NINA

Nuclear Innovation
North America LLC
4000 Avenue F, Suite A
Bay City, Texas 77414

April 25, 2011
U7-C-NINA-NRC-110066

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville MD 20852-2738

South Texas Project
Units 3 and 4
Docket Nos. 52-012 and 52-013
<u>Supplemental Response to Request for Additional Information</u>

During an audit on March 14-18, 2011, the NRC Staff requested that Nuclear Innovation North America LLC (NINA) provide additional information to support the review of the Combined License Application (COLA). Attached are supplemental responses to NRC staff questions included in Request for Additional Information (RAI) related to COLA Part 2, Tier 2, Sections 3.7 and 3.8. The attachments provide supplemental responses to the RAI questions listed below:

03.07.02-13
03.08.04-17
03.08.04-19
03.08.04-28

Where there are COLA markups, they will be made at the first routine COLA update following NRC acceptance of the RAI response.

There are no commitments in this letter.

If you have any questions regarding these responses, please contact me at (361) 972-7136 or Bill Mookhoek at (361) 972-7274.

D091
NRO

STI 32858100

I declare under penalty of perjury that the foregoing is true and correct.

Executed on 4/25/11

Scott Head
Manager, Regulatory Affairs
South Texas Project Units 3 & 4

jep

Attachments:

1. RAI 03.07.02-13, Supplement 2
2. RAI 03.08.04-17, Supplement 2
3. RAI 03.08.04-19, Supplement 1
4. RAI 03.08.04-28, Supplement 1

cc: w/o attachment except*
(paper copy)

Director, Office of New Reactors
U. S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

Regional Administrator, Region IV
U. S. Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 400
Arlington, Texas 76011-8064

Kathy C. Perkins, RN, MBA
Assistant Commissioner
Division for Regulatory Services
Texas Department of State Health Services
P. O. Box 149347
Austin, Texas 78714-9347

Alice Hamilton Rogers, P.E.
Inspection Unit Manager
Texas Department of State Health Services
P. O. Box 149347
Austin, Texas 78714-9347

*Steven P. Frantz, Esquire
A. H. Gutterman, Esquire
Morgan, Lewis & Bockius LLP
1111 Pennsylvania Ave. NW
Washington D.C. 20004

*Tom Tai
Two White Flint North
11545 Rockville Pike
Rockville, MD 20852

(electronic copy)

*George F. Wunder
*Tom Tai
Loren R. Plisco
U. S. Nuclear Regulatory Commission

Jamey Seely
Nuclear Innovation North America

Peter G. Nemeth
Crain, Caton and James, P.C.

Richard Peña
Kevin Pollo
L. D. Blaylock
CPS Energy

RAI 03.07.02-13, Supplement 2

QUESTION:

(Follow-up Question to RAI 03.07.02-1)

With regard to Item c of the response to RAI 03.07.01-13, the applicant is requested to address the following:

1. The FSAR mark-up in the response to item (b) of RAI 03.07.02-1, did not include the list of non- Category I structures requiring the enhanced seismic design and analysis. The applicant is requested to include in FSAR 3.7.2.8 the five identified non-Category I structures that could interact with the Category I structures.

2. The response to item (c) of RAI 03.07.02-1 indicated that non-Category I structures with the potential to interact with Category I structures have not yet progressed to a point where sliding and overturning potential as a result of the SSE can be evaluated. However, as identified in SRP guidance 3.7.2I.8., the staff must review the applicant's seismic design of these non- Category I structures. As such, the applicant is requested to provide in the FSAR factors of safety against sliding and overturning including the basis of coefficient of friction used in the analysis during an SSE for Turbine Building, Radwaste Building, Service Building, Control Building Annex, and Plant Stack.

