# Rates of Fire Events at

# U.S. Nuclear Power Plants

# 1987–2010

The fire study uses operating experience to characterize the frequency and nature of fire event data from operating U.S. commercial nuclear power plants.

This report presents an analysis of fire event frequencies at United States (U.S.) nuclear power plants. The evaluation is based on the operating experience from fiscal year 1987 through 2010. The data sources for this report include:

- Licensee Event Reports (LERs), 1987 to 2010
- Emergency Notifications (ENs)[1], 1990 to 2010
- Nuclear Plant Reliability Data System (NPRDS), 1987 to 1996
- Equipment Performance and Information Exchange (EPIX), 1997 to 2010
- Electric Power Research Institute (EPRI), 1986 to 1988[2]
- National Electric Insurers Limited (NEIL), 1993 to 2008.

This report updates the Office for Analysis and Evaluation of Operational Data (AEOD) report AEOD/S97-03, "*Special Study, Fire Events – Feedback of U.S. Operating Experience*," June 1997, updating data, frequency estimates, trends, and figures.

## 1 LATEST FREQUENCIES AND TRENDS

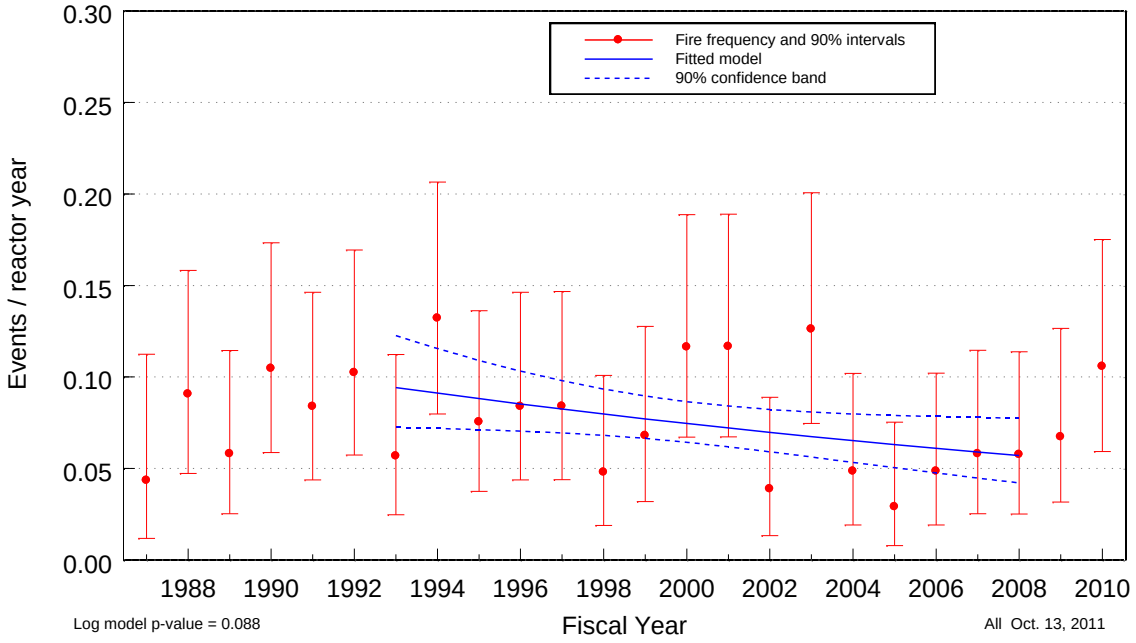
Fire frequency trends are plotted for fires that are of sufficient duration and size to be called "severe." Small fires that last longer than 5 minutes and are not "self-extinguished", medium fires that are not self-extinguished, and any large fires are included in the plots as long as they have a stated location (rather than "Other"). Figure 1 shows the trend of fires for all plant conditions, the trend is not statistically significant[3]. Figure 2 shows the trend of fires for at-power conditions, the trend is not statistically significant. Figure 3 shows the trend of fires for at-shutdown conditions, the trend is not statistically significant. Table 1, Table 2, and Table 3 show the data points for these figures.

[1] The Emergency Notification data source was added to the fire data collection in 2008.

[2] The EPRI data resides in the database. However, it is not included in any of the trend or engineering plots since it is only for a two-year period in 1986 to 1988.

[3] 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).

For each trend plot, a histogram based on the same data set shows the data source for the fire events. These histograms show that the data sources are only consistent from fiscal year 1993 to fiscal year 2008 (the NEIL data was updated through 2008 in fiscal year 2009). Therefore, trend lines and trend significance are only evaluated through this period.



