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Comments on Proposed Rules FR, V57, No. 203, Tuesday, October 20, 1992
Appendix S to Part 50
Appendix B to Part 100

My major comments are on the single earthquake design approach. My perspective is that of a person who has been designing piping systems, including seismic effects, since 1971. At present, I chair the Working Group on Piping Design (SC III). This Group is responsible for nuclear piping design rules of the ASME Boiler and Pressure Vessel Code.

~~Design~~ for a single limiting event and inspection for lessor earthquakes is <u>not</u> a sound regulatory approach for pressure-retaining components designed to Section III. There are several errors of reasoning in the justification for "SSE only" design. Adopting this approach will severely compromised safety.

The two earthquake criterion is a prudent way to insure the safety of a nuclear power plant. Newmark proposed this approach in the 60s. The OBE was originally called the *design earthquake,* and the SSE, the *maximum credible earthquake.* Since the OBE was expected to occur in the life of the plant, you "designed " for it using normal allowable stress limits. Since the SSE was not expected to occur (low probability), you didn't "design" for it using normal allowable stress limits. Newmark did not specify the acceptance criteria. Severe deformations were expected, and decisions on margins of safety would have to be made based on the nature and importance of the structure.

Pressure-retaining components in the nuclear side of a plant have to meet ASME Section III requirements. Section III provides stress criteria for Design, Level A (normal), Level B (upset), Level C (emergency) and Level D (faulted). OBE is a Level B condition. The Level B stress criteria ensure that the pressure retaining component can withstand the loading without damage requiring repair. Cyclic considerations (fatigue) are included. SSE is a Level D condition -- an extremely low probability event. The stress limits for Level D are much higher than Level B, and cyclic effects are not considered. The component will survive the loading, but there may be gross structural damage requiring

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replacement of the component. Section III criteria are consistent with the Newmark approach. Design for the expected earthquake, where design means no damage, and accept large deformations but survive the extremely low probability earthquake. The key to understanding the Section III requirements is that cyclic effects are controlled for Level B, but not for Level D.

In the discussion of the proposed rules it says, *"... the NRC staff states that it agrees that the OBE should not control the design of safety systems."* [V.B.5] I cannot understand how the NRC staff can make this statement. If the site characteristics are such that significant lower level earthquakes are expected during the life of a plant, then cyclic effects may be significant. In this situation, cyclic effects could control the design. Therefore, OBE controlling the design is appropriate, and necessary, in some situations.

We do have a problem in the industry with the present requirements. Requiring "design" for five OBE events at 1/2 SSE is unrealistic for most (all?) sites and requires an excessive and unnecessary number of seismic supports. The solution is to define appropriately the OBE magnitude and the number of events expected during the life of the plant. And to require "design" for that loading. OBE may or may not control the design. But you cannot assume, before you have the seismicity defined and before you have a piping system design, that OBE will not govern the design. Of course, you can ensure that OBE will not control design by arbitrarily defining very limiting SSE stress criteria. But, this is not a reasonable approach since it would require too many pipe supports.

Implicit in the reasoning behind the proposed rules is that if a piping system (or other pressure-retaining component) meets the Section III requirements for an SSE as a Level D condition, then that piping system (or other pressure-retaining component) will automatically satisfy Level B stress criteria at 1/3 SSE. Obviously, if a piping system (or other pressure-retaining component) can survive an SSE, then that component can survive an OBE at 1/3 SSE. That is not the technical issue. The technical issue is whether significant cyclic fatigue "usage" will occur. Fatigue usage from the OBE reduces the cyclic life for the other Level A and B conditions. Without explicit consideration of the earthquake cyclic stresses, these stresses would have to be below the endurance limit of the material to have no influence on the cyclic life. This is highly improbable. Therefore, to say that, *"The proposed regulation would allow the value of the OBE to be set at: (i) One-third or less of the SSE, where OBE requirements are satisfied without an explicit response or design analysis being performed, ..."* [V.B.5], is not technically justified. I cannot understand how this decision was reached. I can imagine that if you looked at some piping systems designed to the present requirements, you may be able to show that OBE seismic effects are insignificant. But this is not relevant. Systems designed to the new rulemaking, without design for OBE at 1/3 SSE, would be very different. There is no way, as far as I can see, to make assumptions about the earthquake stresses at 1/3 SSE if you do not design for the OBE loading.

