Proposed Initiative to Improve Nuclear Safety and Regulatory Efficiency

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Abstract: In early 2013, the Commissioners at the US Nuclear Regulatory Commission (NRC) issued requirements for the NRC staff to pursue an exploratory effort on an initiative to enhance safety by applying probabilistic risk assessment to determine the risk significance of current and emerging reactor issues in an integrated manner and on a plant-specific basis. Recognizing that each operating nuclear power plant has unique contributors to risk, a licensee who performs such an assessment could use the insights gained to propose to the NRC a risk-prioritized plant modification schedule with respect to regulatory actions. Such prioritization, if approved, should both focus the licensee on the completion of the most important new safety measures first while also addressing the challenges in dealing with various concurrent new and existing regulatory positions, programs, and requirements. This paper discusses the initiative and explores how addressing plant-specific risk insights can reduce to overall plant-specific risk as well as the overall average risk.

Keywords: PRA, Policy, Prioritization, RPI, CER

1. INTRODUCTION

The United States (US) nuclear industry has specific particularities which include a fairly heterogeneous nuclear fleet with respect to plant design, siting, and operation. (e.g., unlike other countries where the nuclear industry is more homogeneous, such as France). This includes variability in various Nuclear Steam Supply System (NSSS) vendors and designs, each with its own architecture and engineering firm and sited at various locations throughout the country (e.g., includes high and low seismicity zones). Therefore, each plant will have its own unique risk profile and set of vulnerabilities that already requires a specific focus on distinct areas of the regulatory process. Recognizing this reality and in an attempt to incentivize the development and use of Probabilistic Risk Assessment (PRA), the US Nuclear Regulatory Commission (NRC) issued a staff requirements memorandum (SRM) COMGEA-12-0001/COMWDM-12-0002 – "Proposed Initiative to Improve Nuclear Safety and Regulatory Efficiency" [1] on February 6, 2013. With this SRM, the Commission tasked the NRC staff to explore a plant-specific prioritization method that would rank regulatory initiatives in an integrated manner and on a plant-specific basis. By doing this the staff and the Commission believe that safety of the nuclear fleet would be further advanced by focusing the staff's and the licensee's time, attention, and resources on the issues of greater safety significance at each plant – i.e. addressing the most safety significant issues first. This initiative, more commonly known as the Risk Prioritization Initiative (RPI), aims at improving the overall safety of a site and the nuclear fleet, while advancing the incentive for using the benefits and insights of PRA. A discussion of this effort and its current status will be demonstrated in this paper.

2. BACKGROUND

In November 5, 2012 Commissioners Apostolakis and Magwood issued a joint commission action memorandum (COM) COMGEA-12-0001/COMWDM-12-0002 – "Proposed Initiative to Improve Nuclear Safety and Regulatory Efficiency" [2] that delineated their vision of RPI. The COM's purpose was to enhance safety by applying PRA to determine the risk significance of current and emerging operating issues, address the challenges facing licensees in implementing new regulatory positions, programs, and requirements (cumulative effects of regulation), and incentivize the development of high-quality PRAs. The Commission then voted and approved the initiative in Commission Voting Record – "Proposed Initiative to Improve Nuclear Safety and Regulatory Efficiency" [3]. SRM COMGEA-12-0001/COMWDM-12-0002 – "Proposed Initiative to Improve

Nuclear Safety and Regulatory Efficiency" [1] was then issued and tasked the staff to further explore RPI. The NRC staff is working with industry and other interested stakeholders to explore options for achieving this initiative, and will develop a paper that describes those options and the staff's recommendation to be presented to the Commission for their review and consideration. The NRC staff believes that RPI, if implemented, would be a tool that operating reactors could use to address the cumulative effects of regulation and to further incentivize the use of PRAs.

3. RECENT ACTIVITIES

The NRC staff conducted its first public meeting on RPI on April 24, 2013 [4]. At that time, the NRC staff engaged industry and other interested parties to gather comments and feedback on how such a process could be used to prioritize regulatory activities. NRC has conducted additional public meetings (See Table 1) and public interactions, including a recent technical session at the NRC's 2014 Regulatory Information Conference (RIC). Industry has already held three plant-specific tabletop exercises in March 2013, which the NRC observed (NRC insights are documented in a public trip report [5]). Overall, the NRC staff sees the process presented by industry and NEI as a potential viable path to implementing the RPI. The industry is also planning six demonstration pilots [6] which may include NRC participation. The staff will continue to work with industry and interested parties to develop options to present to the Commission in a notation vote paper scheduled for March 2015.

