Safety System Actuations (SSA) Analysis

Introduction

Exceeding a single early-warning threshold is not uncommon, because this threshold is based on a 95% prediction limit. For each indicator and each year, there is a 1 in 20 chance of exceeding an early-warning threshold with no change in the factors that influence the underlying performance indicator (PI) occurrence rate. When unforseen events occur, such as the August 2003 blackout event, a “spike” may be observed in one or more indicators. This occurred with scrams and safety system actuations (SSAs) in FY 2003.

The SSA indicator exceeded its prediction limit in FY 2005. The FY 2005 data were reviewed to identify possible trends and patterns that would account for the higher number of events, but no pattern was found. The events occurred at many sites and were caused by many different factors. No trend was observed in the proportion of the events involving emergency diesel generator (EDG) actuations rather than emergency core cooling system (ECCS) actuations. The only notable trend observed in the data is that, among the ECCS actuations, a statistically significant increasing incidence of events involving scrams was observed for the FY 1996 – FY 2005 period.

There appears to be no single driving factor behind this unexpected increase from FY 2004 levels, especially since there was no corresponding increase in scrams. This enclosure illustrates the various trends and patterns associated with this increase and offers some possible causes.

SSA Trends and Patterns

Figure 1 displays the number of SSAs per year for the last 10 fiscal years. As can be seen, there were sharp spikes in the number of SSAs in FY 2003 and FY 2005. The FY 2003 spike had a single driving factor behind it and a corresponding spike in scrams; numerous electrical grid problems caused both indicators to increase dramatically.

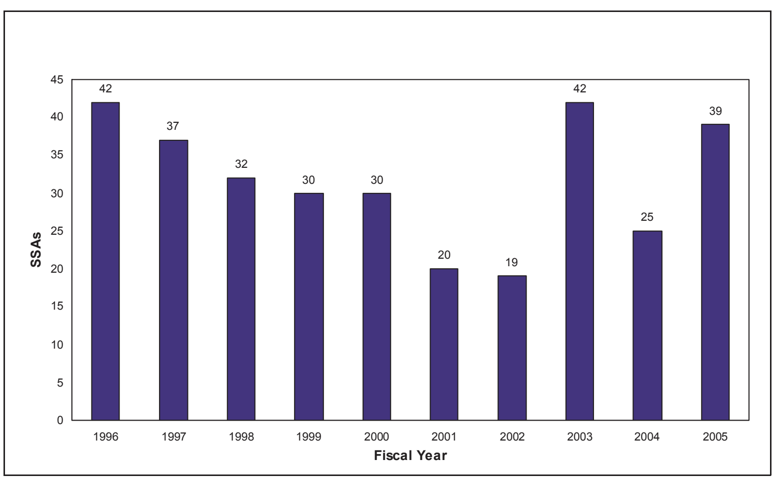

Figure 1. Safety System Actuations

There are two types of SSAs: EDG actuations and ECCS actuations. Figure 2 displays the number and approximate proportion of each type. As can be seen from Figure 2, neither type was predominantly responsible for the FY 2005 increase. Many SSAs are associated with scrams. This occurs either from the cause of the scram (e.g., losses of offsite power often actuate EDGs and scram the reactor) or, in the case of ECCS, are triggered by the scram transient. Figure 3 displays the percentage of SSAs that were associated with scrams. As can be seen, the percentage of FY 2005 SSAs associated with scrams is not unusual, which explains why there was no corresponding spike in FY 2005 scrams.

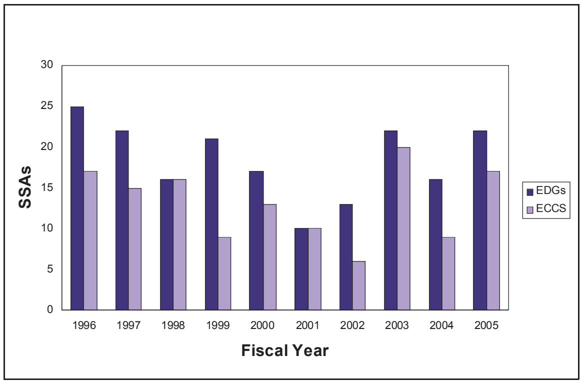

Figure 2. EDG and ECCS SSAs

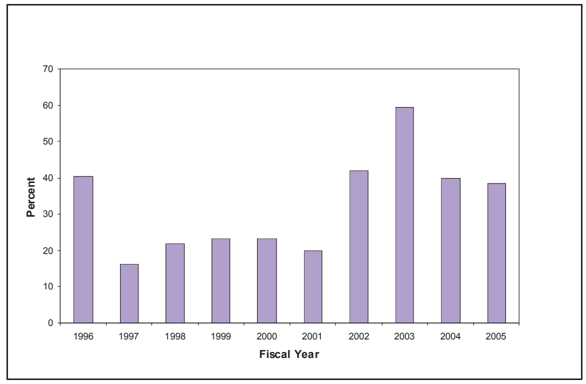

Figure 3. Percentage of SSAs associated with scrams

When the two types of SSAs are separated and the percentages of each type associated with scrams are reviewed, the picture becomes more informative. Figure 4 displays the percentage of EDG and ECCS SSAs that are associated with scrams.

The FY 2001 – FY 2005 period displays first an increase and then a decrease in EDG SSAs associated with scrams, with a peak in FY 2003. Grid-related scrams caused both scrams and SSAs to exceed their prediction limits in FY 2003.

