DRAFT OF

REPORT

to

AEC REGULATORY STAFF

SEISMIC EFFECTS ON BODEGA BAY REACTOR

by

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INTRODUCTION

This report concerns the ability of the reactor proposed by the Pacific Gas and Electric Company to resist an earthquake opposite Bodega Head having the maximum effects described by the U. S. Geological Survey and the U. S. Coast and Geodetic Survey. Reference is made in this report to Amendment No. 8 of the Pacific Gas and Electric Company concerning this reactor. Consideration has been given to the danger to public health and safety in the event of the earthquake occurring, accompanied by movements on faults under the reactor containment structure.

The general description of the maximum possible earthquake involves a pattern of ground motions similar to that recorded by the Coast and Geodetic Survey in the El Centro Earthquake of May 18, 1940, but with approximately twice the intensity, corresponding to a maximum acceleration of two-thirds gravity, a maximum velocity of 2.5 ft/sec., and a maximum ground displacement of 3 feet, but with occasional and intermittent pulses of acceleration up to 1.0 times the acceleration of gravity. The response spectrum for the earthquake without the acceleration pulse up to 1.0g will be similar to that of the El Centro Earthquake. With the additional accelerations, the high frequency part of the spectrum will be increased somewhat.

In addition, the structures are considered to be subjected to simultaneous ground displacements ranging up to 3 feet, along faults extending under the containment structure or other parts of the plant, with motions in either horizontal or vertical directions along the fault. It is assumed also that after-shocks of intensity equal to the El Centro quake might be suffered before remedial action could be taken.

Under these conditions, and with the design considerations described in Amendment No. 8, it is my conclusion, after study of the matter, that the structural integrity and leak tightness of the containment building can be maintained under the conditions described, and with the provisions made by the applicant, as described in Amendment No. 8 and in previous amendments and applications. However, certain precautions that must be considered in the design are outlined more fully herein. There are also questions expressed concerning the behavior of the structure in the event of somewhat higher input motions and fault motions.

Similarly, the ability to shut down the reactor and maintain it in the shut-down condition would not be impaired, provided that the intensities of motion and the magnitudes of fault slip do not exceed those described. Again, certain precautions are required as described more fully below.

The primary system, being contained in the massive reactor containment structure, would remain intact up to fault movements not exceeding 3 feet, and under earthquake motions as described above, provided that the piping system carrying the main steam lines from the dry well to the turbine inlet is made sufficiently flexible to accommodate a relative movement of 3 feet without failure, and at the same time is damped to reduce its dynamic response to earthquake oscillations. Further comment on this matter is made below.

The supply of power to the facility, from power lines crossing the major fault, might be interrupted, although the probability of such interruption is probably fairly low. In the event of such interruption, auxiliary power supplies are required. The description of these auxiliary power provisions seems adequate.

In general, the provisions for meeting the various requirements are based on methods for which some background of experience is available, or on minor modifications of such methods, which in the light of analysis and study appear to be reasonably adequate.

The earthquake motions, including acceleration and velocity as well as displacement, appear to be 2 to 3 times more intense than any that have been ~~experienced~~ recorded in the United States, and probably about twice as intense as those experienced anywhere else in the world in recent years for which we have fairly good records. Nevertheless, it appears that the design objectives can be accomplished.

A more detailed discussion of the various points described in Amendment No. 8 is contained in the following material. In addition, consideration is given to several points not specifically discussed in the amendment.

ISOLATION OF SHOCK FROM FAULTING BY MEANS OF SAND LAYER

In the study of this problem I have had the benefit of a review of the current state of knowledge of this aspect of the problem made by Mr. R. A. Williamson of Holmes and Narver. The statements made herein reflect in general his studies, as interpreted by me, and the final conclusions are based on my views as well as his.

The properties of sand under static loading have been studied for many years and are well understood. The frictional resistance in natural beds of sand has been measured and compared with behavior of such beds under various conditions. Within recent years dynamic tests of the behavior of sand have been made by Dr. R. V. Whitman of MIT, Dr. H. B. Seed of the University of California at Berkeley, and by others. The results of these tests, and of the engineering experience for many years, indicate that the frictional resistance of sand, as measured by the angle of internal friction, changes very little for velocities of the order of 2 ft/sec., and the change is not greater than about 20% for velocities slightly greater than 3 ft/sec. The coefficient of friction, as measured by the tangent of the angle of internal friction, corresponds to values ranging from about 0.5 or slightly greater up to about 0.9, and in general there appears to be a slight decrease in the coefficient of friction for high contact pressures or for high loadings.