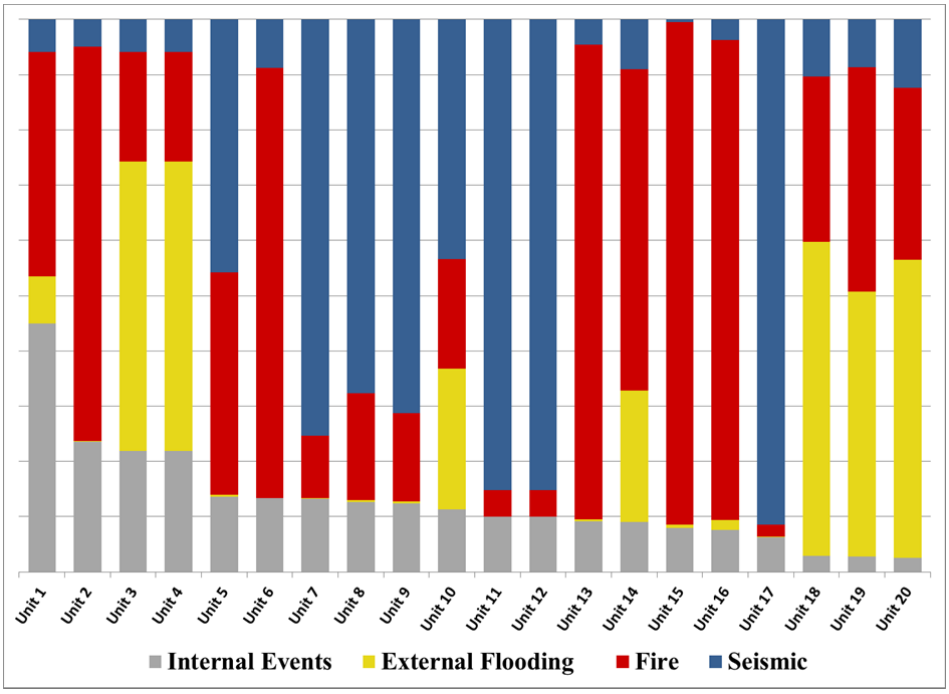
Table 1. List of RPI Public Meetings and Public Interactions

Date	Purpose	Meeting Summary (ADAMS Accession No.)	Associated Correspondence (ADAMS Accession No.)
April 24, 2013	• Inform external stakeholders of the Commission proposed Risk Prioritization initiative • Describe the NRC staff's current thoughts on ways to address the proposed initiative; and • Obtain feedback that will inform the NRC's efforts to address the proposed initiative.	ML13135A075 [4]	ML13113A141 [7]
May 22, 2013	• Nuclear Energy Institute's (NEI's) draft comments and proposal on the Commission's proposed initiative.	ML13171A110 [8]	ML13150A105 [9]
November 6, 2013	• Provide an update on CER and RPI. • Provide forum for NEI to present its draft process for RPI.	ML13316B426 [10]	ML13276A155 [11] ML13276A147 [12]
December 18-19, 2013	• Observe generic tabletop exercises of NEI's draft guidance.	ML14015A090 [13]	
March 11, 2014	• Regulatory Information Conference Technical Session "Agency Efforts to Address the Cumulative Effects of Regulation."		

4. POTENTIAL BENEFITS

As stated earlier, the US nuclear fleet is diverse and, in many respects, unique; representing significant challenges to the generic treatment of reactor regulatory activities. By using plant-specific risk information, the licensee can focus their efforts on the most safety significant items first improving their overall risk profile and the risk profile of the nuclear fleet. Figure 1 below uses existing plant information to illustrate the differences in the risk profile of a sample of US nuclear plants. For each site, the contribution of risk from internal events, external flooding, fire, and seismic is unique. The differences can be due to the unique plant configuration, its geographic location, its proximity to the ultimate heat sink, varying levels of plant mitigation approaches, and other factors. This is not an implication of uncertainty on plant safety status, but simply a statement of fact that different sites will have different risk contributors that are more important to that site. The data is illustrative but typical of the US nuclear fleet.