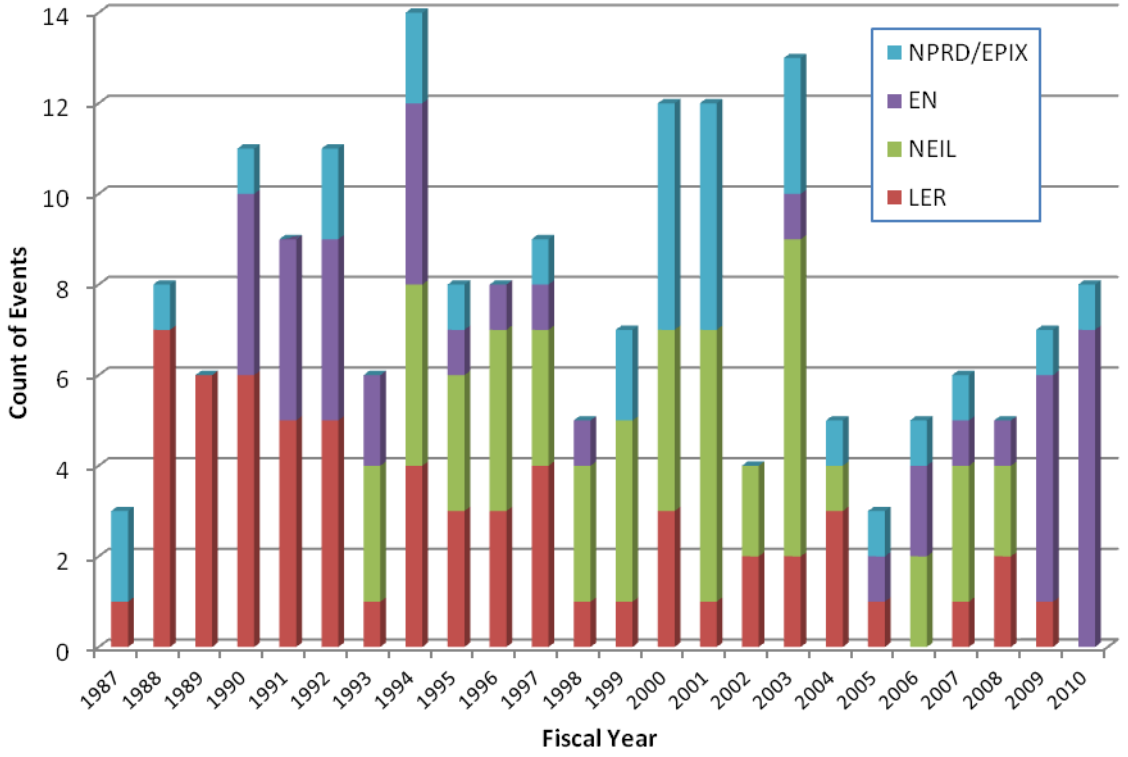
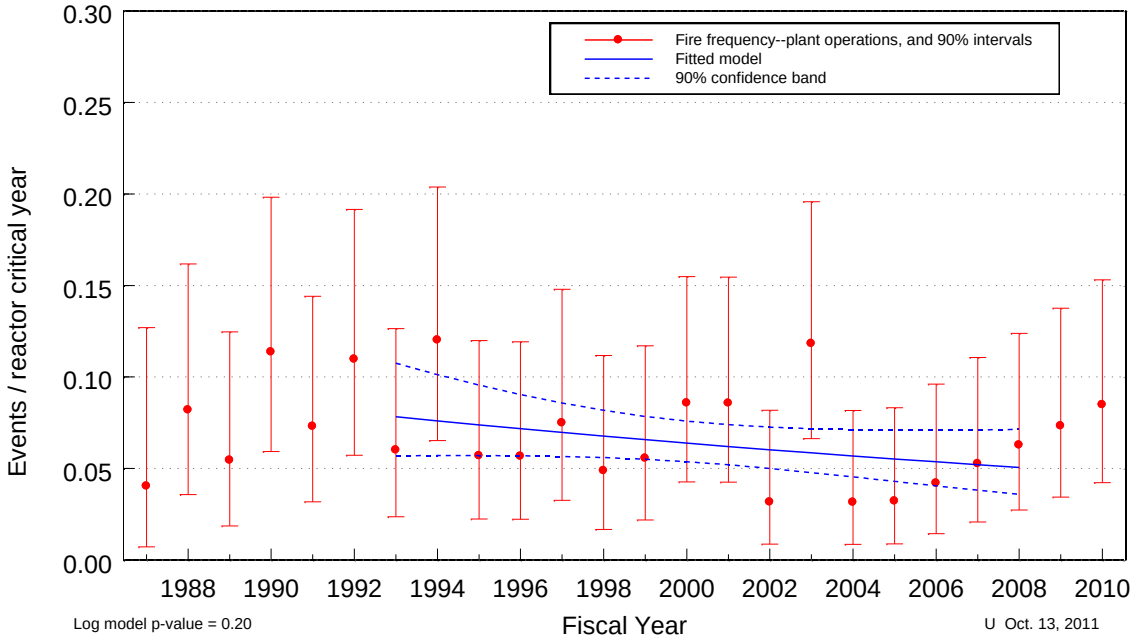




