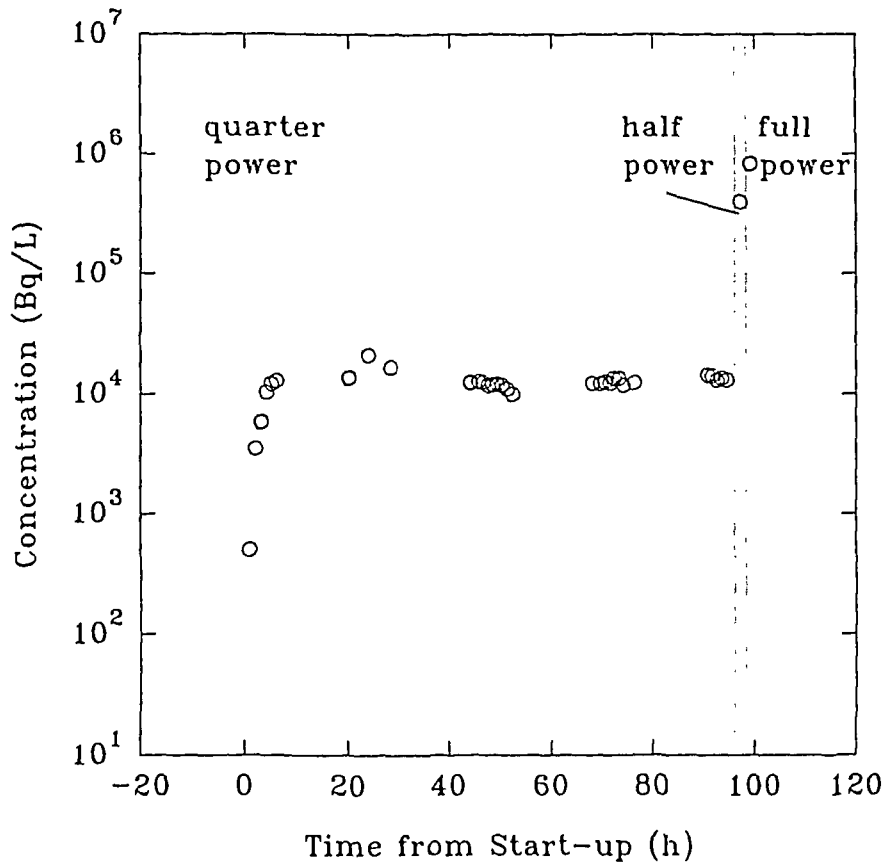




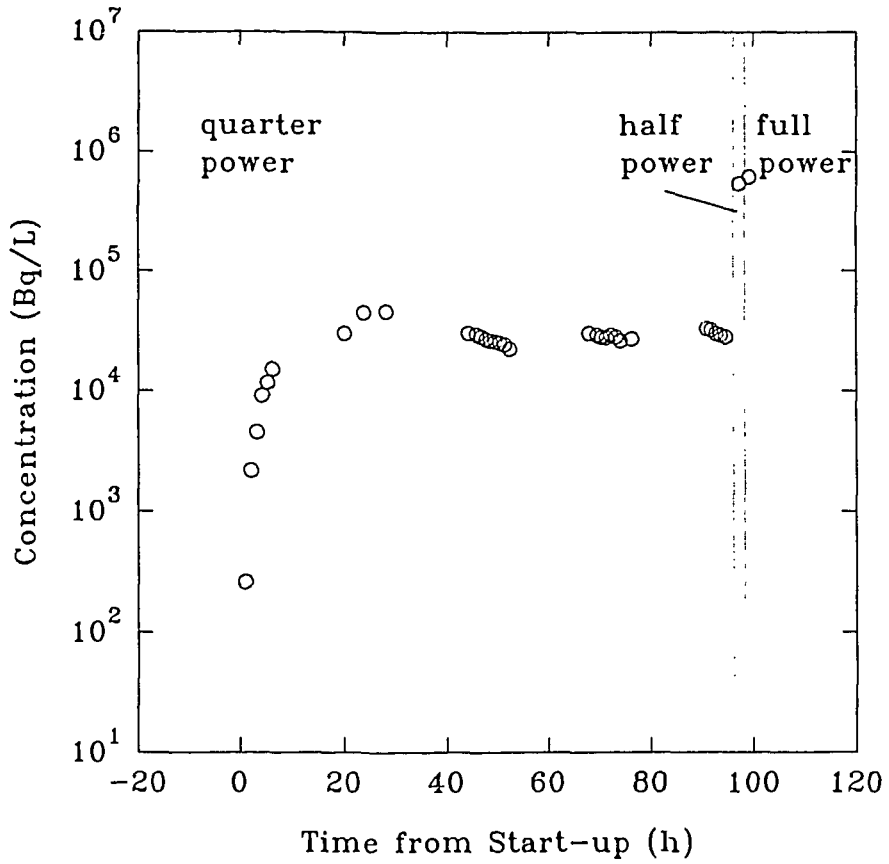




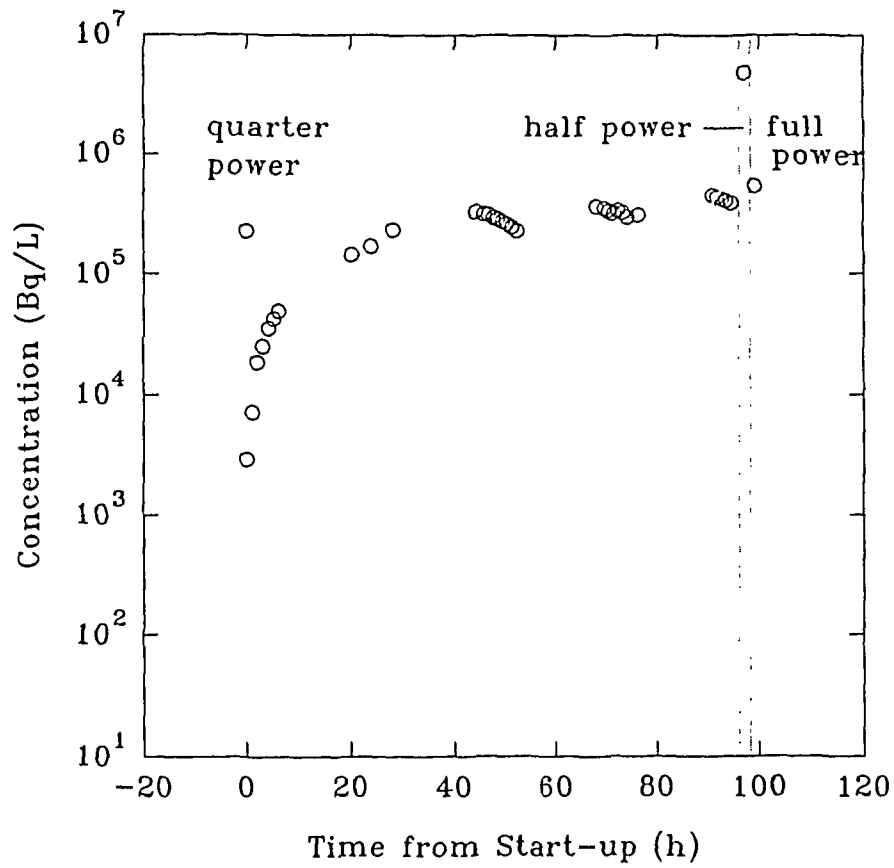
Concentration of Kr-87 in the Gas Headspace of the EP SLOWPOKE-2 Reactor (403 keV)



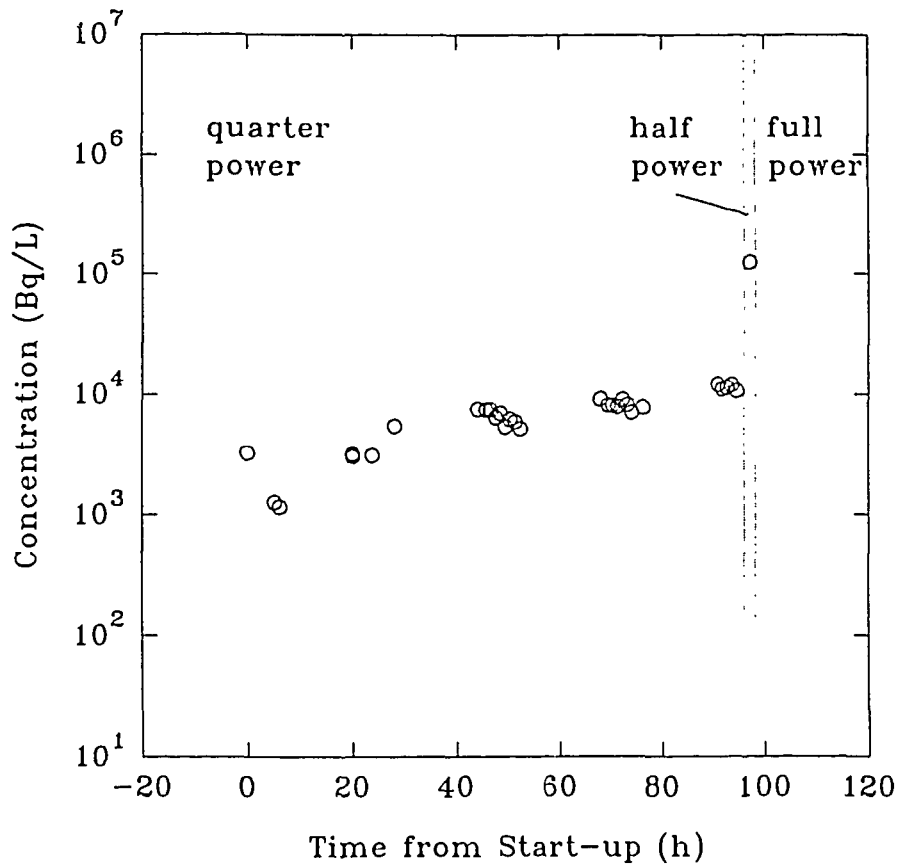
Concentration of Kr-88 in the Gas Headspace of the EP SLOWPOKE-2 Reactor (196 keV)



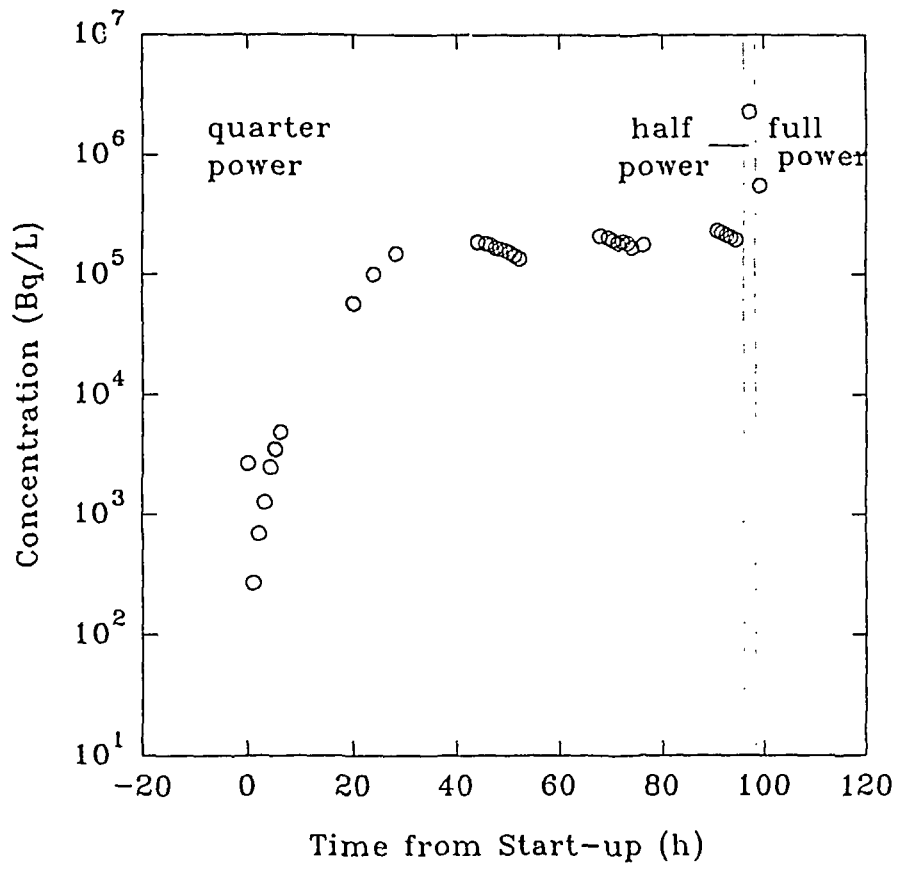
Concentration of Xe-133 in the Gas Headspace
of the EP SLOWPOKE-2 Reactor (81 keV)



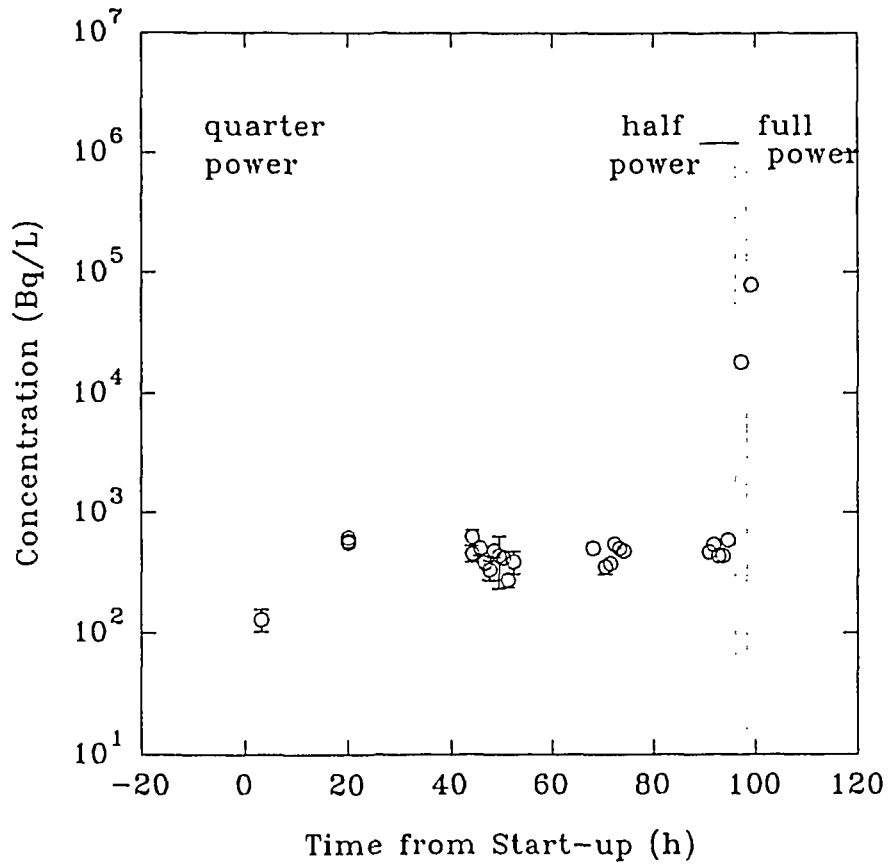
Concentration of Xe-133m in the Gas Headspace of the EP SLOWPOKE-2 Reactor (233 keV)



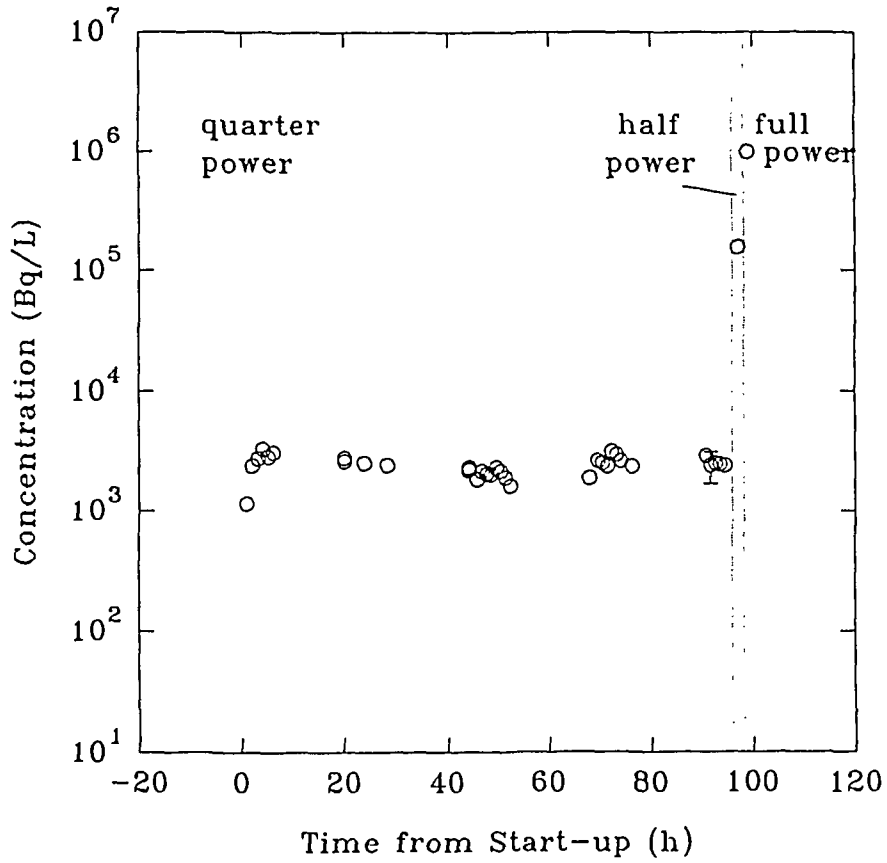
Concentration of Xe-135 in the Gas Headspace of the EP SLOWPOKE-2 Reactor (250 keV)



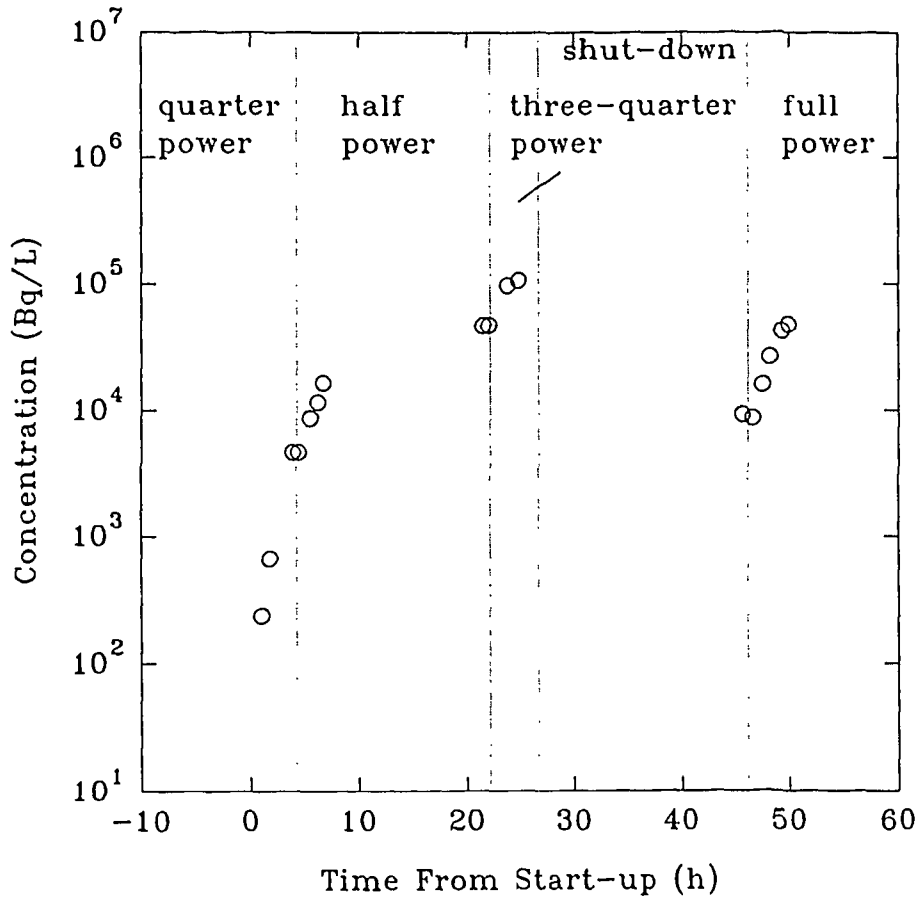
Concentration of Xe-135m in the Gas Headspace
of the EP SLOWPOKE-2 Reactor (527 keV)



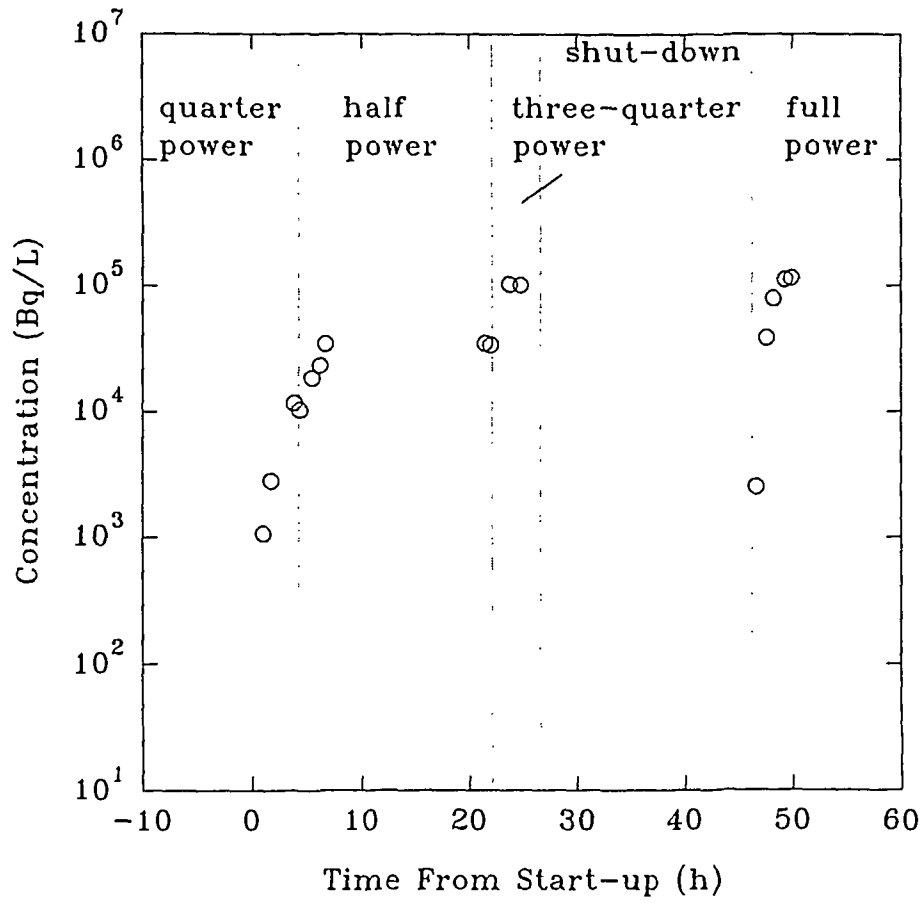
Concentration of Xe-138 in the Gas Headspace of the EP SLOWPOKE-2 Reactor (258)



