

Rates of Initiating Events at U.S. Nuclear Power Plants 1988–2005

This report presents an analysis of initiating event frequencies at United States (U.S.) commercial nuclear power plants. The evaluation is based on the operating experience from fiscal year 1988 through 2005, as reported in Licensee Event Reports (LERs). This is the latest update to NUREG/CR-5750, updating data, frequency estimates, trends, and figures.

1 LATEST FREQUENCIES AND TRENDS

1.1 Selected Frequencies

This report displays occurrence rates for the categories of initiating events that contribute to the NRC's Industry Trend monitoring program. Sixteen initiating event groupings are trended and displayed. BWR and PWR specific initiators are plotted separately because the occurrence rates differ between the two plant types. Each figure is annotated with the p-value¹ for the presence of a trend in the baseline period.

In accordance with the Industry Trend program, particular starting years have been identified for each of these initiating events for baseline periods during which the initiating event frequencies are approximately constant. The baseline periods for all of these initiating events are extended to 2002. The maximum likelihood estimate (the total number of events divided by the total number of reactor critical years) has been taken as the mean for each occurrence rate in each year. For each baseline period, the mean is the ratio of the total event count (summed over the calendar years in the baseline period), divided by the corresponding sum of reactor critical years.

The limits in each year are simple confidence bounds. For the baseline period, the horizontal limits are computed from the predictive distribution (Poisson-Gamma) that describes the number of events that would be expected in a following year based on the number of events (plus 0.5), the occurrence time in the baseline period, and the exposure time in the following year. The predictive bounds for the baseline period assume that the occurrences are following a constant rate for that period and the future. Comparing future data with those bounds helps to determine whether the data are changing.

[Table 1](#) lists the initiating events, overall data, and horizontal bounds used in the plots.

1. Statistically significant is defined in terms of the 'p-value.' A p-value is a probability indicating whether to accept or reject the null hypothesis that there is no trend in the data. P-values of less than or equal to 0.05 indicate that we are 95% confident that there is a trend in the data (reject the null hypothesis of no trend.) By convention, we use the "Michelin Guide" scale: p-value < 0.05 (statistically significant), p-value < 0.01 (highly statistically significant); p-value < 0.001 (extremely statistically significant).

Table 1. Initiating events with baseline frequencies.

Initiating event functional impact category	Figure	All Data		Baseline						
		Number of events ²	Reactor critical years	Baseline period starting year (CY)	Baseline period ending year (CY)	Number of events	Reactor critical years	5% Lower Prediction Limit	Mean Frequency	95% Upper Prediction Limit
Loss of offsite power	Figure 1	56	1557.4	1997	2004	24	724.4	0.00E+00	3.31E-02	8.51E-02
Loss of vital AC bus	Figure 2	10	1557.4	1992	2002	8	965.1	0.00E+00	8.29E-03	4.26E-02
Loss of vital DC bus	Figure 3	1	1557.4	1988	2002	1	1281.5	0.00E+00	7.80E-04	2.13E-02
Very small LOCA	Figure 4	5	1557.4	1992	2002	1	965.1	0.00E+00	1.04E-03	2.13E-02
Partial Loss of Component Cooling Water	Figure 5	1	1557.4	1988	2002	1	1281.5	0.00E+00	7.80E-04	2.13E-02
Loss of feedwater	Figure 6	197	1557.4	1993	2002	84	881.5	4.26E-02	9.53E-02	1.70E-01
Partial Loss of Service Water	Figure 7	3	1557.4	1988	2002	2	1281.5	0.00E+00	1.56E-03	2.13E-02
BWR loss of instrument air	Figure 8	11	507.9	1991	2002	3	343.0	0.00E+00	8.75E-03	6.25E-02
BWR stuck open SRV	Figure 9	15	507.9	1993	2002	6	291.5	0.00E+00	2.06E-02	9.38E-02
BWR loss of heat sink	Figure 10	162	507.9	1996	2002	41	208.4	6.25E-02	1.97E-01	3.75E-01
BWR general transients	Figure 11	733	507.9	1997	2002	149	180.1	5.63E-01	8.27E-01	1.16E+00
PWR loss of instrument air	Figure 12	13	1049.5	1997	2002	3	356.8	0.00E+00	8.41E-03	4.84E-02
PWR steam generator tube rupture	Figure 13	3	1049.5	1991	2002	2	706.0	0.00E+00	2.83E-03	3.23E-02
PWR stuck open SRV	Figure 14	2	1049.5	1988	2002	2	866.0	0.00E+00	2.31E-03	3.23E-02
PWR loss of heat sink	Figure 15	109	1049.5	1995	2002	38	474.7	3.23E-02	8.00E-02	1.61E-01
PWR general transients	Figure 16	1467	1049.5	1998	2002	228	303.9	5.65E-01	7.50E-01	9.68E-01

2. In 2006, the loss of vital ac, loss of vital dc, and loss of instrument air initiating event data were reviewed for applicability to the SPAR model needs. As a result of this review, the three initiating event counts decreased significantly. The excluded events were subsequently reclassified as general transients. The counts in this table reflect the outcome of that review.