**Figure 1. Fire events by fiscal year for plant at power and shutdown.**



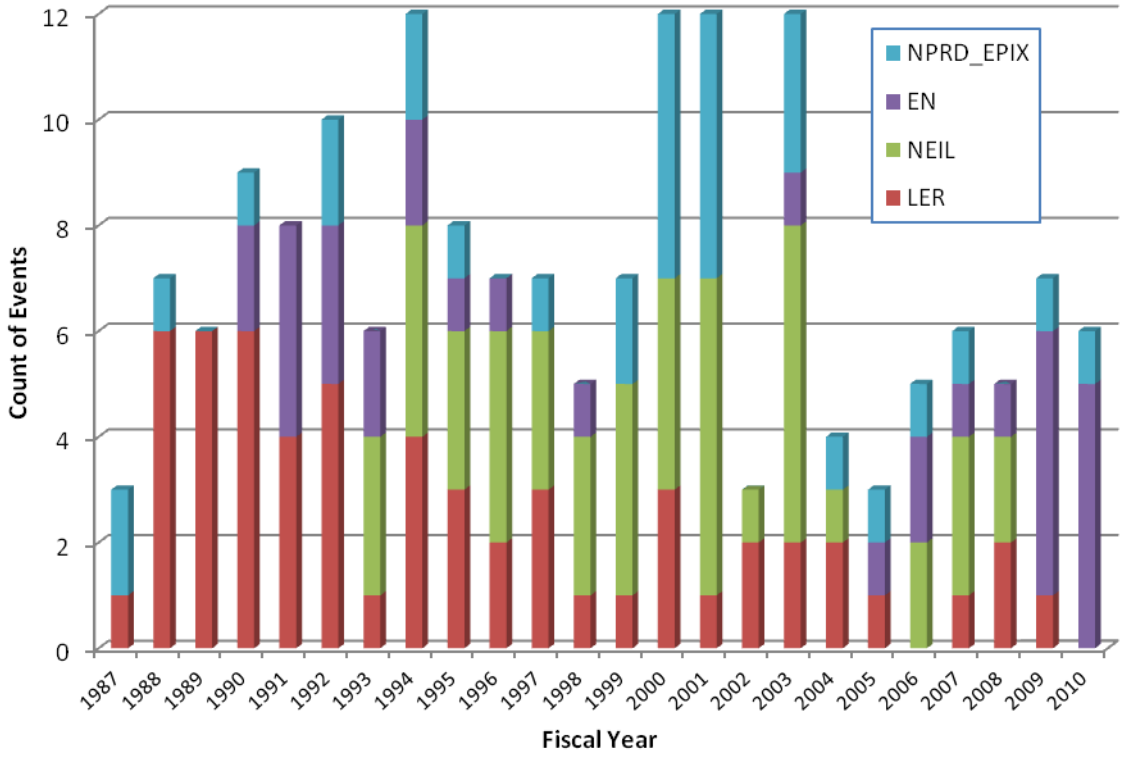
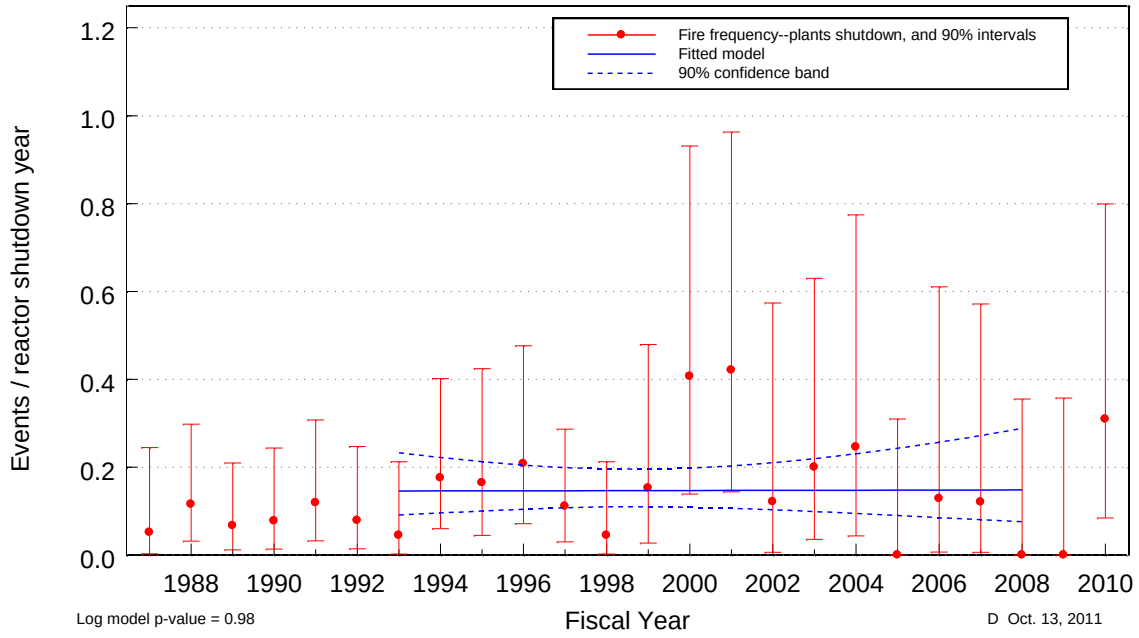