The constancy of the angle of internal friction is dependent on the relative density of the sand. If it is in a condition corresponding to a density of the order of 90 to 95% of its maximum possible density, the friction angle does not increase with motion. For very low relative densities, or for loosely packed sand, the friction angle of dry sand will increase with loading. On the other hand, this increase in friction angle of loosely packed sand is accompanied by a reduction in volume, and this reduction in volume, under conditions of saturation, corresponds to a great increase in the pressure carried by the inter-granular water. This results in a temporarily decreased effective frictional resistance, and therefore it is quite reasonable to expect that under the conditions of deposition of the sand layer, the frictional resistance will not effectively be increased over the value corresponding to the density achieved in placement, over a long period of time. However, after an earthquake has occurred, the conditions prior to the next earthquake will have been slightly changed, if the sand is in a very loose condition to begin with. Nevertheless, a change in density of the sand would not be expected to occur unless relatively large motions take place. Consequently, the structure should be able to resist very successfully a major earthquake, although there are possibilities of it not being able to react with full effectiveness against a second major earthquake of the same intensity. Since this is a most unrealistic condition, however, it will not be considered further in this report.

The skin friction angle between relatively smooth concrete and sand is generally slightly less than the friction angle in the sand itself; hence the resistance to sliding of a properly constructed structure on a sand bed can be made as low as that which corresponds to a coefficient of friction of the order of 0.6 to 0.8, and it can be expected with some confidence that this coefficient of friction will not increase with time if the sand is clean and the water inundating it does not contain cementing compounds.

Minor earthquakes having accelerations less than that required to overcome the frictional resistance would not affect the behavior of the sand at all.

DESIGN OF PIPING, ETC., TO ACCOMMODATE RELATIVE MOVEMENT AND VIBRATORY EFFECTS

The amendment indicates that adequate anchors and bracing will be provided to prevent large relative motions of the piping connecting the dry well to the containment shell. Beyond the anchor at the containment shell, and extending to the anchor near the turbine generator foundation, the piping will be subject to the differential fault motions ranging up to or as much as three feet, as well as the vibratory motions induced by the earthquake accelerations. Since the time sequence of the faulting and the oscillation is entirely a random matter, both of the effects must be considered as occurring at any time, even simultaneously.

The precise strains in the pipe due to relative motions or due to earthquake vibrations are functions of the length of the pipe runs in the various directions and the method of anchoring. The curvatures in the pipe, and hence the maximum strains in it, due to a slow relative motion of the ends of a pipe run, are primarily a function of the geometry of the system, and are independent of the thickness of the pipe shell. The diameter of the pipe and the length of the runs in the various directions, as well as the conditions at the support, namely whether these are fixed or hinged to provide rotation, are the primary influences affecting the strains accompanying a given relative motion of the ends of the run. The maximum strain is in general of the order of 4 times the diameter of the pipe times the relative displacement divided by the square of the component of length of the run in the direction perpendicular to the displacement. This value of the strain corresponds to a condition of fixity at the ends of the run. If the ends are hinged, which is an almost extreme condition that can not be obtained except with flexible connections, then the strains are reduced to possibly ~~three-fourths~~ two-thirds as much as those corresponding to fixed ends. Therefore, the higher value will be used in the estimates made herein.

Both the horizontal and vertical components of the pipe runs ~~between~~ of the 20 inch ~~range~~ main steam lines are approximately 80 feet. Since the pipe is 20 inches in diameter, the corresponding strain is approximately 0.0035 in/in. This is about twice the strain at the yield point. Therefore, without flexible connections, the strain in the pipe due to a three foot relative motion will exceed the yield point, but only slightly, and by an amount that should not cause any serious problem. To reduce the strains to yield point values would require the introduction of flexibility at possibly two of the joints or elbows in the pipe, or one or more bellows connections at the ends of the pipe run. It does not seem feasible to increase the length of the pipe run from 80 ft. to 115 ft., which would be the requirement to reduce the strain to the yield point value merely by flexibility of the pipeline itself.

