Fuel Cycle Annual Operating Experience Report 2017

1.0 Purpose:

The Fuel Cycle Operating Experience Program (FC OpE) supports technical and licensing staff, inspectors, and management by providing insights that can inform inspection planning, licensing reviews, and program changes. The purpose of this annual report is to provide an analysis of reported events at fuel cycle facilities that identifies trends and to make recommendations to improve fuel cycle programs.

2.0 Discussion:

Fuel cycle events are reported under Title 10 of the *Code of Federal Regulations (10 CFR)*, Part 40.60 “Reporting Requirements,” 10 CFR Part 70.50 “Reporting Requirements”, 10 CFR Part 70.74 “Additional Reporting Requirements,” 10 CFR Part 70 Appendix A, “Reportable Safety Requirements,” and 10 CFR Part 76.120 “Reporting Requirements.” Table A below shows the total number of events received per fuel cycle facility during 2007-2017. Security-related and fitness for duty events are not included in this data set. The data includes retracted events for trending purposes[1]. This report analyzes the data over a period of 11 years.

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
AREVA	3	3	5	1	2	2	2	1	2	2	0
BWXT	8	4	2	2	1	2	1	0	3	1	1
Global Nuclear Fuels - Americas	4	5	1	7	14	8	3	2	0	2	1
Honeywell	2	1	4	1	16	10	7	12	5	0	0
Louisiana Energy Services/ URENCO USA	0	0	0	0	3	0	1	0	2	1	2
Nuclear Fuel Services	3	5	6	2	0	1	0	6	1	3	0
Paducah & Portsmouth	13	15	10	5	9	4	3	4	0	0	0
Westinghouse	2	1	2	5	1	2	0	0	1	2	1
Total number of events per year	35	34	30	23	46	29	17	25	14	11	5

Table 1. Total Number of Events at Fuel Facilities

Last year the FC OpE report provided an analysis of fuel cycle events reported from 2012 to 2017; this year, the FC OpE report includes events back to 2007. The staff increased the period of data to perform a more in-depth analysis. An assessment of the data that only highlights the number of reports per year does not overtly reveal any statistically significant behavior. This observation led the staff to perform a sensitivity study. For the sensitivity study, the staff eliminated certain events from the data pool. From a total of 268 events, the staff removed

[1] The Fuel Cycle Annual Operating Experience Report 2016 does not include data on events that were reported to the NRC but subsequently retracted. The staff believes that data from these retracted events still provide useful information for assuring continuous improvement of regulatory programs. Therefore, data on retracted events are included in the 2017 report.

events at Paducah, totaling 63 events. The NRC ceased regulatory activities at the Paducah facility in the fall of 2014. As such, Paducah did not provide data for the last three years of the period. In addition, the agency no longer regulates this facility, or any other gaseous diffusion plants, and it is unlikely that operating experience for this facility will provide useful information to the inspection program. Additionally, the staff removed 39 unplanned medical treatment events.[2] These events were not considered because they involved personal health issues (e.g., low blood sugar, heart attacks), non-radiological, or non-chemical exposure events (e.g., a pinched finger). The contributing factors leading to these events are considered occupational hazards or personal health. After removing the Paducah and unplanned medical treatment events, the staff retained 166 events for the sensitivity study.

The staff performed a linear regression analysis on the sensitivity study data. The purpose of this analysis was to identify potential trends in the data and to determine if there are recurring issues of safety significance that would merit changes to the inspection program. Figure 1 provides a visual representation of the data included in the sensitivity study and the linear regression. The results of linear regression on the data suggest that a linear trend analysis may not appropriately model the data. The value of R^2 as shown in Figure 1 means that the linear regression model explains a little more than 50% of the variance in the model; therefore, linear regression may not be the best method for analyzing the data or predicting trends. Given that the data consists of events occurring over a period of time, the staff chose to apply a time series analyses. The staff applied several time series models, including simple moving average, autoregressive integrated moving average, and single and double exponential smoothing. The model with the best fit is double exponential smoothing with a mean absolute deviation (MAD) of four (4) events. This analysis provides a reasonable mean absolute percent error (MAPE) of 36% which indicates a significantly better fit than the linear regression model and suggests that the total number of events follows a time series model.