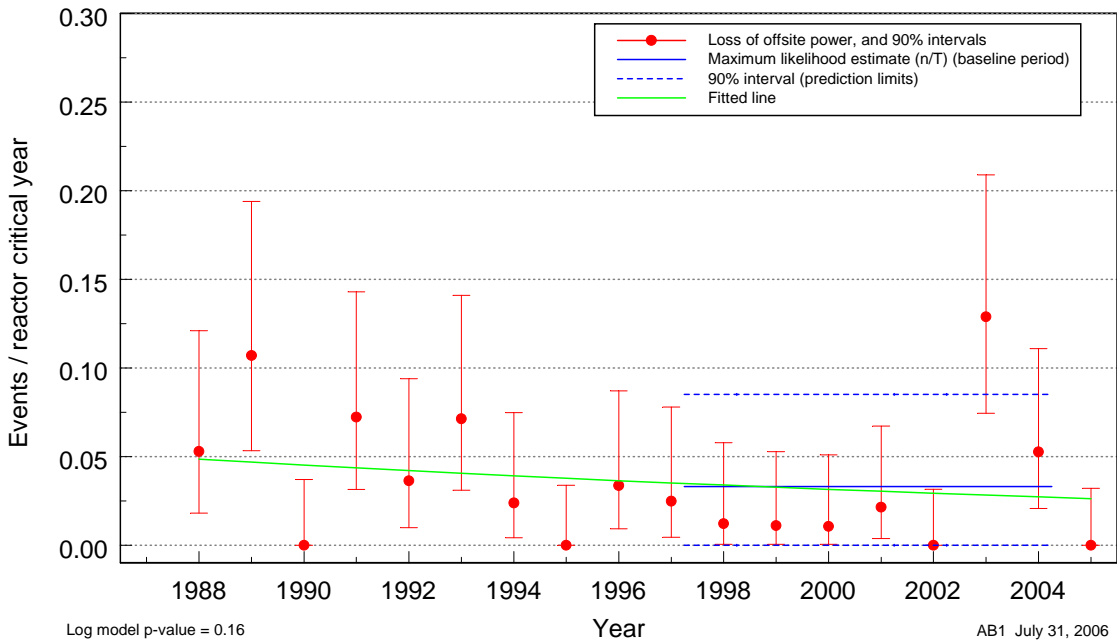


Figure 1. Frequency of initiating events with a loss of off-site power.

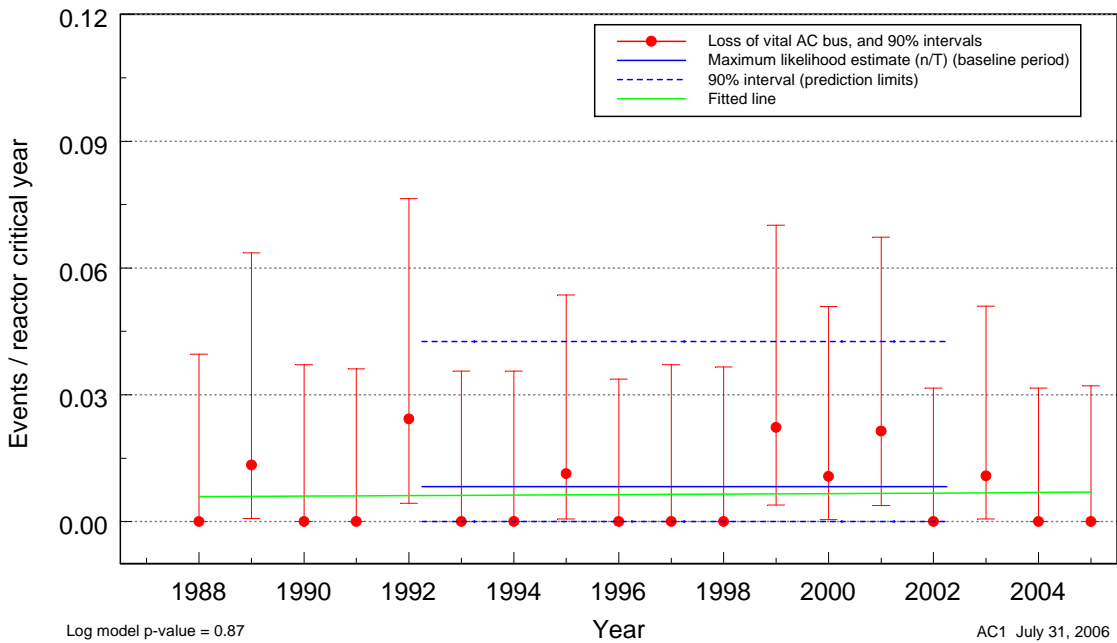


Figure 2. Frequency of initiating events with loss of vital AC bus.

