GLOBAL NUCLEAR FUELS – AMERICAS
REQUEST FOR SUPPLEMENTAL INFORMATION

Regulatory Basis:

The regulations in Title 10 of the *Code of Federal Regulations* (10 CFR) Paragraph 70.62(c)(1), require, in part, that each licensee shall conduct and maintain an Integrated Safety Analysis that is of appropriate detail for the complexity of the process that identifies, among other things, "potential accident sequences caused by process deviations or other events internal to the facility and credible external events, including natural phenomena."

The regulations in 10 CFR 70.62(c)(1) also require, in part, identification of the consequence and the likelihood of occurrence of each potential accident sequence, the methods used to determine the consequences and likelihoods, and identification of each item relied on for safety, the characteristics of its preventive, mitigative, or other safety function, and the assumptions and conditions under which the item is relied upon to support compliance with the performance requirements of 10 CFR Section 70.61.

Requests:

1. The report "Seismic, Wind, Rain, and Snow Evaluation of the Global Nuclear Fuels - America FMO and FMOX Buildings" by Atkins Energy states the seismic response modification coefficient, R, is taken as 4.5 and the lateral force resisting system is assumed to be a steel intermediate moment frame in both directions for both the FMO/FMOX structure. The report states, "The calculated displacements and story drifts indicate that the building connections have seismic capacity and are indicative of intermediate seismic capacity joints and are reflective of the intermediate moment frame building classification." This statement fails to adequately justify the basis to use a seismic response modification coefficient of 4.5 and a categorization of the lateral force resisting system in both directions as an Intermediate Moment Frame.

   As discussed in Figure 3-1 of FEMA 350[1] provided below, the conditions required for ensuring adequate ductile behavior of frame structures rely on the development of sufficient number of plastic hinges forming in the beams and providing significant energy dissipation. Also, as discussed in the figure, development of plastic hinges in the column is undesirable as this provides relatively little energy dissipation. Although the staff understand that there is a certain level of ductility in the FMO/FMOX structure, the existing report provides little evidence to support the use of a response modification factor consistent with an Intermediate Moment Frame structure.

Address the following:

a) Provide justification for the assumption that the east-west lateral force resisting frame consisting of columns, roof trusses, and bracing and the north-south lateral force resisting frame consisting of columns and roof trusses meet the member and connection requirements of an Intermediate Moment Frame provided in Section E2 of AISC 341-10 Seismic Provisions for Structural Steel Buildings. The seismic requirements of ASCE 7 require steel structures to meet the requirements of AISC 341 in order to classify the structure as an Intermediate Moment Frame. The

[1] As stated in the commentary of AISC 341 *Seismic Provisions for Structural Steel Buildings*, the requirements of AISC 341 have been derived from research summarized in FEMA 350 *Recommended Seismic Design Criteria for New Steel Moment-Frame Buildings*.

capacity to achieve a specific story drift is only one of the requirements for a lateral force resisting system to be qualified to achieve the ductility under cyclic loading that is expected of Intermediate Moment Frames.

b) Confirm whether or not the reported "calculated story drifts" represent the strength degradation drift angles determined by detailed finite element models of the lateral force resisting frame connections. The minimum story drift angle required in AISC 341 for Intermediate Moment Frames is based on the strength degradation drift angle where the strength of the connection degrades to less than the nominal plastic capacity. This plastic deformation consists of plastic rotation of the beam and panel zone shear distortion. The minimum story drift angle requirement assures sufficient ductility and energy dissipation that are needed to justify the use of the response modification factor for an Intermediate Moment Frame.

c) Provide detailed analyses that consider all potential failure modes of the connections of the lateral force resisting frames under the applied loads. Provide the results of walk-downs of the connections to confirm that the as-built conditions do not vary significantly from analyzed conditions.

d) The FMO/FMOX structural report identified that lateral force resisting system bracing was being overloaded in the seismic load cases. The report states that the lateral force resisting system containing braced frames was re-classified as an Intermediate Moment Frame and re-analyzed without the brace elements. Justify this re-classification. Discuss the effects of the overloaded braces in the re-analysis of the lateral force resisting frame members and connections. If this was not considered, justify neglecting these effects.