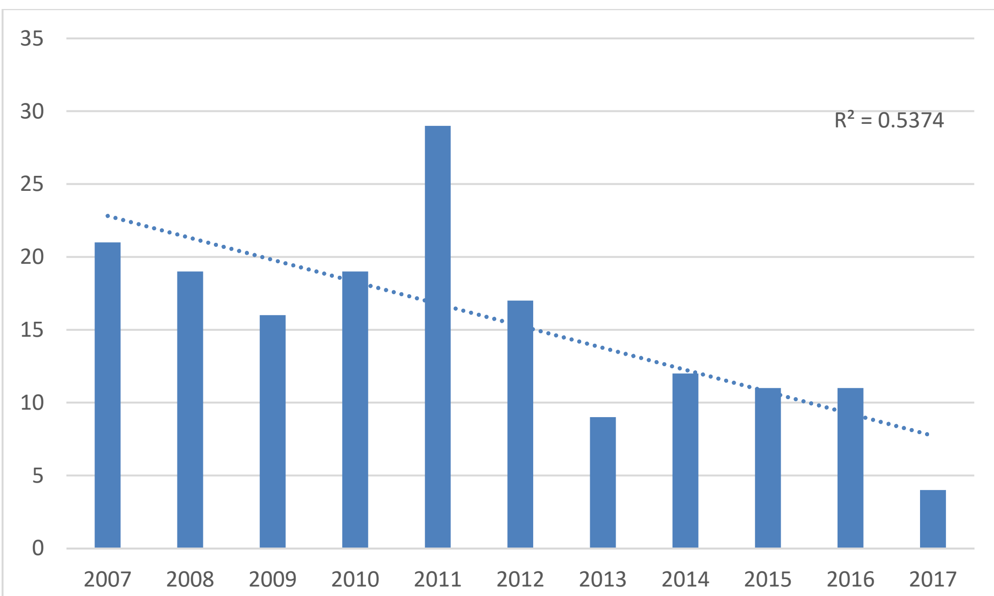
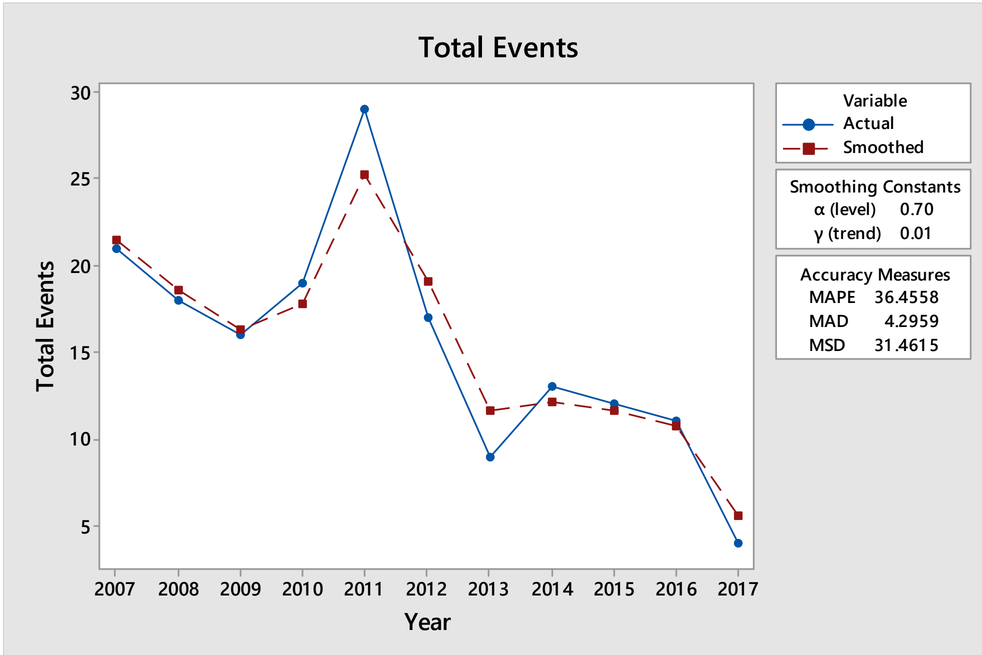


Figure 1. Sensitivity Study Data

[2] Events reported under 40.60(b)(1) and 70.50(b)(1)



Note: *Mean Absolute Percent Error (MAPE); Mean Absolute Deviation (MAD); Mean Standard Deviation (MSD)*

Figure 2. Time Series Model

Figure 2 shows the time series model with the sensitivity study data.