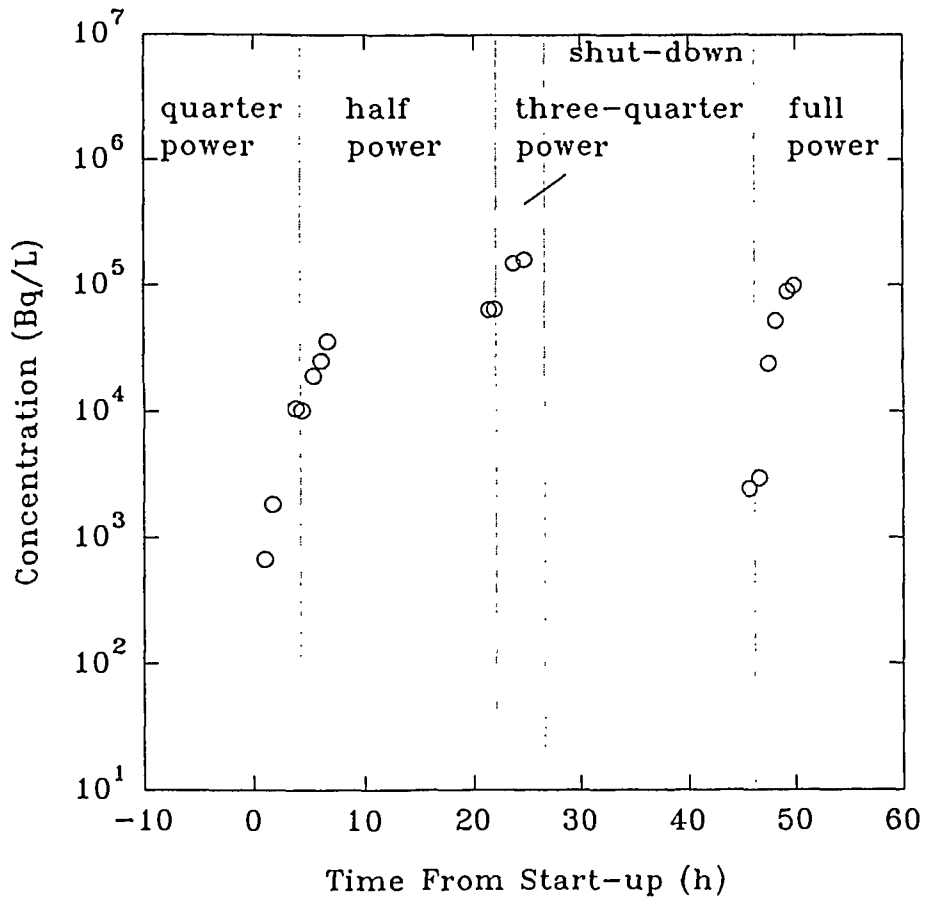
Concentration of Kr-85m in the KIPF Reactor
Headspace - April Trip (151 keV)



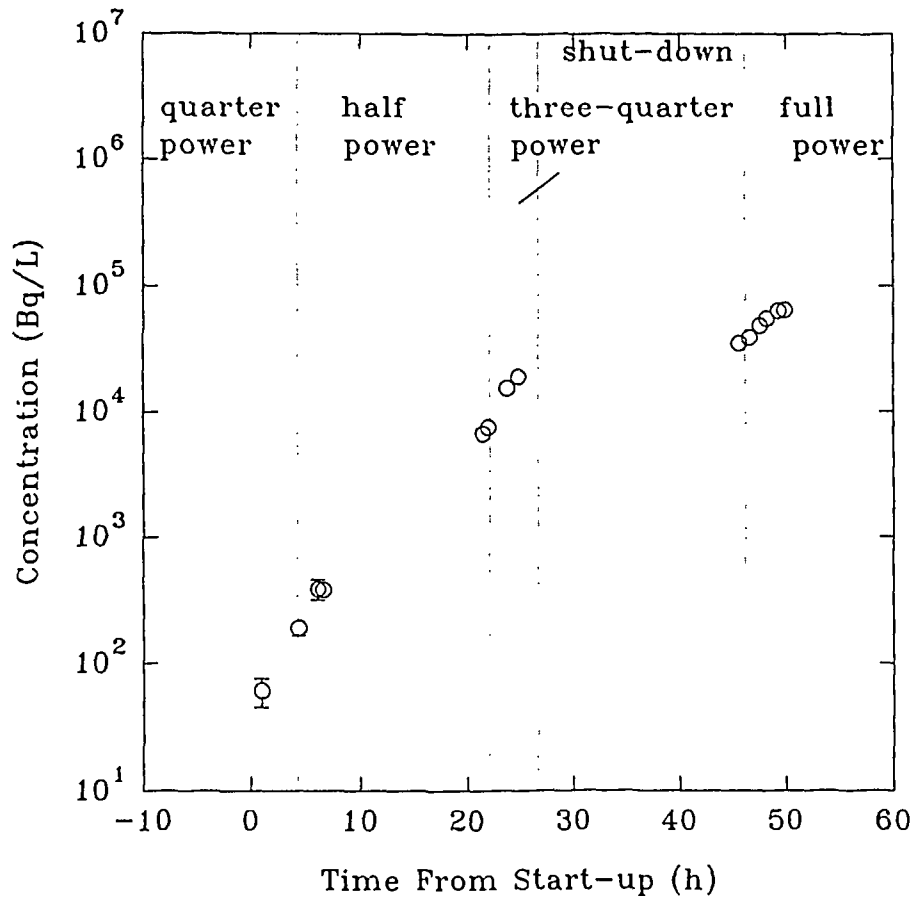
Concentration of Kr-87 in the KIPF Reactor
Headspace - April Trip (403 keV)



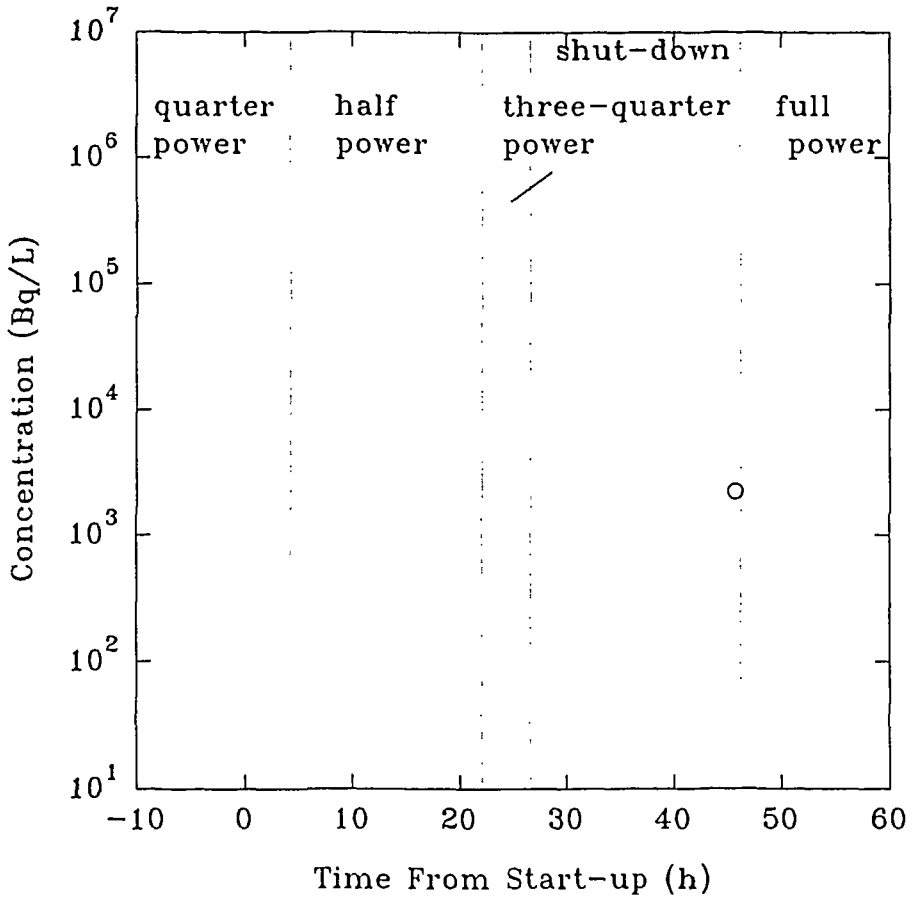
Concentration of Kr-88 in the KIPF Reactor
Headspace - April Trip (196 keV)



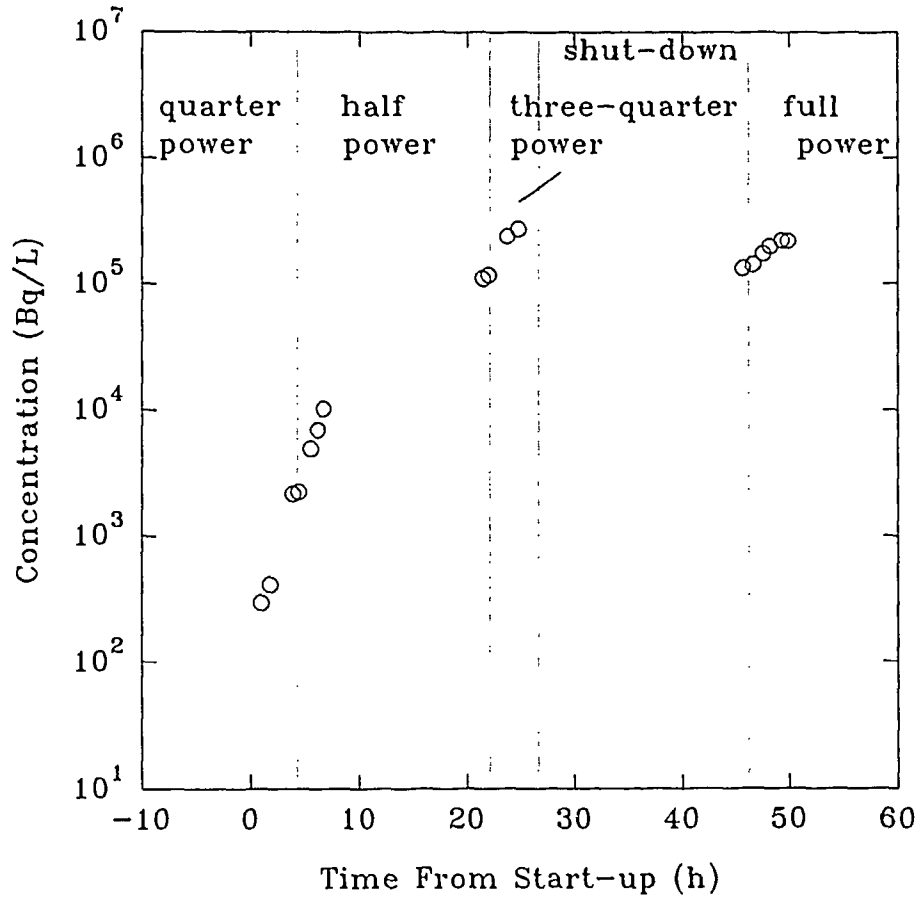
Concentration of Xe-133 in the KIPF Reactor
Headspace - April Trip (81 keV)



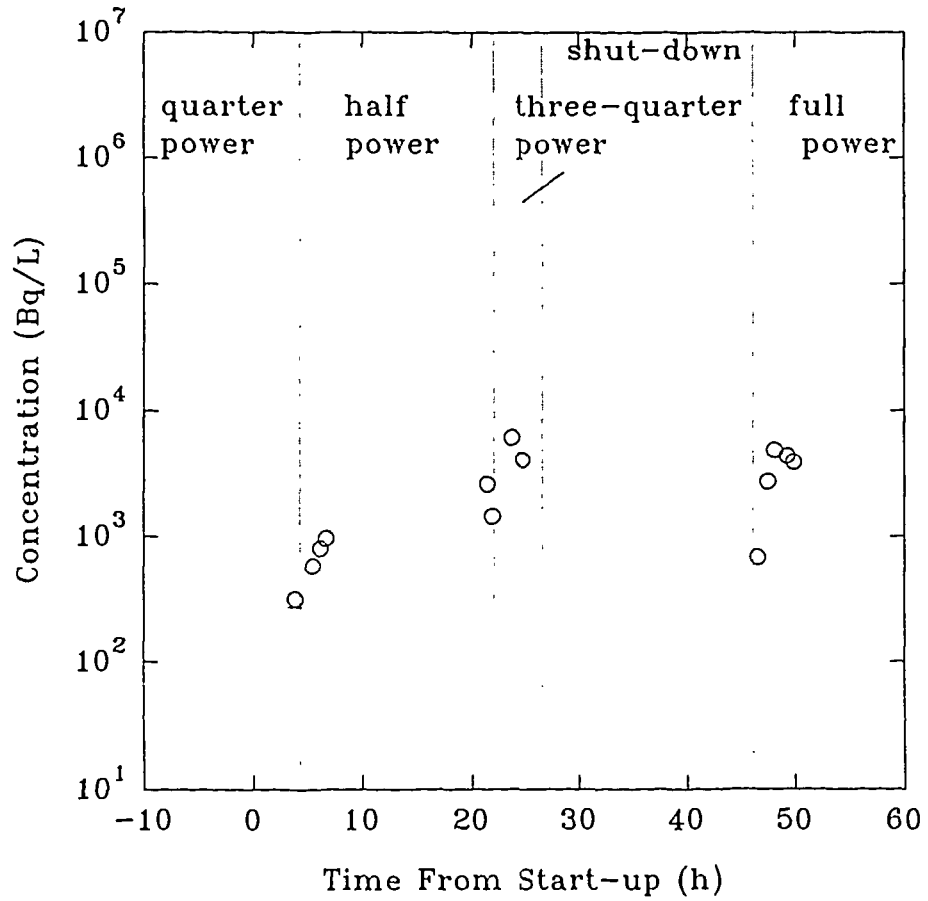
Concentration of Xe-133m in the KIPF Reactor
Headspace - April Trip (233 keV)



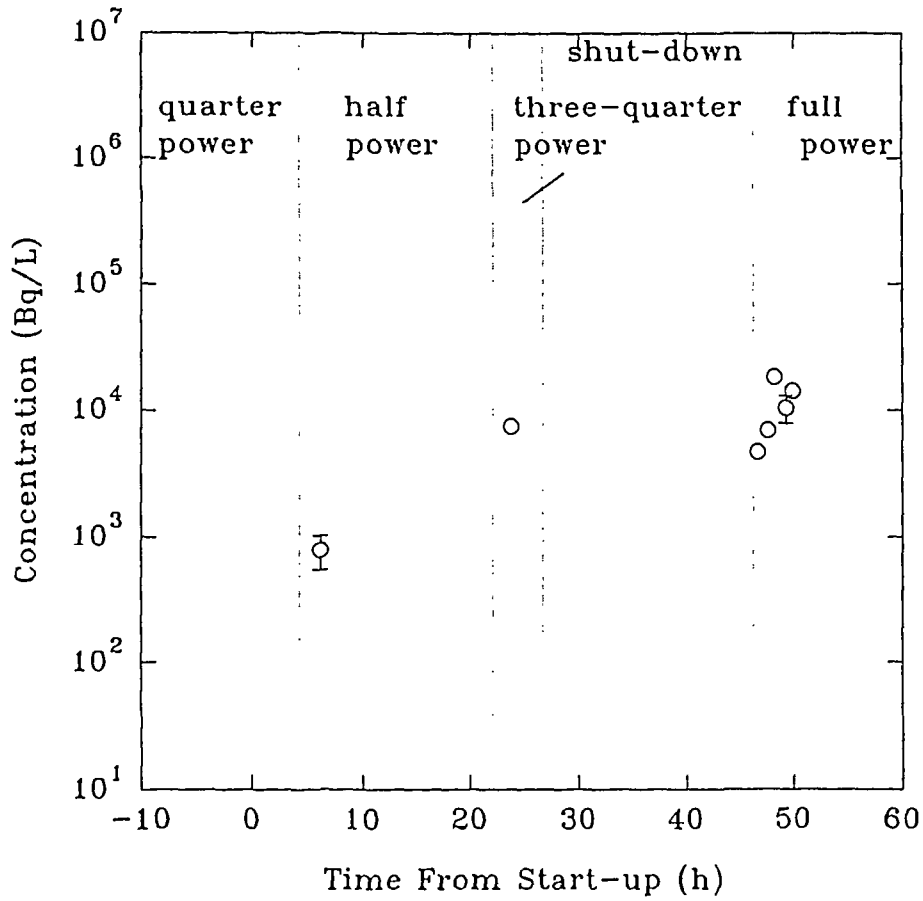
Concentration of Xe-135 in the KIPF Reactor
Headspace - April Trip (250 keV)



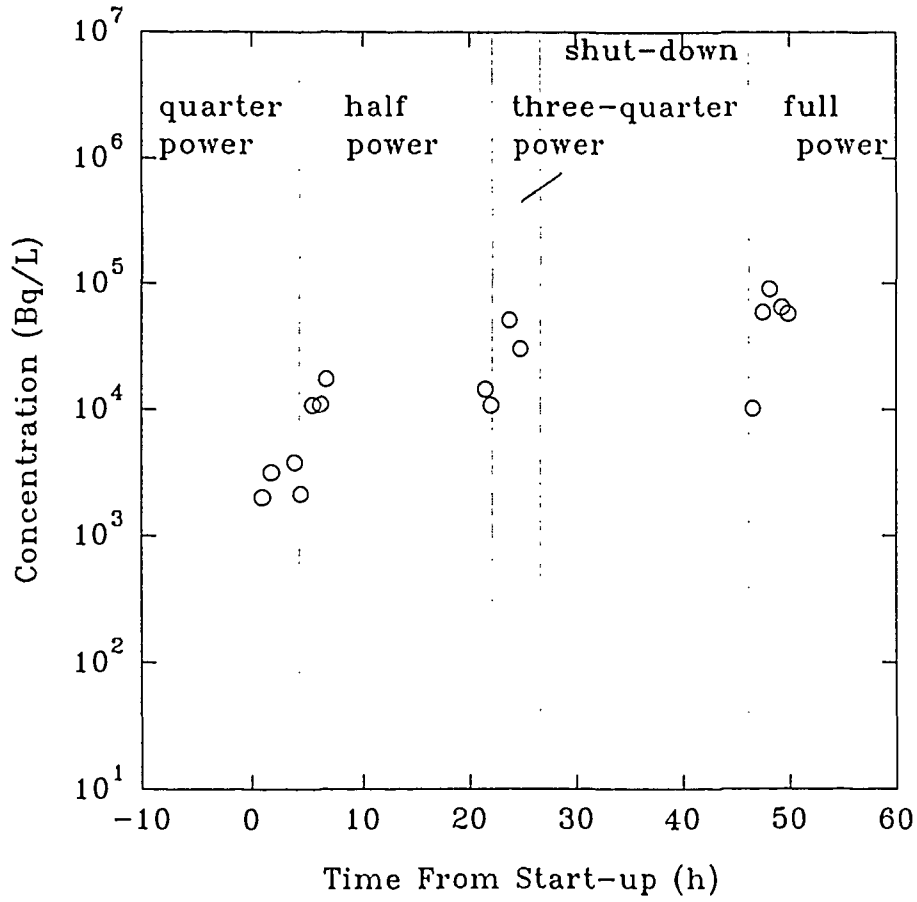
Concentration of Xe-135m in the KIPF Reactor
Headspace - April Trip (527 keV)



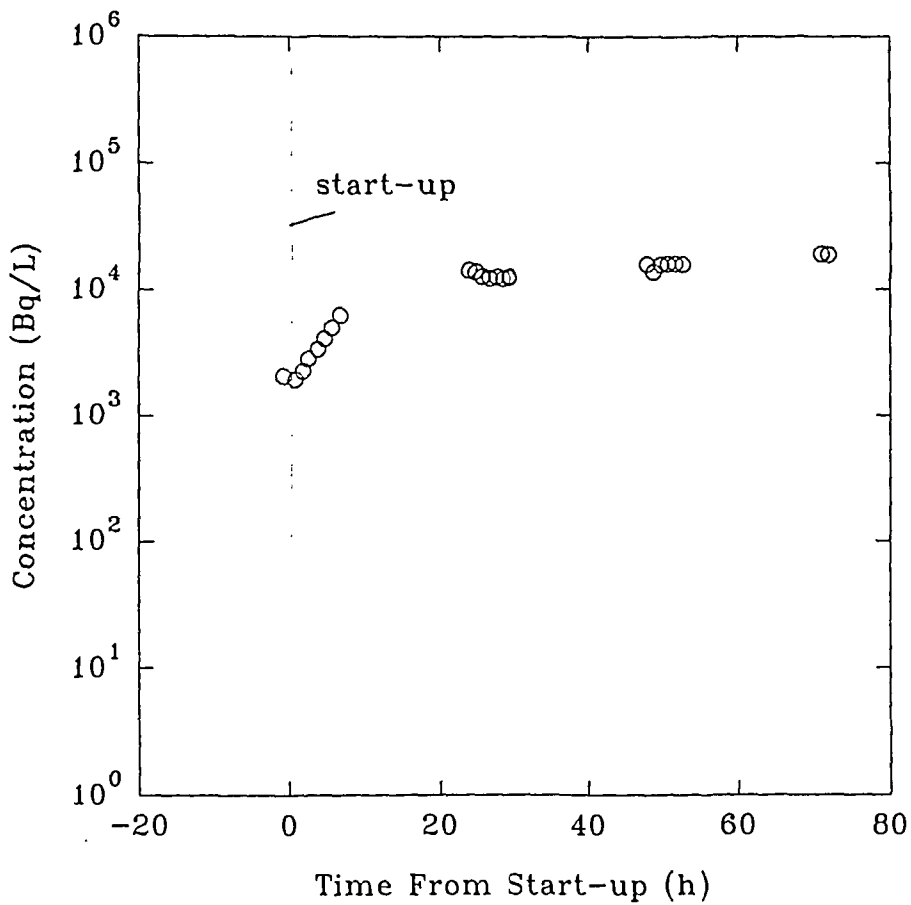
Concentration of Xe-137 in the KIPF Reactor
Headspace - April Trip (456 keV)