The dynamic response of the piping depends on its fundamental period of vibration and can be obtained from the shock response spectrum. Since both the weight of the piping and its stiffness depend on its wall thickness, the deflection of the piping due to a given acceleration is independent of the wall thickness. Only the diameter of the pipe and the length of the pipe runs determine the frequency of a pipe not carrying additional load. For several different configurations of pipe a fairly consistent relationship between maximum dynamic strain due to earthquake vibration and maximum strain due to movement of the supports can be obtained.

The ratio of the maximum strain due to a spectral displacement, D, for vibration at a given frequency, compared with the strain due to a relative static displacement at the ends, Δ, is approximately $2 \frac{D}{\Delta}$. Hence the earthquake strains which accompany earthquake motions will be of the same order as the strains for the three foot movement of the ends if the earthquake displacement is approximately 1.5 ft. For the pipe runs considered, Mr. Williamson estimates a period of vibration of the order of 1 to 2 secs. ~~and I confirm this figure from rough calculations that I have~~ My calcolations indicate a period of about 0.5 sec. for two "fundamental" modes, one primarily vertical and the other primarily horizontal, when the ends are fixed. These periods are about twice as long, or one sec., for hinged ends. The maximum combined stress when both modes are excited is only slightly greater than the maximum stress for one of the modes.

assuming hinged ends

For a period of 0.5 secs., and for the PG & E spectrum in Figure 1 of Amendment 8, for 0.5% damping, the displacement is of the order of ~~[illegible]~~ 0.25 feet, and for twice this earthquake the displacement will be ~~[illegible]~~ about 0.5 feet. On this basis, it can be estimated that the strains due to the earthquake response are ~~almost twice~~ about one-third as great as those due to the 3 ft. relative displacement of the supports. Hence, under combined earthquake and relative displacement due to faulting, the pipe will be overstressed, but not beyond three times the yield strain.

It should be noted that the response determined above varies directly as the natural period in the range from about 0.4 sec. to more than 3.0 sec. In other words, if the period of the pipe can be reduced, its displacement will be decreased in the same proportion. However, reducing the period of the pipe will require an increase in stiffness in general, which would cause difficulties in resisting the relative displacement of the ends. Conversely, introducing flexible connections will in general increase the period of the pipe which will increase the dynamic earthquake ~~response characteristics~~ strains.

It appears therefore that some further consideration of the piping design is required before assurance can be given that the piping can sustain both the earthquake vibrations and the relative fault motions without being overstrained.

It might be pointed out in this regard that the maximum displacement of the pipe, should it become inelastic in an earthquake, would probably not be different from the maximum displacement were the pipe to remain elastic. Hence the pipe, under the most serious combination of conditions, will be strained to about ~~6~~ 3 times the elastic limit strain at yielding (under the combined effects of the fault motion and earthquake motion). This is a

Insert after 1st ¶ on p. 9.

All umbilical connections to the reactor containment structure, including the main steam lines, should be designed to assure freedom from contact with other structures, walls, or earth and rock, by such a distance as to provide for the possibility of a three foot fault motion and, in addition, the vibratory motion of the element considered. Also, all vital piping, etc., must be arranged in such a way that a three foot fault motion occurring elsewhere in the area will not cause a failure of the vital element.

The main steam lines and similar important lines should be designed to be locally stiffened by sleeves or doubler plates, at points where isolation ~~safety~~ valves or where anchors are attached, to prevent ovalling or distortion of the lines that would impair its behavior.

bit severe, but might be tolerated. A possible means of reducing the stress involves introduction of damping by artificial means. If the damping factor is increased from 0.5% to about 20%, the dynamic displacements are cut by almost a factor of 3. ~~and~~ [illegible] Hence, dampers or snubbers attached to the pipe in some fashion may be required. These should probably be attached in such a way that they correspond to internal damping in the pipe rather than absolute damping by connection to the ground, since the latter will introduce additional disturbing forces in the pipe when relative motions of the ground or the containment structures take place.

SAFETY OF AUXILIARY EQUIPMENT

The auxiliary equipment contained within the reactor containment building will, in general, move as a unit within the containment structure. The fault displacement of 3 ft. for which provision is made does not produce a similar displacement within the structure, although it may produce a rotation or tilting of the containment structure. However, the equipment described in the amendment and in the original application can certainly be designed for the slight tipping or tilting and rotation, provided it is not rigidly attached to items which move either a different amount or do not move at all.