2. Section 5.1.6 of the report, "Seismic, Wind, Rain, and Snow Evaluation of the Global Nuclear Fuels - America FMO and FMOX Buildings" by Atkins Energy, states that the structural analysis models showed displacements as large as 9.45 inches and story drift angles as large as 0.026 radians. The report also states that the base of each column is assumed to be pinned at the connection to the floor.

Address the following:

a) Describe how the effects on the stability of structures that are addressed in Chapter C of AISC 360 were considered in the evaluation. Provide a detailed description of the method used to analyze the stability of the structure in the evaluation. Describe how the effects on the stability of the structure were incorporated into the mathematical models.

b) Provide any analyses of the connection elements, anchorage, and effects on the foundation that were performed in this evaluation. Provide a justification for modeling the columns as free to rotate at the column base connection, particularly in the direction of the columns' strong axis bending. Provide analyses to demonstrate that the connections at the base of the columns can achieve the rotations and loads observed at the base of the columns in the mathematical model.

c) Provide a detailed description of the mathematical models created to analyze the structure. Include the applied loads, section properties, connection details, constraints, boundary conditions, fundamental modes of vibration and mass assignments. Include figures depicting the steel members and connections comprising the lateral force resisting systems.

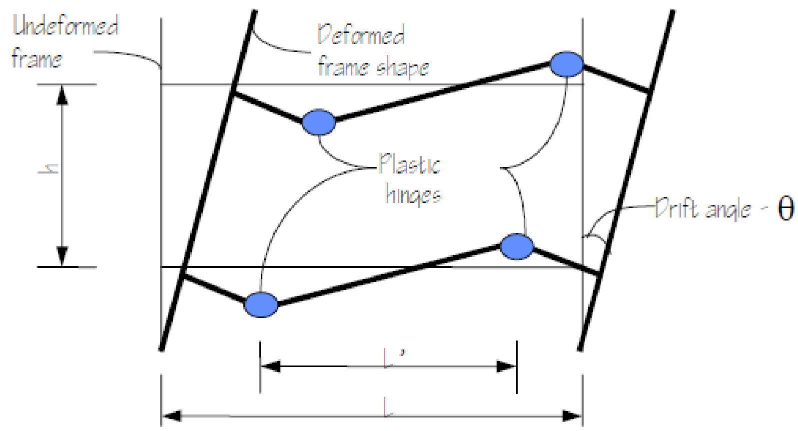

Figure 3-1 Inelastic Behavior of Frames with Hinges in Beam Span

Commentary: Nonlinear deformation of frame structures is accommodated through the development of inelastic flexural or shear strains within discrete regions of the structure. At large inelastic strains these regions can develop into plastic hinges that can accommodate significant concentrated rotations at constant (or nearly constant) load through yielding at tensile fibers and yielding and buckling at compressive fibers. If a sufficient number of plastic hinges develop in a frame, a mechanism is formed and the frame can deform laterally in a plastic manner. This behavior is accompanied by significant energy dissipation and potentially substantial damage to the highly strained elements. The formation of hinges in columns, as opposed to beams, is undesirable, as this may result in the formation of mechanisms with relatively few elements participating, so called "story mechanisms," and consequently little energy dissipation throughout the structure.

The prequalified connection contained in the building codes prior to the 1994 Northridge earthquake was presumed to result in a plastic behavior that consisted of development of plastic hinges within the beams at the face of the column, or within the column panel zone, or as a combination of the two. If the plastic hinge develops primarily in the column panel zone, the resulting column deformation may result in very large secondary stresses on the beam flange to column flange joint, a condition that, for certain types of connections, can contribute to brittle failure. If the plastic hinge forms in the beam at the face of the column, this can result in large inelastic strain demands on the weld metal and surrounding heat-affected zones. These conditions can lead to brittle failure.