U.S. Department of Energy
Office of River Protection
P.O. Box 450, MSIN H6-60
Richland, Washington 99352

JUL 19 2007

07-WTP-189

The Honorable A. J. Eggenberger
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, N.W., Suite 700
Washington, D.C. 20004-2901

Dear Mr. Chairman:

THE U.S. DEPARTMENT OF ENERGY (DOE), OFFICE OF RIVER PROTECTION (ORP) STATUS OF STRUCTURAL STEEL FIRE PROTECTION AT THE WASTE TREATMENT AND IMMOBILIZATION PLANT (WTP)

References:
1. DNFSB letter from A. J. Eggenberger, Chairman to S. W. Bodman, Secretary of Energy, dated October 17, 2005.
2. ORP letter from Roy J. Schepens, Manager to A. J. Eggenberger, Chairman of DNFSB, "Status and Path Forward for the Seismic Ground Motion Issue at the Waste Treatment and Immobilization Plant (WTP)," dated June 28, 2006.
3. DNFSB Seventeenth Annual Report from A. J. Eggenberger; Chairman, John E. Mansfield, Member; Joseph F. Bader, Member; Larry W. Brown, Member; Peter S. Winokur, Member to the Congress of the United States, dated February 28, 2007.

This letter explains the design approach that ORP and the WTP Contractor are using to determine which structural steel members in plant facilities will be provided with two hour fire protection, as identified in Reference 1 and 2.

The WTP strategy is to provide fire protection for selected structural steel members based on their role in supporting the structure during and after a fire. In Reference 1, the Defense Nuclear Facilities Safety Board (DNFSB) stated this methodology would be acceptable provided it can be reasonably shown that unprotected structural members with reduced material properties due to a fire would not be relied upon to support the building. In addition, Reference 3 noted that the WTP Contractor is expected to develop a technically sound methodology for identifying structural steel members that do not require fireproof coating; and structural analyses should support the conclusion that such a structural steel member could fail without impacting the structure or adjacent safety systems.

While the final resolution requires the detailed design to be complete, the WTP Contractor has made measurable progress by incorporating methodologies in the WTP Structural Design Criteria (SDC), Revision 12, to address how each facility shall be designed to preserve confinement capability, and protect important-to-safety structures, systems, and components, while accounting for degradation of the non-fireproofed steel members as the result of a fire. These measures include increase in tributary areas for loading, and increase in unrestrained

lengths and spans of the fireproofed members due to non-fireproofed members considered inactive during and immediately after a fire event. The SDC also identifies additional load combination and stability evaluations required to be considered for the fire events. Attached for your information is Section 4.19, *Fire Resistant design of structures*, from the SDC, Revision 12 (Attachment 1), that describes these changes.

The WTP Contractor also continues to incorporate the revised SDC methodology into the structural design calculations. The calculations are on-going and commensurate with the design schedule as identified in Attachment 2.

The DNFSB technical staff has also raised additional concerns regarding the risk to the plant operations due to a fire event. ORP acknowledges that a fire unmitigated could impact non-safety related equipment necessary to operate the plant. However, ORP considers the risk of damage to non-safety related equipment from unprotected steel in a credible fire scenario to be extremely unlikely mitigated, since the WTP plant is provided with multiple levels of defense-in-depth controls, including fire barriers, administrative procedures for combustible control, automatic fire sprinkler protection systems, fire alarm and detection systems, and automatic fire department notification. The fire sprinkler systems are expected to control the credible fires as discussed in the Preliminary Fire Hazards Analyses.

The SDC incorporated requirements of primary (fireproofed) members to retain their design capacity, post fire to account for the low-risk event of a fire. If a fire occurs, an assessment of the damage of other affected structures, systems and components, and subsequent repair and/or replacement will occur prior to the restart of the plant as part of the post-fire recovery.

DNFSB technical staffs have been informed of the details of these changes to the SDC. ORP will continue to keep the DNFSB informed on the completion calculations.

If you have any questions, you may contact me, (509) 372-3062.

Sincerely,

Shirley J. Olinger, Acting Manager
Office of River Protection

Attachments (2)

cc w/attachs:
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Attachment 1

24590-WTP-DC-ST-01-001, Rev. 12
Structural Design Criteria
4.19, Fire Resistant Design of Structures

4.16 Drop Load

Drop loads shall be treated as live loads with impact. Postulated dropped loads will be evaluated for local damage (for example, penetration, perforation and spalling of a concrete slab) as well as for structural integrity. For the local impact design of structures, credit may be taken for the inelastic absorption (ductilities) of the structural element. The acceptability of damage due to the dropped load will be evaluated by the ISM Process (for example, penetration may be acceptable but perforation may not be acceptable due to loss of confinement). Drop load analysis methods shall be based on:

- ASCE manuals and reports on engineering practice, no. 58., Structural Analysis and Design of Nuclear Plant facilities, ASCE 1980 (Ref. 2.4.21), and
- US Department of the Army, Structures to resist the effects of accidental explosions, Tri-Service Manual TM5-1300 (Ref. 2.4.22).
- ACI 349 Appendix C (Ref. 2.1.2).