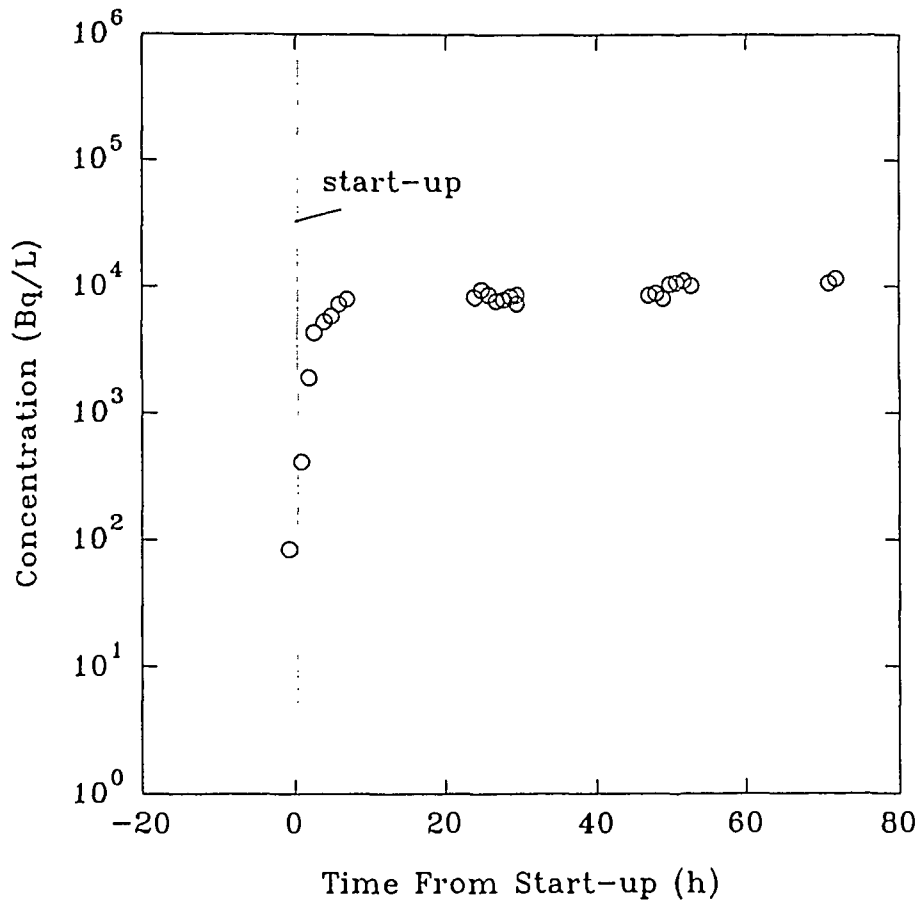
Concentration of Xe-138 in the KIPF Reactor
Headspace - April Trip (258 keV)



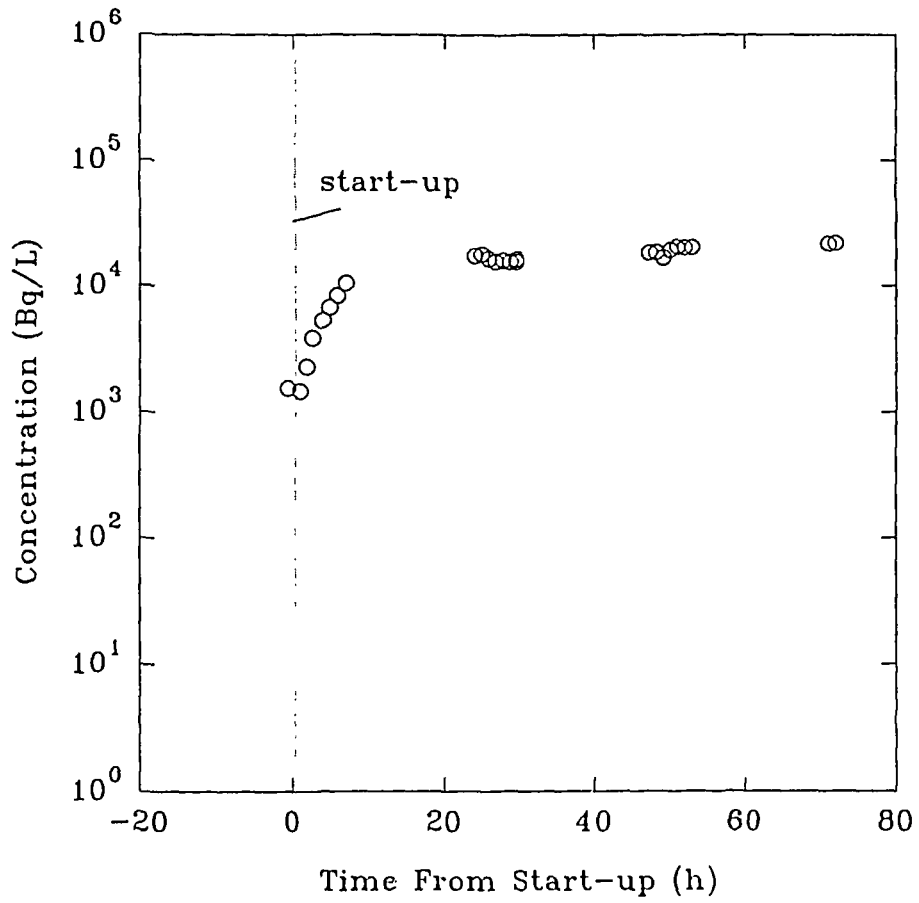
Concentration of Kr-85m in the KIPF Reactor
Headspace - May Trip (151 keV)



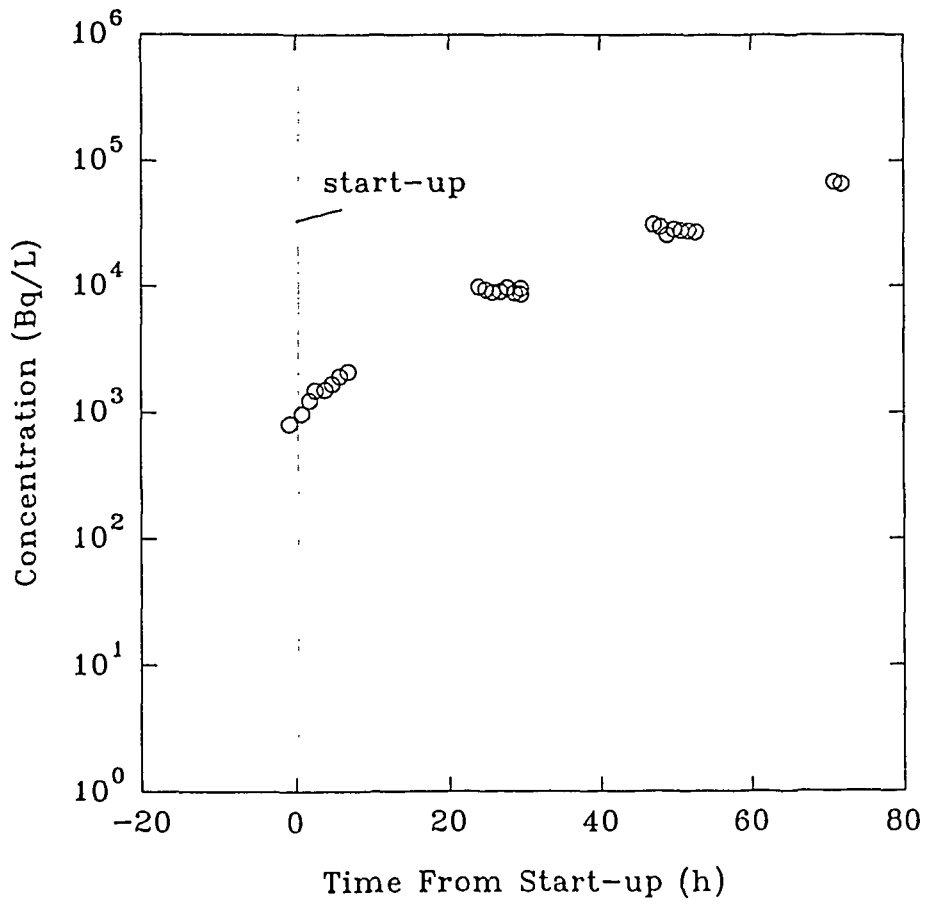
Concentration of Kr-87 in the KIPF Reactor
Headspace - May Trip (403 keV)



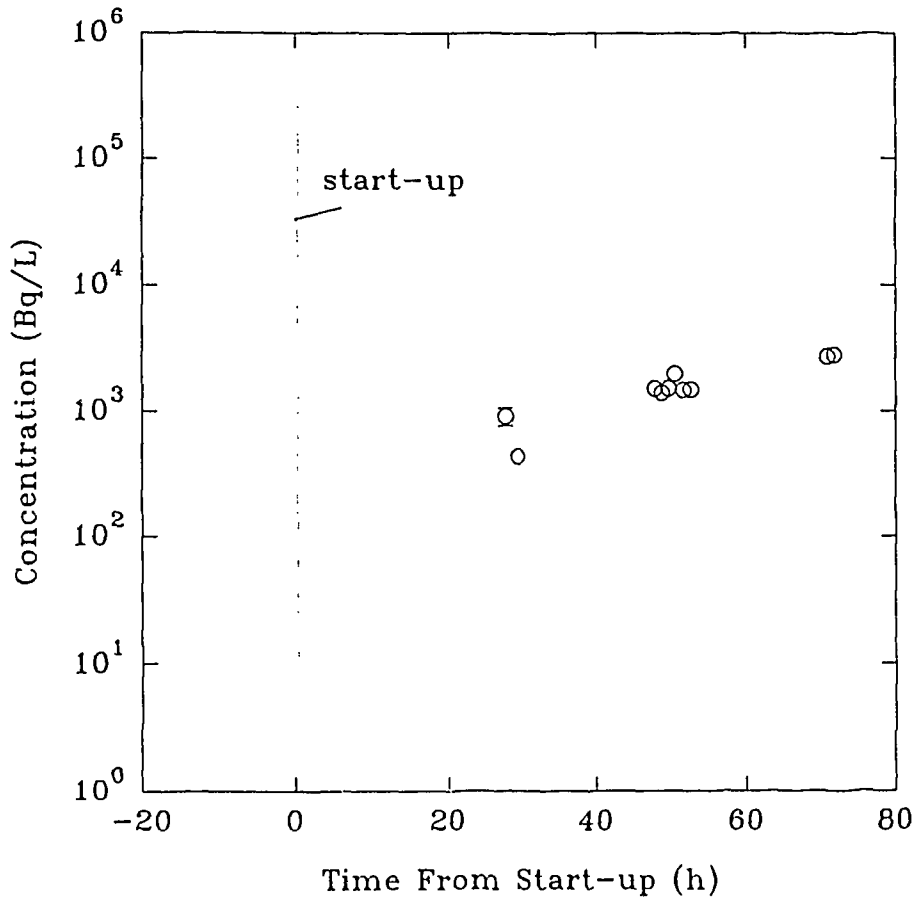
Concentration of Kr-88 in the KIPF Reactor
Headspace - May Trip (196 keV)



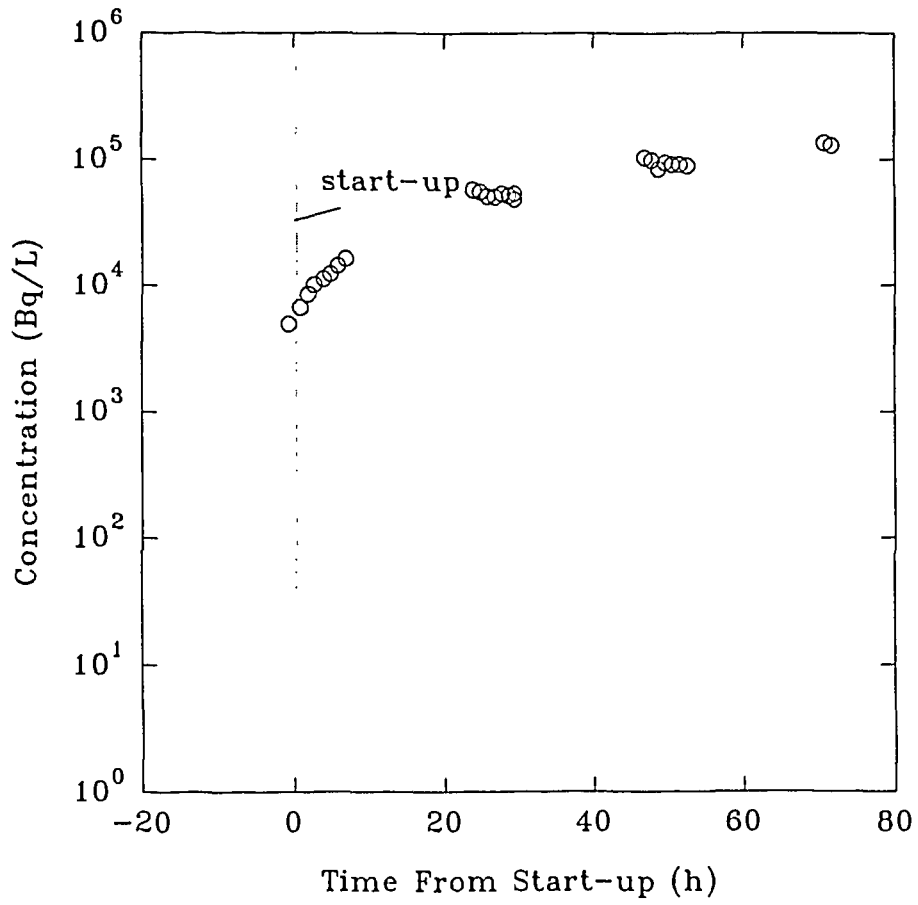
Concentration of Xe-133 in the KIPF Reactor
Headspace - May Trip (81 keV)



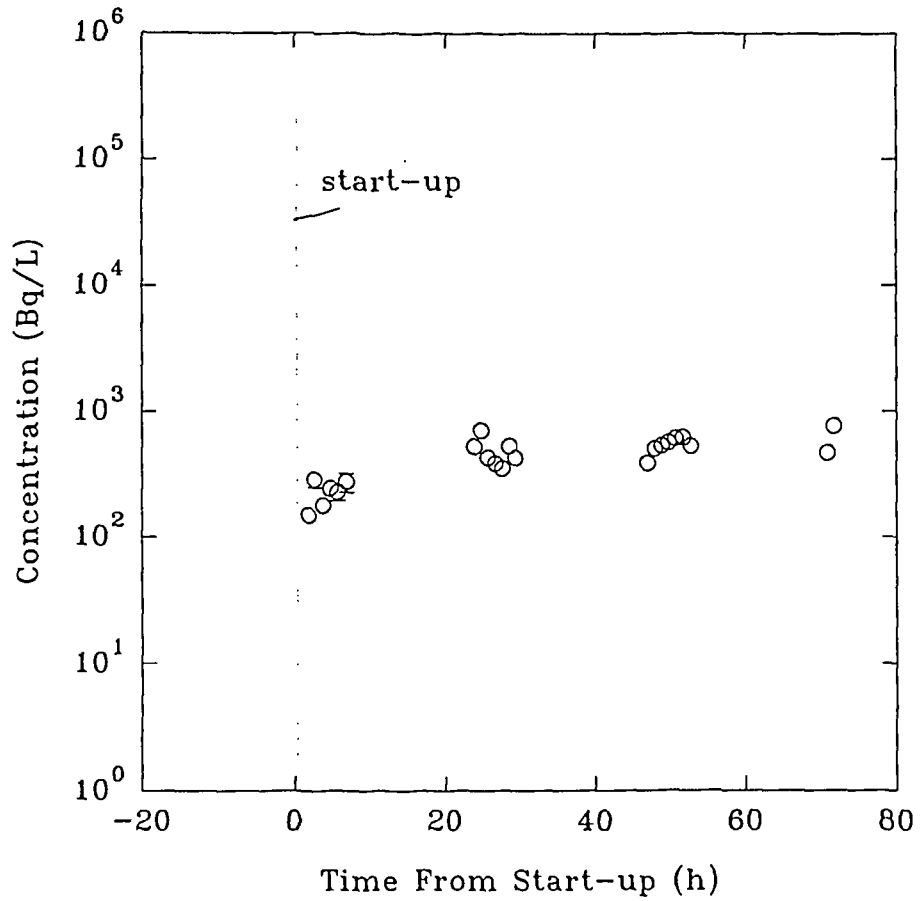
Concentration of Xe-133m in the KIPF Reactor
Headspace - May Trip (233 keV)



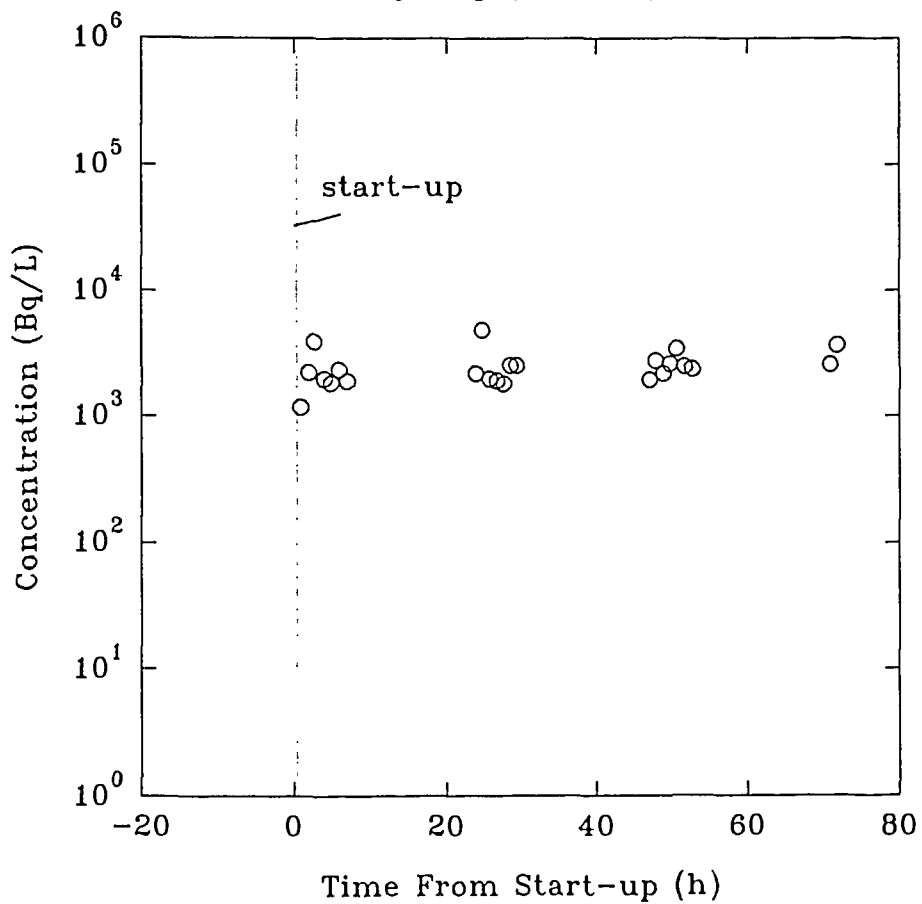
Concentration of Xe-135 in the KIPF Reactor
Headspace - May Trip (250 keV)



Concentration of Xe-135m in the KIPF Reactor
Headspace - May Trip (527 keV)



Concentration of Xe-138 in the KIPF Reactor
Headspace - May Trip (258 keV)



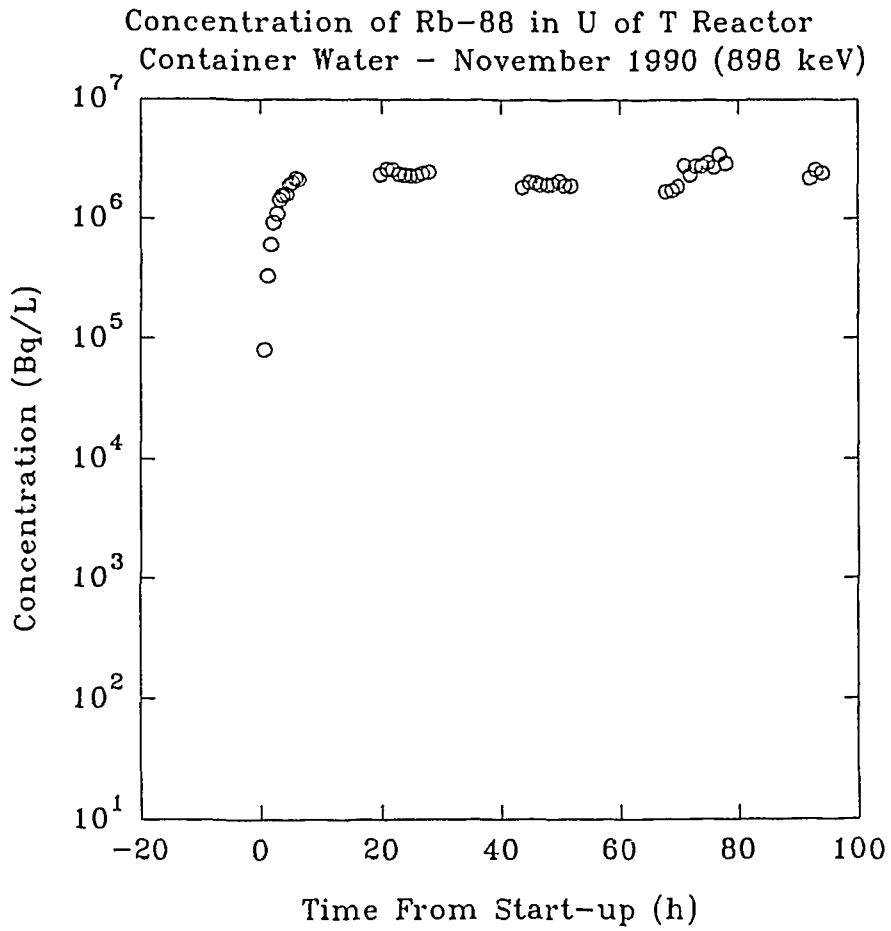
APPENDIX B.