**Figure 2. Fire events by fiscal year for plant at power.**



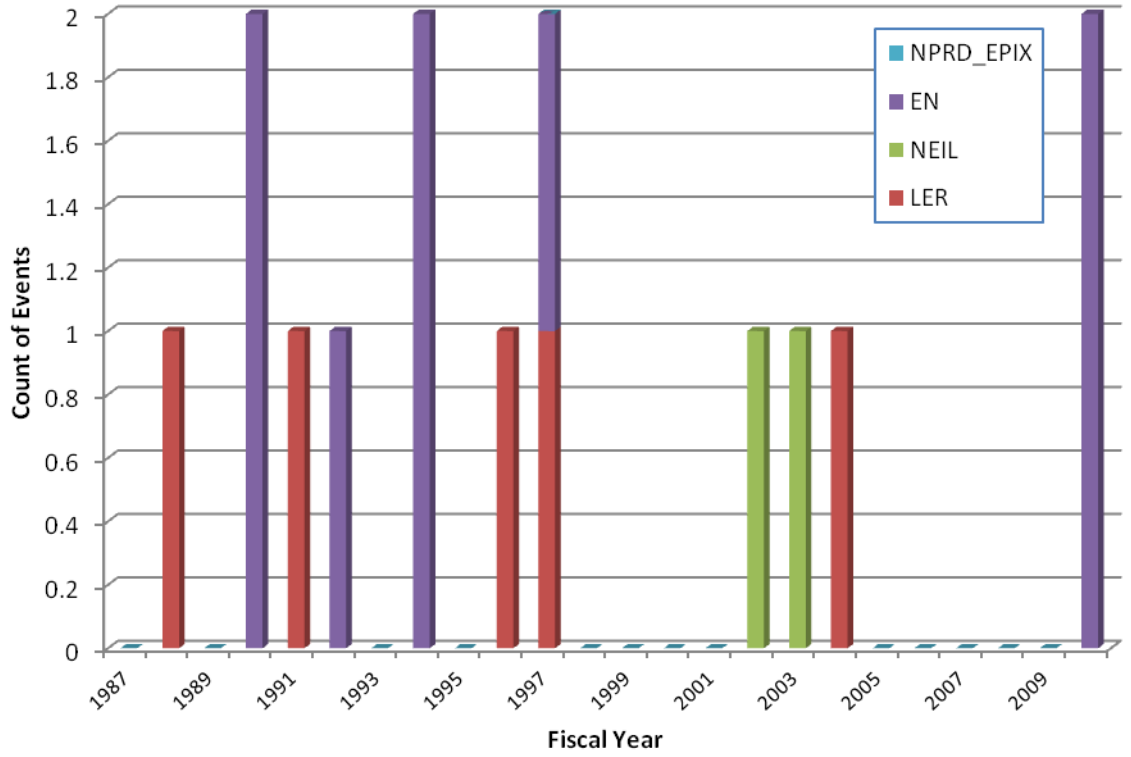




**Figure 3. Fire events by fiscal year for plant shutdown.**

# 2 FIRE DATA SUMMARY

The raw fire event data were sliced to show selected distributions. These distributions (Figure 4 to Figure 7) are based on all modes of operation and all severities of fires.

