

**Canada Comments on
DS490 Seismic Design of Nuclear Installations**

Country/Organization: Canada Date: May 15, 2019					RESOLUTION Comments received on August 19, 2019. The document is already in Step 10.			
Comment No.	Para/Line No.	Proposed new text	Reason	Project lead response	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
1.	3.2 & 3.3	Cross referencing should be made between the design requirements in this document and the beyond design basis/design extension conditions in other documents, as applicable. For example, SL-1 and SL-2 are performance criteria within the design basis. Similarly, performance criteria for design extension conditions and beyond design basis condition should be referenced.	Cross referencing will reduce the potential for confusion in interpretation.	Accepted			x	Cross references to design requirements are discussed in Section 2. Seismic design levels, SL1, SL2 and BDBE, including their use, are discussed in Section 3 and 7 (for BDBE)
2.	3.4	Delete the 1 st sentence in paragraph 3.4 and move the 2 nd sentence to the Scope section as per: 3.4. Earthquakes generate several direct and indirect phenomena. From vibratory ground motions to associated geological and geotechnical hazards, as permanent ground displacement (e.g. soil liquefaction, slope instability, tectonic and non-tectonic subsidence, cavities leading to ground collapse, and settlements) to concomitant events such as seismically induced fires and floods. This Specific Safety Guide provides guidance on how to design a	The 2 nd sentence describes the scope of this draft guide in keeping with clauses 1.10 and 1.11 and should be included in the scope section.	Accepted			x	Can be interpreted like that however we believe that Paragraph 3.4 is useful at the beginning of Section 3. This paragraph clarifies some concepts relevant for seismic design.


Country/Organization: Canada Date: May 15, 2019				RESOLUTION Comments received on August 19, 2019. The document is already in Step 10.			
		nuclear installation against the effects of vibratory ground motions.					
3.	3	Amend the section title to read: "3. INPUT FOR SEISMIC DESIGN: INPUT AND PROCESS "	Amending the title more accurately addresses the content in Section 3 and reduces confusion that comes from dividing information among various sections.	Accepted	o.k.		
4.	3.9, 3.10	Add time history to these clauses to recognize that seismic input can be in the form of time history.	The absence of time history incorrectly implies it is an unacceptable seismic input. Time histories have been mentioned in several sections such as 6.12(a), 3.8, 3.19 etc.	Accepted		x	This subsection is about Required input from the site evaluation stage From DSHA/PSHA you get only GMRS not TH. For design purpose artificial TH compatible to GMRS can be generated.
5.	3.15	Correct 3 rd bullet to read: "Type 3 sites: 300m/s > Vs; 300m/s < Vs;"	Mathematical error.	Accepted	o.k.		
6.	3.19	Add the following to the list associated with point 1): "f) soil properties (e.g., internal friction angle, cohesion and hardening, dilation angle) required to determine soil strength in drained and/or undrained condition. "	This provides information to support Para 3.13 a) for strength capacity and Para 5.18 for nonlinear constitutive behaviour.	Accepted		x	Para 3.19 is dealing with dynamic soil properties relevant for site response analysis not with geotechnical issues related to soil capacity.
7.	3.23	PGA and ZPA should only be defined once in the document.	Confusing and repetitive language. For example clause 3.23 and 3.33 use	Accepted	O.K.	PGA/ZPGA removed (addressing	



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			exactly the same wording			other MS comments)	
8.	3.23	Change PGA to "relevant parameter" or "reference ground motion parameter" (EPRI 3002012994) and mention PGA (ZPA) as an example. Then, explain that PGA is typically used and, accordingly, this guide uses PGA as an example unless noted otherwise.	Characteristic measure of a hazard's intensity (relevant parameter) could be chosen to be peak ground acceleration, peak spectral acceleration, average spectral acceleration, floor spectral acceleration, or others.	Accepted	O.K.	PGA/ZPGA removed (addressing other MS comments)	
9.	3.28	Either remove this clause or specify minimum PGA of 0.10 g at free field.	As currently written, this clause can lead to confusion because the PGA at rock is found to be much less than 0.10 g in some of the world's stable, continental regions.	Accepted	O.K.		
10.	3.29	Amend the 3 rd bullet point to read: "c) Demonstrate that cliff edge effects are evaluated and mitigated-avoided within the uncertainty of the determined DBE values."	The requirement of cliff edge effect avoidance might be difficult to fulfil in some cases.	Accepted	O.K.	Also modified by other MS comment.	
11.	3.44	Amend the 1 st sentence to read: "The items of nuclear installations included in Seismic Category 3 should be designed	In building codes, conventional risk is categorized as 'High',	Accepted	O.K.	Accepted with modification	