4.17 Concrete Wall Out-of-Plane Embedment Load Guidelines

All concrete walls, except for free-standing non-load bearing walls, shall be designed for the additional out-of-plane embedment loads due to equipment/commodity loading. See Appendix B for guidelines.

4.18 Fall Restraints

Fall restraints shall be designed for a 5000 pound load per person.

4.19 Fire Resistant Design of Structures

This section addresses the criteria for the design of structural steel elements. See reference 2.4.29 for guidance in selecting fire coatings and ASCE/SEI/SFPE 29-99 Table X3.1 Construction Classification for Restrained and Unrestrained for guidance in determining thicknesses of structural steel fire coatings.

Project structures shall be designed for fire resistance as required to meet building codes, support fire barriers, support fire protection features, support the confinement structure, or to protect ITS components. Fire resistance of buildings and structures is ensured by fireproofing selected structural members and through evaluations for stability and strength of the structure during and immediately after a fire event.

For the purpose of fire resistant design, columns, girders, purlins, beams, bracing, or floor slabs that are required to support the design loads during and after a fire are defined as primary members. Members that are not required to support design loads during or after a fire are defined as secondary members. Primary members are protected by applying (e.g. sprayed or wrapped) fireproofing material, whereas, secondary members are not protected by fireproofing (Figure 3) and not considered active in the stability and strength evaluations. Secondary steel members may span between primary members, concrete walls or other secondary members. They support floor slabs and/or primary members to provide vertical and lateral support for normal operating plant conditions and seismic events. Reinforced concrete walls and slabs are protected by their concrete cover and do not need additional fireproofing.

The use of non-fireproofed secondary members to carry Safety Class commodity and equipment loads is not permitted unless physical separation redundancy is provided for the safety class commodities. The ISM process through focused reviews may determine and document additional fireproofing requirements to ensure adequate protection of safety class commodities.

The primary and secondary members shall be designed to meet the loads and load combinations of Sections 5 and 6. Additional load combinations and stability evaluations are required for fire events for the primary members.

The additional load combinations (for fire events) shall be in accordance with ASCE-7 Section 2.5 (Ref. 2.1.9) and the AISC Design Guide 19 (Ref. 2.1.16). It should be noted that the load combinations for fire cases do not include seismic or wind loads. For the fire loading cases, the floor slabs and roof decks shall be designed for longer spans considering the loss of non-fireproofed structural members. Similarly, primary girders are required to carry the larger tributary areas of floor slabs or roof decks that span between fireproofed members. Secondary vertical and horizontal bracings that are not fireproofed shall not be considered active when computing forces and moments in the primary members (columns and girders). Similarly, primary members (columns and girders) shall not be considered laterally supported at those bracing points.

Building stability, individual column stability and strength shall be ensured during fire events. This stability evaluation shall account for longer unbraced column lengths due to the loss of non-fireproofed secondary beams, girders, and diagonal bracings that are postulated to no longer provide lateral support to the columns. The design demand of columns shall be evaluated for higher loads caused by the loss of fire-degraded vertical-load members (bracing that carries vertical load) that are non-fireproofed and postulated to be inactive in the structural path. It is not required to consider fire events in multiple fire areas for the strength and stability evaluations.

The failure mechanism of secondary members due to fire shall also be considered in the design of primary members. The failure of the secondary member shall not permanently impact the primary members, e.g., primary members shall be designed to resist loads from secondary member expansion, distortion or other deformation in a fire event. The primary members shall be able to retain their design capacity post fire and not require replacement. All damaged structural members will be repaired/replaced as necessary so as to restore the structure as it was originally designed.

Load Combinations for Fire Case

- **Primary Steel Girders** are fireproofed girders that frame into concrete walls, Primary columns or other fire-protected Primary girders; and along with the concrete walls, support the floor slabs during fire events. Following are the additional load combinations, enveloping ASCE-7 fire load combinations.

