
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.: 367-8436
SRP Section: 02.05.04 – Stability of Subsurface Materials and Foundations
Application Section: 2.5.4
Date of RAI Issue: 01/13/2016

Question No. 02.05.04-16

In response to RAI 8-7847, Question 02.05.04-13 (9/17/2015, ML15260B316), updates were made to the DCD Tier 1, Table 2.1-1 and Tier 2, Table 2.0-1 parameter descriptions related to backfill material dynamic properties. Specifically, the response states “For clarification to COL applicants, the shear moduli values are defined as the minimum and damping values are the maximum values”. This may imply that the maximum values for backfill damping can be greater than 15% as it is the case for strains larger than 0.1% as stated in the table. According to SRP section 3.7, “The maximum soil damping value acceptable to the staff is 15 percent.” The staff understands that the damping values presented in the aforementioned tables were likely used as input to calculate the shear-strain-compatible shear-wave-velocity profiles for the SFG backfill as explained in Section 4.5 of APR1400-E-S-NR-14003-P, Rev. 0. In order to avoid confusion with a COL applicant referencing the APR1400 design, please clarify the purpose of the damping values listed; and provide modifications in appropriate sections of 2.5.4, in DCD Tier 1 Table 2.1-1 and Tier 2 Table 2.0-1.

Response

The backfill material dynamic properties (normalized minimum shear moduli and maximum damping) in the DCD Tier 1, Table 2.1-1 and Tier 2, Table 2.0-1 are used to calculate the shear-strain-compatible shear-wave-velocity profiles for the SFG backfill. The COL applicant should confirm that the backfill material dynamic properties to be used in construction of the APR1400 seismic Category I structures satisfy the SFG requirements provided in DCD Tier 2, Table 2.0-1, as specified in DCD Tier 2, Subsection 2.5.6, COL 2.5(8). The DCD Tier 1, Table 2.1-1 and Tier 2, Table 2.0-1 will be revised to specify the use of the backfill material dynamic properties in the aforementioned tables.

Impact on DCD

DCD Tier 1, Table 2.1-1 and Tier 2, Table 2.0-1 will be revised, as indicated in the attachment associated with this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

APR1400 DCD TIER 2

RAI 8-7847 Question 02.05.04-6

RAI 149-8147 Question 02.05.04-13

RAI 367-8436 Question 02.05.04-16

Table 2.0-1 (3 of 4)

Parameter Description	Parameter Value
Certified Seismic Design Response Spectra (CSDRS) Referencing SSE	See Figures 2.0-1 and 2.0-2
Hard Rock High Frequency (HRHF) Response Spectra ⁽⁴⁾	0.46g peak ground acceleration See Figures 2.0-3 and 2.0-4
Fault Displacement Potential (yes/no)	No
Minimum Allowable Static Bearing Demand	718.2 kPa (15 ksf) ⁽³⁾
Minimum Allowable Dynamic Bearing Demand	2,872.8 kPa (60 ksf) ⁽³⁾
Minimum Shear Wave Velocity	304.8 m/s (1,000 ft/s)
Liquefaction Potential (yes/no)	No
Maximum Differential Settlement inside Building	12.7 mm (0.5 in) per 15.24 m (50 ft) in any direction
Maximum Differential Settlement between Buildings	12.7 mm (0.5 in)
Minimum Soil Angle of Internal Friction	35 degrees
Slope Failure Potential (yes/no)	No
Backfill Material Density	137 pcf
Backfill Material Dynamic Poisson's Ratio	0.33
Backfill Material Dynamic Properties (Minimum Dynamic Shear Modulus, kg/cm ²) - Shear strain 1% 0.1% 0.01% 0.001% 0.0001%	(Normalized Minimum Shear Moduli & Maximum Damping) 0.05 0.22 0.54 0.85 1.00 Damping ⁽⁵⁾

~~(Normalized Shear Moduli & Damping)~~

Shear Strain(%)	G/G _{max}	Damping(%)
1.0	0.05	24.0
0.1	0.22	16.0
0.01	0.54	6.0
0.001	0.85	2.0
0.0001	1.00	1.0

APR1400 DCD TIER 2

RAI 8-7847 Question 02.05.04-6

RAI 149-8147 Question 02.05.04-13

RAI 367-8436 Question 02.05.04-16

Table 2.0-1 (4 of 4)

Parameter Description	Parameter Value
Backfill Material Dynamic Properties (Minimum Damping Ratio, %)	
Shear strain	
1%	24
0.1%	16
0.01%	6
0.001%	2
0.0001%	1
Strain-compatible Minimum Shear-wave Velocity of Backfill	510 fps

- (1) Plant grade represents the level of ground adjacent to the nuclear island buildings and is established at a plant elevation 98 ft 8 in.
- (2) 100-year recurrence interval: Value to be used for design of seismic Category I and II structures only.
- (3) Bearing capacity is defined at the foundation level of the nuclear island structures.
- (4) The HRHF response spectra are provided for evaluation of site-specific ground motion response spectra which exceed the CSDRS in the high frequency range at hard rock sites.

(5) The backfill material dynamic properties are used to calculate the shear-strain-compatible shear wave velocity profiles for the backfill. The strain-compatible damping values of the backfill cannot be greater than 15%.