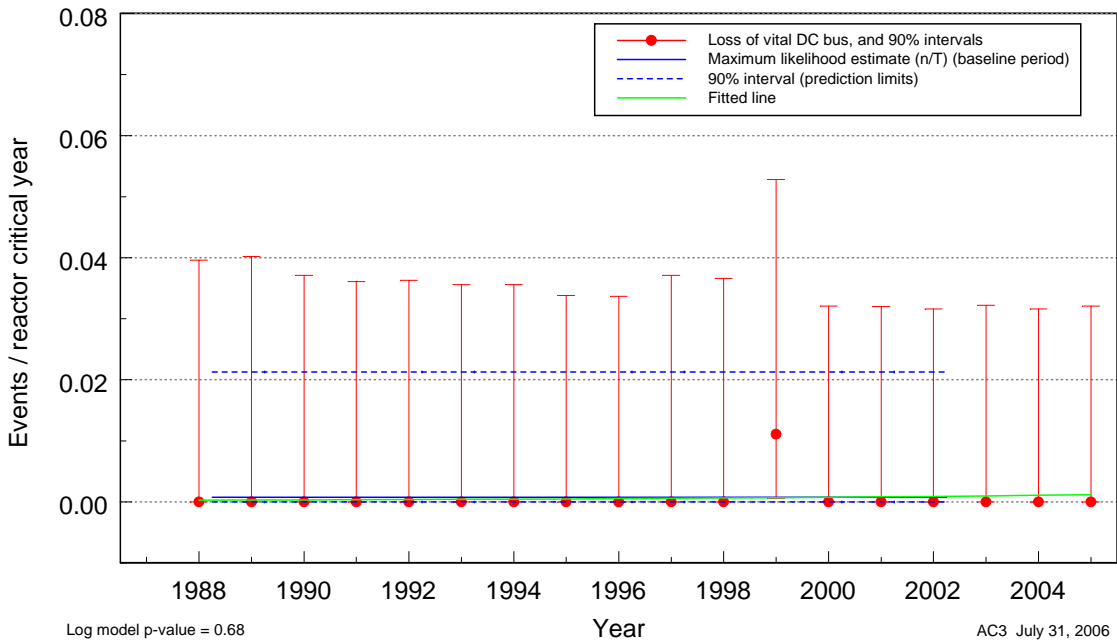


Figure 3. Frequency of initiating events with loss of vital DC bus.

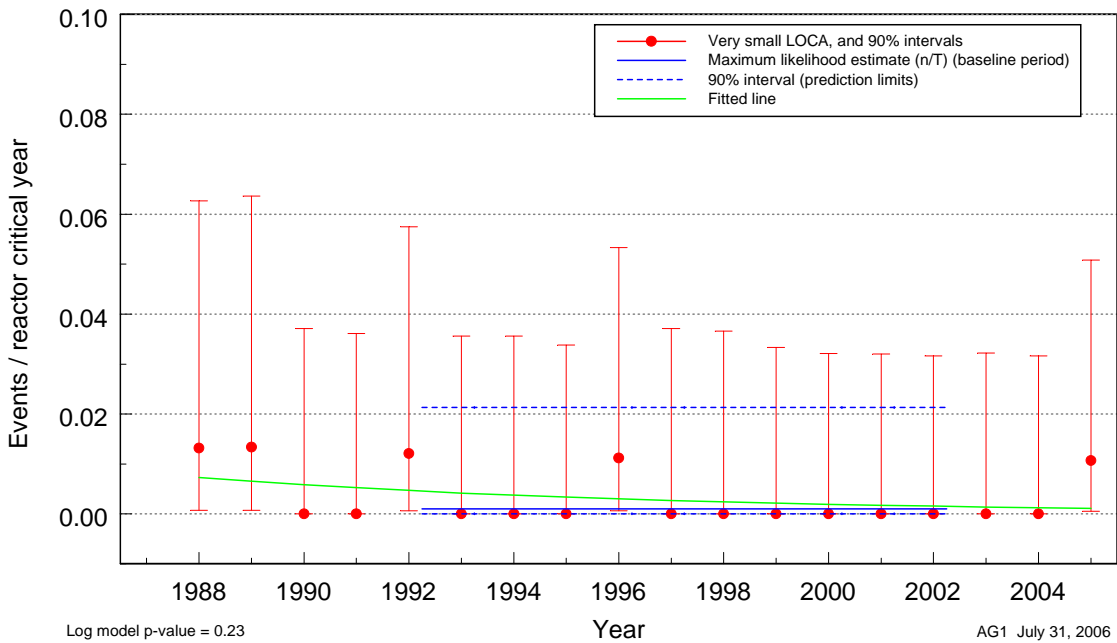


Figure 4. Frequency of initiating events with very small loss of coolant accident.

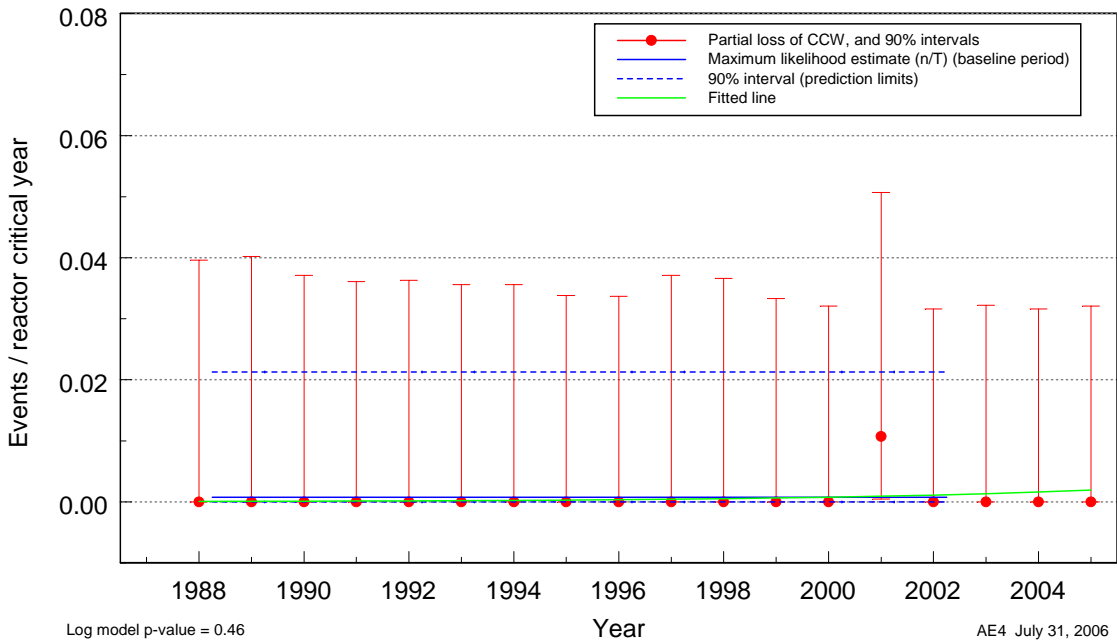


Figure 5. Frequency of initiating events with partial loss of component cooling water.

