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105 Pashley Road
Scotia, NY 12302
September 8, 2000

Secretary, U.S. Nuclear Regulatory Commission
Rulemakings and Adjudications Staff
Mail Stop O-16C1
Washington, DC 20555-0001

Dear Sir:

The following remarks are submitted in response to the proposed rule titled, Operator License Eligibility and Use of Simulation Facilities in Operator Licensing. The proposal will amend regulations to allow operator applicants to fulfill a portion of the experience prerequisites (reactivity management requirements) on a plant-referenced simulator rather than on the plant itself.

GENERAL COMMENTS ABOUT REACTIVITY

Since reactivity is what is to be managed, a few remarks about this important parameter are in order. Reactivity, (keff - 1)/keff, is widely used as the paramount means for defining nuclear status. Reactivity is a physical property of the core (based on composition, geometry, temperature, pressure, and the ability of the core to produce fission neutrons) and may be either constant or changing with time.

Unfortunately, reactivity it is not well explained, understood, or presented in conventional operator training materials. Problems arise in developing the concept of reactivity in the class room, long before the student reaches the challenge of Reactivity Management. The derivation of reactivity is based on a primitive lifecycle model employing fictitious "average" neutrons with an lifetime called the "generation time." This model is not capable of accurately representing actual reactor behavior.

Despite the operational limitations of the lifecycle model, reactivity can be used as a measure of the deviation of the reactor from criticality. When reactivity is negative (less than zero), the reactor is subcritical. When reactivity is equal to zero, the reactor is at criticality. When reactivity is positive (greater than zero), the reactor is supercritical. However, one of the serious flaws in the lifecycle model is that for the off-critical state power always exhibits increase when reactivity is positive and always exhibits decrease when reactivity is negative. This behavior does not accurately represent actual reactor behavior, where power can be decreasing while supercritical and increasing while subcritical. The condition of subcriticality is not synonymous with power decrease, and the condition of supercriticality is not synonymous with power increase. Thus, observation of reactor power behavior, the indirect means for the operator to assess nuclear status, is not a reliable indicator of whether reactivity is positive or negative.

Operationally, reactivity is the prime mover of all power change in a nuclear reactor. During certain reactivity management operations, such as reactor startup, the reactor operator introduces enormous positive reactivity change, while generating a small and sluggish power increase. Yet, once criticality is attained, a further relatively minute positive reactivity change can cause a power excursion to escalate so rapidly that all reactor power and rate meters peg at full scale before the operator can blink. This is a clear threat to reactor safety and to serious core damage. The avoidance of such an event is claimed to be by thorough training, by adherence to procedures, and by the reactor protection system. But, it turns out that the training is flawed, procedures have been violated, misinterpreted, or found inadequate, and

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protection systems have failed. Simply put, this behavioral characteristic argues that reactivity is, far and away, the most important parameter to be monitored in the Control Room. But instruments to provide reactivity status to the operator are nowhere to be found.

It so happens that reactivity meters have existed for a number of years. Analytically, the relationship between reactivity and reactor power in real time can be determined either from the known reactivity behavior or from the known power behavior. Reactivity behavior with time can be calculated, rather simply and almost instantaneously, from the ongoing behavior of reactor power with time. A few reactors employ such a reactivity calculator - digital display combination, known as a reactivity meter. The reactivity meter provides the reactor operator with a direct indication of (net) reactivity, which is a much more definitive indication of the nuclear status of the core than is the indirect and flawed power meter/reactor rate meter combination. The indicated reactivity is correct regardless of the observed power behavior. As such, the reactivity meter offers greater safety in reactor operation, aids the task of reactivity management, and is strongly recommended as meter indication in the Control Room.

GENERAL COMMENTS ABOUT REACTIVITY MANAGEMENT

Reactivity Management requirements mandate that the license candidate perform certain normal reactivity evolutions (such as reactor startup, shutdown, boration, and power change) and that certain operator responses be demonstrated for selected system and component failures, or malfunctions, that seriously degrade safe reactor operation or effect core reactivity directly. Reactivity Management is the final phase of an overall treatment of the subject of reactivity and reactor behavior that the prospective reactor operator is exposed to, starting from the early days of class room fundamentals training in Reactor Theory.

Unfortunately, reactivity management, as currently practiced, delegates a task of mental evaluation to the reactor operator that is impossible for the operator, or anyone else, to perform. Such analysis, done correctly, is only possible by computer. Worse yet, the operator is trained to believe that this is possible. Even though provided with hundreds of meters in the control room, reactivity management must be accomplished without the benefit of meter indication of reactivity. The cause (reactivity) must be controlled indirectly by observing the effect (power response). This convoluted mental procedure more often than not yields no quantitative measure of reactivity, but at best indicates only whether the algebraic sign of reactivity is positive or negative, i.e. whether the reactor is supercritical or subcritical. And even this may be an erroneous determination, because, as discussed above, power behavior does not always reflect the true reactivity status.

In the final analysis, Reactivity Management is a misnomer. If the concept of reactivity is not fully understood, and neither quantitative nor algebraic indication exists in the Control Room, how is the operator expected to manage reactivity? Such is akin to eliminating all power indication in the Control Room and requiring the operator to control power by observing the temperature meters. Since reactivity and reactor behavior are not fully understood, a carry over from the early days of the industry, a black box mentality prevails. By controlling reactor power and reactor rate, reactivity should be kept under control and take care of itself, even if not understood. This thinking is seriously flawed. Chernobyl well illustrated the folly of playing fast and loose with reactivity. The main problem with Reactivity Management is not whether operator experience requirements should be completed on the simulator or the plant, but rather that reactivity management is not being done at all.

GENERAL COMMENTS ABOUT THE RULE CHANGE

As a subject matter expert on reactor behavior, and not one who has an operating license, I must defer to the qualified reactor operators who have direct experience with simulator replication of plant evolutions as related to this rule proposal. However, I submit the following general observations:

1. The Nuclear Regulatory Commission should give very high priority and the most serious consideration to comments submitted by qualified operators and to any concerns they have about this proposed rule change. If qualified operators do not believe that plant-referenced simulators are adequate replication for this purpose, or indicate that this proposal is a step toward degrading operator training, or judge that safety in reactor operation is compromised, then the rule change should not go forward without modifications that can gain the operators support.

2. It would appear that there are so many required reactivity manipulations for each operator that the time constraint alone precludes all manipulations from being currently performed on the reactor. Also, it would appear that many of the reactivity manipulations cannot be performed on the operating reactor because of their very nature. The simulator must already be used extensively in meeting Reactivity Manipulation requirements.

3. Hands-on performance of a reactivity manipulation is a more valid demonstration of proficiency than merely being a member of a crew (team). On this basis, if the simulator allowed more individual demonstrations, this would seem to be a significant benefit of the rule change.

4. With more reliance being placed on the plant-referenced simulator for operator qualification, it would seem logical that greater attention is taken to ensure that the simulator is the best possible replication of the plant. If removal of current requirements for certification of simulation facilities and routine submittal of simulator performance test reports to the NRC is not consistent with greater attention, then the proposal seems self-contradictory.

The primary concern should be that the proposed rule change improves operational reactor safety and not whether the current rule is some kind of burden.

Sincerely yours,

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