Figure 1. Relative Risk Profile of a Sample of 20 US Nuclear Power Plants (for illustration only)



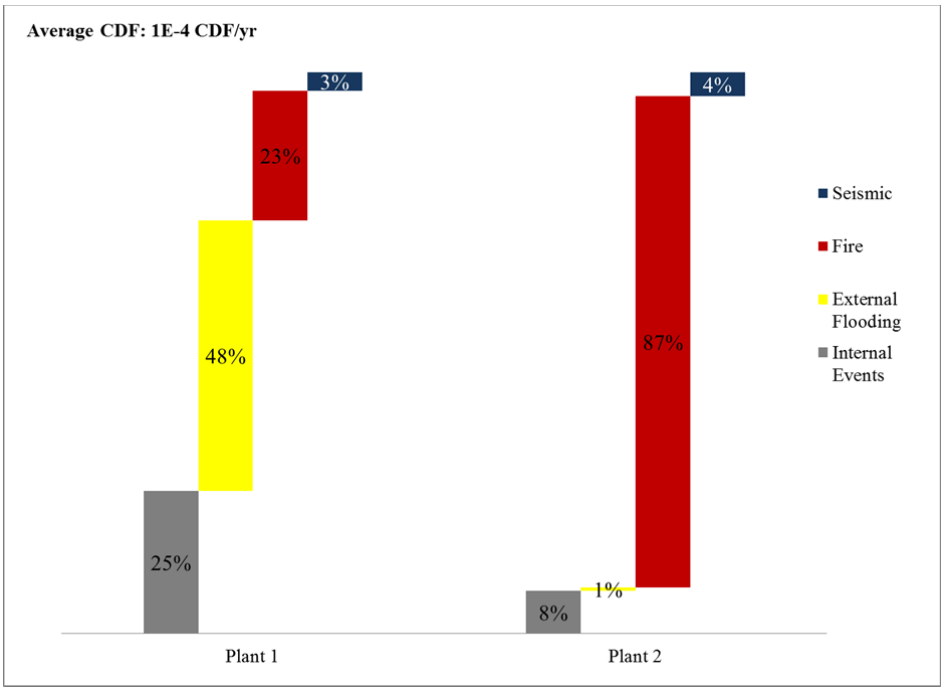
The RPI uses this unique insight to justify prioritizing regulatory initiatives on a plant-specific bases. Current regulations are developed considering their generic impact to the entire fleet. In addition, they look at each regulatory issue individually. By using a risk prioritization process, it allows each individual site to look at their regulatory issues and activities in an integrated manner weighing each issue against its safety significance and addressing those issues first. The case study below will illustrate this point.

For this case study, we analyze reducing the risk for sample plants, Plant 1 and Plant 2. The representative data for our fleet is shown in Table 2. The nominal case is shown in Figure 2. Figure 2 illustrates the current risk profile for our fleet of two plants. The overall average risk for our sample fleet is 1.1E-4 Core Damage Frequency (CDF)/year (yr). In this case study, we hypothetically impose an order of magnitude risk reduction for each regulatory action. This was done for simplicity and since it would be very difficult to fully analyze the risk reduction for a hypothetical plant.

Table 2. Representative Data for the Case Study Fleet

Reactor Name	Internal Events (CDF/yr)	External Flooding (CDF/yr)	Fire (CDF/yr)	Seismic (CDF/yr)	Total (CDF/yr)	Average (CDF/yr)
Plant 1	1.4E-05	2.66E-05	1.27E-05	1.82E-06	5.5E-05	1.1E-04
Plant 2	1.3E-05	1.15E-06	1.49E-04	7.33E-06	1.7E-04	

Figure 2 Nominal Risk Profile for Plant 1 & 2



Case 1 will evaluate the risk profile and overall average risk for the fleet by hypothetically imposing flooding risk reduction measures at both Plant 1 and Plant 2. In essence, we are generically imposing a hypothetical regulatory action to reduce the flooding vulnerability at both plants. By doing this we have slightly changed the overall risk of the fleet while Plant 2 is still dominated by fire risk (Figure 3). Therefore, the overall safety impact of the regulatory action is limited since Plant 2 did not have a significant vulnerability to external flooding while the burden of responding to the flooding requirement would have had the same priority for Plant 2 as for other concurrent regulatory requirements.