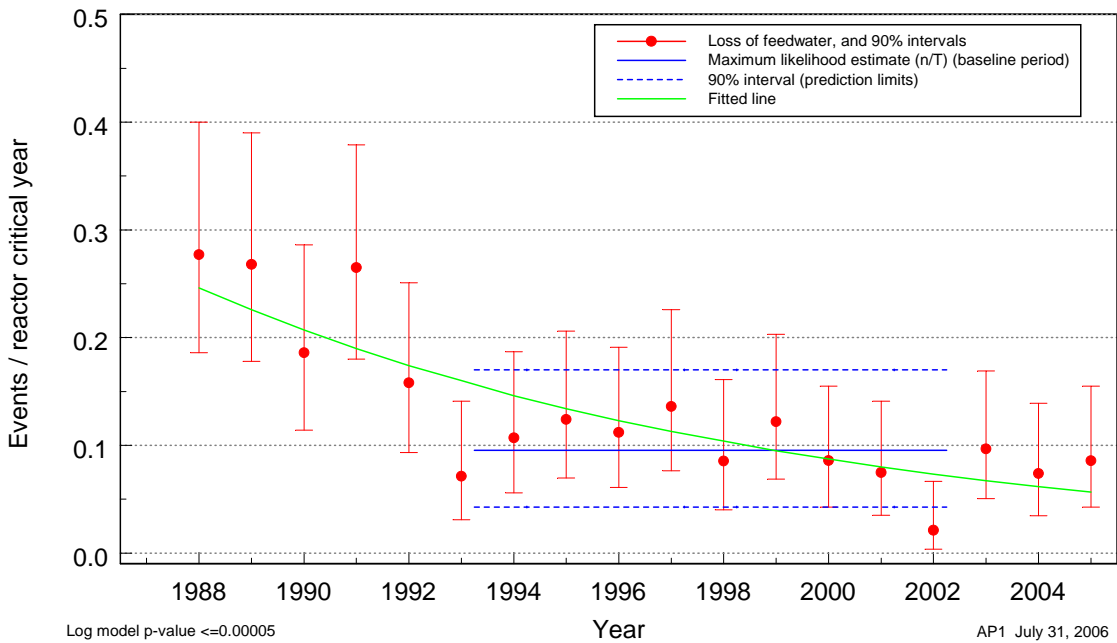


Figure 6. Frequency of initiating events with loss of feedwater.

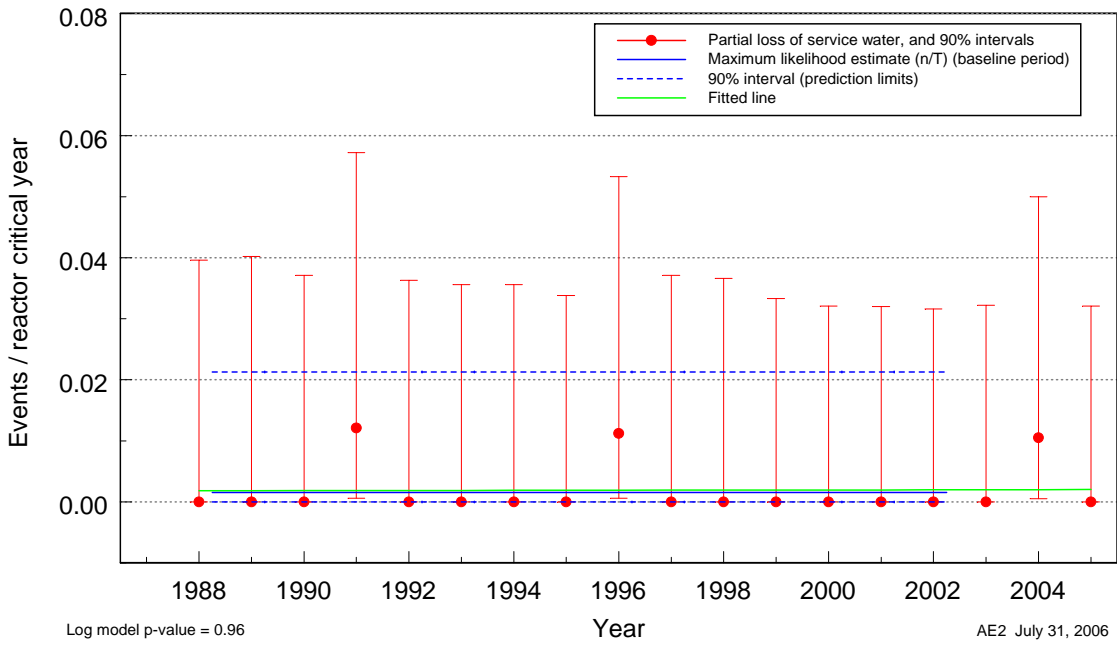


Figure 7. Frequency of initiating events with partial loss of service water.