The problem with not designing for OBE can be simply stated. The piping (or other pressure-retaining component) may be designed to the limit for other Level A and B loads (for example, thermal expansion cycling). In this situation, OBE stresses above the endurance limit reduce the operational life of the component. It is highly improbable that OBE stresses will be below the endurance limit. The only way to accept the OBE stress cycles is to accept lower margins of safety. This is compromising the design of the plant, and is unnecessary. Design for OBE, if the OBE magnitude is reasonably defined, will not result in an excessive number of seismic supports.

The error in the logic of not requiring design for OBE is evident in the last statement in V.B.5., *"With regard to piping analysis, positions on fatigue ratcheting and seismic anchor motion are being developed and will be issued for public comment in a draft regulatory guide separate from this rule making."* If you understand piping design, you realize that this statement means that it is not valid to assume that the OBE requirements (at 1/3 SSE) are satisfied without an explicit response or design analysis being performed. What this statement implies to me is that NRC is going to specify stress criteria in a regulatory guide. This is inappropriate! As a member of the Section III code committee, I object strongly to NRC defining stress criteria. Stress criteria should be the responsibility of the ASME Boiler and Pressure Vessel Code committee. What I expect to happen, if the proposed rules are implemented, is that NRC will require fatigue analysis for the SSE and the OBE events. This essentially means considering SSE as a Level B condition. This is too conservative, unreasonable, and will require even more pipe supports than the present regulations -- a step in the wrong direction.

The first error is the assumption that a pressure-retaining component automatically satisfies the OBE requirements (at 1/3 SSE) if the SSE requirements are satisfied. The second error is the assumption that a utility will be able, by inspection and test, *"... to demonstrate to the Commission that no functional damage has occurred to those features necessary for continued operation without undue risk to the health and safety of the public."* [V.B.6] If an earthquake at slightly above 1/3 SSE occurs, the plant has to shut down. The piping systems (and other pressure-retaining components) have not had explicit response or design analysis performed. It is not feasible, by inspection or test, to decide whether the earthquake impacts the cyclic life of the component. Obviously, you will be able to tell if the pressure boundary is leaking, but that is not the issue. The issue is whether the earthquake has "used up" an unacceptable amount of the cyclic fatigue life. The only practical way to assess fatigue usage is by analysis. A piping system is a collection of many fittings and joints. The maximum stressed locations in the system and within the individual fittings and joints are not readily determined. I cannot see how you can determine the amount of cyclic life used by the earthquake with inspection or test.

The third error is that some pressure-retaining components required for plant operation after an earthquake will not have explicit response or design analysis for the OBE or the SSE. The three types of structures, systems, and components that must be designed to

remain functional for the SSE are a subset of the structures, systems, and components *"necessary for continued operation without undue risk to the health and safety of the public"* [Appendix S, III]. Therefore, the structures, systems, and components that are not required for shutdown, but are required for safe continued operation, will have no seismic qualification performed. This certainly is not prudent.

In summary, design for "SSE only" is not a prudent approach, and the safety of a nuclear plant will be severely compromised by this approach. It is not technically valid to assume that a Section III pressure retaining component that meets SSE requirements automatically satisfies the OBE requirements. It is not technically valid to assume no impact on the cyclic life of a Section III component if an OBE at 1/3 SSE occurs. It is not technically valid to rely on inspection or test after an OBE event to determine whether the OBE event has reduced the cyclic life of a component. It is not prudent to require no seismic qualification for structures, systems, and components that are not required for safe shutdown but are required for continued operation.

The intent of the rule making, to uncouple the OBE and the SSE, is a necessary change in the seismic requirements. The problem is that the proposed rules are not valid. There is a simple solution. My recommendations follow. Appendix S should define the magnitude of both the SSE and OBE ground motion and require design for both earthquakes. I see no reason to arbitrarily set the OBE at 1/3 SSE instead of the present 1/2 SSE. My preliminary suggestion is to set the SSE at 1E-5 to 1E-6 and the OBE at 1E-1 to 1E-2. There may be certain structures or systems for which a separate analysis for OBE is not required to verify the seismic capability. A regulatory guide can be prepared to specify under what conditions only one seismic analysis is needed.

I appreciate the opportunity to comment on the rulemaking, and I hope my comments are clearly understood. We need to be able to design more cost effective piping systems. To uncouple the OBE from the SSE is an appropriate way to allow practical and safe design of piping systems. To not require design for OBE is not prudent. I do not see how we can explain to the public that we do not need to design a nuclear plant for the earthquake loading that we expect to occur in the life of the plant.

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