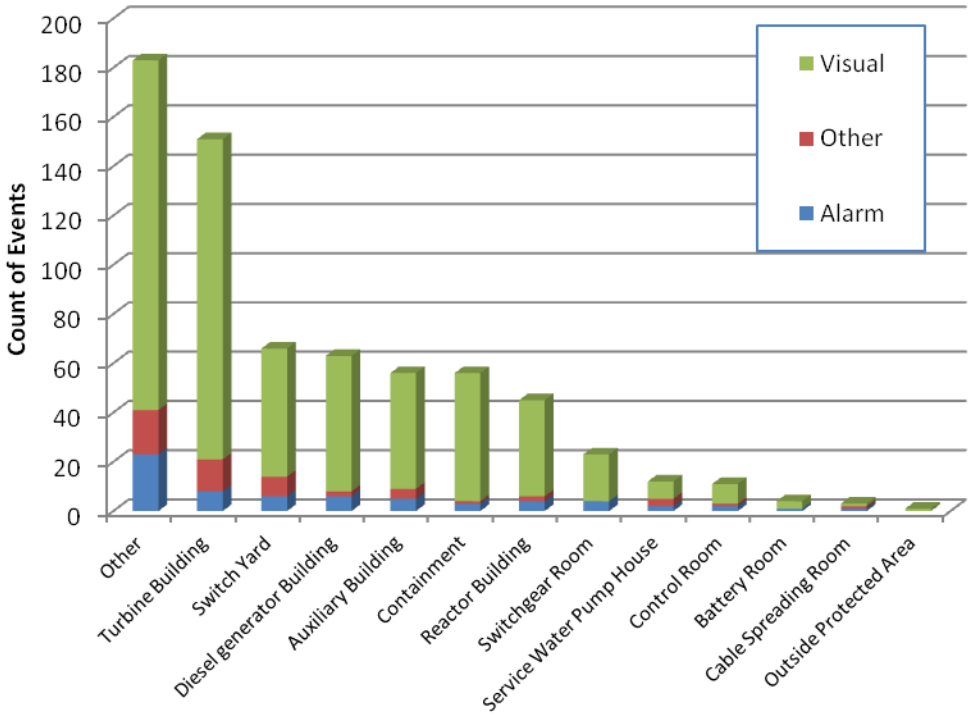



**Figure 4. Distribution of fire events by plant location and fire discovery method.**

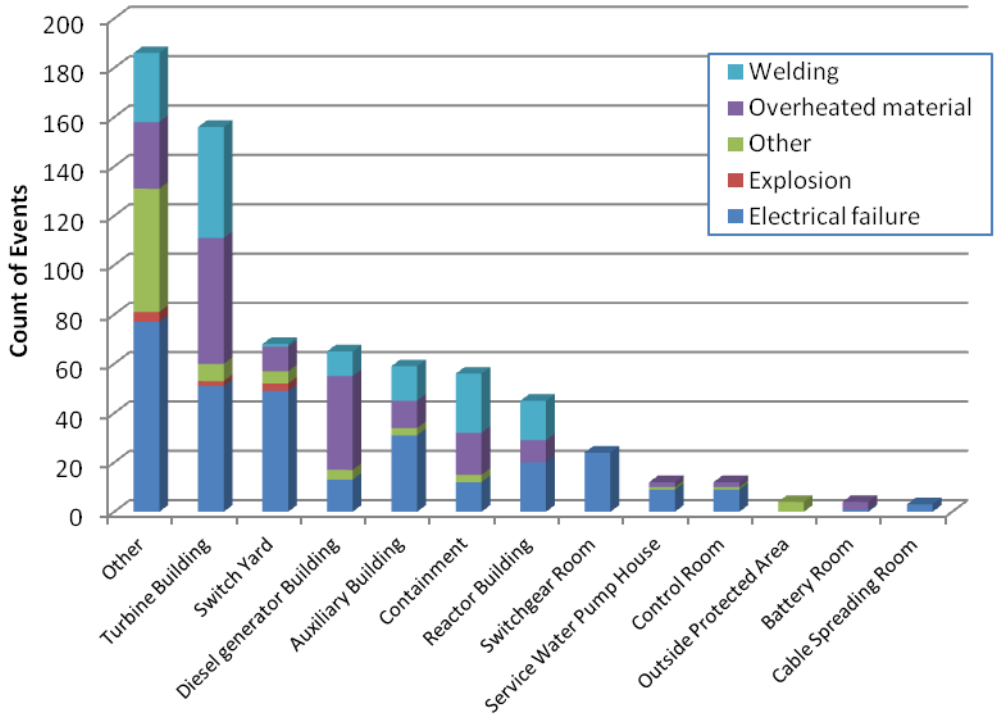



**Figure 5. Distribution of fire events by plant location and cause.**

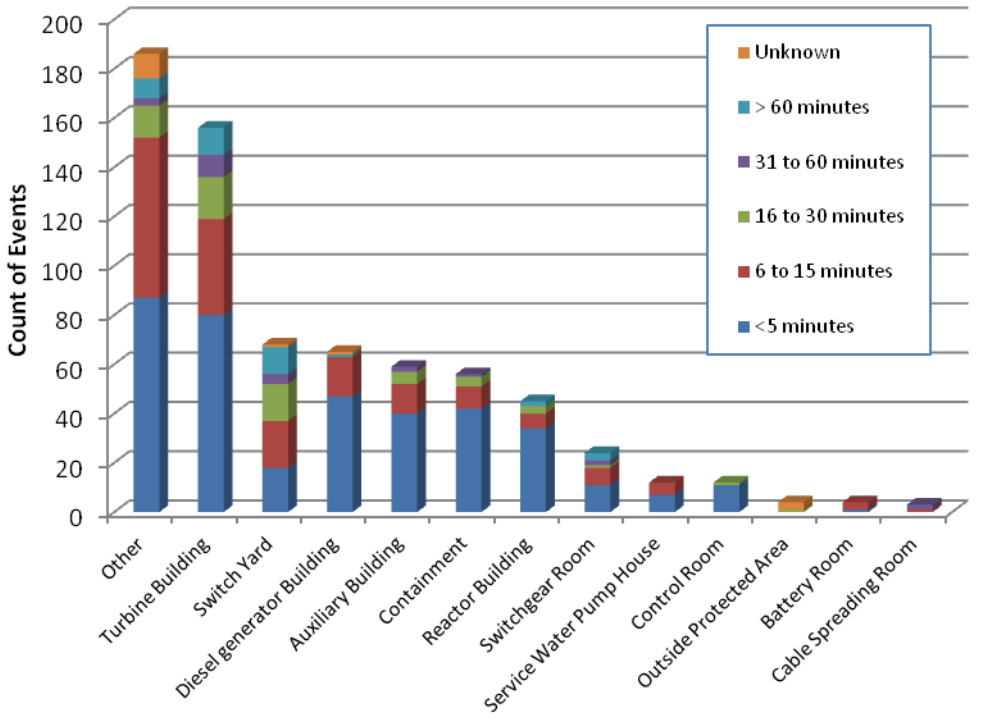



**Figure 6. Distribution of fire events by plant location and fire duration.**

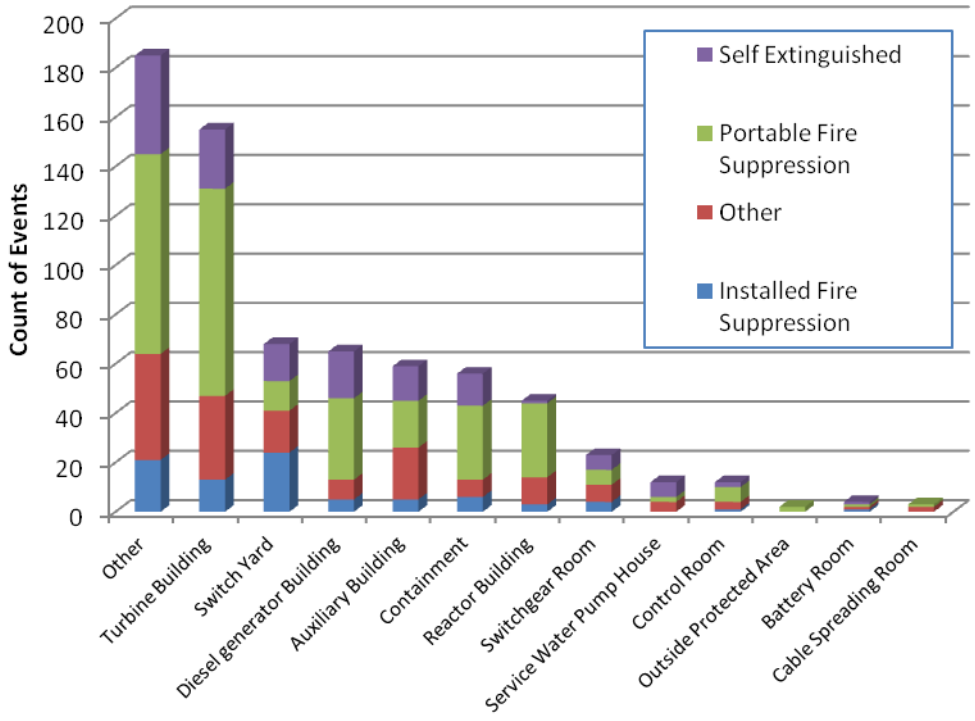



**Figure 7. Distribution of fire events by plant location and method of suppression.**

# 3 DATA TABLES

## 3.1 Data Tables for Fire Event Trends

**Table 1. Fire events all modes of operation. Figure 1**

| FY | Plot Trend Error Bar Points | | | Regression Curve Data Points | | |
|---|---|---|---|---|---|---|
| | Lower (5%) | Mean | Upper (95%) | Lower (5%) | Mean | Upper (95%) |
| 1987 | 1.19E-02 | 4.35E-02 | 1.12E-01 | . | . | . |
| 1988 | 4.73E-02 | 9.07E-02 | 1.58E-01 | . | . | . |
| 1989 | 2.53E-02 | 5.80E-02 | 1.14E-01 | . | . | . |
| 1990 | 5.87E-02 | 1.05E-01 | 1.73E-01 | . | . | . |
| 1991 | 4.37E-02 | 8.38E-02 | 1.46E-01 | . | . | . |
| 1992 | 5.74E-02 | 1.02E-01 | 1.69E-01 | . | . | . |
| 1993 | 2.48E-02 | 5.69E-02 | 1.12E-01 | 7.25E-02 | 9.43E-02 | 1.23E-01 |
| 1994 | 7.98E-02 | 1.32E-01 | 2.06E-01 | 7.19E-02 | 9.12E-02 | 1.16E-01 |
| 1995 | 3.76E-02 | 7.55E-02 | 1.36E-01 | 7.13E-02 | 8.82E-02 | 1.09E-01 |
| 1996 | 4.37E-02 | 8.38E-02 | 1.46E-01 | 7.05E-02 | 8.53E-02 | 1.03E-01 |