It is stated in Amendment 8 that "where vital components of the emergency systems are located within the turbine generator foundation of the control building, the inter-connecting piping and cable will be designed to withstand up to 3 feet of relative displacement between the reactor containment structure and the turbine generator foundation, or control building." The provision of resistance to large relative displacement combined with resistance to oscillations seems capable of achievement for relatively small diameter pipes, or for wires, although it is difficult for the 20 inch main steam lines.

SAFETY OF PRIMARY SYSTEM

Comments have been made previously regarding the main steam lines and the difficulties involved in providing the necessary resistance to relative motion and to earthquake vibrations. The statement is made in the amendment that "accelerations experienced by the primary system during such a displacement would be less than the acceleration used in the design of the equipment." It is not clearly stated that the accelerations experienced by the primary system during the maximum earthquake would be less than the acceleration used in the design of the equipment. Moreover, it is not clear, if the relative motion of faulting should exceed 3 ft., whether there will not be a greater maximum acceleration than that provided during the earthquake, owing to a possible crashing or battering of the retaining walls outside the gap against the reactor containment structure. These could induce fairly large, but high frequency, accelerations. Because of the large mass to be moved, the inertia of this mass, and the possible weakness of the walls of the reactor containment structure against a localized line loading from outside, it is not clear at all that a relative movement of more than 3 feet can be sustained without producing serious damage to the reactor containment structure or serious accelerations to the primary system within it. Nevertheless, for less than the three foot fault motion, questions of this sort can not be raised.

POSSIBLE INTERRUPTION TO SUPPLY OF POWER

The vulnerability of the overhead transmission lines has not been established. These lines cross the San Andreas fault, and although they are supported on widely spaced towers, there is a possibility that one or more of the towers may be displaced by as much as 20 ft. relative to a neighboring tower. It is possible that the towers can sustain such a motion without loss of all of the lines. However, further study of this problem is desirable if it is necessary to depend on this source of power. The amendment states, however, that if the external sources are unavailable the engine generator, located within the reactor containment structure, will be capable of handling the load required to shut down the plant safely. A further supply of power is available in the battery contained within the reactor containment structure and control building.

It must be regarded as possible that the main overhead transmission line would be severely impaired in its functioning where it crosses the main fault.

ABILITY OF STRUCTURES AND EQUIPMENTS TO RESIST EARTHQUAKE OSCILLATIONS

The procedure described for the design of critical and non-critical structures, on pages 19-25, appears in general, to be satisfactory, with minor exceptions. On page 21, the second paragraph indicates that "the design of the plant will be checked to assure that all critical structures, equipment and systems will be capable of withstanding earthquake ground motions corresponding to spectrum...(values)...two times as great as shown on Figure 1 without impairment of functions..." This means an earthquake of maximum acceleration of 0.67g, but not with acceleration spikes ranging up to 1.0g. The difference is not important for items having periods of vibration greater than about 0.5 sec., but it can be substantial for elements having shorter periods or higher frequencies, and the discrepancies become progressively larger as the frequency becomes higher or the period becomes lower. A clear and unequivocal statement about this point would be desirable.

In general, there is a reserve margin in almost every element beyond the point at which yielding begins, even in items of equipment, control rods, fuel assemblies, etc. Dr. Housner's study of the reserve capacity of structural elements, in Appendix II of Amendment 8, is sound. Nevertheless, for items of equipment which are not designed for yielding at all, but which have to satisfy certain criteria such as clearance or magnitude of [illegible] displacement, it is [illegible]t essential to consider the higher spikes of acceleration in their design in order to provide the necessary reserve margin to assure operation of these items under the extreme maximum conditions.