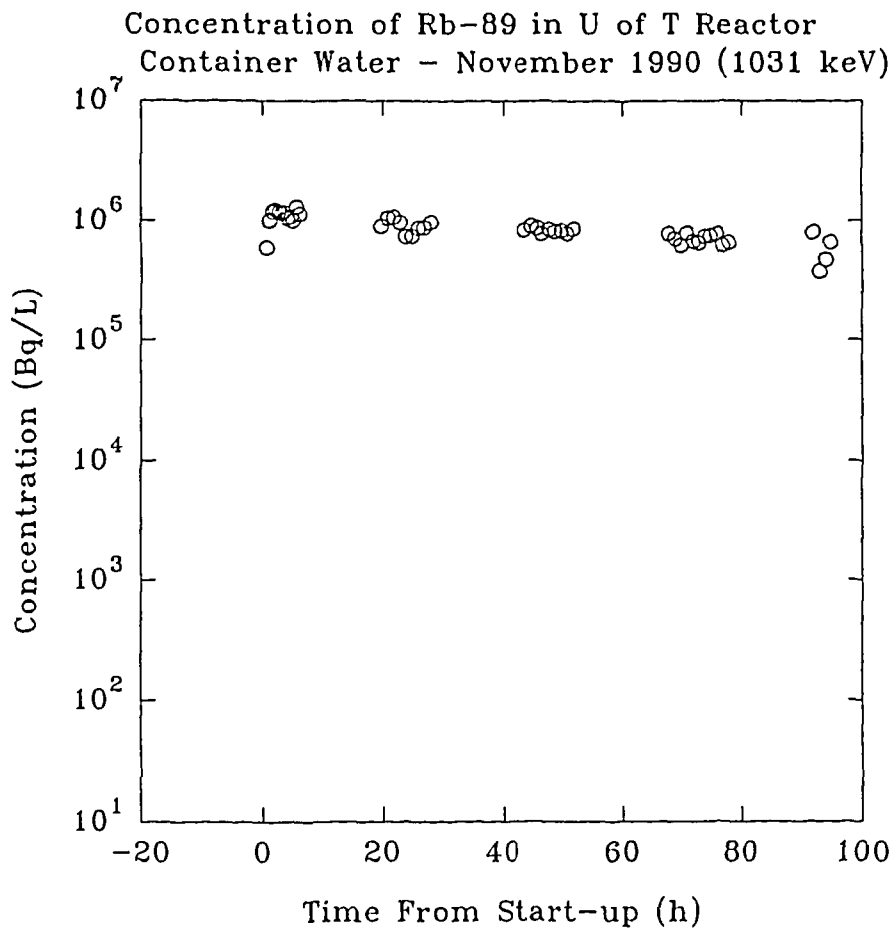
**FISSION-PRODUCT CONCENTRATIONS IN THE REACTOR CONTAINER WATER
AND GAS HEADSPACE FOR THE U OF T REACTOR^(a)**

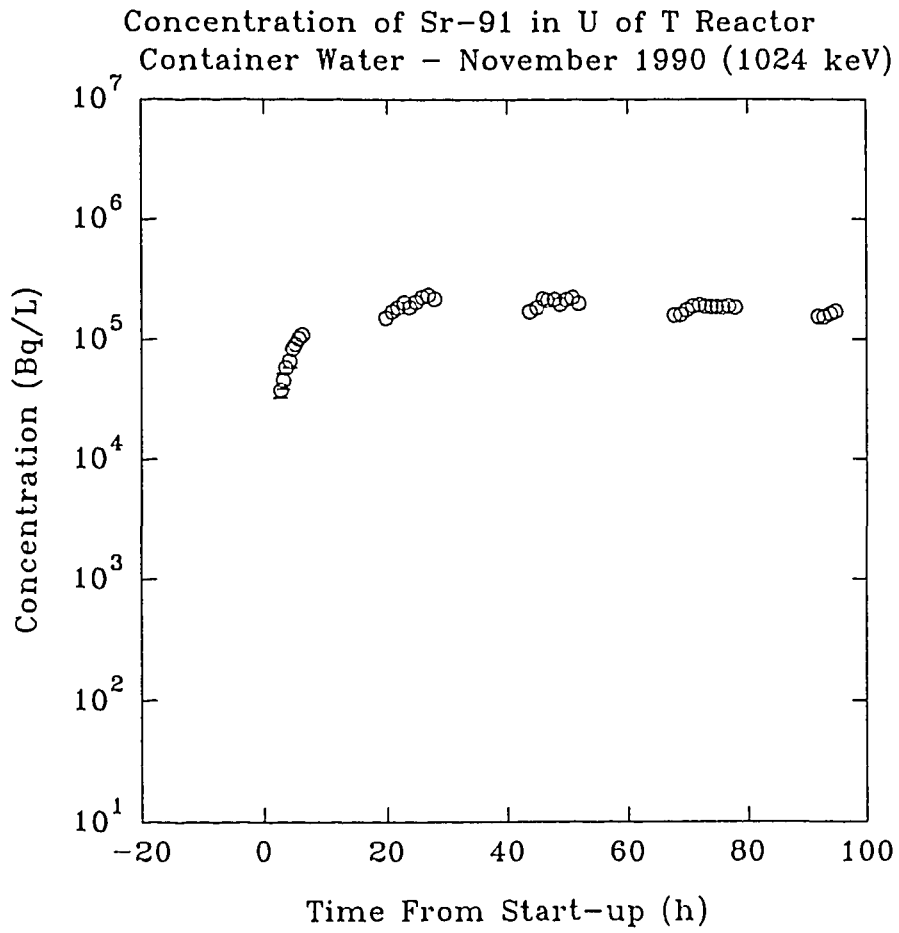
(a) The noble gas species are reported in Appendix A.

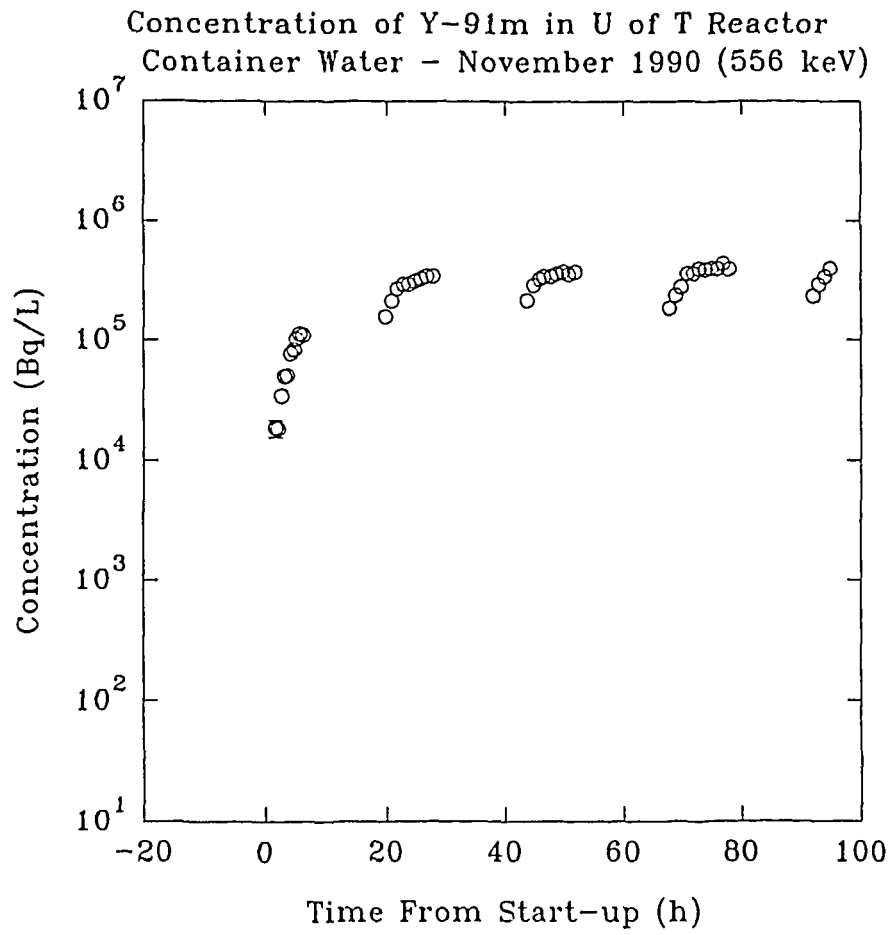
B.1 Reactor Container Water

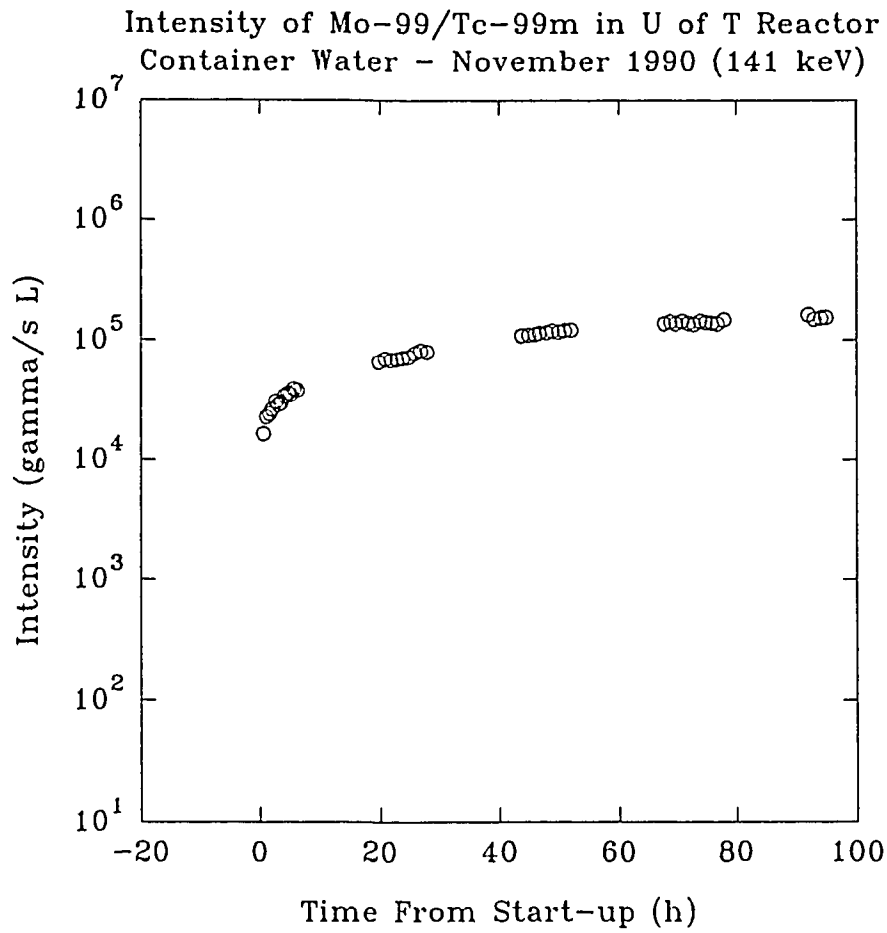
The activity concentrations of fission products (other than noble gases) measured in the reactor container water at U of T, at a steady power level of 5 kW, are given in the following plots, with error bars indicating one standard deviation of error. The concentrations of ^{95}Zr , ^{95}Nb and ^{239}Np are also given in Table B.1. These latter isotopes were measured in two water samples taken at the end of the experiment and counted several days later in order to allow for the decay of the short-lived isotopes which contribute to a high Compton background.

