11/17/99
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HUMAN RELIABILITY ASSESSMENT
(HRA)

HRA values (Cases 1 and 2; i.e., at 1 year and at 1 month after last fuel was removed from the reactor) used in the Draft Decommissioning Spent Fuel Pool Risk Assessment (PRA) were based on the known procedures at decommissioning plants found during staff visits, known instrumentation at the sites, known staffing levels, known communication conventions, and known training of the operators. The HRA values for Case 3 (1 year after last fuel was removed from the reactor) assumed procedures were the same as today or less detailed, had less qualified Certified Fuel Handlers, had a general breakdown of the management structure, and had technical specifications and instrumentation that met the near minimum allowed by the Regulations.

In the staff's strawman HRA draft made public in August 1999, the staff identified, in a systematic way, under what design features and operational practices, taking into account the full range of possible challenges to the pool functionality, the non-response probabilities can be low. The design features include the physical plant characteristics (e.g., nature and number of alarms, available mitigation equipment) and the operational practices include operational and management practices (including crew structure and individual responsibilities), procedures, contingency plans, and training. Since the details will vary from plant to plant, the staff focused on identifying general design features and operational practices that can support low non-response probabilities. Once the details of how the licensees intend to operate during this phase of operation were known, it would then be possible to turn the question around, and, on a plant specific basis, identify error forcing conditions that would lead to non-response probabilities that are not low.

The HRA approaches that have been developed over the past few years have primarily been for use in PRAs of nuclear power plants at full power. Methods have been developed for assessing the likelihood of errors associated with routine processes such as restoration of systems to operation following maintenance, and those errors in responding to plant transients or accidents from full power. For spent fuel pool operation during the decommissioning phase, there are unique conditions not typical of those found during full-power operation. Thus the human reliability methods developed for full power operation PRAs, and their associated error probabilities, are not directly applicable. However, some of the methods can be adapted to provide insights into the likelihood of failures in operator performance for the spent fuel pool analysis by accommodating the differences in conditions that might impact operating crew performance in the full power and decommissioning phases are identified. There are both positive and negative aspects of the difference in conditions with respect to the reliability of human performance.

In developing the improved HRA values, the following issues were considered:

- Because of the long time scales, we addressed the potential for recovery of failures on the part of one crew or individual by other plant staff, including subsequent shifts, and considered potential sources of dependency that could lead to a failure of the organization as a whole to respond adequately.

- We identified the conditions under which operating staff performance can be considered as providing high reliability based upon current understanding of the factors that

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influence human performance. References that provided good overviews of the factors of importance were used.

- Those factors that the industry has suggested that will help ensure adequate response (instrumentation, monitoring strategies, procedures, contingency plans) were addressed.

- Where possible, any evaluations of human error probabilities (HEPs) were calibrated against currently acceptable ranges for HEPs.

- We attempted to make the reasoning behind the assumptions transparent.

What might utilities need to do to minimize human errors?

In order to be successful in coping with an incident at the facility, there are three basic functions that are required of the operating staff, and these are either explicit (awareness) or implicit (situation assessment and response planning and response implementation) in the definitions of the human failure events in the PRA model.

- plant personnel must be able to detect and recognize when the spent fuel cooling function is deteriorating or pool inventory is being lost (Awareness).

- plant personnel must be able to interpret the indications (identify the source of the problem) and formulate a plan that would mitigate the situation (Situation Assessment and Response Planning).

- plant personnel must be able to perform the actions required to maintain cooling of and/or add water to the spent fuel pool (Response Implementation).

In assessing the effectiveness of alarms there are several factors that could be taken into account, for example:

- alarms (including control room indications) are maintained and checked/calibrated on a regular basis
- the instruments that activate instruments and alarms measure, as directly as possible, the parameters they purport to measure
- alarm set-point is not too sensitive, so that there are few false alarms
- alarms cannot be permanently canceled without taking action to clear the signal
- alarms have multiple set-points corresponding to increasing degradation
- the importance of responding to the alarms is stressed in plant operating procedures and training
- the existence of independent alarms that measure different primary parameters (e.g., level, temperature, airborne radiation), or provide indirect evidence (sump pump alarms, secondary side cooling system trouble alarms)

For active monitoring, examples of the factors used in assessing the effectiveness of the monitoring include:

- scheduled walkdowns required within areas of concern, with specific items to check (particularly to look for indications not annunciated in, or monitored from, the control room, for example, indications of leakage, operation of sump pumps if not monitored, steaming over the pool, humidity level)
- plant operating procedures that require the active measurement of parameters (e.g., temperature, level) rather than simply observing the condition of the pool
- requirement to log, check, and trend results of monitoring
- alert levels specified and noted on measurement devices

The types of procedures that might be available are:

- annunciator/alarm response procedure that is explicit in pointing towards potential problems
- detailed procedures for use of alternate systems indicating primary and back up sources, recovery of power, etc..

The response procedures may have features that enhance the likelihood of success, for example:

- guidance for early action to establish contingency plans (e.g., alerting offsite agencies such as fire brigades) in parallel with a primary response such as carrying out repairs or lining up an on-site alternate system.
- clearly and unambiguously written, with an understanding of a variety of different scenarios and their timing.

In addition:

- training for plant staff to provide an awareness of the time scales of heat up to boiling and fuel uncovery as a function of the age of the fuel would enhance the likelihood of successful response.

Successful implementation of planned responses may be influenced by several factors, for example:

- accessibility/availability of equipment
- staffing levels that are adequate for conducting each task and any parallel contingency plans, or plans to bring in additional staff
- training
- timely feedback on corrective action