| 1997 | 4.38E-02 | 8.40E-02 | 1.47E-01 | 6.94E-02 | 8.25E-02 | 9.80E-02 |
| 1998 | 1.89E-02 | 4.80E-02 | 1.01E-01 | 6.81E-02 | 7.98E-02 | 9.34E-02 |
| 1999 | 3.19E-02 | 6.80E-02 | 1.28E-01 | 6.64E-02 | 7.71E-02 | 8.96E-02 |
| 2000 | 6.72E-02 | 1.16E-01 | 1.89E-01 | 6.43E-02 | 7.46E-02 | 8.65E-02 |
| 2001 | 6.73E-02 | 1.17E-01 | 1.89E-01 | 6.19E-02 | 7.21E-02 | 8.41E-02 |
| 2002 | 1.33E-02 | 3.88E-02 | 8.89E-02 | 5.92E-02 | 6.98E-02 | 8.23E-02 |
| 2003 | 7.47E-02 | 1.26E-01 | 2.01E-01 | 5.63E-02 | 6.75E-02 | 8.09E-02 |
| 2004 | 1.91E-02 | 4.85E-02 | 1.02E-01 | 5.33E-02 | 6.53E-02 | 7.98E-02 |
| 2005 | 7.94E-03 | 2.91E-02 | 7.53E-02 | 5.04E-02 | 6.31E-02 | 7.90E-02 |
| 2006 | 1.91E-02 | 4.85E-02 | 1.02E-01 | 4.75E-02 | 6.10E-02 | 7.84E-02 |
| 2007 | 2.53E-02 | 5.80E-02 | 1.15E-01 | 4.48E-02 | 5.90E-02 | 7.79E-02 |
| 2008 | 2.51E-02 | 5.77E-02 | 1.14E-01 | 4.21E-02 | 5.71E-02 | 7.74E-02 |
| 2009 | 3.16E-02 | 6.74E-02 | 1.27E-01 | . | . | . |
| 2010 | 5.93E-02 | 1.06E-01 | 1.75E-01 | . | . | . |

**Table 2. Fire events at power. Figure 2**

| FY | Plot Trend Error Bar Points | | | Regression Curve Data Points | | |
|---|---|---|---|---|---|---|
| | Lower (5%) | Mean | Upper (95%) | Lower (5%) | Mean | Upper (95%) |
| 1987 | 7.17E-03 | 4.03E-02 | 1.27E-01 | . | . | . |
| 1988 | 3.57E-02 | 8.19E-02 | 1.62E-01 | . | . | . |
| 1989 | 1.86E-02 | 5.45E-02 | 1.25E-01 | . | . | . |
| 1990 | 5.93E-02 | 1.14E-01 | 1.98E-01 | . | . | . |