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		as a minimum in accordance with national practice for seismic design of non-nuclear applications and, therefore, for facilities at the highest conventional risk level. "	'Normal', and 'Low'. The highest importance category should be selected.			due to some conflict with other MS comment.	
12.	3.44	This clause is not acceptable for containment. All systems and components in containment are to be designed for SL-2 irrespective of their category.	Modifications in a plant may require several existing components to be qualified to SL-2 which were qualified to the national building code prior to modification because of potential seismic interaction with the new components. For instance, operating experience from Wolsong NPP indicates several components were designed to the national building code and seismic loading that was four times less than the DBE.	Accepted			x Containment system (Safety classified) should be in Seismic category 1 or 2. Seismic category 3 is for non-safety classified SSCS see Table I.
13.	3.45 TABLE 1	Add a note to the remarks in the table's final row to reflect the correction suggested in the previous comment, "Containment components to be designed to SL-2 irrespective of the category."	An SSC may sound like Category 3 one day, but a new Category 1 component may be installed close to it the next day. Containment, being congested, does	Accepted			x Table 1 should be read together with para 3.37 and 3.41 (covers all possible interactions of not categorized items with items from seismic category 1).

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			not allow for post-installation modifications.				
14.	3.48	Amend the 4 th sentence to read: “Consistent acceptance criteria should be established and good industrial practices used to provide safety consistency If this is unavoidable, this consistency should be attained for SSCs of same material (e.g. for reinforced concrete and steel structures) and/or same type of item (e.g., piping, mechanical and electrical components).”	The same material or same type of item does not provide or guarantee safety consistency. Consistent acceptance criteria provide safety consistency.	Accepted	O.K.	Slightly modified.	
15.	3.9	Amend the sentence to read: “If a deterministic approach was used for determining the site specific vibratory ground motion, a single value of such parameters (peak ground acceleration and spectral representation of ground motion and relevant parameters such as peak ground acceleration should be determined.”	A “single value of such parameters” is not enough.	Accepted	O.K.	Slightly modified.	
16.	4.4	For point b) centre of rigidity may be reasonable for SL-1, but it may be the centre of strength for SL-2 in some cases depending on the post yield strain.	Centre of rigidity changes to centre of strength post yielding.	Accepted			x Only localized nonlinearity is accepted within design basis limits. The overall behavior of the SSCs is basically linear.
17.	4.6	The SSCs shall be detailed to exhibit	In the absence minimum	Accepted			x This level of details is

Country/Organization: Canada Date: May 15, 2019				RESOLUTION Comments received on August 19, 2019. The document is already in Step 10.			
		minimum ductility =2. The ductility is to enhance beyond design capacity of a SSC and should not be used to reduce the seismic demand in SL-1 or SL-2	ductility criterion, the evaluation to a beyond design basis event becomes a bit too challenging.				not appropriate for a safety guide. It is covered by applicable codes and standards.
18.	4.6	Amend the list to read: a) Structures made of reinforced concrete shear walls providing the lateral force resisting system; b) Steel or reinforced concrete moment-resisting frames, specially detailed to provide ductile behaviour; c) Steel eccentrically braced frames, specially detailed to provide ductile behaviour. d) Reinforced concrete slab/wall moment frames.	EBF should be added since they promise large ductility	Accepted		x	Covered by b). How you get ductile behavior is addressed by applicable codes and standards.
19.	4.8	Amend point b) to read: "For reinforcement, an appropriate minimum ratio of the ultimate tensile stress to the yield tensile strength should be defined, to ensure a minimum ductility of at least 2."	Minimum ductility threshold is required.	Accepted		x	This level of details is not appropriate for a safety guide. It is covered by applicable codes and standards.
20.	4.9	Add the following text to the clause: "No nonlinear behaviour shall be allowed for an SL-1 event."	Nonlinear behaviour to be restricted to SL-2. SL-1 to be essentially elastic.	Accepted		x	Acceptance criteria are covered by applicable codes and standards. Stress strain limits for SL-1 are well below yield limits.
21.	4.10	Add the following text to the clause: "No nonlinear behaviour shall be	Nonlinear behaviour to be restricted to SL-2. SL-	Accepted		x	Covered by acceptance criteria.

		Country/Organization: Canada Date: May 15, 2019			RESOLUTION Comments received on August 19, 2019. The document is already in Step 10.			
		allowed for an SL-1 event.”	1 to be essentially elastic					
22.	4.22	Add the following text to this clause: “Isolation is applicable only to the nuclear island and not to the conventional structures. Umbilicals should be used for connecting piping or any other component between the conventional structures and the nuclear island. The umbilicals should be demonstrated to meet large differential displacement between the conventional and nuclear side of the plant.”	Umbilical requirement is missing.	Accepted			x	Covered by para 4.25.
23.	4.27	Add: “Experience data from strong motion earthquakes and past test reports to be a source of seismic qualification.”	Experience data is missing.	Accepted			x	Seismic experience data has no sufficient quality to be used for seismic design qualification.
24.	4.30	Remove sentence c) related to unanchored tanks until it is better studied.	 Malhotra et al Sometimes, unanchored tanks are better than anchored ones. Please see <i>Malhotra et al (2000)</i> .	Accepted	O.K.	Accepted with modification. I just remove the text about elephant foot buckling.		The paper you are provided is not conclusive in the favor of the un-anchor tanks (depends of many factors). Unanchored tanks may exhibit larger displacements that may affect the attached lines.
25.	4.31	Amend the title that precedes this paragraph to read: “PIPING AND VESSELS”. For consistency, amend all	Piping and vessels follow the same design code.	Accepted			x	Only piping are addressed in that subsection. Pressure