Case 2 evaluates the risk insights to address the significant vulnerability at each plant first. By using the risk insights from our sample plants, we know that Plant 1 has a large contribution to risk from external flooding while Plant 2 is dominated by fire risk. Using a prioritization process, the plants could then prioritize the most safety significant regulatory actions first. For Plant 1 it would be addressing the external flooding risk and for Plant 2 the fire risk. Doing this exercise, for our sample plants, results in a CDF reduction of 43% for Plant 1 and 79% for Plant 2. The overall risk for the fleet is reduced by 70% to 3.5E-5 CDF/yr. In addition, the overall risk to the plants are more balanced and not overwhelmingly dominated by one accident type (Figure 4). In addition, the plants could prioritize work that would reduce the internal events (e.g. for Plant 1) or other scenarios if these become the more dominant contributors; by developing a schedule that implements those activities with the most risk reduction first. Therefore, using risk insights and understanding the unique risk profile for a plant, the site could address the most safety significant issues first thus reducing the CDF for the plant and the overall CDF for the fleet in a more efficient manner.

Figure 3 Case 1 Generic Application of Flood Risk Reduction for Plant 1 & 2

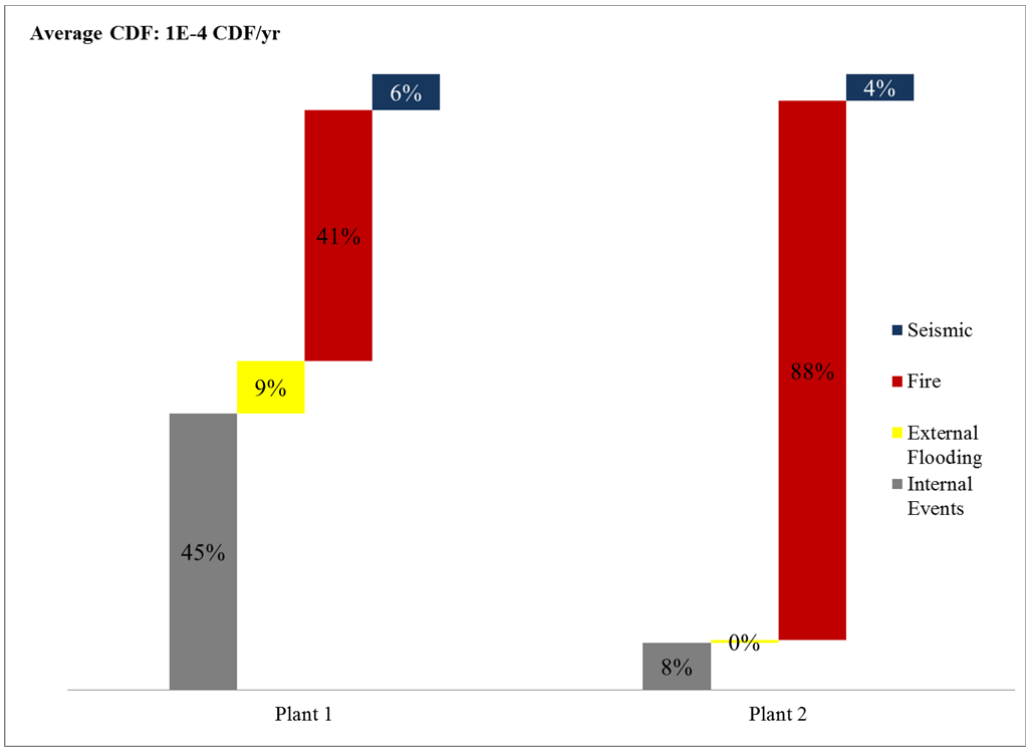
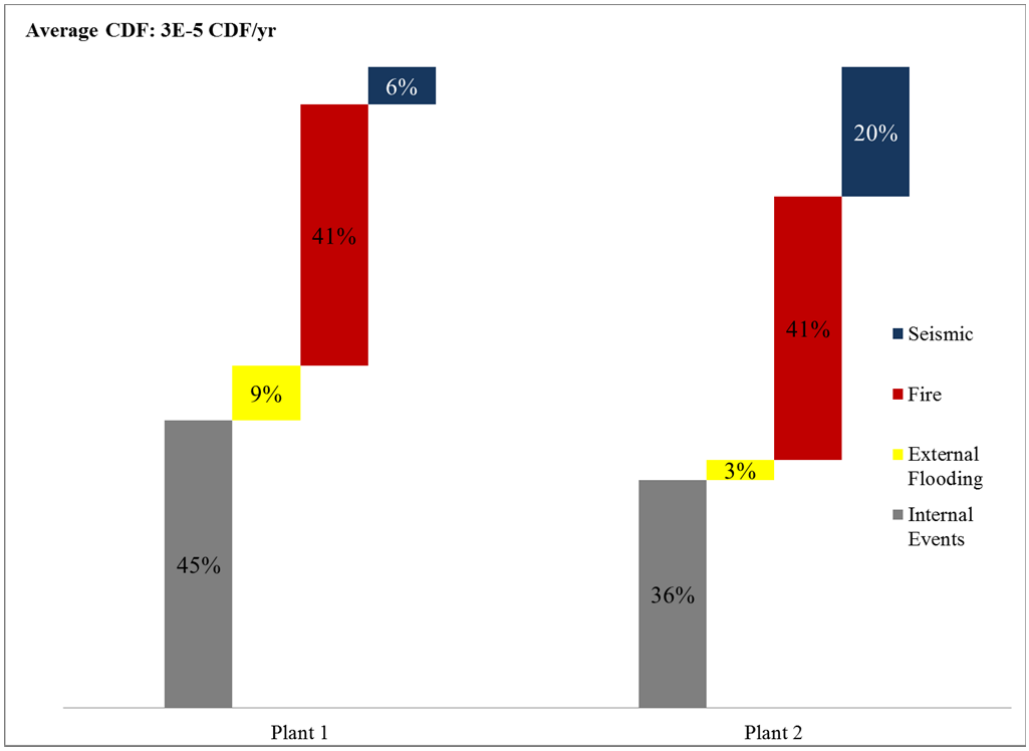