SUPPLEMENTAL RESPONSE:

Supplement 1 of the response to this RAI was submitted with STPNOC letter U7-C-STP-NRC-100093, dated April 29, 2010. This Supplement 2 response is provided in response to Issue #4 provided by the NRC staff subsequent to the NRC Audit held during March 14-18, 2011. This supplement clarifies that the friction coefficients reported in COLA Part 2, Tier 2, Table 3H.6-14 are dynamic (i.e. sliding) coefficients of friction for the Turbine, Service, and Radwaste Buildings and static coefficient of friction for the Control Building Annex. For the Control Building Annex, the static coefficient of friction is used since the structure does not start to slide.

COLA Part 2, Tier 2, Table 3H.6-14 will be revised as shown below. This mark-up is based on COLA Rev. 5 and subsequent mark-ups provided in RAI responses submitted through March 25, 2011.

Table 3H.6-14: Calculated Overturning and Sliding Factors of Safety Under Site-Specific SSE for TB, SB, RWB and CBA

Structure	Calculated Factor of Safety		Minimum Required Factor of Safety	Coefficient of Friction for Sliding Evaluation
	Overturning	Sliding		
Turbine Building (TB)	2.18	1.11	1.1	0.30 (dynamic)
Service Building (SB)	2.65	1.81	1.1	0.39 (dynamic)
Radwaste Building (RWB)	4.23	1.92	1.1	0.39 (dynamic)
Control Building Annex (CBA)	2.03	1.16	1.1	0.58 (static)

RAI 03.08.04-17, Supplement 2

QUESTION:

Follow-up to Question 03.08.04-1 (RAI 2964)

The staff reviewed the applicant's response to Question 03.08.04-1 and needs the following additional clarification and information to complete its review:

a) In its response the applicant uses the term "at-rest seismic lateral earth pressure in non-yielding walls." In general, "at-rest" soil pressure relates to static lateral soil pressure on non-yielding walls due to the self-weight of soil including effects due to hydrostatic pressure and surcharge pressure. The dynamic soil pressure is calculated separately and added to the lateral pressure due to static loads (e.g., at-rest, hydrostatic, surcharge, etc.). Therefore, the applicant is requested to clarify the terminology of "at-rest seismic lateral earth pressure" used to describe lateral loads in the response to this RAI.

b) For the staff to conclude that the design of structures with deep foundations, such as the Reactor Building (RB) and Control Building (CB), is satisfactory for the site, the site-specific design loads are needed to compare with the design loads used for the DCD. Lateral soil pressure is one such load. Therefore, please provide the lateral soil pressures for the RB and the CB, and compare these calculated pressures with those used in the ABWR standard plant design. Please also confirm if the effects of adjacent structures are considered in computing the lateral soil pressures, and if not, provide the justification for not doing so.

SUPPLEMENTAL RESPONSE:

Supplement 1 of the response to this RAI was submitted with NINA letter U7-C-NINA-NRC-110042, dated March 7, 2011. The information provided in this supplement describes the clarification requested by the NRC staff in the NRC Audit held during March 14-18, 2011 (Action Item 3.8-2). Specifically, COLA Section 3H.6-7 will be revised to clarify that the incremental seismic soil pressure used for the design enveloped the incremental seismic soil pressures obtained from the structure-soil-structure-interaction analyses and those computed per Subsection 3.5.3.2 of ASCE 4-98.

COLA Part 2, Tier 2, Section 3H.6-7 will be revised as shown below. This mark-up is based on COLA Rev. 5 and subsequent mark-ups provided in RAI responses submitted through March 25, 2011.

3H.6.7 Diesel Generator Fuel Oil Storage Vaults (DGFOSV)

The incremental seismic soil pressures used in design, which envelope the incremental seismic soil pressures from the SSSI analyses and those computed per Subsection 3.5.3.2 of ASCE 4-98, are shown in Figures 3H.6-226 through 3H.6-231.