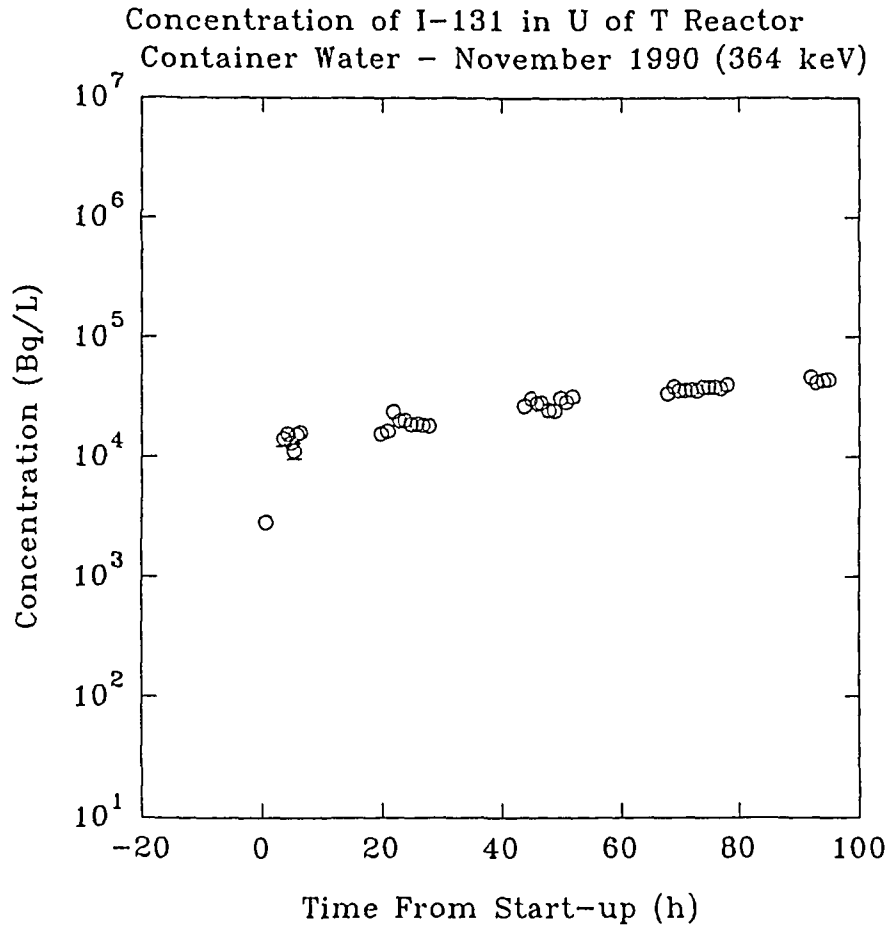


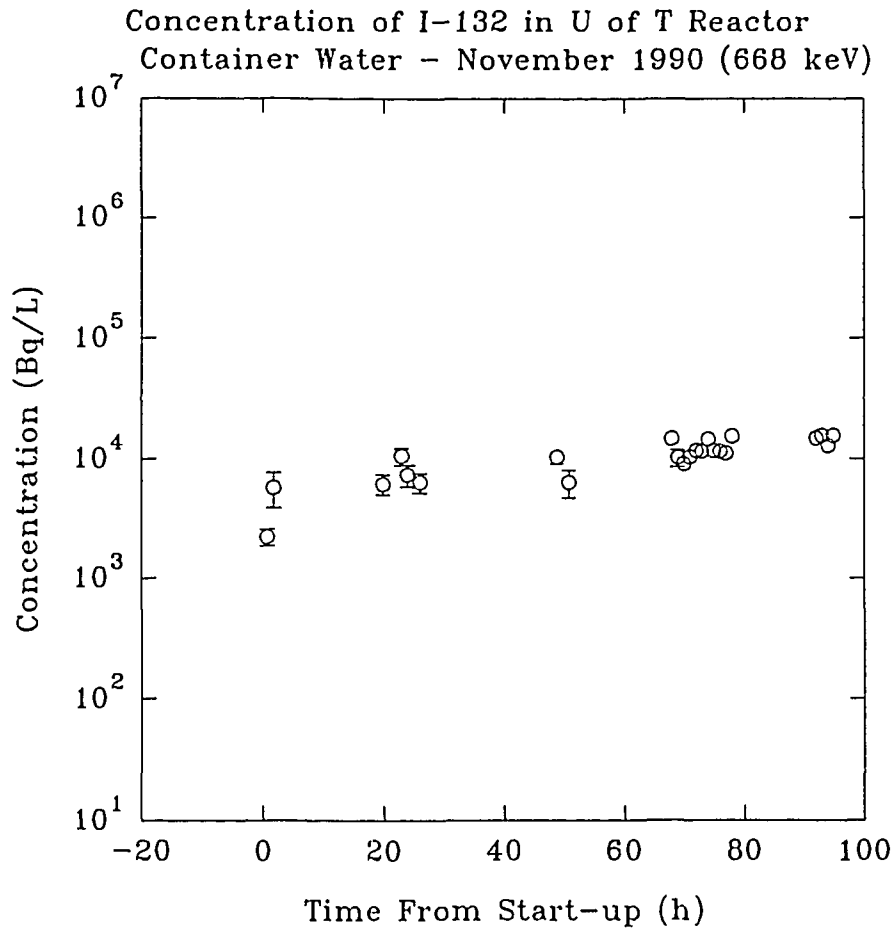


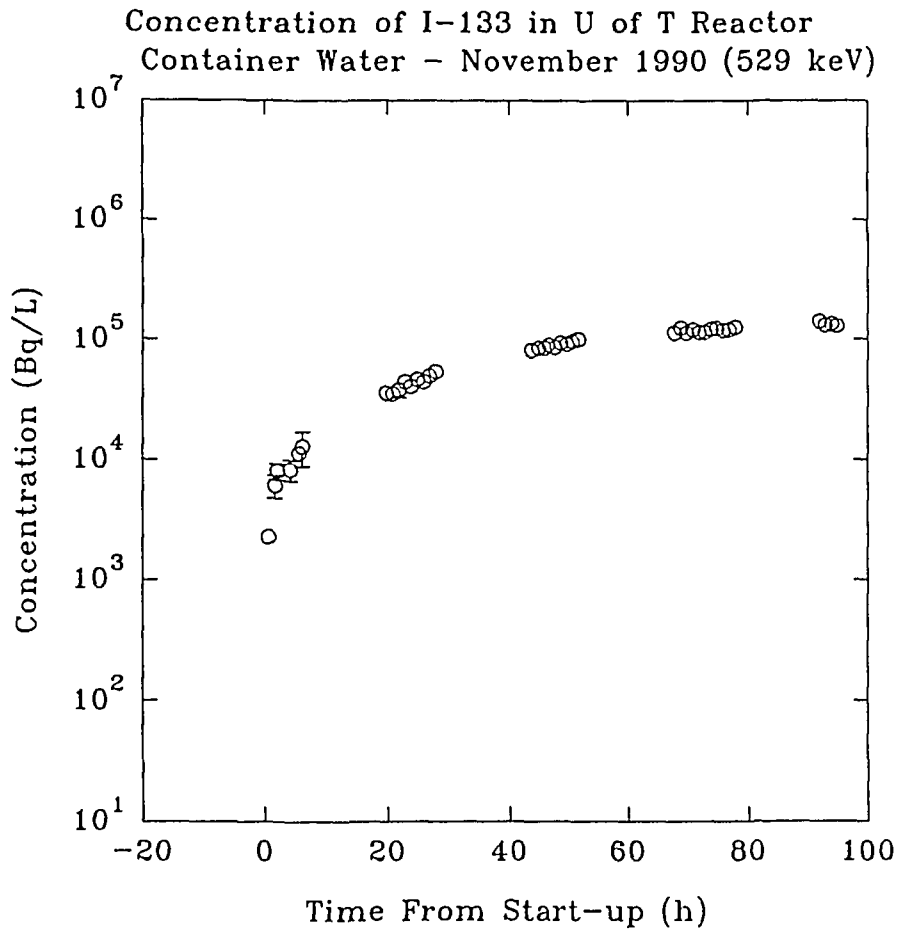


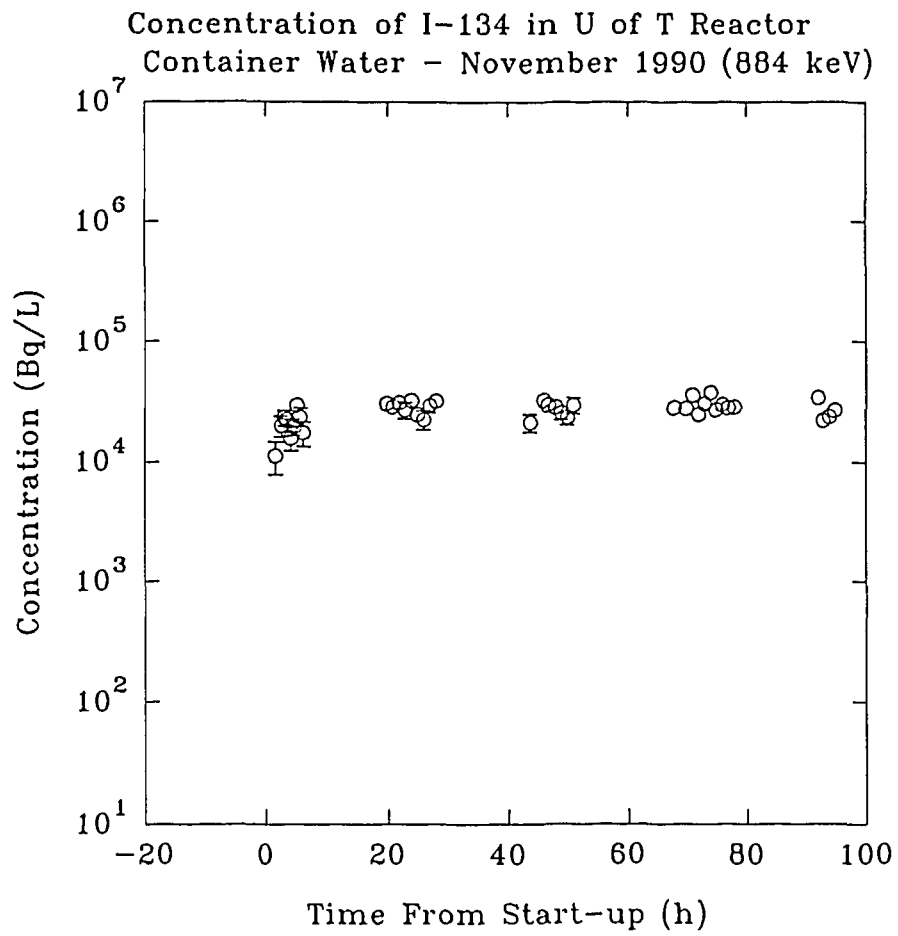


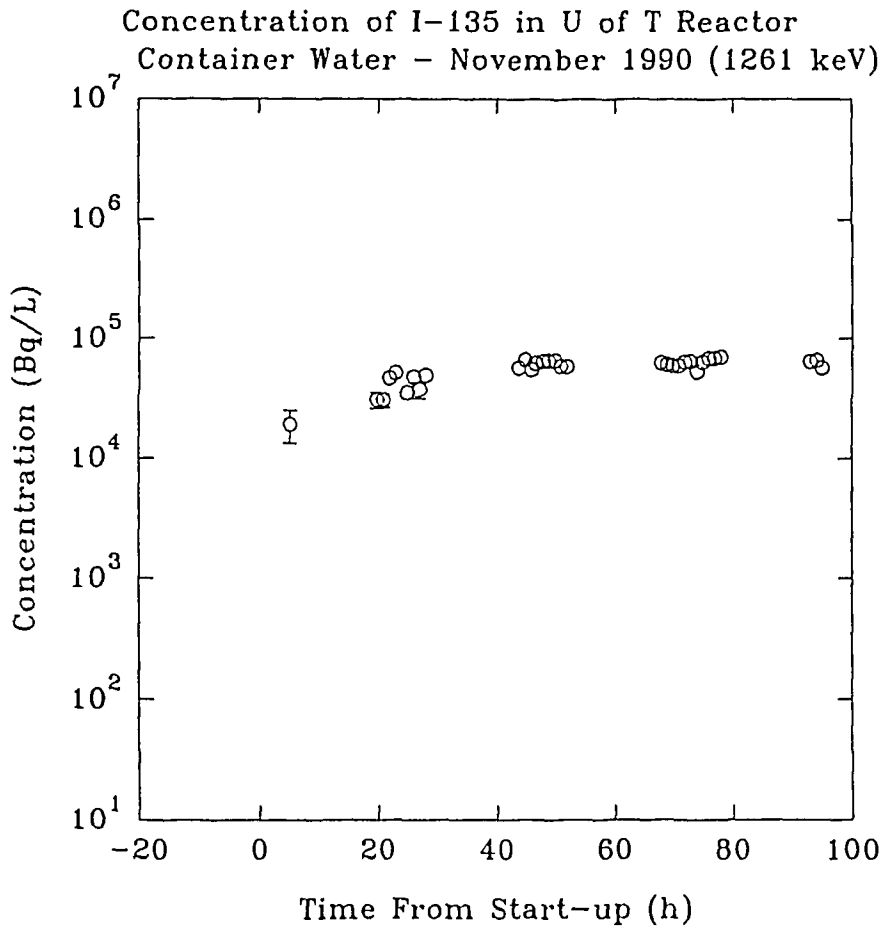




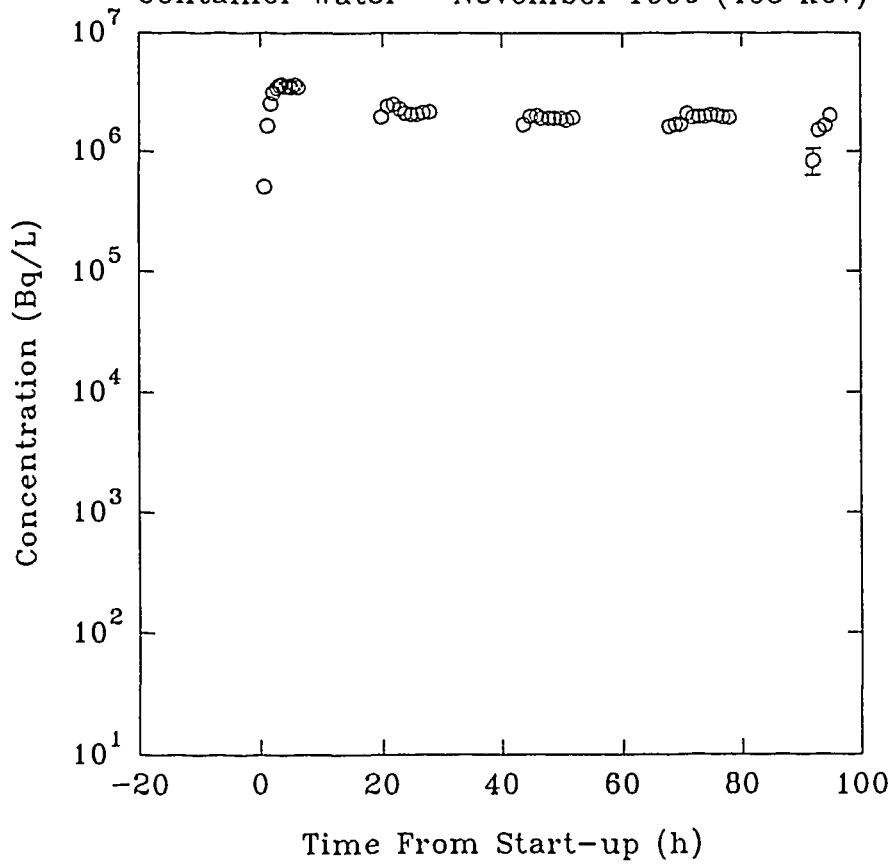


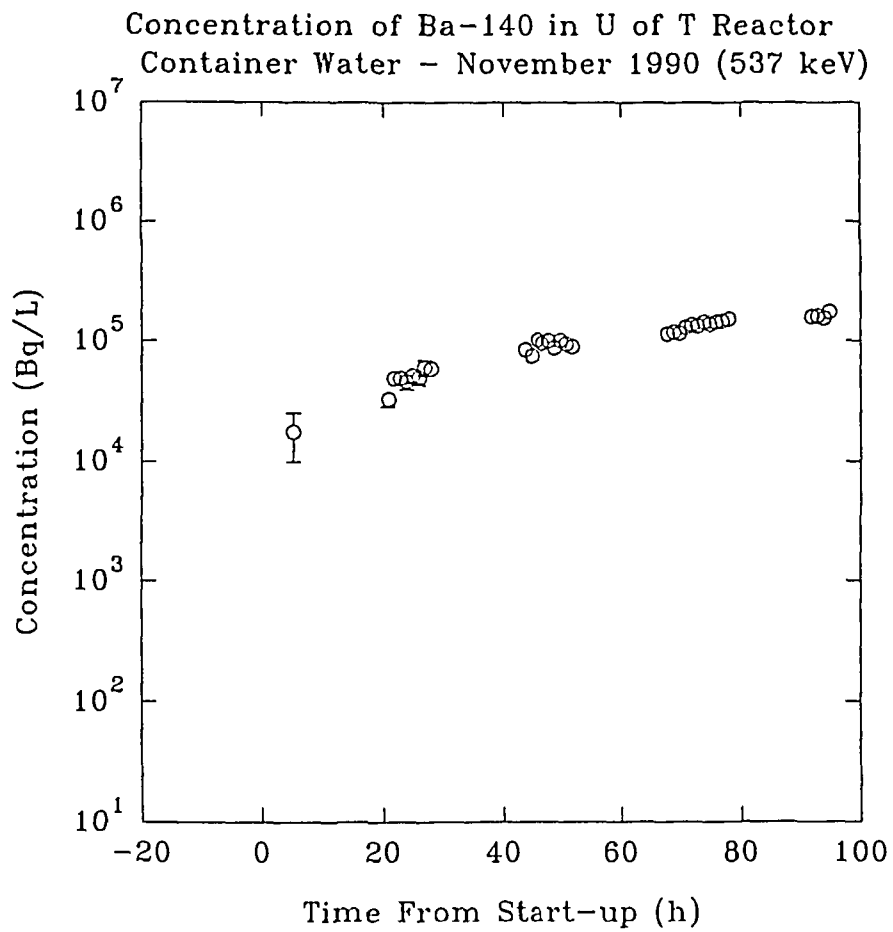


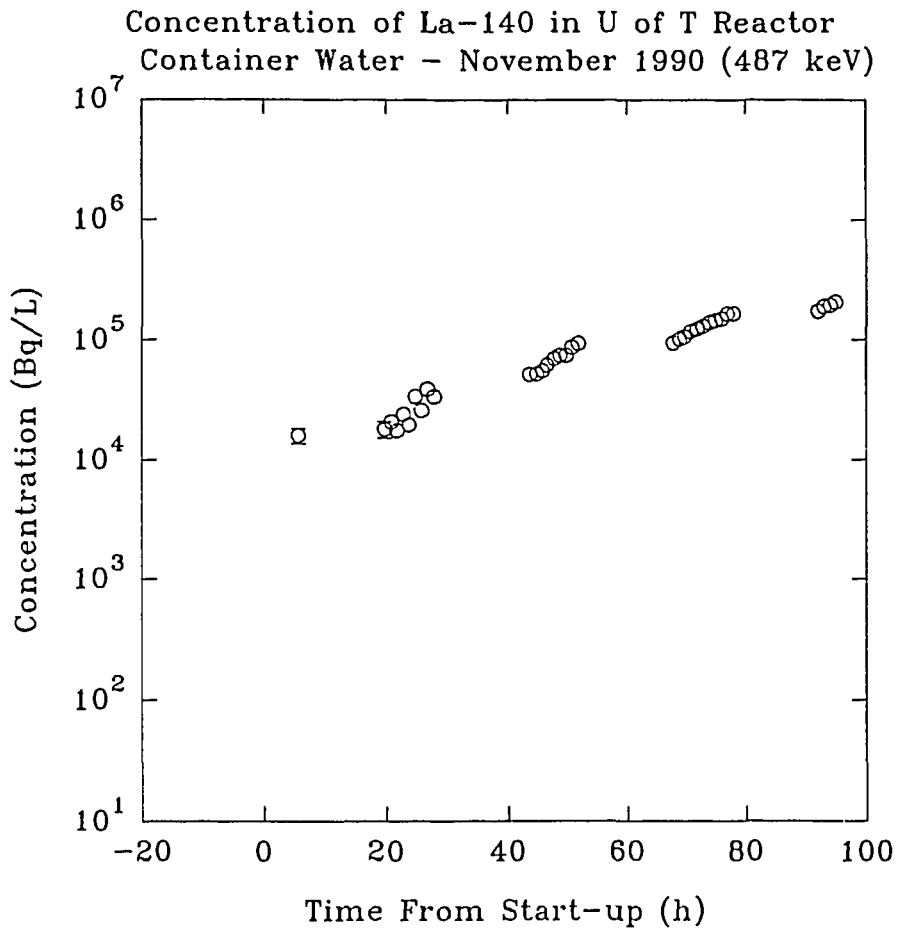




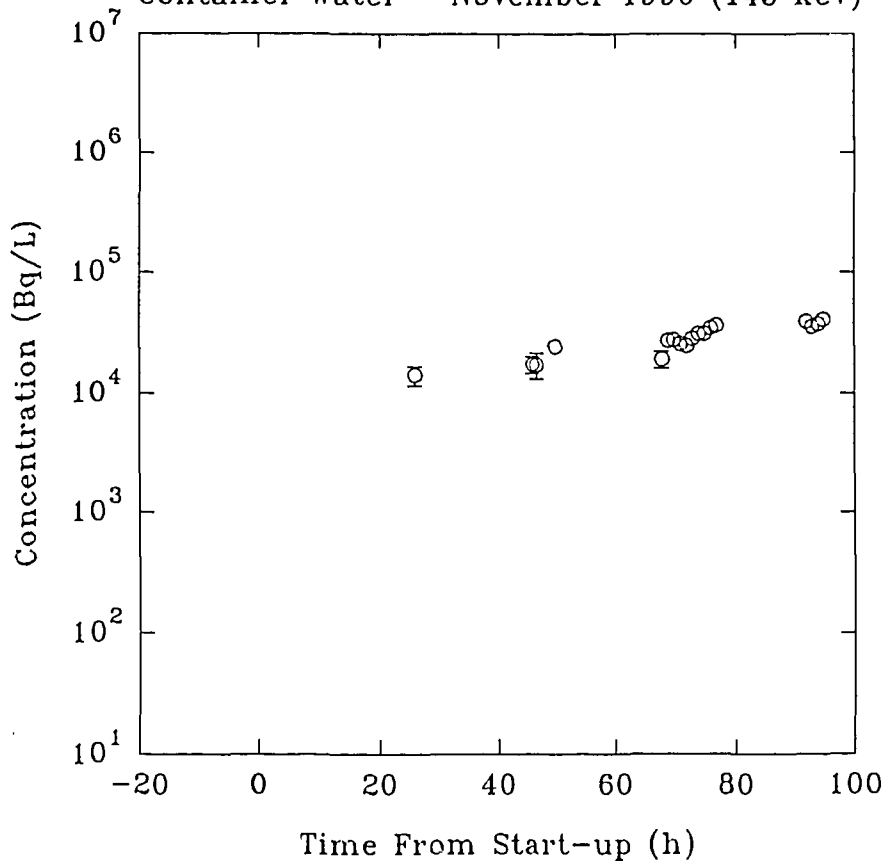
Concentration of Cs-138 in U of T Reactor
Container Water - November 1990 (463 keV)







Concentration of Ce-141 in U of T Reactor
Container Water - November 1990 (145 keV)



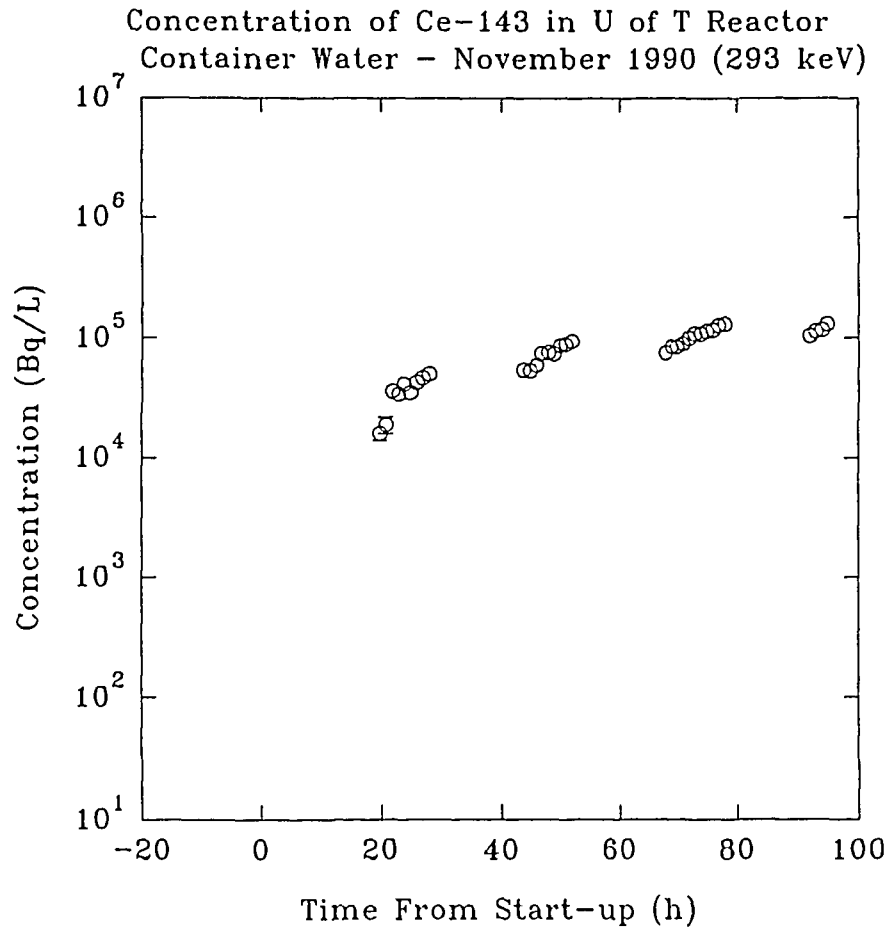


Table B.1: Concentration of ^{95}Nb , ^{95}Zr , and ^{239}Np in the Reactor Container Water at U of T

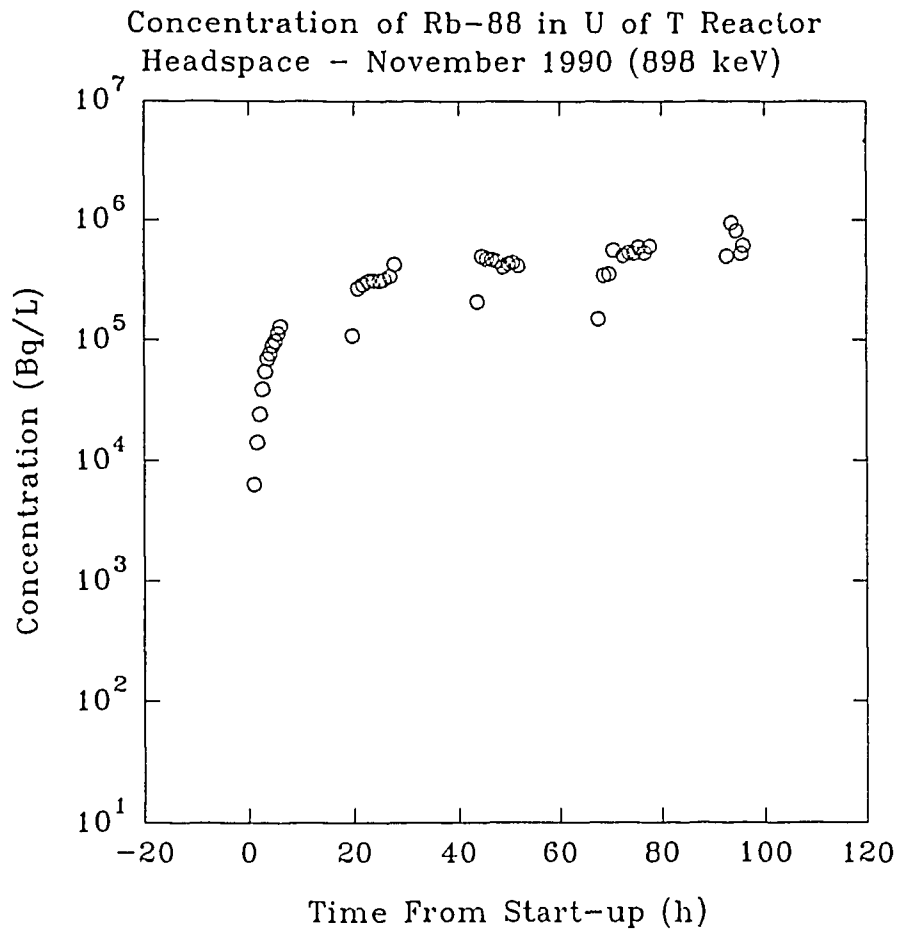
Isotope	E_γ (keV)	Concentration ^(a) (Bq/L)
Nb-95	766	$128 \pm 20 \%$
Zr-95	757	$311 \pm 7.4 \%$
Np-239	106	$939 \pm 9.0 \%$

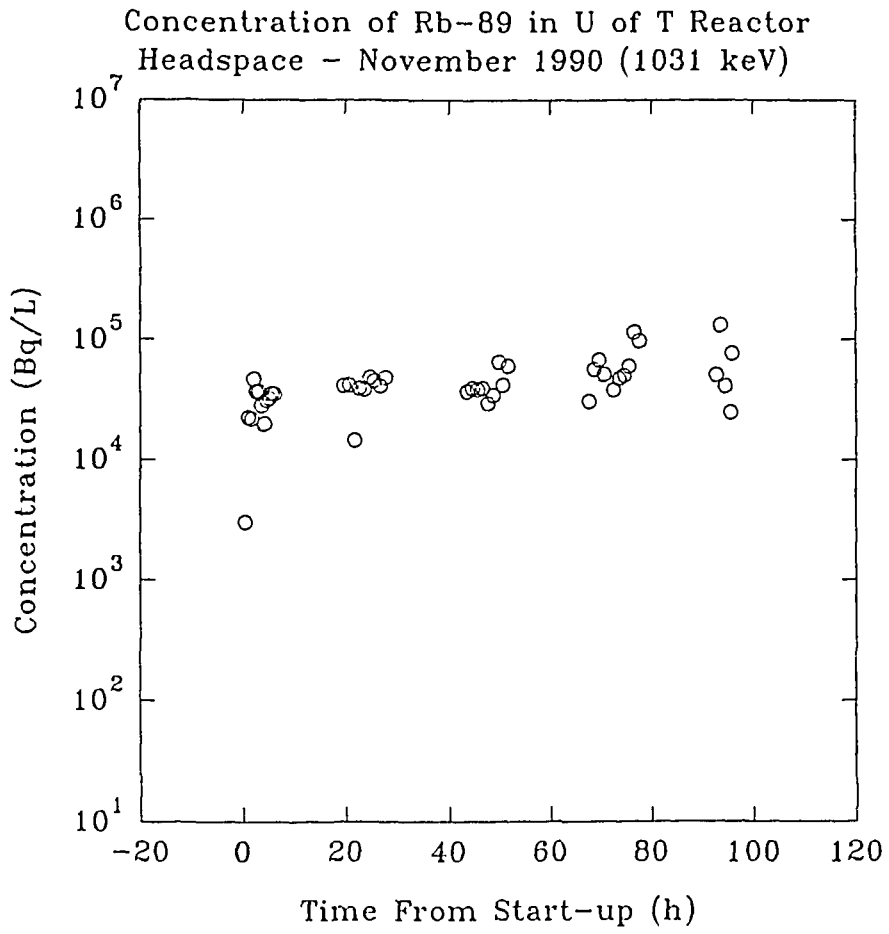
- (a) Concentrations have been corrected for decay back to the time of sampling (i.e. 94 h after start-up).

B.2 Gas Headspace

The activity concentrations of the alkali metals measured in the gas headspace at U of T at a steady power level of 5 kW are given in the following plots, with error bars indicating one standard deviation of error.

The alkali metals observed in the gas headspace are produced from the decay of the noble gas species within the gas sample chamber. These non-volatile daughter products deposit onto the surface of the chamber, i.e. the ratio of the parent-to-daughter activity concentration is constant and equal to the surface-to-volume ratio of the sample chamber.





APPENDIX C.**RELEASE RATES FOR THE NOBLE GAS SPECIES IN THE GAS HEADSPACE FOR THE U OF T, EP, AND KIPF REACTORS**

Release rates for the noble gases were calculated using the Savitzky-Golay method of curve fitting (see Volume 1, Ref. 11). The concentration data was smoothed using a cubic polynomial fit to either a seven- or five-point interval (depending on the number of data points). The derivative was calculated for the polynomial, and the release rate was then evaluated according to Eq. (5) in Volume 1. The volume of the gas headspace was assumed to be 108 L for this calculation. Errors were propagated by summation since the smoothed values and the derivatives are calculated by simple addition and subtraction. A sample spreadsheet is included in this Appendix.

The units of the release rates are in atoms/s.