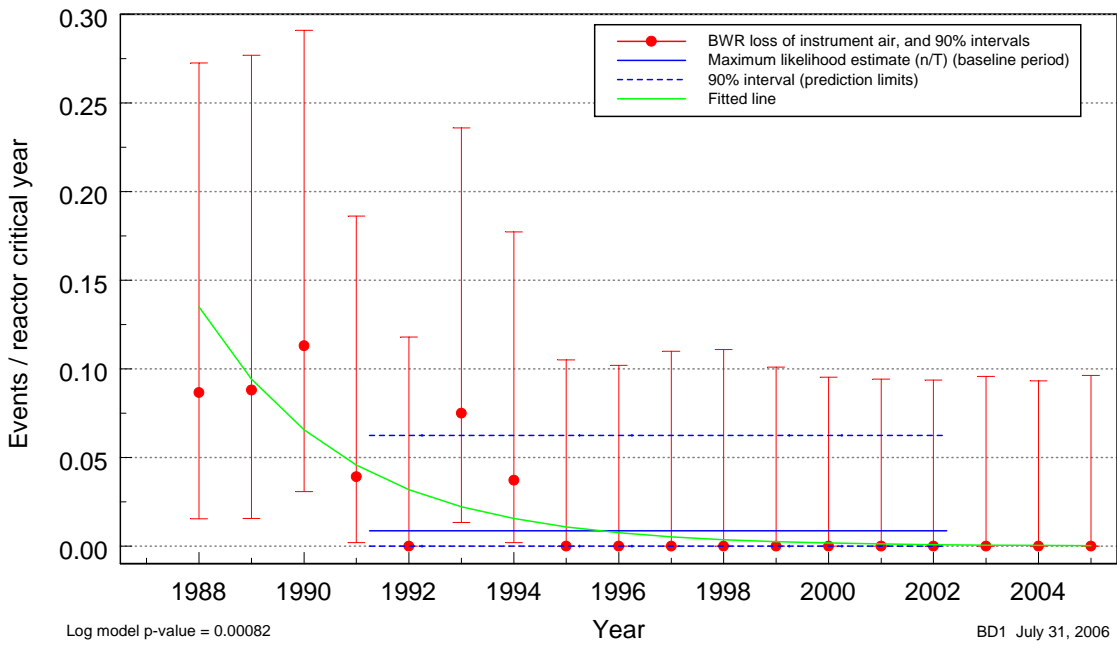


Figure 8. Frequency of BWR initiating events with loss of instrument air.

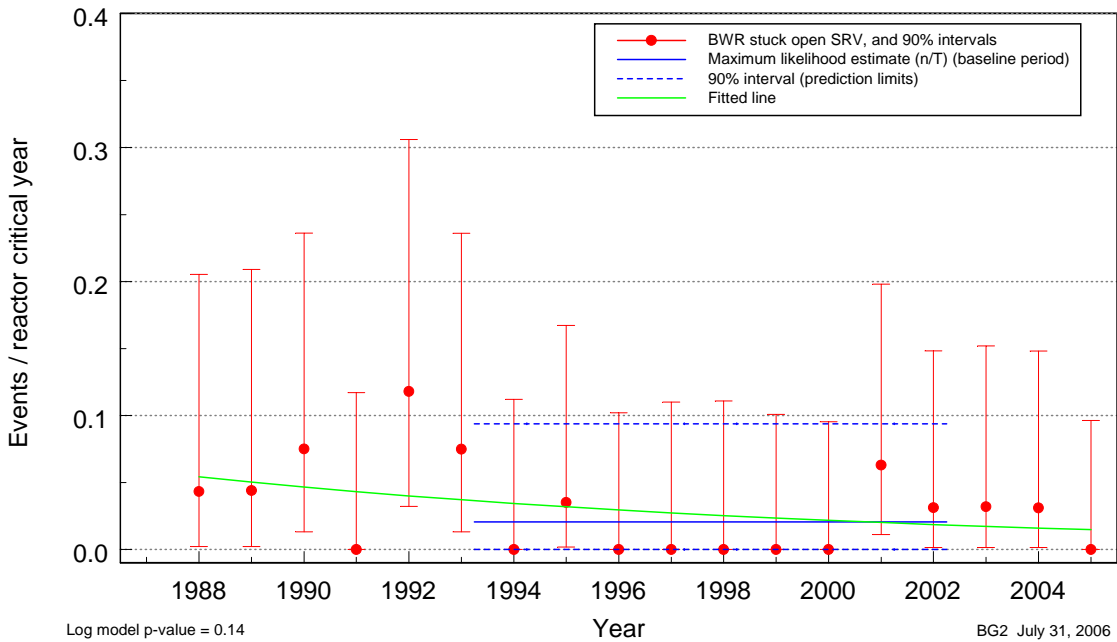


Figure 9. Frequency of BWR initiating events with stuck open safety relief valve.

