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Comment on DG 1157 Damping Values for Piping
from :

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We hereby comment on the Draft Regulatory Guide 1157 section on damping as it applies to piping and mechanical equipment.

1. Piping

While it is appreciated that the proposed new NRC regulatory position in DE 1157 has increased piping damping values from the values contained in R.G. 1.61 dated October 1973, they do not appear to fully reflect the large amount of the damping test data gathered and evaluated in the mid 1980's. This data evaluation was supported to a considerable degree by the NRC's Office of Regulatory Research(1,2,3,4,5,6,7,8,9) and it formed the basis of the Pressure Vessel Research Committee recommendation to the ASME B&PVC Section on Pipe Damping(9) and should form the basis of any new damping design values selected in the new draft guide. These data and evaluations are summarized in Referenced 10. That data established best estimate damping values of 6.0 percent for SSE and 5.0 percent damping for OBE (>0.33 SSE). The 6.0 percent damping value for SSE was reduced to 5.0 percent by the B&PVC when published in Appendix N of the ASME B&PVC Section III for piping system to simplify the design procedures.

Best estimate (mean) values were purposely used rather than some lower bound values because of the role damping plays in safe seismic design of piping. Piping failure due to earthquakes were reviewed in NUREG/CR-6239(11,12,13,14) which surveyed the behavior of approximately 2,000,000 feet of piping in fossil fuel power plants in response to strong motion damaging earthquakes (pga ≥0.2g) in California from the 1950's to 1980's and the effects of the Alaska 1964 earthquake. The results of these surveys attribute seismic failures of piping to (a) inertial failures of <u>isolated points</u> of <u>weakness</u> in the piping and piping support systems, and (b) excessive deformations due to large header piping, support or equipment movements, commonly called seismic anchor motions. This latter failure mode (anchor motion effects) was much more problematic than the former failure mode (isolated inertial failures). The use of lower than best estimate (or mean) damping values in design increases the computed inertia stresses in the pipe which results in pipe lateral supports being placed closer together; thereby increasing the stiffness and rigidity of the piping system. As a result of this increased rigidity of the piping system, any applied seismic anchor, nozzle or support motion will increase stresses induced in the piping. This increased rigidity (reduced flexibility) also increases the thermal expansion pipe stress and pipe support loads in piping systems normally operating at elevated temperature. Traditionally, the RCS and associated Safety Class 1 piping systems fall into this category. These high thermal stresses can significantly reduce the reliability and fatigue life of these very important systems.

The configurations that contained isolated points of weakness included severely corroded pipe, components constructed of cast iron and brittle materials, and threaded fittings, and poorly constructed or defective welds in piping and supports. It was believed these issues could easily be controlled through design and inspection rules and nuclear quality assurance requirements.

For these reasons, a best estimate (mean) value for damping was selected for the ASME B&PVC Appendix N in an attempt to balance the safe design of piping systems designed to resist all aspect of earthquake induced inertia and anchor motion loads. Further, it was desired to reduce the effects that low probability of occurrence loads (seismic – 10^{-2} to 10^{-4}/year) would have on high probability (1.0) of service (normal operating thermal expansion) loads.

In our opinion, while the DG 1157 damping being less than best estimate damping values would have minimal effect on the potential for seismic failure of piping due to inertia loads, and would significantly increase the potential for failure due to seismic anchor motion effects. More importantly, the reduction in damping from current ASME Code values will make elevated temperature piping systems more susceptible to reduced reliability and fatigue failure during normal operation. Finally, this reduction in system flexible with the use of the proposed damping values with its corresponding increase in thermal stress will result in an increase in Section XI ISI locations. This will increase long term plant employee radiation exposure and plant operational costs.

As a final consideration, if plants were built in high seismic regions, the owner may desire to select an OBE that is greater than SSE/3. In such a case, the OBE would now control design further, resulting in (a) increased supports, (b) increased use of scrubbers and (c) the resulting reduction in piping flexibility and reliability. Further, there would be increased inspection costs and radiation exposure due to the snubber and Section XI ISI. These issues would essentially preclude any owner from selecting an OBE > SSE/3, even if it is in the best interest of safety to do so.

2. Equipment

In the resolution of USI A-46, the USNRC permitted use of the SQUG-GIP. Table 1 compares the SSE damping values of the proposed regulatory guideline updated to those used in the resolution of USI A-46. As can be seen, the proposed values are significantly lower than those accepted in the program for resolution of USI A-46. If these higher values were acceptable for evaluation of the equipment in the current operating plants that had much less rigor in seismic design, it appears inconsistent to apply lower damping values to modern equipment that is subject to much more rigorous seismic design and analysis.

Equipment Class Number and Name	USI A46 Damping	DG-1157 Damping (SSE)
#1 Motor Control Centers	5% Damping	3%
#2 Low Voltage Switchers	5% Damping	3%
#3 Medium Voltage Switcher	5% Damping	3%
#4 Transformers	5% Damping	3%

Equipment Class Number and Name		USI A46 Damping	DG-1157 Damping (SSE)
#5	Horizontal Pumps with Motors	5% Damping	3%
#6	Vertical Pumps with Motors a. Vertical Immersion	3% Damping	3%
	b. Centrifugal	5% Damping	3%
	c. Deep-Well	3% Damping	3%
#12	Air Compressors	5% Damping	3%
#13	Motor-Generators	5% Damping	3%
#15	Batteries on Racks	5% Damping	3%
#16	Battery Chargers and Inverters	5% Damping	3%
#17	Engine-Generators	5% Damping	3%
#18	Instrument Racks	3% Damping	3%
#14 & #20	Generic Equipment Cabinets	5% Damping	3%
#14 & #20	Walk-Through Control Panels	5% Damping	3%

The recent changes in Section QR and QR-A of the QME-1 standard implemented 5% damping across the board for experienced and smilianly SSE qualification of mechanical equipment. A similar change was recently made in IEEE-344-2004. The regulatory agency did not express any concerns with the use of 5% damping for equipment qualification during the consensus process that brought about the changes to these standards.

As a result of the above discussion, we strongly urge the NRC to reconsider its DG 1157 position on piping damping and accept the current ASME B&PVC Section III, Div. 1, Appendix N values as a means to provide balance in overall seismic and operational safety of piping systems. Also, to accept higher equipment damping values consistent with those implemented in ASME QME-1 and IEEE-344.

Please advise if you desire any clarification of these comments.

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