EXCEL for Windows File: GKR85MU2.XLS

Filename	Cono (Bq/L)	% Error	7 point Smooth	Derivative (Bq/L s)	Release Rate (atoms/s)	Error in Smoothed Conc	Error In	δRwg	Rwg
							Derivative	Error	% error
UOTG1	5.48E+02	3.9							
UOTG2	4.12E+03	5.2							
UOTG3	6.74E+03	5.1							
UOTG4	1.25E+04	5	1.17E+04	2.37	7.24E+06	3.80E+02	0.09	2.30E+05	3.18
UOTG5	1.60E+04	5	1.65E+04	2.38	7.77E+06	5.00E+02	0.10	2.66E+05	3.42
UOTG6	2.12E+04	5	2.10E+04	2.48	8.50E+06	6.27E+02	0.13	3.26E+05	3.83
UOTG7	2.60E+04	5	2.52E+04	2.40	8.75E+06	7.46E+02	0.15	3.75E+05	4.29
UOTG8	2.84E+04	5	2.97E+04	2.40	9.24E+06	8.71E+02	0.17	4.31E+05	4.67
UOTG9	3.45E+04	5.1	3.33E+04	2.62	1.02E+07	1.00E+03	0.20	5.10E+05	5.01
UOTG10	3.80E+04	5							
UOTG11	4.23E+04	5.1							
UOTG12	5.11E+04	5							
UOTG13	1.31E+05	5.1							
UOTG14	1.52E+05	5.1	hourly sampling						
UOTG15	1.54E+05	5.1					0.44	1.22E+06	5.09
UOTG16	1.68E+05	5.1	1.68E+05	2.27	2.39E+07	4.90E+03	0.47	1.31E+06	5.51
UOTG17	1.77E+05	5.1	1.73E+05	2.05	2.38E+07	5.15E+03	0.56	1.53E+06	5.32
UOTG18	1.79E+05	5.1	1.75E+05	3.96	2.88E+07	5.41E+03			
UOTG19	1.82E+05	5.2							
UOTG20	1.99E+05	5.2							
UOTG21	2.65E+05	5.3							
UOTG22	2.61E+05	6.5							
UOTG23	2.60E+05	6.6							
UOTG24	2.58E+05	6.5					0.91	2.51E+06	8.83
UOTG25	2.64E+05	6.6	2.56E+05	0.30	2.85E+07	9.83E+03	0.93	2.56E+06	8.50
UOTG26	2.53E+05	6.6	2.57E+05	0.94	3.02E+07	9.82E+03	0.93	2.58E+06	8.14
UOTG27	2.55E+05	6.5	2.63E+05	1.29	3.16E+07	9.93E+03			
UOTG28	2.77E+05	6.5							
UOTG29	2.82E+05	6.6							
UOTG30	2.81E+05	6.6							
UOTG31	2.25E+05	6.7							
UOTG32	2.34E+05	6.6							
UOTG33	2.35E+05	6.6							
UOTG34	2.47E+05	6.5	5 point	hourly sampling					
UOTG36	2.54E+05	6.5							
UOTG37	2.38E+05	6.5							
UOTG38	2.48E+05	6.6	2.49E+05	1.59	3.09E+07	1.14E+04	1.48	3.92E+06	12.68
UOTG39	2.68E+05	6.5	2.64E+05	1.84	3.31E+07	1.19E+04	1.44	3.84E+06	11.58
UOTG40	2.67E+05	6.5							
UOTG41	2.61E+05	6.5							
UOTG43	2.43E+05	6.5							
UOTG44	2.49E+05	6.5							
UOTG45	2.56E+05	6.6	2.54E+05	0.71	2.92E+07	1.16E+04	1.42	3.79E+06	12.96
UOTG46A	2.54E+05	6.6							
UOTG46B	2.53E+05	6.5							

University of Toronto

Release Rate: Water to Gas (R_{wg})

1. Kr-85m

Filename	Time Since Start-up (h)	R_{wg}	δR_{wg}
UOTG4	2.02	7.24E+06	2.30E+05
UOTG5	2.52	7.77E+06	2.66E+05
UOTG6	3.02	8.50E+06	3.26E+05
UOTG7	3.52	8.75E+06	3.75E+05
UOTG8	4.02	9.24E+06	4.31E+05
UOTG9	4.52	1.02E+07	5.10E+05
UOTG16	22.65	2.39E+07	1.22E+06
UOTG17	23.65	2.38E+07	1.31E+06
UOTG18	24.67	2.88E+07	1.53E+06
UOTG25	46.60	2.85E+07	2.51E+06
UOTG26	47.58	3.02E+07	2.56E+06
UOTG27	48.60	3.16E+07	2.58E+06
UOTG38	74.62	3.09E+07	3.92E+06
UOTG39	75.60	3.31E+07	3.84E+06
UOTG45	94.63	2.92E+07	3.79E+06

2. Kr-87

Filename	Time Since Start-up (h)	R_{wg}	δR_{wg}
UOTG4	2.02	1.23E+07	4.00E+05
UOTG5	2.52	1.26E+07	4.46E+05
UOTG6	3.02	1.30E+07	5.12E+05
UOTG7	3.52	1.25E+07	5.61E+05
UOTG8	4.02	1.26E+07	5.96E+05
UOTG9	4.52	1.27E+07	6.52E+05
UOTG16	22.65	1.77E+07	8.17E+05
UOTG17	23.65	1.77E+07	8.26E+05
UOTG18	24.67	2.17E+07	1.01E+06
UOTG25	46.60	1.79E+07	1.39E+06
UOTG26	47.58	1.95E+07	1.22E+06
UOTG27	48.60	2.10E+07	1.15E+06
UOTG38	74.62	2.41E+07	1.52E+06
UOTG39	75.60	2.68E+07	1.55E+06
UOTG45	94.63	2.49E+07	1.73E+06

3. Kr-88

Filename	Time Since Start-up (h)	R_{wg}	δR_{wg}
UOTG4	2.02	1.29E+07	4.02E+05
UOTG5	2.52	1.36E+07	4.54E+05
UOTG6	3.02	1.45E+07	5.39E+05
UOTG7	3.52	1.47E+07	6.21E+05
UOTG8	4.02	1.53E+07	6.94E+05
UOTG9	4.52	1.63E+07	7.93E+05
UOTG16	22.65	2.94E+07	1.31E+06
UOTG17	23.65	2.96E+07	1.38E+06
UOTG18	24.67	3.66E+07	1.62E+06
UOTG25	46.60	3.51E+07	2.66E+06
UOTG26	47.58	3.64E+07	2.60E+06
UOTG27	48.60	3.71E+07	2.56E+06
UOTG38	74.62	4.02E+07	3.62E+06
UOTG39	75.60	4.28E+07	3.54E+06
UOTG45	94.63	3.83E+07	3.69E+06

4. Kr-89

Filename	Time Since Start-up (h)	R_{wg}	δR_{wg}
UOTG4	2.02	8.64E+06	2.57E+05
UOTG5	2.52	7.57E+06	2.33E+05
UOTG6	3.02	5.33E+06	1.71E+05
UOTG7	3.52	3.50E+06	1.54E+05
UOTG8	4.02	5.04E+06	1.72E+05
UOTG9	4.52	6.01E+06	2.04E+05
UOTG16	22.65	7.29E+06	2.53E+05
UOTG17	23.65	8.87E+06	2.77E+05
UOTG18	24.67	1.00E+07	2.81E+05
UOTG25	46.60	7.61E+06	4.20E+05
UOTG26	47.58	8.84E+06	4.15E+05
UOTG27	48.60	7.74E+06	4.89E+05
UOTG38	74.62	1.14E+07	6.72E+05
UOTG39	75.60	2.23E+07	9.96E+05
UOTG45	94.63	----	----

5. Kr-90

Filename	Time Since Start-up (h)	R_{wg}	δR_{wg}
UOTG4	2.02	1.68E+06	6.67E+04
UOTG5	2.52	1.67E+06	6.36E+04
UOTG6	3.02	1.31E+06	6.08E+04
UOTG7	3.52	1.08E+06	6.38E+04
UOTG8	4.02	----	----
UOTG9	4.52	----	----
UOTG16	22.65	2.95E+06	1.60E+05
UOTG17	23.65	2.89E+06	1.60E+05
UOTG18	24.67	2.74E+06	1.68E+05
UOTG25	46.60	----	----
UOTG26	47.58	----	----
UOTG27	48.60	----	----
UOTG38	74.62	----	----
UOTG39	75.60	----	----
UOTG45	94.63	----	----

6. Xe-133

C-6

Filename	Time Since Start-up (h)	R_{wg}	δR_{wg}
UOTG4	2.02	3.15E+07	2.66E+06
UOTG5	2.52	3.25E+07	2.25E+06
UOTG6	3.02	3.45E+07	2.01E+06
UOTG7	3.52	3.63E+07	2.09E+06
UOTG8	4.02	3.75E+07	2.41E+06
UOTG9	4.52	4.02E+07	3.00E+06
UOTG16	22.65	9.97E+07	5.64E+06
UOTG17	23.65	1.03E+08	6.09E+06
UOTG18	24.67	1.10E+08	6.31E+06
UOTG25	46.60	2.09E+08	1.61E+07
UOTG26	47.58	2.15E+08	1.68E+07
UOTG27	48.60	2.18E+08	1.71E+07
UOTG38	74.62	3.09E+08	8.44E+07
UOTG39	75.60	3.10E+08	7.21E+07
UOTG45	94.63	3.41E+08	5.03E+07

7. Xe-133m

Filename	Time Since Start-up (h)	R_{wg}	δR_{wg}
UOTG4	2.02	----	----
UOTG5	2.52	----	----
UOTG6	3.02	----	----
UOTG7	3.52	----	----
UOTG8	4.02	----	----
UOTG9	4.52	----	----
UOTG16	22.65	8.89E+06	1.60E+06
UOTG17	23.65	9.71E+06	1.81E+06
UOTG18	24.67	9.60E+06	3.68E+06
UOTG25	46.60	----	----
UOTG26	47.58	----	----
UOTG27	48.60	----	----
UOTG38	74.62	----	----
UOTG39	75.60	----	----
UOTG45	94.63	----	----

8. Xe-135

Filename	Time Since Start-up (h)	R_{wg}	δR_{wg}
UOTG4	2.02	3.67E+06	1.32E+05
UOTG5	2.52	4.48E+06	1.72E+05
UOTG6	3.02	5.62E+06	2.22E+05
UOTG7	3.52	6.63E+06	2.74E+05
UOTG8	4.02	7.72E+06	3.28E+05
UOTG9	4.52	9.52E+06	4.35E+05
UOTG16	22.65	9.42E+07	5.12E+06
UOTG17	23.65	9.96E+07	5.95E+06
UOTG18	24.67	1.19E+08	6.90E+06
UOTG25	46.60	1.77E+08	1.88E+07
UOTG26	47.58	1.86E+08	1.98E+07
UOTG27	48.60	1.92E+08	2.06E+07
UOTG38	74.62	1.95E+08	4.12E+07
UOTG39	75.60	1.95E+08	4.07E+07
UOTG45	94.63	1.70E+08	3.93E+07

9. Xe-135m

Filename	Time Since Start-up (h)	R_{wg}	δR_{wg}
UOTG4	2.02	3.95E+05	1.16E+04
UOTG5	2.52	4.32E+05	1.25E+04
UOTG6	3.02	4.05E+05	1.32E+04
UOTG7	3.52	3.81E+05	1.32E+04
UOTG8	4.02	4.13E+05	1.35E+04
UOTG9	4.52	4.16E+05	1.46E+04
UOTG16	22.65	1.35E+06	4.11E+04
UOTG17	23.65	1.51E+06	4.47E+04
UOTG18	24.67	1.61E+06	5.43E+04
UOTG25	46.60	1.05E+06	7.93E+04
UOTG26	47.58	1.66E+06	7.22E+04
UOTG27	48.60	1.76E+06	7.32E+04
UOTG38	74.62	2.43E+06	1.11E+05
UOTG39	75.60	2.86E+06	1.19E+05
UOTG45	94.63	1.92E+06	1.00E+05

10. Xe-137

Filename	Time Since Start-up (h)	R_{wg}	δR_{wg}
UOTG4	2.02	5.04E+06	1.71E+05
UOTG5	2.52	4.34E+06	1.58E+05
UOTG6	3.02	3.02E+06	1.18E+05
UOTG7	3.52	2.09E+06	1.03E+05
UOTG8	4.02	3.23E+06	1.20E+05
UOTG9	4.52	3.89E+06	1.46E+05
UOTG16	22.65	5.05E+06	1.91E+05
UOTG17	23.65	6.46E+06	2.23E+05
UOTG18	24.67	7.34E+06	2.33E+05
UOTG25	46.60	4.99E+06	3.58E+05
UOTG26	47.58	6.07E+06	3.10E+05
UOTG27	48.60	5.40E+06	3.34E+05
UOTG38	74.62	8.20E+06	5.31E+05
UOTG39	75.60	1.53E+07	8.00E+05
UOTG45	94.63	----	----

11. Xe-138

Filename	Time Since Start-up (h)	R_{wg}	δR_{wg}
UOTG4	2.02	8.30E+06	2.13E+05
UOTG5	2.52	7.88E+06	2.20E+05
UOTG6	3.02	6.92E+06	2.05E+05
UOTG7	3.52	5.66E+06	1.86E+05
UOTG8	4.02	5.80E+06	1.81E+05
UOTG9	4.52	5.83E+06	1.88E+05
UOTG16	22.65	9.09E+06	2.92E+05
UOTG17	23.65	1.03E+07	3.20E+05
UOTG18	24.67	1.10E+07	3.72E+05
UOTG25	46.60	7.36E+06	4.90E+05
UOTG26	47.58	1.10E+07	4.21E+05
UOTG27	48.60	1.14E+07	4.53E+05
UOTG38	74.62	1.44E+07	6.56E+05
UOTG39	75.60	1.84E+07	8.04E+05
UOTG45	94.63	1.25E+07	6.21E+05

Ecole Polytechnique

Release Rate: Water to Gas (R_{wg})

1. Kr-85m

Filename	Time Since Start-up (h)	R_{wg}	δR_{wg}
epg3.doc	3.19E+00	1.17E+06	4.20E+04
epg4.doc	4.14E+00	1.53E+06	5.70E+04
epg21.doc	4.67E+01	2.01E+06	3.20E+05
epg22.doc	4.77E+01	2.02E+06	3.10E+05
epg23.doc	4.86E+01	1.96E+06	2.98E+05
epg24.doc	4.95E+01	1.96E+06	2.81E+05
epg25.doc	5.04E+01	1.76E+06	2.67E+05
epg30.doc	7.05E+01	2.31E+06	3.15E+05
epg31.doc	7.14E+01	2.57E+06	3.07E+05
epg32.doc	7.23E+01	2.41E+06	2.90E+05
epg33.doc	7.33E+01	2.42E+06	2.92E+05
epg40.doc	9.27E+01	2.18E+06	3.28E+05

2. Kr-87

Filename	Time Since Start-up (h)	R_{wg}	δR_{wg}
epg3.doc	3.19E+00	1.30E+06	4.78E+04
epg4.doc	4.14E+00	1.55E+06	6.11E+04
epg21.doc	4.67E+01	1.28E+06	7.91E+04
epg22.doc	4.77E+01	1.25E+06	7.82E+04
epg23.doc	4.86E+01	1.27E+06	7.75E+04
epg24.doc	4.95E+01	1.28E+06	7.59E+04
epg25.doc	5.04E+01	1.17E+06	7.39E+04
epg30.doc	7.05E+01	1.37E+06	8.05E+04
epg31.doc	7.14E+01	1.43E+06	8.18E+04
epg32.doc	7.23E+01	1.43E+06	8.21E+04
epg33.doc	7.33E+01	1.39E+06	8.13E+04
epg40.doc	9.27E+01	1.39E+06	8.66E+04

3. Kr-88

Filename	Time Since Start-up (h)	R_{wg}	δR_{wg}
epg3.doc	3.19E+00	1.85E+06	6.20E+04
epg4.doc	4.14E+00	2.35E+06	8.29E+04
epg21.doc	4.67E+01	2.61E+06	2.29E+05
epg22.doc	4.77E+01	2.55E+06	2.24E+05
epg23.doc	4.86E+01	2.52E+06	2.16E+05
epg24.doc	4.95E+01	2.50E+06	2.08E+05
epg25.doc	5.04E+01	2.33E+06	1.99E+05
epg30.doc	7.05E+01	2.90E+06	2.37E+05
epg31.doc	7.14E+01	3.00E+06	2.31E+05
epg32.doc	7.23E+01	2.94E+06	2.24E+05
epg33.doc	7.33E+01	2.85E+06	2.24E+05
epg40.doc	9.27E+01	2.75E+06	2.48E+05

4. Xe-133m

Filename	Time Since Start-up (h)	R_{wg}	δR_{wg}
epg3.doc	3.19E+00	-----	-----
epg4.doc	4.14E+00	-----	-----
epg21.doc	4.67E+01	-----	-----
epg22.doc	4.77E+01	-----	-----
epg23.doc	4.86E+01	-----	-----
epg24.doc	4.95E+01	-----	-----
epg25.doc	5.04E+01	-----	-----
epg30.doc	7.05E+01	5.52E+05	1.55E+06
epg31.doc	7.14E+01	1.97E+06	1.28E+06
epg32.doc	7.23E+01	-----	-----
epg33.doc	7.33E+01	-----	-----
epg40.doc	9.27E+01	-----	-----

5. Xe-133

Filename	Time Since Start-up (h)	R_{wg}	δR_{wg}
epg3.doc	3.19E+00	1.78E+08	1.10E+07
epg4.doc	4.14E+00	1.59E+08	1.32E+07
epg21.doc	4.67E+01	-----	-----
epg22.doc	4.77E+01	-----	-----
epg23.doc	4.86E+01	-----	-----
epg24.doc	4.95E+01	-----	-----
epg25.doc	5.04E+01	-----	-----
epg30.doc	7.05E+01	-----	-----
epg31.doc	7.14E+01	-----	-----
epg32.doc	7.23E+01	-----	-----
epg33.doc	7.33E+01	-----	-----
epg40.doc	9.27E+01	-----	-----

6. Xe-135m

Filename	Time Since Start-up (h)	R_{wg}	δR_{wg}
epg3.doc	3.19E+00	----	----
epg4.doc	4.14E+00	----	----
epg21.doc	4.67E+01	4.20E+04	4.16E+03
epg22.doc	4.77E+01	4.06E+04	4.94E+03
epg23.doc	4.86E+01	4.69E+04	8.45E+03
epg24.doc	4.95E+01	4.97E+04	1.09E+04
epg25.doc	5.04E+01	3.86E+04	8.05E+03
epg30.doc	7.05E+01	----	----
epg31.doc	7.14E+01	----	----
epg32.doc	7.23E+01	5.50E+04	3.62E+03
epg33.doc	7.33E+01	----	----
epg40.doc	9.27E+01	4.99E+04	3.73E+03

7. Xe-135

Filename	Time Since Start-up (h)	R_{wg}	δR_{wg}
epg3.doc	3.19E+00	1.31E+06	5.33E+04
epg4.doc	4.14E+00	1.74E+06	7.45E+04
epg21.doc	4.67E+01	9.98E+06	4.08E+06
epg22.doc	4.77E+01	9.56E+06	4.02E+06
epg23.doc	4.86E+01	9.26E+06	3.88E+06
epg24.doc	4.95E+01	9.53E+06	3.64E+06
epg25.doc	5.04E+01	7.04E+06	3.51E+06
epg30.doc	7.05E+01	1.29E+07	4.73E+06
epg31.doc	7.14E+01	1.48E+07	4.53E+06
epg32.doc	7.23E+01	1.32E+07	4.24E+06
epg33.doc	7.33E+01	1.44E+07	4.19E+06
epg40.doc	9.27E+01	1.05E+07	5.00E+06

8. Xe-138

Filename	Time Since Start-up (h)	R_{wg}	δR_{wg}
epg3.doc	3.19E+00	3.33E+05	1.38E+04
epg4.doc	4.14E+00	3.33E+05	1.42E+04
epg21.doc	4.67E+01	2.15E+05	1.21E+04
epg22.doc	4.77E+01	2.27E+05	1.19E+04
epg23.doc	4.86E+01	2.28E+05	1.31E+04
epg24.doc	4.95E+01	2.39E+05	1.39E+04
epg25.doc	5.04E+01	2.31E+05	1.33E+04
epg30.doc	7.05E+01	2.78E+05	1.31E+04
epg31.doc	7.14E+01	2.86E+05	1.27E+04
epg32.doc	7.23E+01	3.17E+05	1.36E+04
epg33.doc	7.33E+01	3.22E+05	1.46E+04
epg40.doc	9.27E+01	2.58E+05	2.84E+04

Kanata Isotope Production Facility (KIPF)

Release Rate Water to Gas (Rwg)

1. Kr-85m

file name	Time Since Start-up (h)	R_{wg}	δR_{wg}
kmg3a	2.32	4.90E+05	2.00E+04
kmg8	21.75	6.72E+05	3.89E+04
kmg9	22.95	8.26E+05	4.69E+04
kmg10	23.90	1.03E+06	5.83E+04
kmg15	44.83	1.02E+06	1.59E+05
kmg16	45.76	1.10E+06	1.56E+05
kmg17	46.70	1.33E+06	1.51E+05
kmg23	68.81	1.81E+06	1.95E+05
kmg24	69.73	2.04E+06	1.86E+05
kmg27	89.97	2.05E+06	1.75E+05

2. Kr-87

file name	Time Since Start-up (h)	R_{wg}	δR_{wg}
kmg3a	2.32	5.46E+05	2.33E+04
kmg8	21.75	7.19E+05	2.70E+04
kmg9	22.95	8.10E+05	3.40E+04
kmg10	23.90	8.38E+05	4.02E+04
kmg15	44.83	8.84E+05	5.48E+04
kmg16	45.76	7.81E+05	5.45E+04
kmg17	46.70	8.52E+05	5.40E+04
kmg23	68.81	1.20E+06	5.23E+04
kmg24	69.73	1.28E+06	5.31E+04
kmg27	89.97	1.19E+06	8.10E+04

C-14

3. Kr-88

file name	Time Since Start-up (h)	R_{wg}	δR_{wg}
kmg3a	2.32	7.83E+05	2.93E+04
kmg8	21.49	9.90E+05	3.83E+04
kmg9	22.69	1.21E+06	4.83E+04
kmg10	23.65	1.42E+06	6.25E+04
kmg15	44.83	1.56E+06	1.40E+05
kmg16	45.76	1.50E+06	1.37E+05
kmg17	46.70	1.69E+06	1.35E+05
kmg23	68.81	2.34E+06	1.62E+05
kmg24	69.73	2.56E+06	1.59E+05
kmg27	89.97	2.38E+06	1.40E+05

4. Xe-133m

file name	Time Since Start-up (h)	R_{wg}	δR_{wg}
kmg3a	2.32	----	----
kmg8	21.49	----	----
kmg9	22.69	----	----
kmg10	23.65	----	----
kmg15	44.83	----	----
kmg16	45.76	----	----
kmg17	46.70	----	----
kmg23	68.81	5.75E+05	2.19E+05
kmg24	69.73	2.72E+05	2.03E+05
kmg27	89.97	2.97E+05	2.03E+05

5. Xe-133

file name	Time Since Start-up (h)	R_{wg}	δR_{wg}
kmg3a	2.32	8.91E+05	1.25E+05
kmg8	21.49	3.43E+06	5.29E+05
kmg9	22.69	3.24E+06	5.94E+05
kmg10	23.65	3.29E+06	6.73E+05
kmg15	44.83	----	----
kmg16	45.76	4.99E+05	3.23E+06
kmg17	46.70	2.97E+06	3.23E+06
kmg23	68.81	----	----
kmg24	69.73	8.54E+06	8.71E+06
kmg27	89.97	7.18E+06	8.71E+06

6. Xe-135m

file name	Time Since Start-up (h)	R_{wg}	δR_{wg}
kmg3a	2.32	----	----
kmg8	21.49	----	----
kmg9	22.69	2.60E+04	2.14E+03
kmg10	23.65	2.29E+04	2.21E+03
kmg15	44.83	5.21E+04	2.66E+03
kmg16	45.76	3.61E+04	2.49E+03
kmg17	46.70	4.52E+04	3.16E+03
kmg23	68.81	6.26E+04	2.32E+03
kmg24	69.73	6.54E+04	2.41E+03
kmg27	89.97	6.70E+04	2.23E+04