Figure 4 Case 2 Using Risk Insights to Address the Most Safety Significant Issues at Plant 1 & 2



5. FUTURE WORK

Currently, the NRC staff is developing a notation vote paper to submit to the Commission, for their review and consideration, various options on how such a prioritization process could work. The options will include input from the NEI process submitted October 2013 [11] and will be further informed from the NRC's participation in the demonstration pilots currently scheduled for the summer of 2014. In addition, to further develop a potential prioritization process, the staff is evaluating the current and future regulatory framework to suggest options on how the changes would be submitted to the NRC, how they will be approved, and what level of documentation is required for both the licensee and the staff. Also, the staff is evaluating the inspection and oversight framework for such a process.

These details will need to be evaluated and presented to the Commission for their consideration. One of the options sent to the Commission will include an option to incentivize the use and further development of PRA. This is a fundamental requirement that was made clear in the SRM that was sent to the staff in February 2013 [1].

6. CONCLUSION

Understanding the diverse nature of the US nuclear fleet and evaluating the risk profile of each site on a plant-specific basis can help prioritize regulatory issues enhancing safety and regulatory efficiency. Therefore, PRA is particularly useful in a number of areas for informing such a process. Both the licensee and NRC staff can focus their resources on addressing the most safety significant issues first. Therefore, not only improving safety for a particular site, but also enhancing the overall safety of the fleet. The NRC staff will continue to engage with industry and other interested stakeholders to further evaluate potential options for a prioritization process and will present those options to the Commission in a notation vote paper scheduled for March 2015.

Acknowledgements

The authors would like to thank Dr. Sunil Weerakkody for his support and feedback during the development of this paper.

Reference

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