RAI 03.08.04-19, Supplement 1

QUESTION:

Follow-up to Question 03.08.04-5 (RAI 2965)

The applicant's response to Question 03.08.04-5 regarding placing a chemical agent on the exposed concrete surface of the mudmat provides descriptive explanations of the waterproofing. Per the SRP 3.8.5 guidance, the applicant needs to show that the foundation can transfer the forces from the structure to soil with the proper factor of safety. Also, because a new material is being used, the applicant needs to provide additional data on testing and other relevant information to meet guidance of SRP 3.8.5. Therefore, the applicant is requested to provide the following additional information, and update FSAR as appropriate:

(1) the specific material that will be used for the waterproof membrane; sufficient data showing that the selected waterproofing will adequately protect the concrete foundations against degradation from soil/groundwater conditions at the STP Units 3 and 4 site;

(2) the final thickness of the membrane based on the physical properties of the selected material;

(3) the application procedures for all aspects of the coating application including batch qualification, surface preparation, application techniques, film thickness, cure time, and repairs;

(4) tests demonstrating that the waterproofing requirements and the coefficient of friction required to transfer seismic loads for STP Units 3 and 4 have been met;

(5) methods for testing that simulate field conditions to demonstrate that the minimum required coefficient of friction is achieved by the structural concrete fill-waterproof membrane structural interface; and documentation summarizing the basis for determining that the material will meet the friction factor and waterproofing requirements;

(6) site-specific sliding evaluation for the Reactor Building and the Control Building to demonstrate that the minimum coefficient of friction needed for maintaining the minimum factor of safety against sliding is available at all sliding interfaces between the structures and foundation soil; and,

(7) specification and properties of the structural concrete fill below the RB and CB foundations.

SUPPLEMENTAL RESPONSE:

Revision 1 of the response to this RAI was submitted with STPNOC letter U7-C-STP-NRC-100093, dated April 29, 2010. In this supplement, the minimum required static coefficient of friction for concrete to concrete and concrete to waterproofing membrane is revised to 0.75, as discussed in the NRC Audit held during March 14-18, 2011 (Action Item 3.8-8).

For the concrete to concrete interfaces, ACI 349-97, Sections 11.7.4.3 and 11.7.9 specify the coefficient of friction, μ, as 1.0 for concrete that is placed against hardened concrete with the surface intentionally roughened to a full amplitude of approximately ¼ in. This requirement for intentional concrete roughening per Section 11.7.9 of ACI 349-97 will be added to the construction drawings. Based on this, the minimum static coefficient of friction for concrete to concrete and concrete to waterproofing membrane is revised to 0.75.

Table RAI 03.08.04-19a below provides a summary of the coefficient of friction provided for each of the sliding interfaces between the structures and foundation soil.

Table RAI 03.08.04-19a

Upper Interface Surface	Lower Interface Surface	Minimum Static Coefficient of Friction μ Provided	Basis
Bottom of reinforced concrete structure	Top of structural concrete fill	>0.75	ACI 349-97, Section 11.7.4.3 (for intentionally roughened joints per Section 11.7.9)
Structural concrete fill	Structural concrete fill at waterproofing membrane	≥0.75	Testing Program per items (4) and (5) described in Revision 1 response of this RAI (see footnote)
Structural concrete fill	Structural concrete fill at a construction joint	>0.75	ACI 349-97, Section 11.7.4.3 (for intentionally roughened joints per Section 11.7.9)
Structural concrete fill	Top of gravel layer	0.75	Discussion in Revision 1 response of this RAI (see footnote)
Bottom of gravel layer	Soil	≥ the smaller of 0.75 or the shear capacity of the soil	Discussion in Revision 1 response of this RAI (see footnote)

Note: Revision 1 of the response to this RAI was submitted with STPNOC letter U7-C-STP-NRC-100093, dated April 29, 2010.

COLA Part 2, Tier 2, Section 3.8.6.1 and Part 9 Table 3.0-13 will be revised as shown below. These mark-ups are based on COLA Rev. 5 and subsequent mark-ups provided in RAI responses submitted through March 25, 2011.