To provide feedback to the inspection program, the staff used the quantitative time series analysis to develop a qualitative analysis method described in the event screening process.

<u>Event Screening Process:</u>

The staff developed an event screening process to categorize and characterize the data. The event screening process consists of three steps: (1) determine the applicable performance areas (e.g., areas relevant to core inspections in fuel cycle); (2) determine contributing factors that led to the events; and (3) determine the level of safety significance (See the Office of Nuclear Material Safety and Safeguards Policy and Procedure 6-14, “Fuel Cycle Operating Experience,” for details regarding the screening criteria). A group of Fuel Cycle, Safeguard, and Environmental review technical staff from the respective performance areas and the respective NRC project manager, responsible for the referenced facility, performed the screening, during which they considered initial event notification information and applicable inspection reports in order to make the determinations.

Performance Area Evaluation:

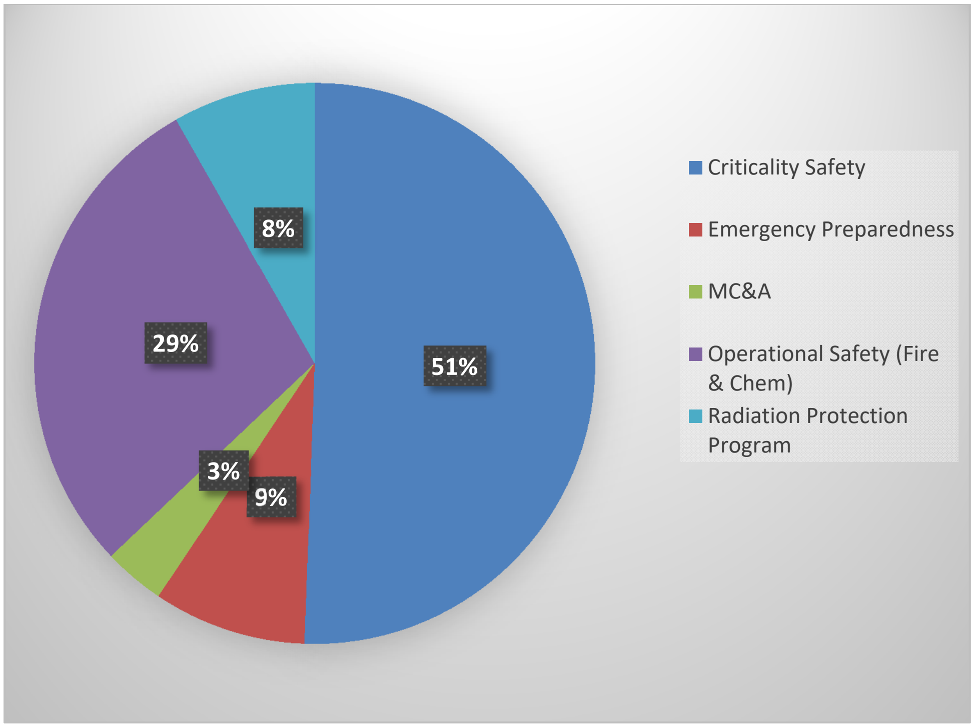


Figure 3. Categorization of Events per Performance Area

Taking into consideration the discrete sensitivity study data and the inspection areas outlined in inspection procedures, the staff selected five performance areas: criticality safety, operational safety, emergency preparedness, radiation safety, and material control and accounting. Figure 3 is a visual representation of the percentage of the total number of events per performance area. Criticality safety is the performance area with the highest number of events in the last 11 years (51 percent), followed by operational safety (29 percent) and emergency preparedness (9 percent). The remaining 11 percent of the events is related to radiation protection and material control and accounting.