In this regard, it should be noted that the design spectrum in Figure 1 is not quite as large as the values that correspond to the extreme peaks of the El Centro spectrum. The values in Figure 1 are in general those that correspond to the mean of the oscillations for the rather jagged peaks in the individual response spectrum curves for various earthquakes, especially in the high frequency region. An envelope through the spikes would generally lie about a factor of 2 above the smoothed spectrum, particularly for the low values of damping, although it would approach the values reported for the higher values of damping. This is not regarded as an important discrepancy, however, as there are indications that the mean of the oscillations in the spectrum is a much more significant value than the magnitude of the spikes. Calculations that have been made and that are reported for equipment mounted on submarines, and for response of buildings to earthquake, in general indicate that the measured responses are more nearly consistent with the mean of the oscillations of the spectral

Insert after 1st ¶ on p.13

The accelerations transmitted to the reactor containment structure will not exceed the acceleration that will cause sliding on the sand layer, which may be from $\frac{2}{3}g$ to 0.9g, depending on the characteristics of the sand, until first contact is reached with the side of the cavity. Since this contact will occur after a three foot fault movement, or even less if some sliding occurs on the sand, a design level for proper functioning of equipment (of 1.0 g) should be used.

values rather than with the peaks. Hence the smoothing of the spectrum is a rational and reasonable procedure.

SUITABILITY OF PROPOSED DAMPING COEFFICIENTS

The damping coefficients listed on page 23 of Amendment No. 8 appear in general to be reasonable. The degree of precision implied in the selection of damping coefficients to two significant figures seems somewhat unwarranted. However, the values are in general reasonable for the stress levels implied in the design of the individual elements, or for the conditions which are involved in their behavior. The damping for the reinforced concrete reactor containment structure would be considered high for a structure supported directly on the rock, but may be reasonable considering the fact that the structure is supported on a sand bed. For low intensity earthquakes, possibly even for the 1/3g earthquake, if such is considered to be a design condition, the damping might be of the order of half as much as that used for the reinforced concrete reactor containment structure. However, for the maximum earthquake considered, the damping factor used is not at all unreasonable.

EFFECTIVENESS OF SAND LAYER IN CLIPPING PEAK ACCELERATIONS

In view of the comments on the behavior of the sand layer, it can be concluded that the sand layer will act to clip high peaks of horizontal acceleration that exceed its frictional capacity to transmit force to the reactor containment structure. It will not clip vertical acceleration peaks.

DETAILED DYNAMIC ANALYSIS OF EQUIPMENT

The method described on pages 23 and 24 for handling the response of equipment within the building appears reasonable, although for sensitive items near the upper part of the building, the approximate method may not be adequate. A detailed dynamic analysis, such as described near the bottom of page 24, will be desirable for all extremely sensitive and critical items of equipment. The method of analysis described can take into account the interaction with the reactor containment structure itself. However, the ground accelerations or ground input motions considered should correspond to the maximum earthquake, and not the 0.33g earthquake for which Figure 1 of the amendment is drawn.

The statement on page 34 implies that double the seismic loads corresponding to Figure 1 will be considered, but this does not take into account the spikes of acceleration ranging up to 1g for the higher frequency components. A further clarification of this point is desirable.

ADDITIONAL COMMENTS

The effect of the water in the annulus surrounding the reactor containment structure should not in general cause accelerations to be transmitted directly to the structure through the water because of the fact that the water has a free surface. However, it would be desirable to have a study by the applicant of this problem to insure that the surging of the water will not introduce additional oscillations within the structure. This does not seem likely and it appears most reasonable to expect that the water contained in the annular space will damp the motion of the structure. Nevertheless, no specific data on this topic are available.

In general, although questions have been raised about the treatment in certain aspects of the amendment, it is not believed that any of these questions involve problems that are not possible of solution within the range of currently available engineering knowledge. It is my considered opinion that the structure and its equipment can be designed to resist the effects of the maximum earthquake postulated.

SUGGESTIONS FOR CHANGES IN REVISED DRAFT REPORT OF N. M. NEWMARK

1. Page 2, second full paragraph - I understand the purpose of this paragraph is to indicate your conclusions with respect to the ability of the containment building to withstand the postulated earthquake effects, and not to deal with other features of the proposed facility design. If this is correct, this paragraph might be clarified to indicate that it does not deal with the adequacy of the design of the penetrations to the containment building, such as the main steam line, since this particular feature would affect the leaktightness of the containment building. Also, it is not clear to me the nature of the "certain precautions" that are referred to in the last sentence of the revised draft.

2. Page 2, last paragraph - This paragraph as written deals only with the primary system. I suggest that it be expanded to include your comments on all vital umbilicals connected to the reactor containment structure. In this event, this paragraph probably ought to contain a qualification concerning the need to provide arrangements to prevent shearing or other failure of the umbilicals caused by contact of concrete walls, rock, earth, etc. against the connections.