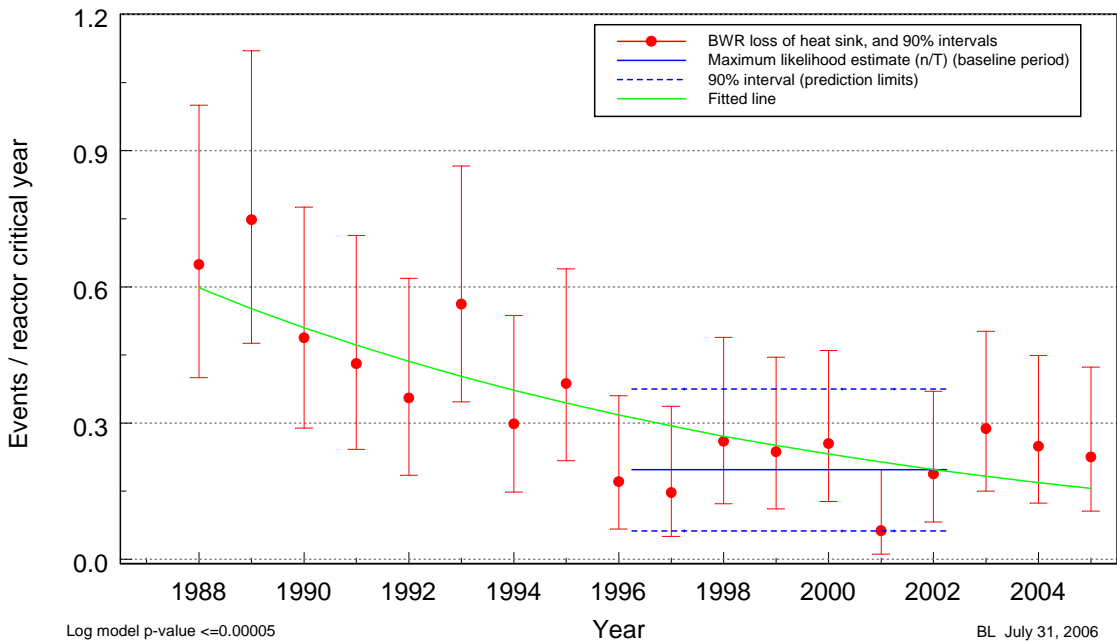


Figure 10. Frequency of BWR initiating events with loss of heat sink.

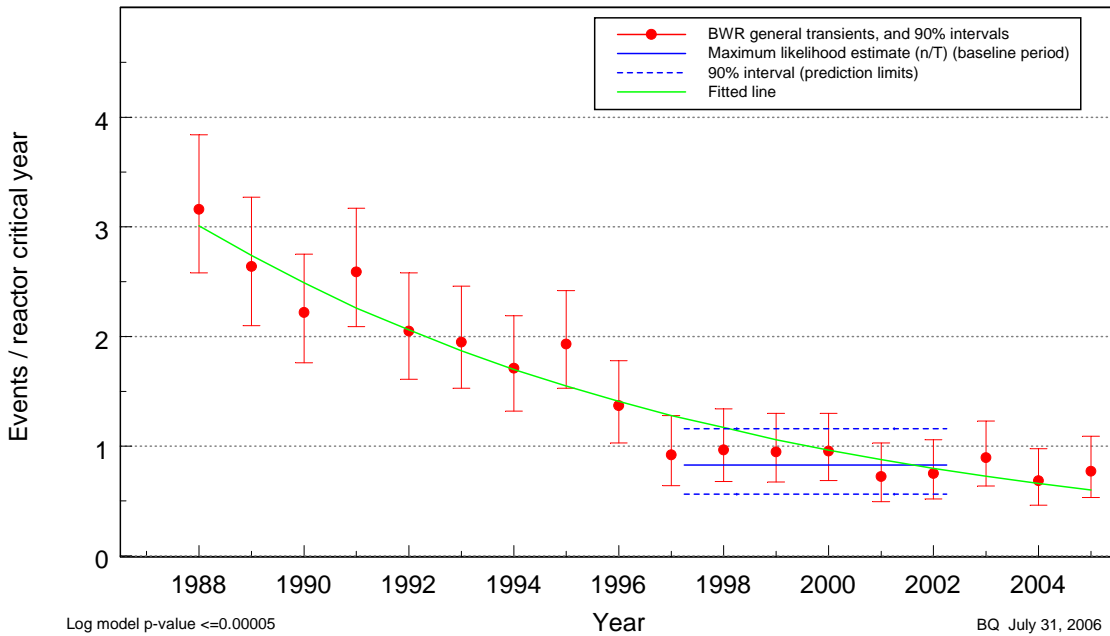


Figure 11. Frequency of BWR initiating events with general transients.