| 1991 | 3.18E-02 | 7.30E-02 | 1.44E-01 | . | . | . |
| 1992 | 5.72E-02 | 1.10E-01 | 1.91E-01 | . | . | . |
| 1993 | 2.37E-02 | 6.01E-02 | 1.26E-01 | 5.69E-02 | 7.83E-02 | 1.08E-01 |
| 1994 | 6.52E-02 | 1.20E-01 | 2.04E-01 | 5.70E-02 | 7.60E-02 | 1.01E-01 |
| 1995 | 2.25E-02 | 5.70E-02 | 1.20E-01 | 5.70E-02 | 7.38E-02 | 9.56E-02 |
| 1996 | 2.24E-02 | 5.67E-02 | 1.19E-01 | 5.69E-02 | 7.17E-02 | 9.04E-02 |
| 1997 | 3.26E-02 | 7.49E-02 | 1.48E-01 | 5.66E-02 | 6.97E-02 | 8.58E-02 |
| 1998 | 1.67E-02 | 4.88E-02 | 1.12E-01 | 5.60E-02 | 6.77E-02 | 8.18E-02 |
| 1999 | 2.19E-02 | 5.56E-02 | 1.17E-01 | 5.50E-02 | 6.57E-02 | 7.85E-02 |
| 2000 | 4.27E-02 | 8.58E-02 | 1.55E-01 | 5.37E-02 | 6.39E-02 | 7.59E-02 |
| 2001 | 4.26E-02 | 8.56E-02 | 1.55E-01 | 5.20E-02 | 6.20E-02 | 7.39E-02 |
| 2002 | 8.63E-03 | 3.17E-02 | 8.18E-02 | 5.00E-02 | 6.02E-02 | 7.26E-02 |
| 2003 | 6.63E-02 | 1.18E-01 | 1.96E-01 | 4.77E-02 | 5.85E-02 | 7.17E-02 |
| 2004 | 8.61E-03 | 3.16E-02 | 8.17E-02 | 4.53E-02 | 5.68E-02 | 7.13E-02 |
| 2005 | 8.77E-03 | 3.22E-02 | 8.31E-02 | 4.29E-02 | 5.52E-02 | 7.10E-02 |
| 2006 | 1.43E-02 | 4.20E-02 | 9.61E-02 | 4.05E-02 | 5.36E-02 | 7.10E-02 |
| 2007 | 2.07E-02 | 5.26E-02 | 1.11E-01 | 3.82E-02 | 5.21E-02 | 7.11E-02 |
| 2008 | 2.73E-02 | 6.27E-02 | 1.24E-01 | 3.59E-02 | 5.06E-02 | 7.13E-02 |
| 2009 | 3.44E-02 | 7.33E-02 | 1.38E-01 | . | . | . |
| 2010 | 4.22E-02 | 8.48E-02 | 1.53E-01 | . | . | . |