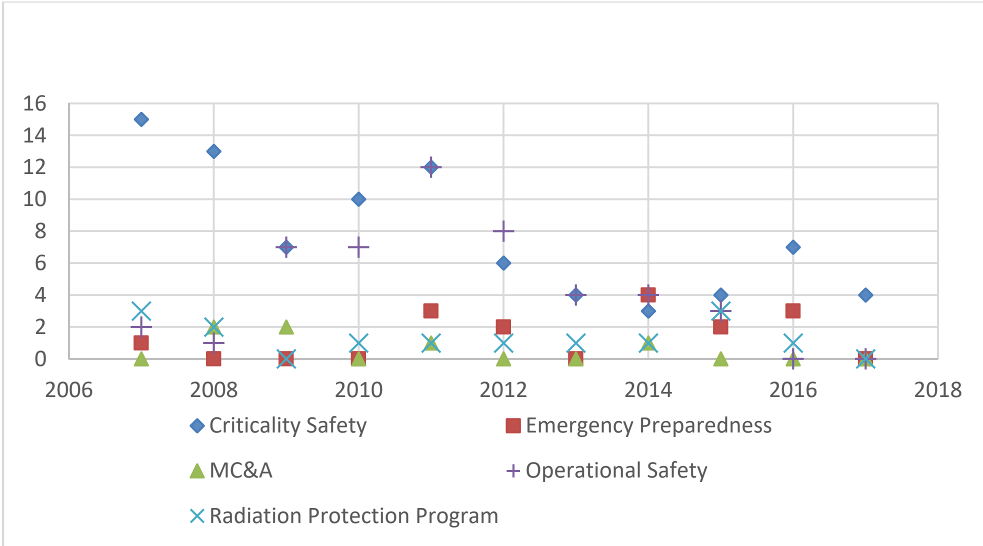


Figure 4. Events per year by performance area

After the staff determined the magnitude of events per performance area, the staff performed a detailed analysis of the number of events per year by performance area. Figure 4 is a scatter plot that illustrates the number of events per year by performance area. The plot shows that criticality safety events have the highest number of events per year followed by operational safety events with the exception of 2012.

To understand the trend of events over the period of 11 years, the staff performed a detailed qualitative analysis of the description of each event and inspection reports. From this evaluation, the staff identified patterns in event themes, leading contributing factors, and corrective actions. The predominant themes for facilities licensed under 10 CFR Part 70 are unexpected accumulation of special nuclear material (SNM); unanalyzed conditions or invalid assumptions in the facility Integrated Safety Analysis (ISA); and Criticality Warning System (CWS) or Criticality Accidents Alarm Systems (CAAS) failures. For the facility licensed under 10 CFR Part 40, the predominant theme was chemical releases.

After the determination of common themes, the staff identified a pattern in the leading contributing factors for these failures. The staff noted that failures and degradations of management measures was the most recurring factor among the total number of events. Specifically, the leading contributing factor was a failure in maintaining configuration management, followed closely by procedural and maintenance inadequacies. The staff also evaluated the licensees' approaches for corrective actions and noted that the corrective actions applied to each individual event also exhibited a pattern. The pattern includes the implementation of additional training combined with modifications to implementing procedures; modification to the ISA; or, if it is an equipment malfunction, repair of the equipment without performing an extent of condition.

Given the cyclic trend of the events and repetitive themes, the staff concludes that the problem identification capabilities at fuel cycle facilities can be improved and a more pro-active philosophy should be the norm. Based on performing an event detailed qualitative analysis, the staff identified that similar events re-appear every 3 to 7 years.

Safety Significance Evaluation:

The staff used the sensitivity study data to analyze safety significant events. Consistent with the NRC Enforcement Policy, the staff rates safety significant events from high to low using NMSS P&P 6-14 criteria. Figure 5 illustrates the distribution of safety significant events per year. Based on the rating criteria, the staff determined that 24 out of 168 events were of medium to high safety significance. Out of the 24 events, the staff notes that 14 are related to criticality safety, seven (7) to operational safety, and five (5) to emergency preparedness.[3] The distribution of these events further supports the staff's recommendation to weight CY 2018 inspection planning towards criticality and operational safety.