3.8.6.1 Foundation Waterproofing

The coefficient of friction of the waterproofing material will be determined with a qualification program prior to procurement of the membrane material. The qualification program will be developed to demonstrate that the selected material will meet the waterproofing and friction requirements. The qualification program will include testing to demonstrate that the waterproofing requirements and the coefficient of friction required to transfer seismic loads for STP 3 & 4 have been met. Testing methods will simulate field conditions to demonstrate that the minimum required static coefficient of friction of ~~0.60~~0.75 is achieved by the structural concrete fill - waterproof membrane structural interface. The material will meet the required friction factor.

3.0 Site-Specific ITAAC

Table 3.0-13
Waterproofing Membrane

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
The static friction coefficient to resist sliding beneath the basemat of Category I structures is at least ~~0.60~~0.75.	Type testing will be performed on a membrane of the material and thickness specified for the waterproof system to determine the minimum static coefficient of friction of the type of material used in the mudmat-waterproofing-mudmat interface beneath the basemats of the Category I structures.	A report exists and documents that the waterproof system (mudmat-waterproofing-mudmat interface) has a coefficient of static friction of at least ~~0.60~~0.75 to support the analysis against sliding.

RAI 03.08.04-28, Supplement 1

QUESTION:

Follow-up to Question 03.08.04-19

In its response to Question 03.08.04-19 (Letter No. U7-C-STP-NRC-100093 dated April 29, 2010), the applicant provided some information about the foundation waterproofing material. However, some of the information provided needs further clarification. In order for the staff to conclude that the foundation waterproofing used is adequate for providing waterproofing, and will not compromise sliding stability of structures, the applicant is requested to provide the following additional information:

1. The applicant stated in its response that a two-coat elastomeric spray-on membrane will be used for waterproofing, and the physical properties of the membrane have been specifically designed to cope with the rigorous requirements of below grade conditions. However, the applicant did not provide any information regarding the meaning of "rigorous requirements of below grade conditions," and how the physical properties of the membrane meet these requirements. The applicant is requested to describe the rigor of the requirements of the below grade conditions, and how the physical properties of the membrane meet these requirements. Please also include in the in the FSAR description and thickness of the material used for the waterproof membrane.

2. The applicant stated in the response that the waterproofing membrane will be 120 mils thick, and a qualification program, which will include testing, will be developed to demonstrate that the selected material will meet the waterproofing requirements. However, the applicant did not provide any information about what the waterproofing requirements are, and the criteria to be used for the testing. Therefore, the applicant is requested to describe these waterproofing requirements to be tested including how these requirements are established, and how they will be tested to demonstrate that the selected membrane is adequate to meet the waterproofing requirements considering long term behavior of the membrane. The applicant is also requested to update the FSAR as appropriate.

3. In response to the staff's question regarding the coefficient of friction for the waterproofing membrane, the applicant has proposed an ITAAC that states that "Type testing will be performed to determine the minimum coefficient of friction of the type of material used in the mudmat-waterproofing-mudmat interface beneath the basemats of the Category I structures." It is not clear from the description if the thickness of the specimen tested will be the same as that used for the membrane. The applicant is requested to clarify this and revise the ITAAC. Also, the acceptance criteria for the ITAAC states that "A report exists and documents that the waterproof system (mudmat-waterproofing-mudmat) has a coefficient of friction to support the analysis against sliding." The applicant stated in the response that the minimum coefficient of friction needed for maintaining the minimum factor of safety against sliding for the Reactor Building (RB) and the Control Building (CB) is 0.47. In its response, the applicant also presented in Table RAI 03.08.04-19a the minimum coefficient of friction provided at the structural concrete fill and waterproofing membrane interface as 0.6. The applicant is requested to clarify which value of coefficient of friction will be used for the acceptance criteria of the ITAAC, and include in the FSAR the minimum coefficient of friction provided at the waterproofing membrane and structural concrete fill interface. Please also revise the ITAAC acceptance criteria accordingly.

4. The applicant stated in its response (Table RAI 03.08.04-19a) that the coefficient of friction provided at the interface of the bottom of the gravel layer and soil to be the smaller of 0.6 and shear capacity of the soil. Elsewhere in the response, the applicant stated that the soil capacity exceeds the value of 0.47 needed for maintaining minimum factor of safety against sliding of RB and CB. The applicant is requested to clarify the minimum coefficient of friction available at the bottom of gravel and soil interface based on site-specific soil properties and explain how it is determined.