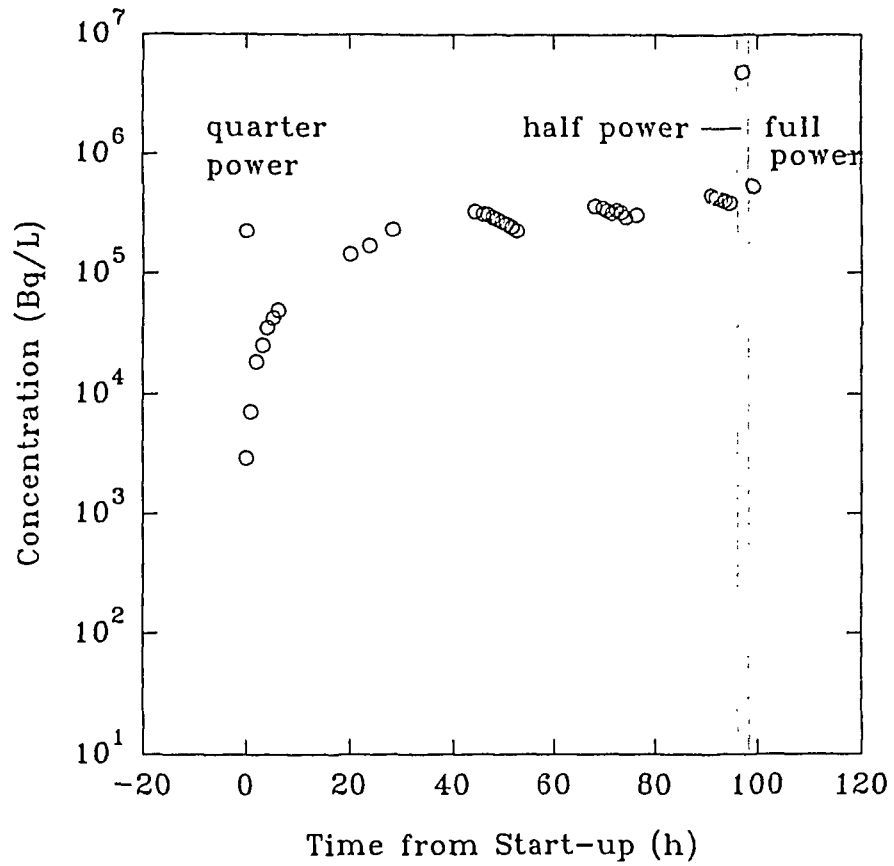
7. Xe-135

file name	Time Since Start-up (h)	R_{wg}	δR_{wg}
kmg3a	2.32	4.16E+05	1.80E+04
kmg8	21.49	3.09E+06	2.33E+05
kmg9	22.69	3.17E+06	2.71E+05
kmg10	23.65	3.50E+06	3.12E+05
kmg15	44.83	3.85E+06	1.30E+06
kmg16	45.76	4.85E+06	1.24E+06
kmg17	46.70	6.57E+06	1.22E+06
kmg23	68.81	8.17E+06	2.28E+06
kmg24	69.73	1.09E+07	2.10E+06
kmg27	89.97	1.40E+07	2.13E+06

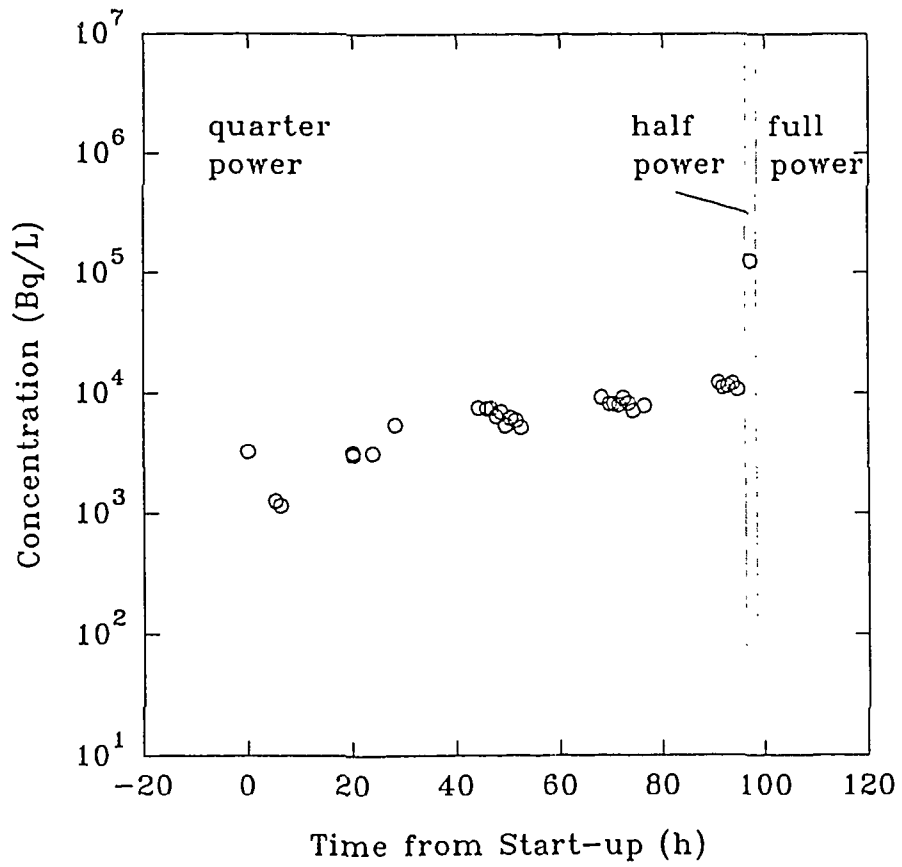
8. Xe-138

file name	Time Since Start-up (h)	R_{wg}	δR_{wg}
kmg3a	2.32	1.93E+05	1.01E+04
kmg8	21.49	3.33E+05	1.60E+04
kmg9	22.69	2.64E+05	1.32E+04
kmg10	23.65	1.85E+05	1.05E+04
kmg15	44.83	3.00E+05	1.28E+04
kmg16	45.76	1.54E+05	9.59E+03
kmg17	46.70	2.23E+05	9.92E+03
kmg23	68.81	2.93E+05	1.10E+04
kmg24	69.73	3.20E+05	1.19E+04
kmg27	89.97	3.35E+05	8.45E+04

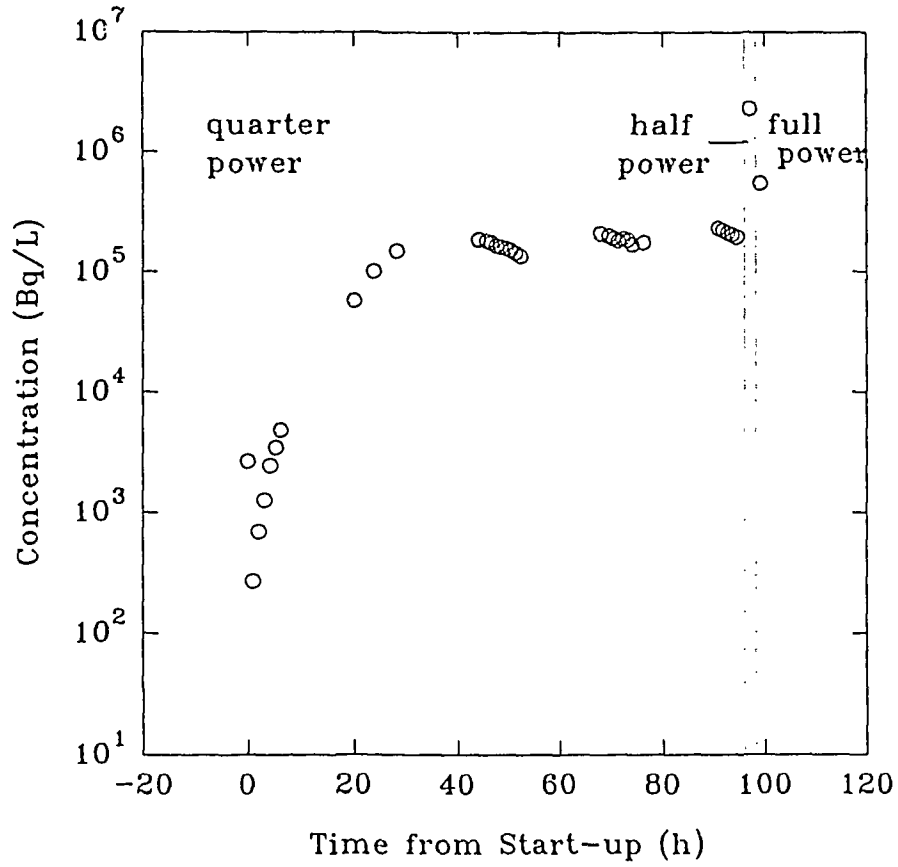
Concentration of Xe-133 in the Gas Headspace
of the EP SLOWPOKE-2 Reactor (81 keV)



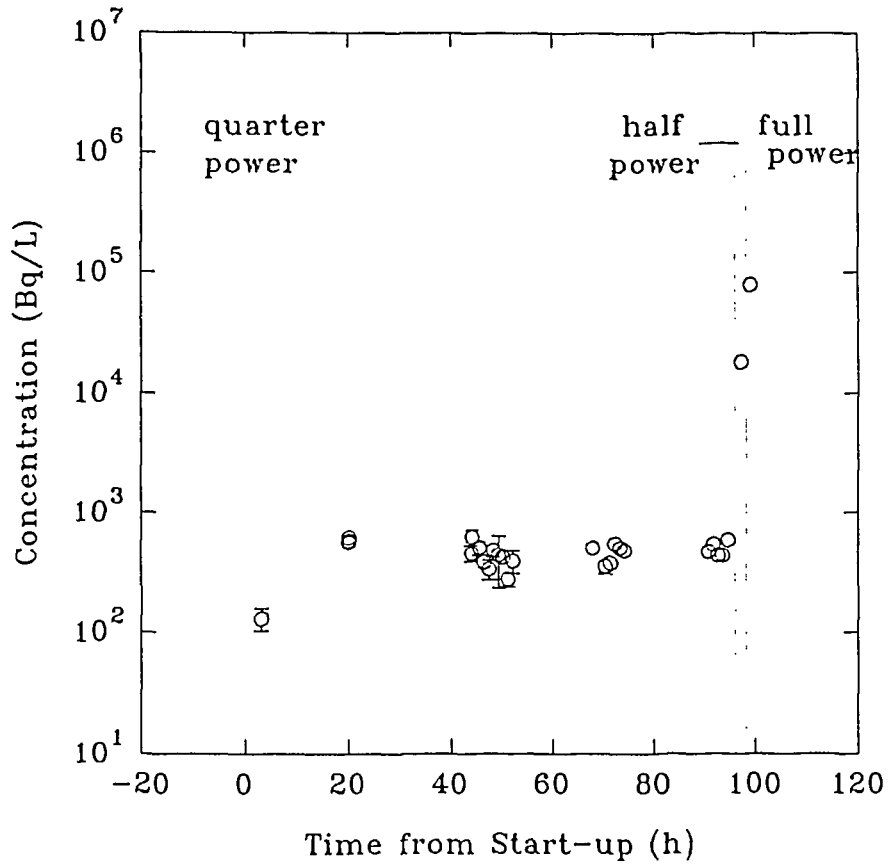
Concentration of Xe-133m in the Gas Headspace
of the EP SLOWPOKE-2 Reactor (233 keV)



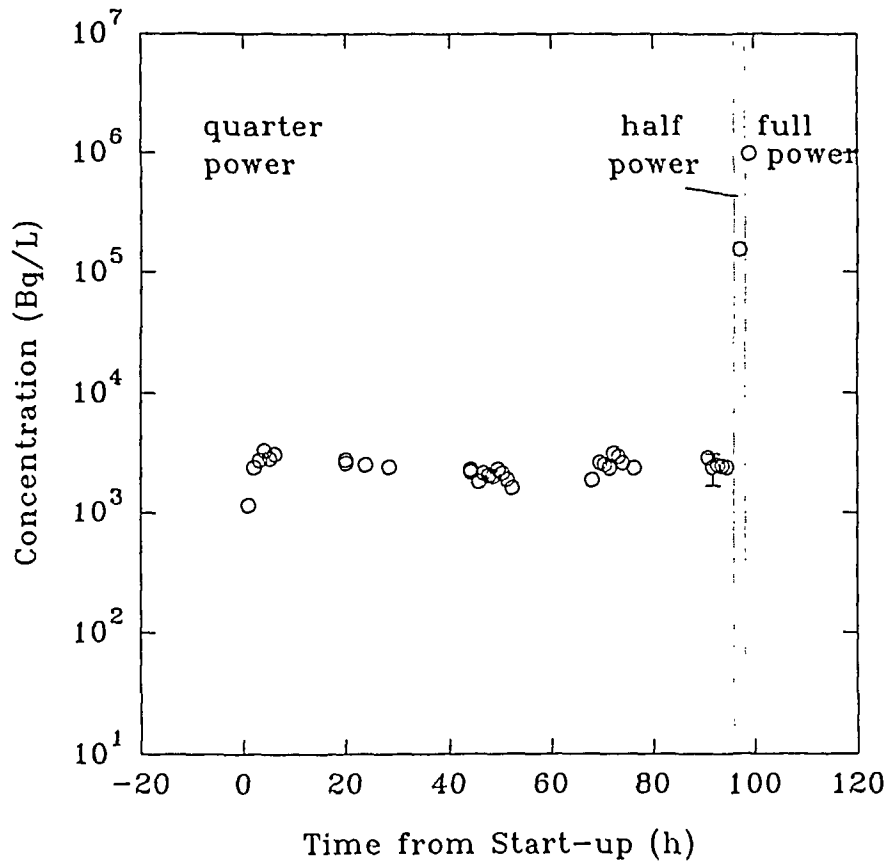
Concentration of Xe-135 in the Gas Headspace
of the EP SLOWPOKE-2 Reactor (250 keV)



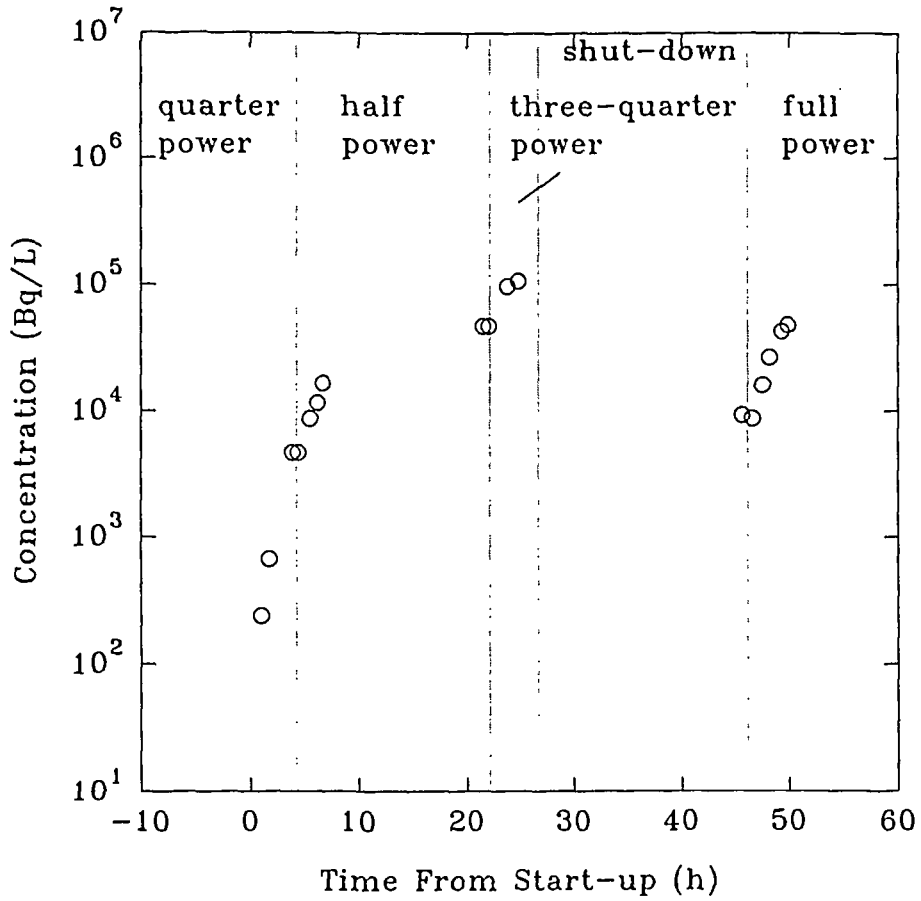
Concentration of Xe-135m in the Gas Headspace
of the EP SLOWPOKE-2 Reactor (527 keV)



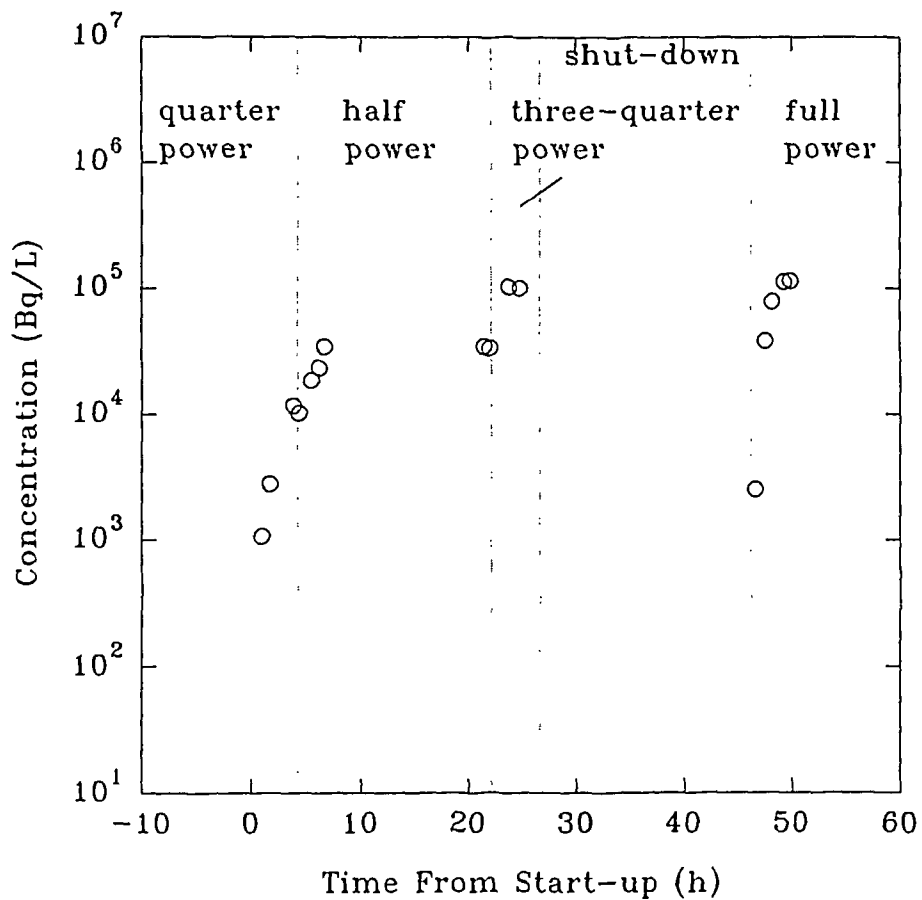
Concentration of Xe-138 in the Gas Headspace of the EP SLOWPOKE-2 Reactor (258)



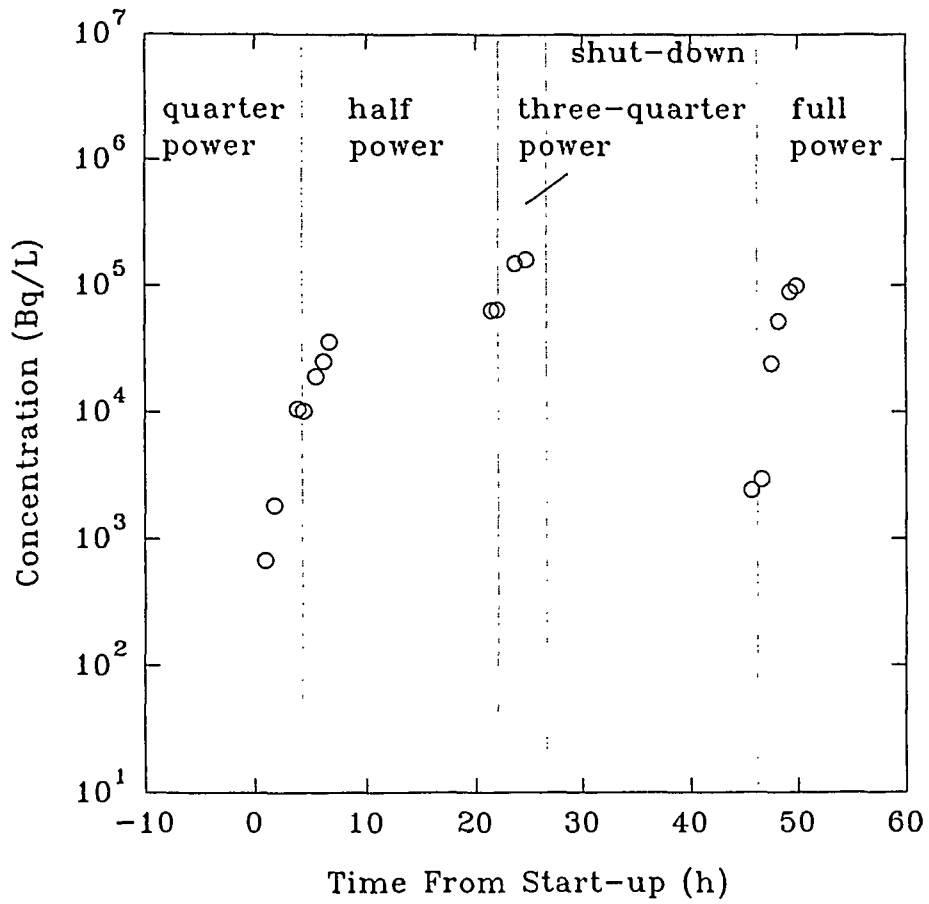
Concentration of Kr-85m in the KIPF Reactor
Headspace - April Trip (151 keV)

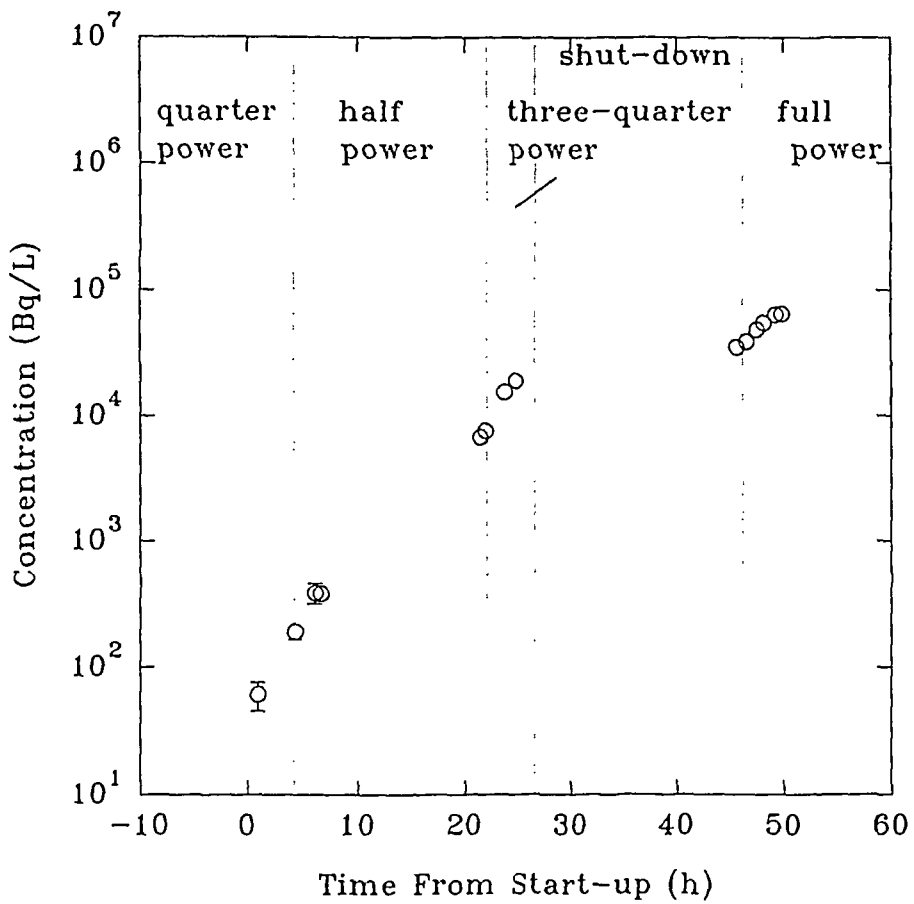


Concentration of Kr-87 in the KIPF Reactor
Headspace - April Trip (403 keV)