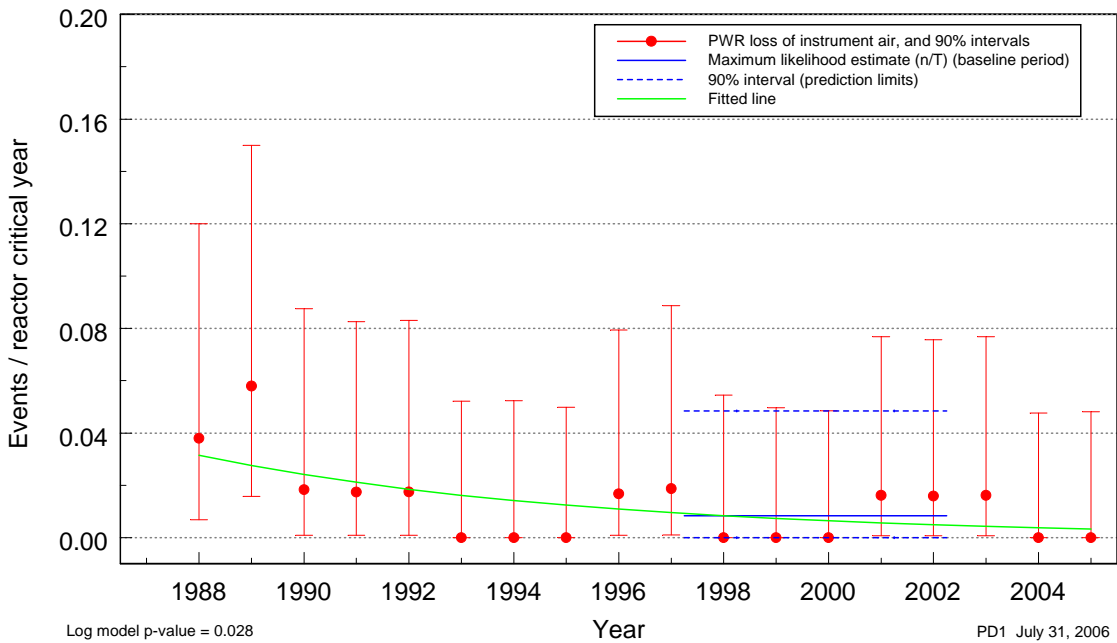


Figure 12. Frequency of PWR initiating events with loss of instrument air.

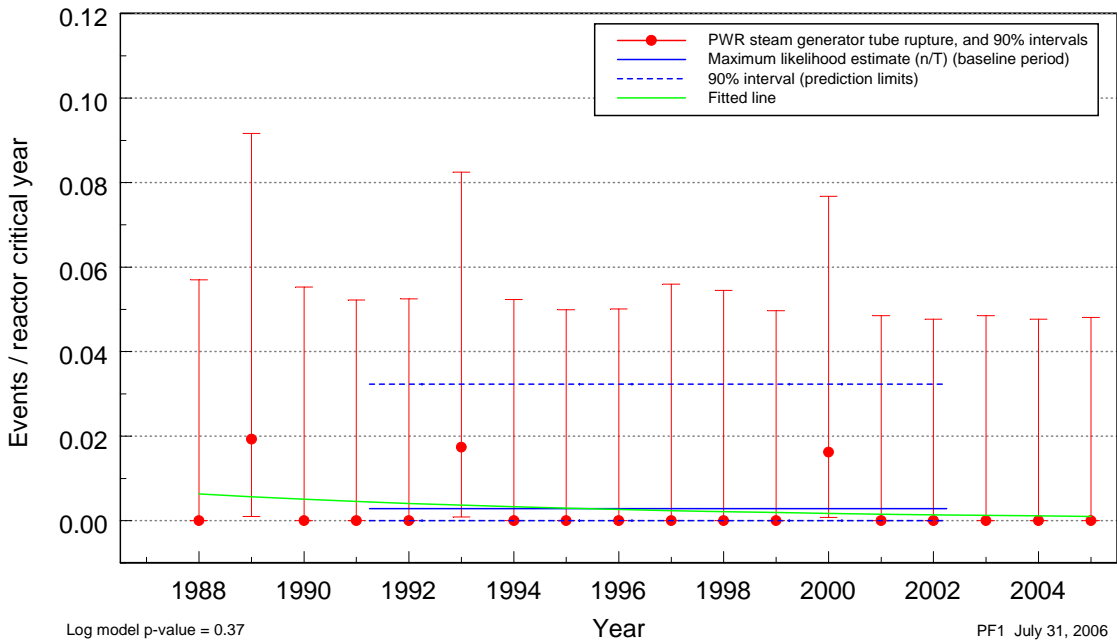


Figure 13. Frequency of PWR initiating events with steam generator tube rupture.

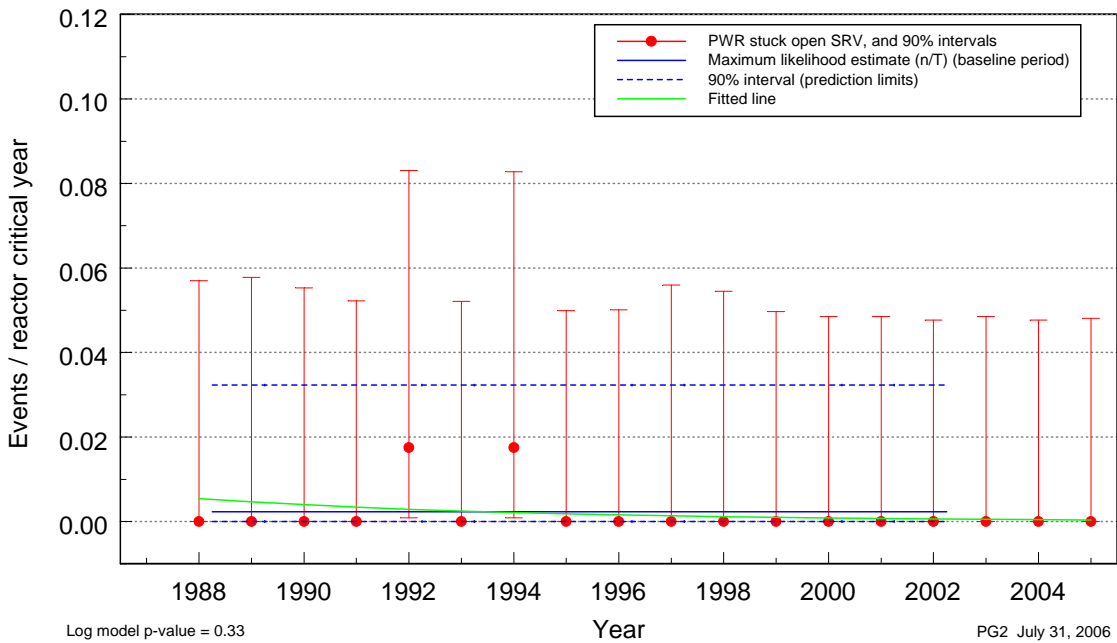


Figure 14. Frequency of PWR initiating events with stuck open safety relief valve.