<u>SUPPLEMENTAL RESPONSE:</u>

Revision 1 of the response to this RAI was submitted with NINA letter U7-C-NRC-NINA-110042, dated March 7, 2011. In this supplemental response, an explanation of the basis for the dynamic (i.e. sliding) coefficients of friction is provided, as discussed in the NRC Audit held during March 14-18, 2011 (Audit Action Item 3.8-3 and Issue #11 provided by the NRC staff subsequent to the NRC Audit).

The friction forces that develop at the gravel to soil interface under the Reactor Building and Control Building are governed by the properties of the soil under the buildings.

The coefficient of friction and cohesion values for gravel and soil interfaces mobilize the full soil shear strength and require adjustment to account for cyclic loading and movement. The cyclic yield strength of soils are the maximum stress level below which the material exhibits nearly elastic behavior and above which the material exhibits permanent plastic deformation whose magnitude depends on the number of cycles applied. These dynamic effects were taken into account for the cyclic seismic loading conditions based on experimental data from Makdisi and Seed (Makdisi, F.I. and Seed, H.B. 1978, "Simplified Procedure for Estimating Dam and Embankment Earthquake Induced Deformations," Journal of the Geotechnical Engineering

Division, ASCE Vol. 104, No. GT7, p 849-867). Makdisi and Seed present and evaluate experimental data and recommend that the value of cyclic yield strength for clay soils can be taken to be 80% of the static undrained strength of the clay. This adjustment also accounts for movement resulting from cyclic loading. Makdisi and Seed (1978) show, in their Table 1, a range of maximum cyclic shear strains of 0.1% to 1%, as indicative of the range of maximum cyclic shear strains they associate with the availability of 80% or more of the static undrained strength of clayey soils subjected to such maximum cyclic shear strains.

COLA Part 2, Tier 2, Figure 2.5S.2-47 indicates mean maximum cyclic shear strains are less than 0.07% in the soils within the approximately 100 ft maximum depth range occupied by the Category 1 buildings of Units 3 & 4. The mean maximum cyclic shear strains in the soils within the 100 ft maximum depth occupied by the Category 1 Buildings of Units 3 & 4 is therefore less than the 0.1% to 1% range of strains over which 80% or more of the undrained strength of the clay soil remains available according to Makdisi and Seed (1978).

The sandy soils are dense materials that are not subject to liquefaction (and resulting loss of strength), and thus their coefficients of friction do not require adjustment (reduction) for cyclic loading effects. The adjustment of the coefficients of friction of the sandy soils for movement is as described below.

Under shear displacement, dense sands first exhibit their peak shear resistance then move toward a residual shear resistance. This effect can be observed in the triaxial shear test results (Figure 2.5.4-32) in the STPEGS updated FSAR of Units 1 & 2 (Revision 15) as well as direct shear test results reflected in a report from the Federal Highway Administration (U.S. Department of Transportation, Federal Highway Administration, 2006. "A Laboratory and Field Study of Composite Piles for Bridge Substructures", Report Number FHWA-HRT-04-043, Chapter 3). These test results indicate that it is reasonable to assign friction coefficient after movement as 67% of the static values.

Sand layers beneath the Unit 3 and Unit 4 Control Buildings have a static coefficient of friction of 0.70, and the clay layers beneath both the Unit 3 and Unit 4 Reactor Buildings have a cohesive strength of 3.4 ksf according to COLA Part 2, Tier 2, Section 2.5S.4. Sliding resistance is provided by both passive lateral soil pressure and friction.

Using 67% of the sand friction coefficient (0.70 reduces to 0.47) and 80% of the cohesive soil strength (3.4 ksf reduces to 2.72 ksf) to account for dynamic effects provides sufficient margin on the lateral passive earth pressure required to meet the safety factor against sliding.

No COLA mark-up is required as a result of this supplemental response.