The New Performance Indicators in the United States

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The US Nuclear Regulatory Commission (NRC) has recently embarked on a program to improve the effectiveness and efficiency of its regulatory process. A key aspect of this program is a change in the way the agency conducts its inspection process for nuclear power reactors. This paper will only discuss the new approaches to evaluating licensee performance in the area of occupational radiation protection.

The basis of this approach is to risk-inform NRC's inspection of nuclear power reactor licensees. Fundamental to this process was that licensee performance that met the objectives and key attributes of the process would provide reasonable assurance that public health and safety would be maintained. Seven safety cornerstones were developed with occupational radiation safety being one of the cornerstones. Under this process, licensee performance is measured with a combination of performance indicators (PI) and inspection results. PIs were developed by industry to provide an objective indication of licensee performance.

A risk-informed baseline inspection program was developed to both independently verify the PIs and to inspect those aspects of licensee performance not adequately covered by a PI. The risk-informed baseline inspection program established the minimum inspection effort that all licensees would receive, regardless of performance. A baseline inspection is maintained to verify the accuracy and completeness of the PI data, supplement the PI data in areas where the PI alone is not sufficient to measure performance, and complement the PIs with inspection finding of performance for areas not covered by the PI.

The objective for the occupational radiation safety cornerstone is to ensure adequate protection of worker health and safety from exposure to radiation from radioactive material during routine operations. This exposure could come from poorly controlled or uncontrolled radiation areas or radioactive material that unnecessarily exposes workers. The assumption is that licensees maintain occupational worker protection by meeting applicable regulatory limits and ALARA guidelines. One PI was developed for this cornerstone and is titled occupational exposure control effectiveness. There are three criteria for this PI. The first covers plant technical specifications requirements for high radiation areas (defined as >10mSv/hour) occurrences. The second criteria addresses very high radiation areas (defined as >5Gy/hour) occurrences. The third criteria addresses unintended exposures in excess of 1mSv, with higher values for non-stochastic doses. In general, the dose criteria were established at or below dose levels that are required by regulation to be monitored. There is no PI for ALARA. The indicator is determined by summing the reported number of occurrences for each of the three data elements during the assessment period.

To illustrate, a nonconformance with technical specifications or comparable regulatory requirements for high radiation areas would result in the loss of radiological controls over access to, or work activities within, the respective high-radiation area. Examples of occurrences that would be counted against this indicator include a failure to secure an area against unauthorized access, a failure to provide a means of personnel dose monitoring or other control required by technical specifications, or an actual unauthorized or unmonitored entry into an area. Similiarly, for a very high radiation area, a nonconformance would result in the loss of radiological controls over access to, or work activities within, a very high radiation area. An unintended exposure occurrence would involve a single occurrence of the degradation or failure of one or more radiation safety barriers resulting in an unintended occupational exposure equal to or exceeding a set percentage of the applicable regulatory limits. For stochastic dose, it is 2% of the regulatory limit of 0.05 Sv, and for non-stochastic dose it is 10% of the applicable limit. The dose criteria were established at levels deemed to be readily identifiable, based on industry experience. Examples of "degradation or failure of radiation barriers" that could potentially count against this indicator include: failure to identify and post a radiological area, failure to implement required physical controls over access

to a radiological area, failure to survey and identify radiological conditions, failure to train or instruct workers on radiological conditions and radiological work controls, and failure to implement radiological work controls.

Risk-informed thresholds were developed for both the PIs and inspection findings to establish performance bands. These performance bands provide for increased regulatory action as licensee performance degrades, as indicated by crossing more risk significant thresholds. Three bands were developed: 1) a white band for increased regulatory response (for greater than 5 PI occurrences in a three year period; 2) a yellow band with required regulatory response (for greater than 11 PI occurrences in a three year period; and 3) a red band for unacceptable performance (for PIs this level cannot be reached).

A significance determination process (SDP) was also developed for each area based on inspection findings. The NRC worked closely with the regulated industry to define the appropriate risk measure for assigning significance to inspection findings. ALARA is covered under this process. The SDP is the mechanism in which the significance of individual events can be normalized and combined with the PI results to arrive at an overall cornerstone performance assessment. Logic flow charts are used to outline the process. A finding that gets through the process flow chart without tripping a decision "gate" ends up as a GREEN finding. This does not mean that the performance on this individual finding is good or even acceptable. It still may be a non-conformance or a violation, but not large enough to warrant further NRC intervention. Licensees are still required to come into compliance with the regulation and their commitments. However, the licensees are given the latitude to self correct these non-conformances. An example of the flow charts used can be found in figure 1.