APR1400 DCD TIER 1

RAI 8-7847 Question 02.05.04-6

RAI 149-8147 Question 02.05.04-13

RAI 367-8436 Question 02.05.04-16

Table 2.1-1 (2 of 3)

Tornado	
Maximum Tornado Wind Speed	102.8 m/s (230 mph)
Translational Speed	20.6 m/s (46 mph)
Maximum Rotational Speed	82.2 m/s (184 mph)
Radius of Maximum Rotational Speed	45.7 m (150 feet)
Pressure Drop	8.274 kPa (1.2 psi)
Rate of Pressure Drop	3.447 kPa/s (0.5 psi/s)
Missile Spectra	Table 2 (Region I) of NRC RG 1.76 (2007)
Hurricane	
Maximum 3-Second Wind Gust Speed	116 m/s (260 mph)
Missile Spectra	Table 1 of NRC RG 1.221 (2011)
Soil Properties	
Minimum Allowable Static Bearing Demand	718.2 kPa (15 ksf) ⁽³⁾
Minimum Allowable Dynamic Bearing Demand	2,872.8 kPa (60 ksf) ⁽³⁾
Minimum Shear Wave Velocity	304.8 m/s (1,000 ft/sec)
Liquefaction Potential (yes/no)	No
Maximum Differential Settlement inside Building	12.7 mm (0.5 in) per 15.24 m (50 ft) in any direction
Maximum Differential Settlement between Buildings	12.7 mm (0.5 in)
Minimum Soil Angle of Internal Friction	35 degrees
Slope Failure Potential (yes/no)	No
Fault Displacement Potential (yes/no)	No
Backfill Material Density	137 pcf
Backfill Material Dynamic Poisson's Ratio	0.33
Backfill Material Dynamic Properties (Minimum Dynamic Shear Modulus, kg/cm ²) - Shear Strain	(Normalized Minimum Shear Moduli & Maximum Damping) Damping) ⁽⁵⁾
<ul style="list-style-type: none"> • 1% • 0.1% • 0.01% • 0.001% • 0.0001% 	<ul style="list-style-type: none"> 0.05 0.22 0.54 0.85 1.00

~~(Normalized Shear Moduli & Damping)~~

Shear Strain(%)	G/G _{max}	Damping(%)
1.0	0.05	24.0
0.1	0.22	16.0
0.01	0.54	6.0
0.001	0.85	2.0
0.0001	1.00	1.0

APR1400 DCD TIER 1

RAI 8-7847 Question 02.05.04-6

RAI 149-8147 Question 02.05.04-13

RAI 367-8436 Question 02.05.04-16

Table 2.1-1 (3 of 3)

Soil Properties (Cont'd)	
Backfill Material Dynamic Properties (Minimum Damping Ratio, %) Shear Strain <ul style="list-style-type: none"> • 1% • 0.1% • 0.01% • 0.001% • 0.0001% 	<ul style="list-style-type: none"> 24 16 6 2 1
Strain-compatible Minimum Shear-wave velocity of Backfill	510 fps
Seismology	
Safe Shutdown Earthquake (SSE)	0.3g peak ground acceleration
Certified Seismic Design Response Spectra (CSDRS) Referencing SSE	See Figures 2.1-1 and 2.1-2
Hard Rock High Frequency (HRHF) Response Spectra ⁽⁴⁾	0.46g peak ground acceleration See Figures 2.1-3 and 2.1-4
Meteorology	
Accident Release χ/Q Values at EAB · 0-2 hr	$1.00 \times 10^{-3} \text{ s/m}^3$
Accident Release χ/Q Values at LPZ · 0-8 hr · 8-24 hr · 24-96 hr · 96-720 hr	$2.20 \times 10^{-4} \text{ s/m}^3$ $1.60 \times 10^{-4} \text{ s/m}^3$ $1.00 \times 10^{-4} \text{ s/m}^3$ $8.00 \times 10^{-5} \text{ s/m}^3$
Meteorology (Cont'd)	
Annual Average χ/Q Values at Site Boundary · Undepleted/No Decay · Undepleted/2.26-Day Decay · Depleted/8.00-Day Decay · D/Q	$2.00 \times 10^{-5} \text{ s/m}^3$ $1.99 \times 10^{-5} \text{ s/m}^3$ $1.84 \times 10^{-5} \text{ s/m}^3$ $2.00 \times 10^{-7} \text{ /m}^2$
Inventory of Radionuclides Which Could Potentially Seep into the Groundwater	See Table 2.1-2

- (1) Plant grade represents the level of ground adjacent to the nuclear island buildings and is established plant elevation of 98 ft 8 in.
- (2) 100-year recurrence interval; value to be used for design of seismic Category I and II structures only.
- (3) Bearing capacity is defined at the foundation level of the Nuclear Island Structures.
- (4) The HRHF response spectra are provided for evaluation of site-specific ground motion response spectra which exceed the CSDRS in the high frequency range at hard rock sites.

(5) The backfill material dynamic properties are used to calculate the shear-strain-compatible shear wave velocity profiles for the backfill. The strain-compatible damping values of the backfill cannot be greater than 15%.