3. Page 3, first full paragraph - The meaning of the last sentence in this paragraph is not clear. Obviously, it is not meant to state that the capacity of the auxiliary power provisions is adequate, but probably to indicate that the design of this equipment is such that it could readily withstand the postulated earthquake effects.

4. Page 3, second full paragraph - This paragraph should be expanded to cite specific instances of the available "background of experience" which

show that the design methods proposed appear to be adequate.

5. Page 4, first full paragraph - The velocities of 2 and 3 feet per second given in the next to last sentence should be related to the velocity of the 3 foot fault motion postulated for Bodega Head. The "high contact pressures" and "high loadings" given in the last sentence of this paragraph should be related to the earthquake effects postulated at Bodega.

6. Page 5, first incomplete paragraph - If possible, the "relatively large motions" given in the third from last sentence should be restated in more qualitative terms. I understand the last sentence to mean that the "most unrealistic condition" referred to is the occurrence of a second earthquake with the same maximum effects postulated by the USGS and USCGS. If this is correct, this sentence could be rephrased to more clearly indicate its meaning.

7. Page 5, first full paragraph - The last sentence states that the coefficient of friction of the sand will not increase with time provided that the sand is clean and the water inundating it does not contain cementing compounds. It would be helpful if this sentence could be expanded to indicate the specific cementing compounds which would be deleterious, and what design measures, if any, would be provided if the inundating water were determined to contain such compounds.

8. Page 5, last paragraph - The value of acceleration of "minor" earthquakes which would not overcome the frictional resistance of the sand should be given.

9. Pages 3 through 5 - Entire section on Shock Isolation by Means of Sand Layer - In general, I understand this section to provide a basis for

a conclusion that a horizontal ground displacement of 3 feet would not result in movement of the containment due to the presence of the sand layer. Further, I understand it to provide a basis for concluding that a vertical ground displacement of 3 feet would at most result in tipping of the containment building. If this is the general purport of this section, it would appear to be advisable to state these conclusions at the end of the section. Is it possible that, if horizontal ground motion should occur, the containment building would undergo some rotational motion about a vertical axis? If so, is it not possible that the rotational displacement at the surface of the containment building would be greater than that at the axis, and therefore greater than 3 feet? If this is possible, it seems appropriate to discuss this fact in this section of the report.

10. Page 7, first full paragraph - Should the calculated strains in the piping take into account the possible rotation of the containment vessel discussed in item 9 above? In addition, the sentence which indicates that strains exceeding the yield point should not cause any serious problem should be rephrased to indicate that such strains would not cause loss of integrity or whatever is considered by you to be a serious problem.

11. Page 7, second full paragraph - I have had at least two comments from persons who do not understand the second sentence of this paragraph. Please try to better explain or clarify why the deflection of the piping due to a given acceleration is independent of the wall thickness.

12. Page 9, first full paragraph - The "further consideration" of the piping design which you believe to be required should be identified in more specific terms.

13. Page 9, second full paragraph - The third sentence indicates that strains of three times the elastic limit strain at yielding are "severe but might be tolerated". A more unequivocal statement would be desirable and the conditions under which such strain would be tolerated should be listed.

14. Page 9, last paragraph - If rotation of the containment is possible as is discussed in item 9 above, the last sentence of this page should make it clear that this effect should also be taken into account in the design of all umbilicals.

15. Page 14, first full paragraph, last sentence - It appears that the conclusion in this sentence is valid only if a high enough seismic design spectrum is used in the design of structures and equipment. If this is so, this qualification should be added to the last sentence.

16. Page 14, last paragraph - The last sentence indicates that contact of the containment would occur after a 3 foot fault movement, or even less if "some sliding occurs on the sand". I understand that you believe that due to the inertia of the containment building, one should not depend on the fact that such sliding might occur. However, it is not clear to me how any sliding could occur unless there is contact with the reactor containment, but the last sentence in this paragraph seems to indicate that this is possible. Please clarify.

17. Page 15, first full paragraph - The next to last sentence indicates that the damping for the containment structure might be of the order of half as much of that proposed in the event of low intensity earthquakes, possibly even for a 1/3g earthquake. Since it must be assumed that

earthquake accelerations lower than the maximum postulated may occur, does this statement mean that you believe that it is necessary to use a lower damping coefficient than that proposed for the reactor containment structure?