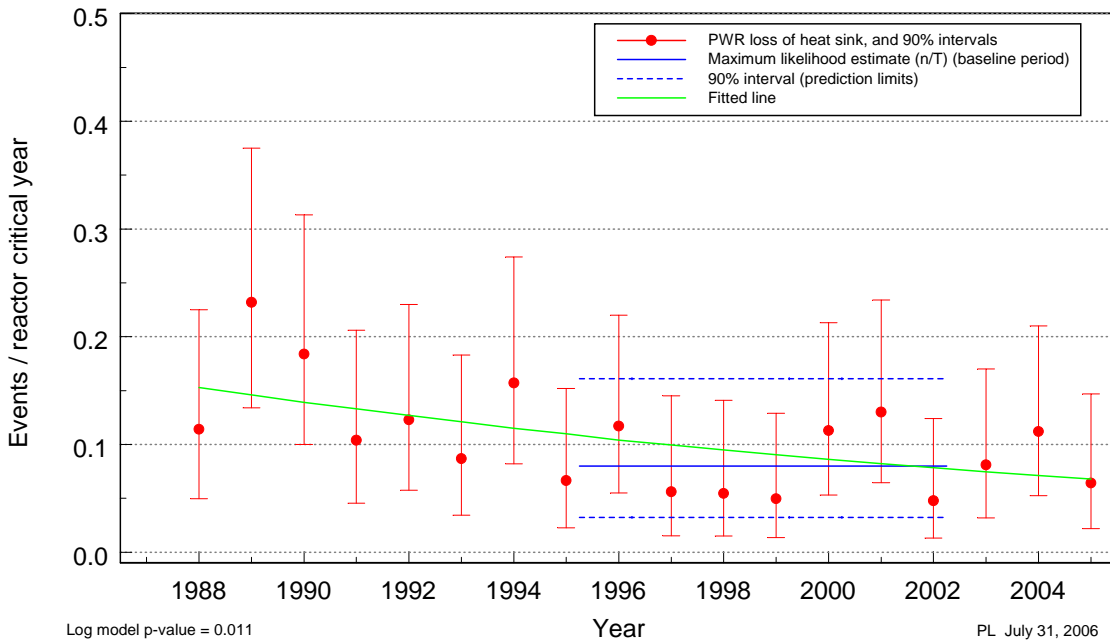


Figure 15. Frequency of PWR initiating events with loss of heat sink.

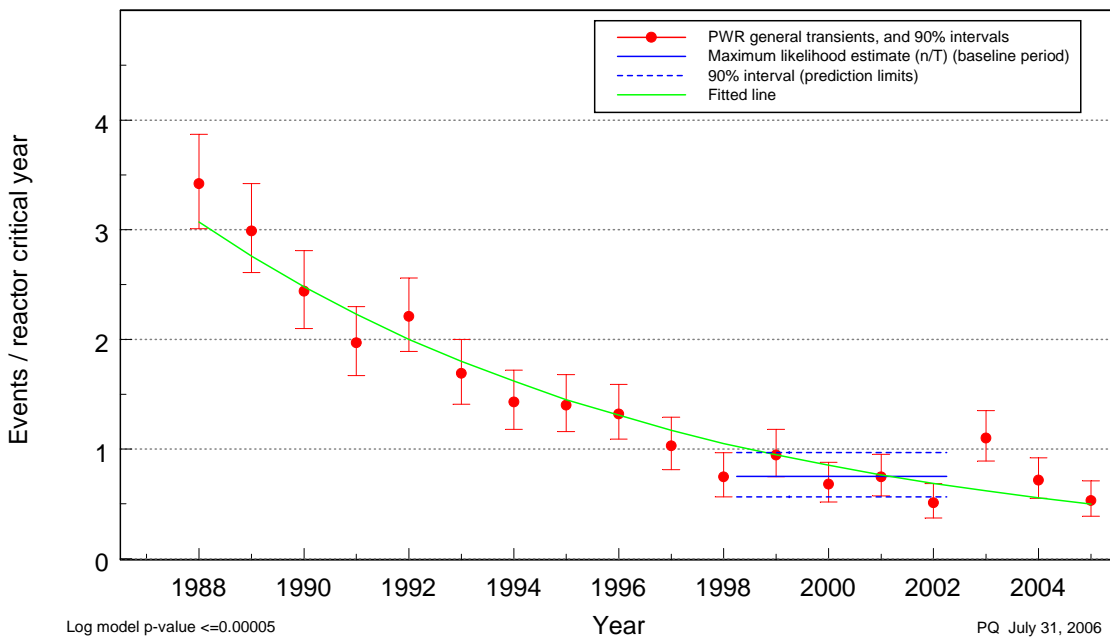


Figure 16. Frequency of PWR initiating events with general transients.