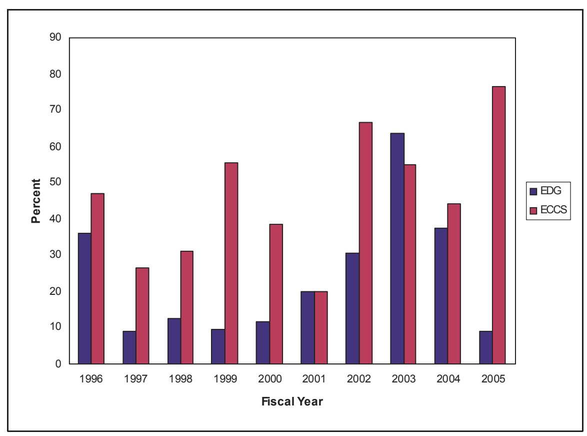

Figure 4. Percentage of EDG and ECCS SSAs associated with scrams

ECCS SSAs associated with scrams show another interesting pattern. Despite a lot of scatter in the data, the percentage of ECCS SSAs associated with scrams has been increasing. In fact, an analysis of the 10-year period shows that the increase is statistically significant. The driving factor behind this increase is not apparent.

Overall, there may be another explanation to the FY 2003 and FY 2005 spikes. It is possible that, other than the contribution to FY 2003 SSA from the single August 2003 blackout event, the FY 2003 and FY 2005 spikes are not anomalous in themselves. Instead, it is possible that the numbers for FY 2001 and FY 2002 were anomalously low. Figure 5 displays the number of SSAs for the last 10 fiscal years, excluding the 12 SSAs associated with the August 2003 blackout event.

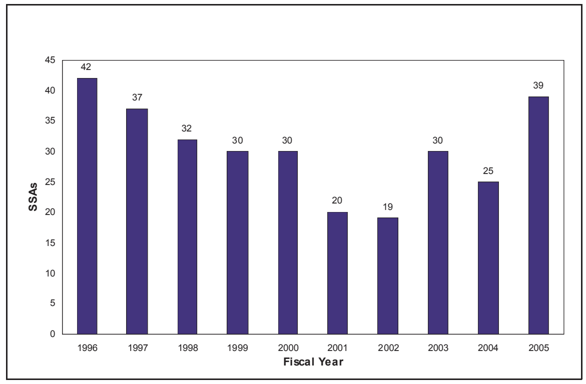

Figure 5. SSAs excluding the 12 SSAs associated with the FY 2003 blackout event

Figure 5 shows that the SSAs from FY 2003 to FY 2005 fall within the range of the data seen previous to FY 2001 within the 10-year period analyzed. Furthermore, the decrease from FY 2000 to FY 2001 represents a 33% drop within a single year. Such a proportionally large drop is unusual for the industry trend PIs that are not influenced by much subjectivity in reporting or analyses. If FY 2001 and FY 2002 are indeed anomalous, then it can reasonably be expected that future SSAs will continue at FY 2003 – FY 2005 levels.

Another way to attempt to characterize the factors behind the FY 2005 SSA spike is to look at the causes of the SSAs. Figures 6 and 7 display the various cause categories for EDG and ECCS SSAs, respectively. For EDG SSAs, human error, which had been on a downward trend previously, was the large FY 2005 contributor and significantly increased from previous years. These human errors were largely attributed to inattention to detail, including such things as shorting a test lead, contacting the wrong terminals during testing, and operating the wrong train's test switch. For FY 2005 ECCS SSAs, the primary cause was equipment problems.

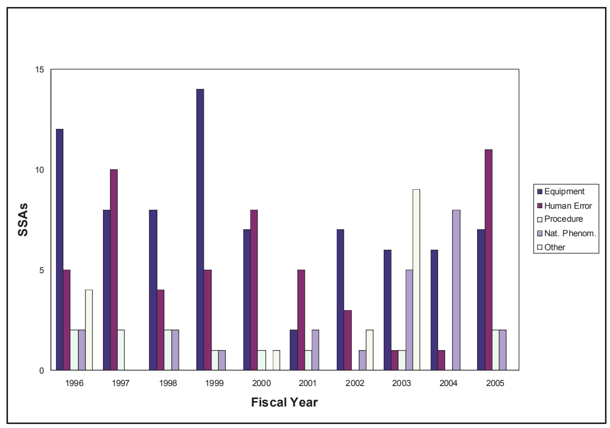

Figure 6. EDG SSA cause categories

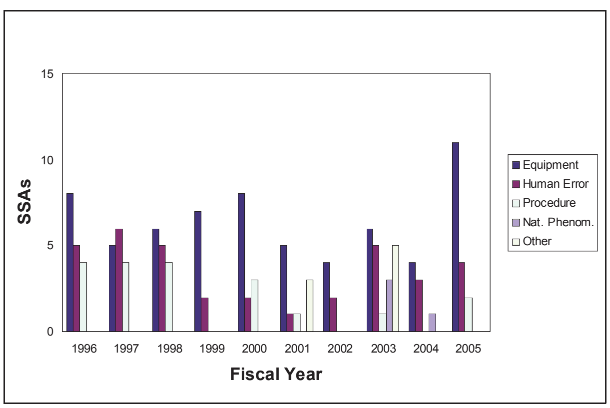

Figure 7. ECCS SSA cause categories

In summary, the analysis did not identify any specific pattern or driving factors behind the increase. The NRC staff will continue to monitor this indicator and take actions, if warranted, for any identified trend or pattern.