**Table 3. Fire events with plant shutdown. Figure 3**

| FY | Plot Trend Error Bar Points | | | Regression Curve Data Points | | |
|---|---|---|---|---|---|---|
| | Lower (5%) | Mean | Upper (95%) | Lower (5%) | Mean | Upper (95%) |
| 1987 | 2.65E-03 | 5.16E-02 | 2.45E-01 | . | . | . |
| 1988 | 3.14E-02 | 1.15E-01 | 2.98E-01 | . | . | . |
| 1989 | 1.18E-02 | 6.66E-02 | 2.10E-01 | . | . | . |
| 1990 | 1.38E-02 | 7.74E-02 | 2.44E-01 | . | . | . |
| 1991 | 3.25E-02 | 1.19E-01 | 3.08E-01 | . | . | . |
| 1992 | 1.40E-02 | 7.85E-02 | 2.47E-01 | . | . | . |
| 1993 | 2.29E-03 | 4.47E-02 | 2.12E-01 | 9.12E-02 | 1.46E-01 | 2.33E-01 |
| 1994 | 6.00E-02 | 1.76E-01 | 4.02E-01 | 9.59E-02 | 1.46E-01 | 2.22E-01 |
| 1995 | 4.47E-02 | 1.64E-01 | 4.24E-01 | 1.00E-01 | 1.46E-01 | 2.12E-01 |
| 1996 | 7.11E-02 | 2.08E-01 | 4.76E-01 | 1.04E-01 | 1.46E-01 | 2.05E-01 |
| 1997 | 3.02E-02 | 1.11E-01 | 2.87E-01 | 1.08E-01 | 1.46E-01 | 1.99E-01 |
| 1998 | 2.29E-03 | 4.47E-02 | 2.12E-01 | 1.10E-01 | 1.46E-01 | 1.96E-01 |
| 1999 | 2.70E-02 | 1.52E-01 | 4.79E-01 | 1.10E-01 | 1.47E-01 | 1.95E-01 |
| 2000 | 1.39E-01 | 4.07E-01 | 9.31E-01 | 1.09E-01 | 1.47E-01 | 1.98E-01 |
| 2001 | 1.44E-01 | 4.21E-01 | 9.63E-01 | 1.07E-01 | 1.47E-01 | 2.03E-01 |
| 2002 | 6.21E-03 | 1.21E-01 | 5.74E-01 | 1.03E-01 | 1.47E-01 | 2.10E-01 |
| 2003 | 3.56E-02 | 2.00E-01 | 6.30E-01 | 9.89E-02 | 1.47E-01 | 2.19E-01 |
| 2004 | 4.37E-02 | 2.46E-01 | 7.74E-01 | 9.44E-02 | 1.47E-01 | 2.30E-01 |
| 2005 | 0.00E+00 | 0.00E+00 | 3.10E-01 | 8.98E-02 | 1.48E-01 | 2.43E-01 |
| 2006 | 6.60E-03 | 1.29E-01 | 6.10E-01 | 8.51E-02 | 1.48E-01 | 2.57E-01 |
| 2007 | 6.18E-03 | 1.20E-01 | 5.71E-01 | 8.06E-02 | 1.48E-01 | 2.72E-01 |
| 2008 | 0.00E+00 | 0.00E+00 | 3.55E-01 | 7.61E-02 | 1.48E-01 | 2.88E-01 |
| 2009 | 0.00E+00 | 0.00E+00 | 3.58E-01 | . | . | . |
| 2010 | 8.43E-02 | 3.09E-01 | 7.99E-01 | . | . | . |