NRC regulations require licensees to use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses that are ALARA, and to develop a program to accomplish this. Three metrics are used as screening tools (figure 2). The first screen focuses on the accuracy of a licensee's dose goals and the strength of job controls established for specific tasks. A job dose which exceeds the dose goal by 50% or more is indicative of poor pre-job planning. If the actual job dose falls within the pre-job dose estimate or exceeds it by less than or equal to 50%, then a "no finding" results. If the actual job dose exceeds the projected dose by greater than 50%, then the next screen considers plant collective dose.

The next metric chosen for screening a potential ALARA finding is the plant's rolling three-year average collective dose. Plants with effective ALARA programs tend to have lower overall collective doses than those which have poor or inadequate ALARA programs. On average, the US industry ALARA performance is considered very good. Total collective dose appears to be reaching an equilibrium minimum value. Therefore, the current median value of the 3-year collective dose was used as a decision gate standard. Due to different challenges for BWRs and PWRs, different values were established for these reactor types. If the plant average is less than the industry median, then a "no finding" conclusion is drawn. If the average is greater than the median, then the logic takes you to the next screening gate.

In the third screen, if the actual collective dose for the job is less than 0.5 person-Sv(PWR) or 1.0 person-Sv(BWR), there is no finding. If the actual collective job dose exceeds these respective values there is an ALARA finding.

The SDP logic sorts findings into WHITE and YELLOW significance bands. If the actual job dose is not greater than 0.25 person-Sv (PWR) or 0.5 person-Sv (BWR) and it is not the third such occurrence in the last rolling 18-month period, then the finding is GREEN. If this is the third occurrence, the finding is WHITE. If the actual job dose collective dose is greater than 0.25 person-Sv(PWR) or 0.5 person-Sv(BWR), then the finding is either WHITE or YELLOW as a function of the plant's rolling 3-year average.

In addition, any individual occurrence of the failure to control radiation exposures resulting in doses in excess of the regulatory limits is at least a YELLOW finding. An occurrence that results in doses in excess of five times the dose limits is a RED finding.

Breakdowns in the radiation protection program, or unintended exposures, that do not exceed a regulatory dose limit can be considered significant if they constitute a substantial potential for overexposure. This is an occurrence in which a minor alteration of the circumstances would have resulted in a violation of regulatory limits and is was just fortuitous that the altered circumstances did not occur. The finding under the SDP can be WHITE or YELLOW, depending on the dose rates associated with the failure. For example, in a very high radiation area (5 Gray/hour), it can take as little as 3 minutes for a worker to receive 0.25 Sv.

The overall process has undergone a testing period and will be refined based on the information obtained during the testing process. The goal for NRC is to have a plant assessment process that is risk-informed, where regulators and licensees can direct resources to the appropriate areas. As this process evolves, both regulator and industry will find effective ways to meet the future challenges that face us.

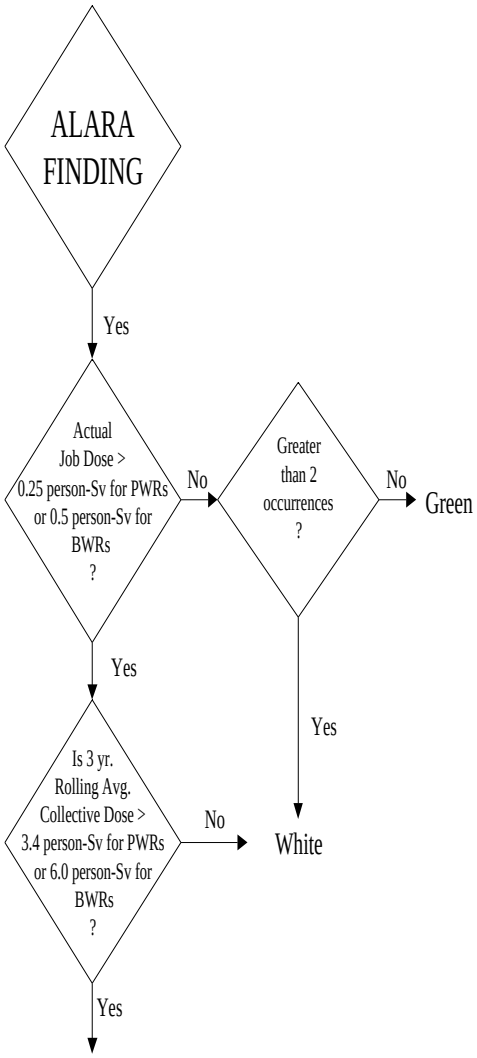

Figure 1. Occupational Radiation Safety (ALARA)

Figure 2. ALARA Finding Screening