Country/Organization: Canada Date: May 15, 2019				RESOLUTION Comments received on August 19, 2019. The document is already in Step 10.			
		references to “piping” in this paragraph to “piping and vessels.”					vessels seismic seismic failure modes are mainly related to anchorage failure, nozzles and attached pipes failure all these are addressed in subchapter Mechanical Equipment Items..
26.	4.31	Include experience data references to Electric Power Research Institute (EPRI) and Seismic Qualification Utility Group Generic (SQUG) Generic Implementation Procedure (GIP).	Experience data is mentioned but without reference to EPRI, SQUG GIP etc.	Accepted		x	Seismic experience data has no sufficient quality to be used for seismic design qualification.
27.	4.35	Add experience data as a means of seismic qualification.	Large electrical equipment is generally qualified by experience data	Accepted		x	Seismic experience data has no sufficient quality to be used for seismic design qualification.
28.	4.43, 4.45	Add experience data as a means of seismic qualification.	Experience data is missing in these clauses.	Accepted		x	Seismic experience data has no sufficient quality to be used for seismic design qualification.
29.	5.4	Amend the first bullet point to read: “a) The seismic input should be defined by either design response spectra or by response spectra compatible acceleration time histories; as per established literature;”	 Section 25-4 art time history Clough Penzin  Li&Xie Time Histories Using Eigenfunctions. For reference, please see	Accepted		x	Codes and standards is better. Literature is too vague – may leave the door open for using non-validated methods.

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			<i>Dynamics of structure-Third Edition, Ray W. Clough, Joseph Penzien, 2003 and Generating Spectrum-Compatible Time Histories Using Eigenfunctions, Bo Li, Binh-Le Ly, Wei-Chau Xie and Mahesh D. Pandey, 2017</i>				
30.	5.4	Amend the second bullet to read: “b) The analysis model should adequately represent the behaviour of the structure under the seismic action, considering the mass, inertial stiffness and damping distribution of the structure;”	Mass is as important as stiffness.	Accepted	O.K.		
31.	5.4	Add an option to scale the existing response analysis (e.g. DBE design response spectra) as a method of estimating responses to the BDBE. Details could be adopted from EPRI 3002012994.	Scaling is one of the approaches to the response analysis.	Accepted		x	Scaling method can be used for SMA observing certain restrictions (rock sites/no significant SSI effect, good quality of the design ISRS, etc.). It is described in SMA methodologies. %4 talks mainly about STRUCTURAL RESPONSE for design. In Section 7 the procedure for quantification of seismic margin is discussed and

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							addressed in Ref. [3].
32.	5.34	Add “state change and functionality interruption of mechanical and electrical components” to address mechanical components.	Mechanical functionality should be listed as well.	Accepted	o.k.	Slightly reworded.	
33.	5.34	Amend the 3 rd sentence to read: “Seismic capacity should be derived from this limiting condition using the appropriate methodology design code.”	Design codes are specific and not intended to determine capacity. See section 4.2 of attached reference.	Accepted	o.k.	appropriate design codes and methodologies.	
34.	5.37	Amend to delete the example so it reads: “For seismic capacity calculations, material properties should be selected according to characteristic values (e.g. 95% non-exceedance probability), supported by appropriate quality assurance procedures.”	The example as currently written causes readers more confusion than clarification.	Accepted	o.k.		
35.	6.19	Add resonance as a requirement.	Resonance is missing.	Accepted			x Resonance test is included in Proof Test.
36.	6.30	Add reference to SQUG GIP and EPRI test data.	Missing references	Accepted			x Not sufficient quality for design seismic qualification.
37.	7.4	Amend the 1 st sentence to read: “There is a relationship correlation between hazard level used to define SL-2, seismic margin capacity (HCLPF) and seismic performance goal...” Amend the 2 nd sentence to read: “In this context, the minimum required seismic	The term "correlation" is not appropriate to explain the relationship between the three aspects of seismic study. The phrase "cliff edge effect will not occur" might not be appropriate	Accepted	o.k.		

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		margin capacity of the nuclear installation should be prescribed to ensure that seismic performance goal is achieved and cliff edge effect will not occur be mitigated. "	in probabilistic space (where hazard, HCLPF and safety goals are probabilistically defined).				
38.	7.6	Amend the 2 nd sentence to read: "For prevention of the core damage, the minimum facility level seismic margin HCLPF should be used in the evaluation of compliance consistent with the required seismic performance goal (e.g. S-CDF <1.0-5 and LERF)."	More concise description of the requirement	Accepted			x Use of the suggested wording "compliance" is a bit strong. We consider that the actual formulation is better.
39.	7.9	Amend the 1 st sentence to read: "In the probabilistic approach, the median, or mean plant state fragility ..."	Unclear as currently written.	Accepted	o.k.		