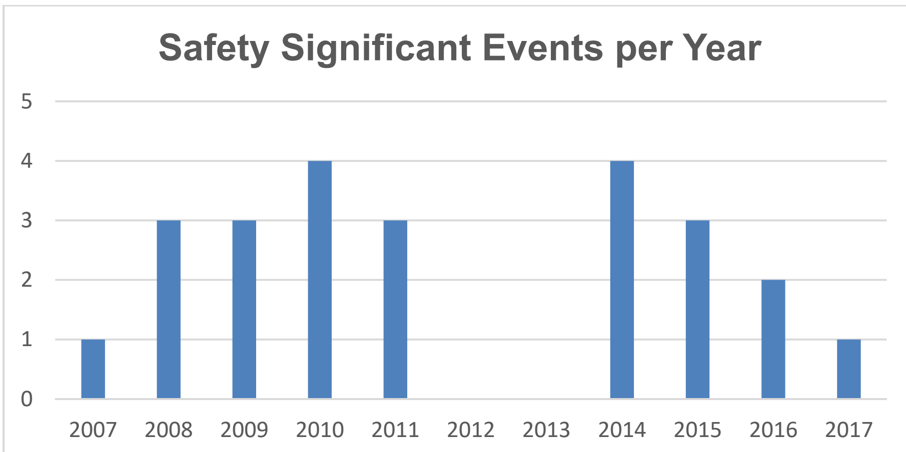


Figure 5. Safety Significant Events per Year

[3]As part of the evaluation process, the staff observed that two safety significant events were applicable to two performance areas. The staff counted these events as a single event which is reflected in a deviation between the total number of safety significant events and the classification of events per performance area.

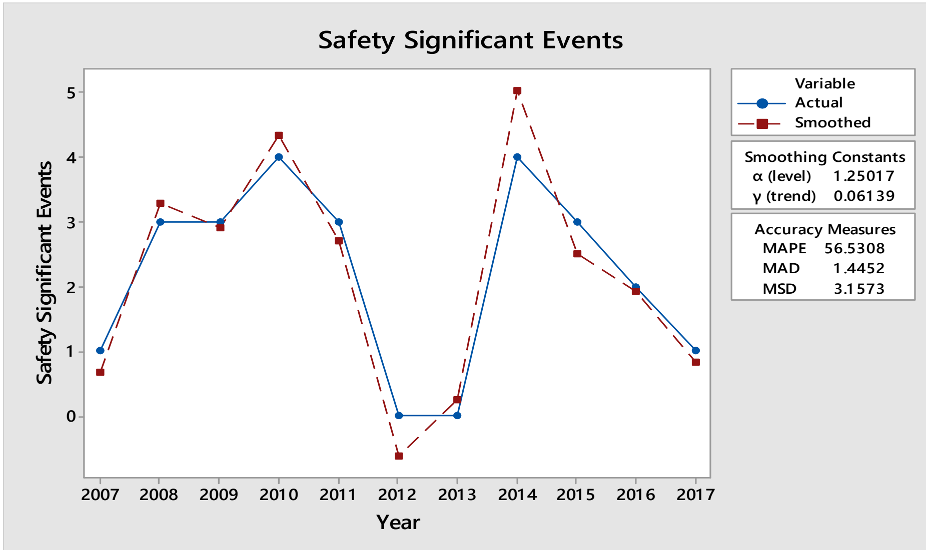


Figure 6. Time Series for Safety Significant Events

Figure 6 illustrates a time series sequence of safety significant events. It is evident that removing events with lower safety significance highlights the cyclic nature of the events.

3.0 Conclusions:

Based on the analysis above, the staff concludes that:

1. A time series plot is a reasonable model for the FC OpE data, that shows a time series trend on the total number of events.

2. A performance area analysis identified the predominant themes of reported events for facilities licensed under 10 CFR Part 70. Those themes are: (1) the unexpected accumulation of SNM; (2) unanalyzed conditions or invalid assumptions in the facility ISA; and (3) failures in CWS or CAAS. For facilities licensed under 10 CFR Part 40, chemical releases are the most commonly reported event.

3. The analysis of events occurring at individual facilities identified a cycle of similar events that re-appear every 3 to 7 years.

4. The analysis of the total number of events (excluding events from Paducah and unplanned medical treatment) indicates that the most frequent contributing factor was a failure or degradation in management measures (i.e., failures in configuration management, procedures, and maintenance.)