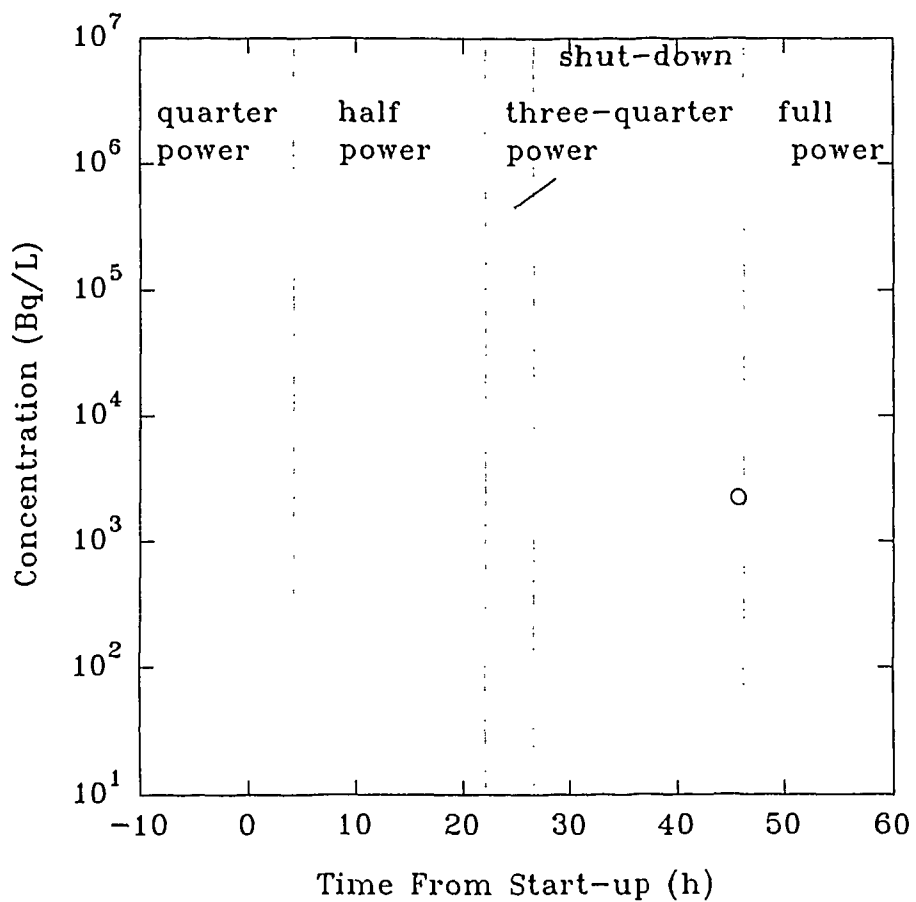


Concentration of Kr-88 in the KIPF Reactor
Headspace - April Trip (196 keV)

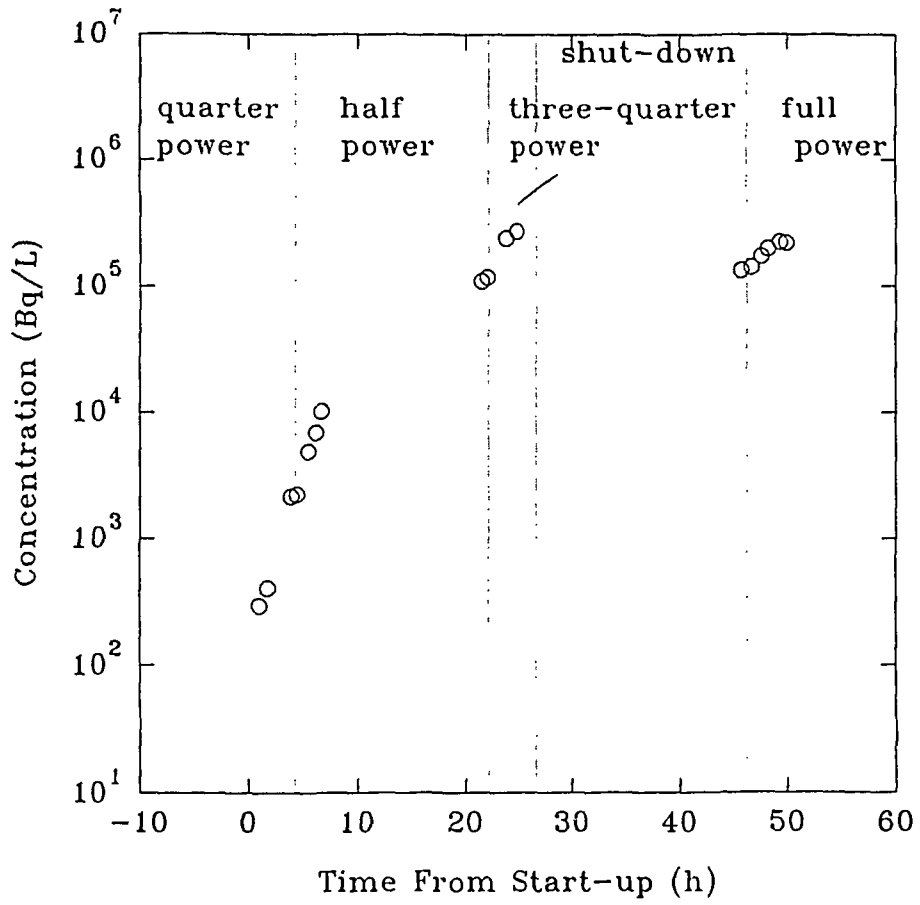


Concentration of Xe-133 in the KIPF Reactor
Headspace - April Trip (81 keV)

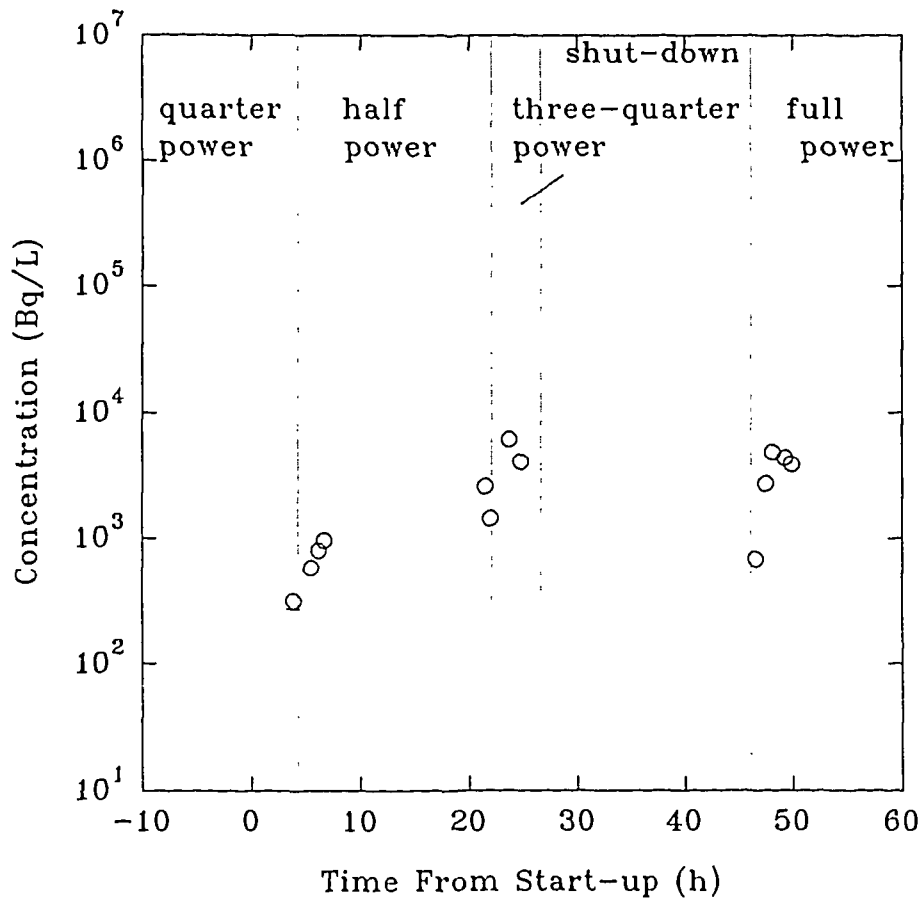
Concentration of Xe-133m in the KIPF Reactor
Headspace - April Trip (233 keV)



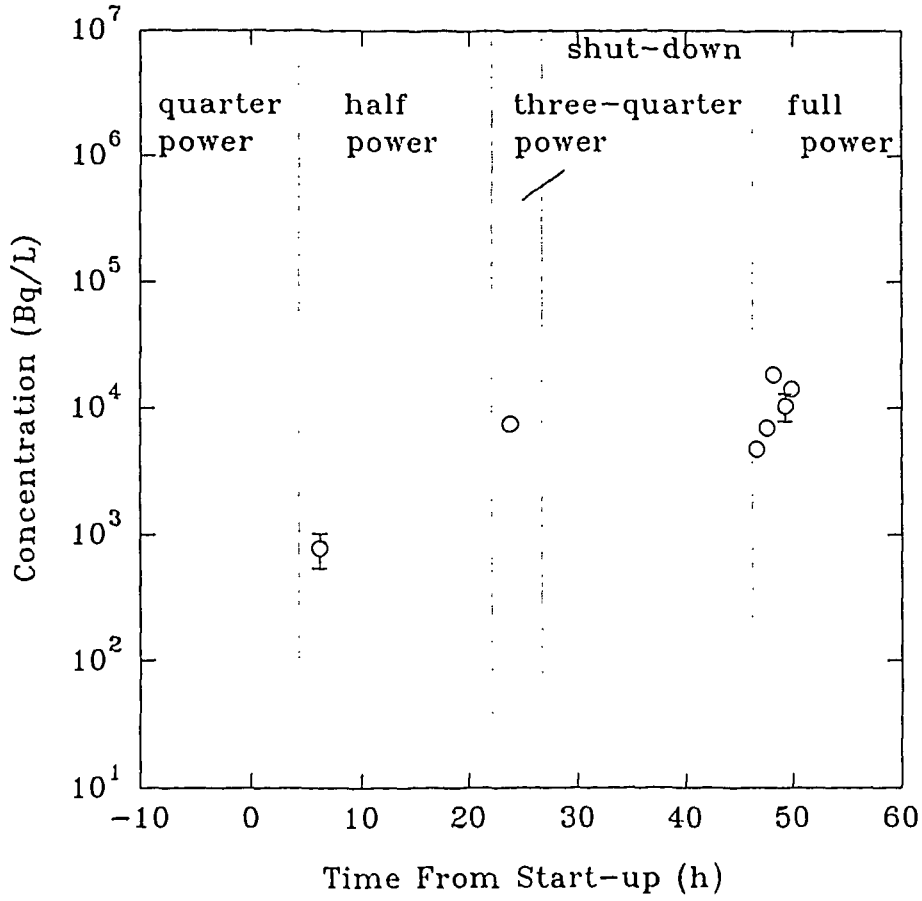
Concentration of Xe-135 in the KIPF Reactor
Headspace - April Trip (250 keV)



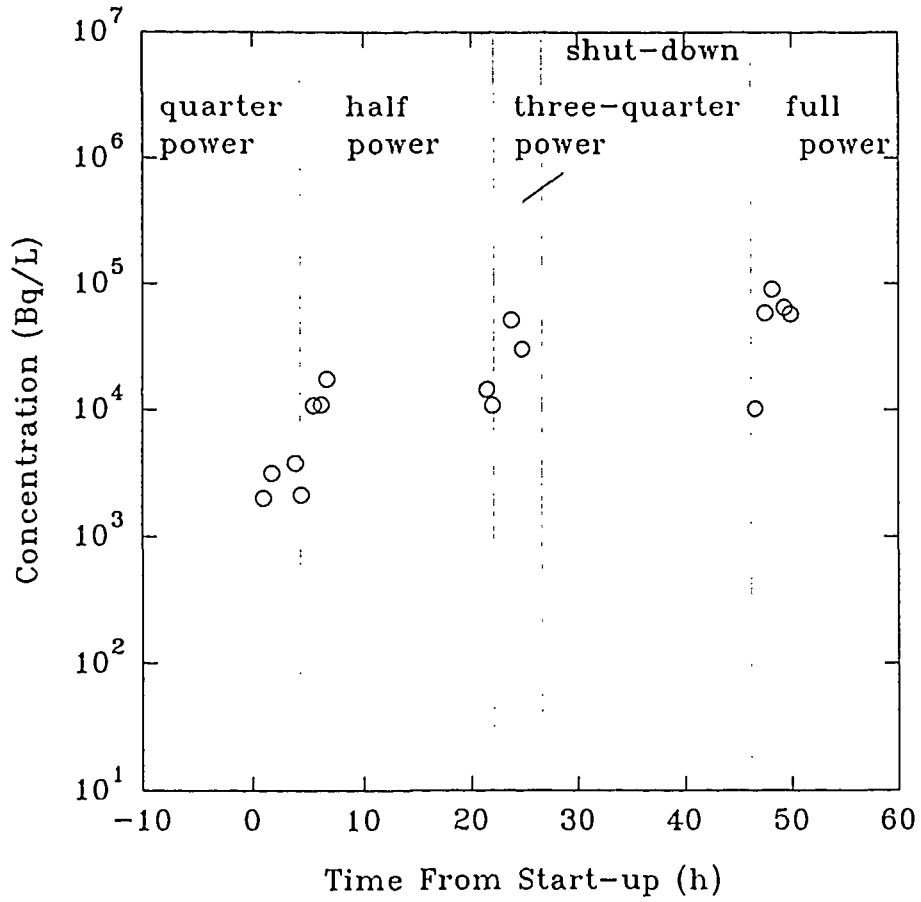
Concentration of Xe-135m in the KIPF Reactor
Headspace - April Trip (527 keV)



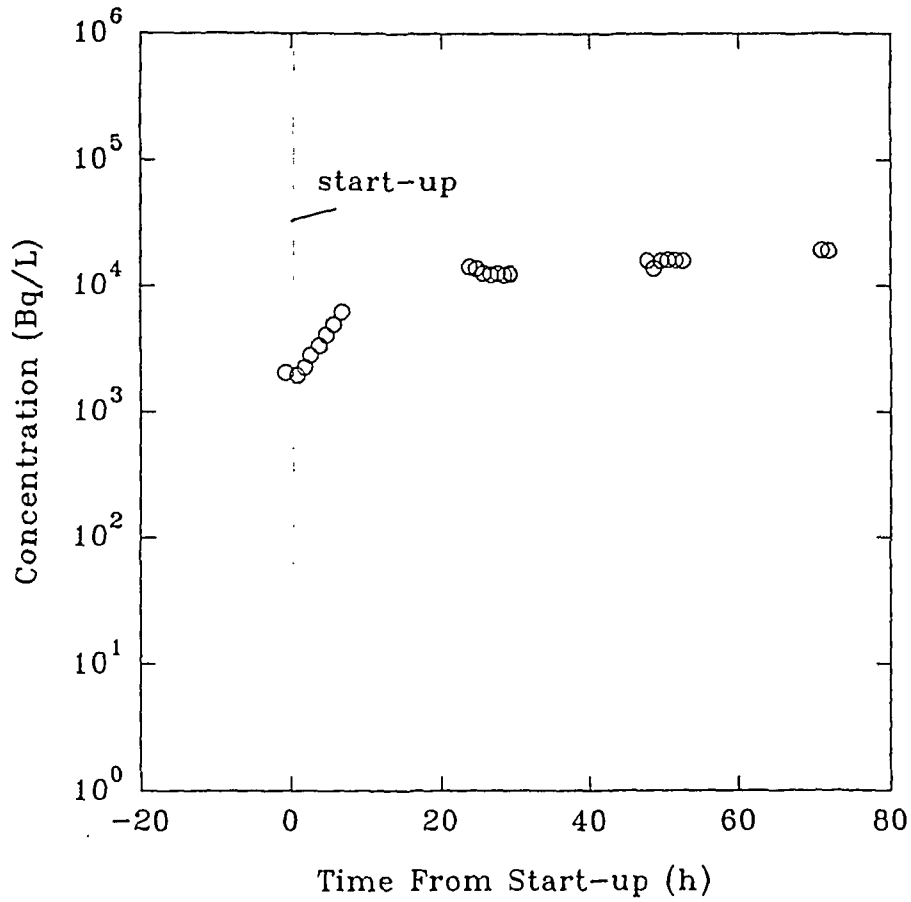
Concentration of Xe-137 in the KIPF Reactor
Headspace - April Trip (456 keV)



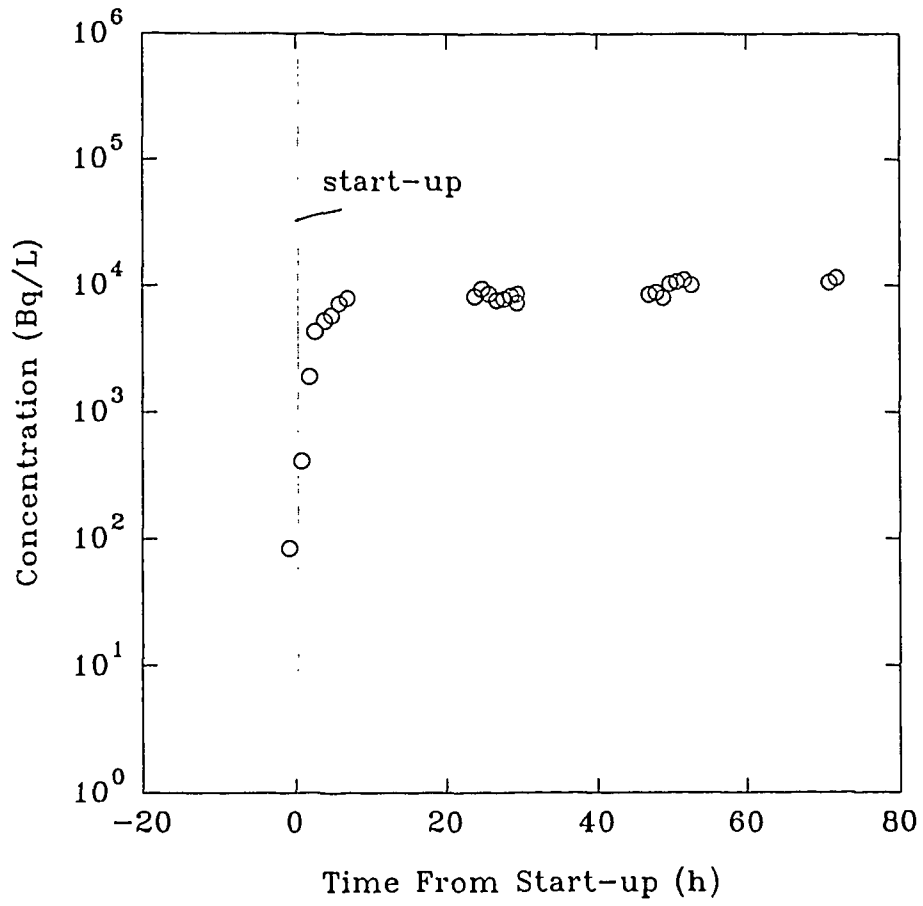
Concentration of Xe-138 in the KIPF Reactor
Headspace - April Trip (258 keV)



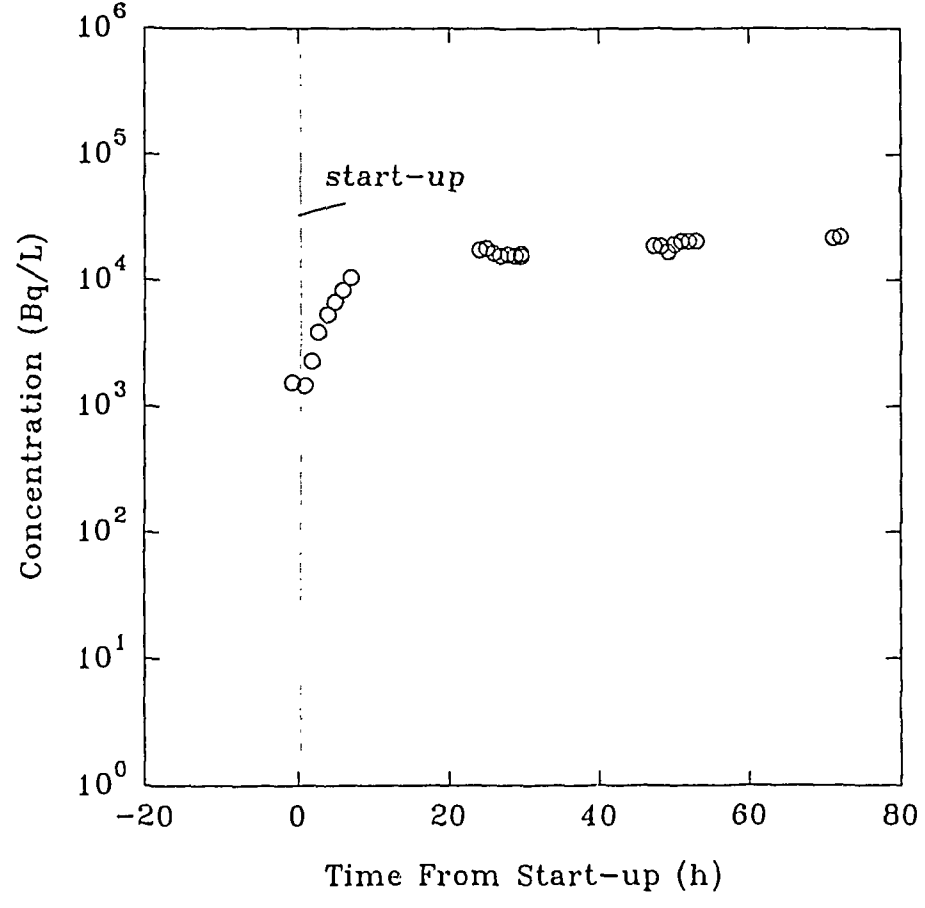
Concentration of Kr-85m in the KIPF Reactor
Headspace - May Trip (151 keV)



Concentration of Kr-87 in the KIPF Reactor
Headspace - May Trip (403 keV)



Concentration of Kr-88 in the KIPF Reactor
Headspace - May Trip (196 keV)



Concentration of Xe-133 in the KIPF Reactor
Headspace - May Trip (81 keV)