  For SC-I, SC-II, SC-III and SC-IV structures:

  $$1.33S = D + Equip + L$$
  $$S = D + Equip + 0.5L$$

  Note: The load term A_k is not used in the above load combinations because it is taken as zero. The load term A_k is taken as zero because there are no transient (i.e., explosive) load cases.

- **Primary Steel Columns** are fireproofed columns that support vertical loads during fire events. These members are designed and evaluated for stability accounting for the loss of lateral support provided by non-fireproofed structural members, and for the additional vertical load released by non-

fireproofed vertical bracing. Following are the additional load combinations, enveloping ASCE-7 fire load combinations.

For SC-I, SC-II, SC-III and SC-IV structures:
$1.33S = D + Equip + L$
$S = D + Equip + 0.5L$

Note: The load term A_k is not used in the above load combinations because it is taken as zero. The load term A_k is taken as zero because there are no transient (i.e., explosive) load cases.

- **Floor Slabs** are concrete floor slabs that span between walls and Primary girders during fire events, and span between steel beams and girders for normal loading. Following are the additional load combinations, enveloping ASCE-7 fire load combinations.

For SC-I, SC-II, SC-III, SC-IV structures:
$U = 0.75 (1.4D + 1.4 Equip + 1.7L)$
$U = 1.4 (D + Equip)$

Note: The load term A_k is not used in the above load combinations because it is taken as zero. The load term A_k is taken as zero because there are no transient (i.e., explosive) load cases.

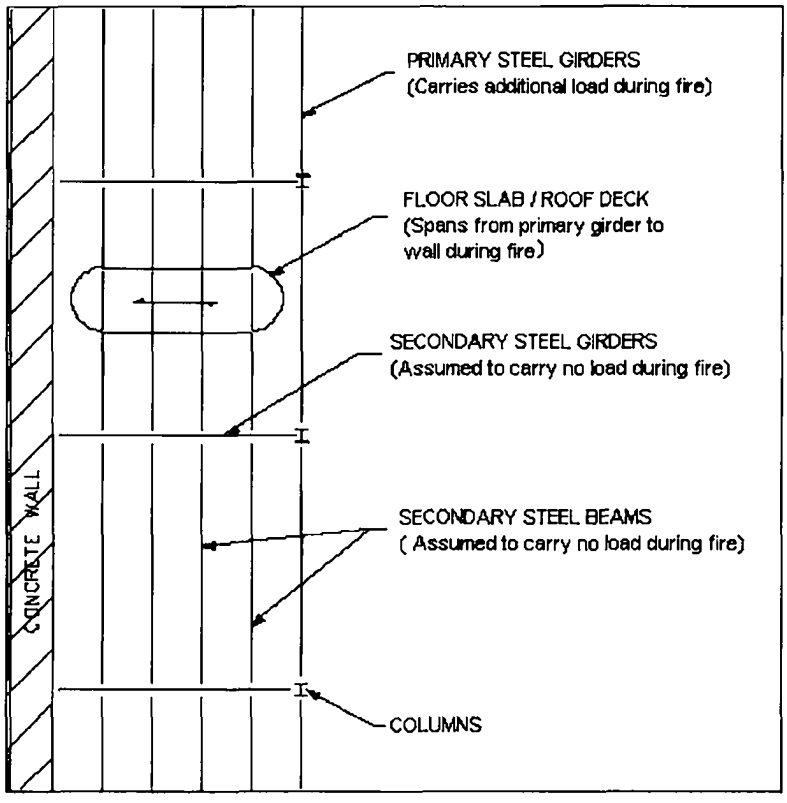
- **Secondary Steel Girders and Beams** are non-fireproofed girders and beams that are assumed to have zero strength during fire events. These members span between Primary girders and concrete walls, they support floor slabs and provide lateral support to columns for normal operating plant conditions and seismic events. No additional load combinations are required.

Roof Member Load Combinations for Fire Case

Roof decks are classified as fire barriers or non-fire barriers depending upon the facility's building code classification. Roof structures that are fire barriers, shall be designed and supported similar to floor slabs for fire events. Roof structures that are non-fire barriers do not require fireproofing. However, these roof structures shall be designed to allow the non-fireproofed members in a fire area to be rendered ineffective without causing collapse of the remaining structure.

Primary Roof Girders are fireproofed steel girders that frame into Primary columns and support roof decks during fire events, they are evaluated the same as **Primary Steel Girders.**

Figure 3 Fire Resistant Floor and Roof Systems



5 SC-I and SC-II Facility Design Requirements

Note: RPP-WTP SSC design requirements for basic physical features are identified on primary design drawings (see 24590-WTP-3DP-G04B-00046 for a list of primary design drawings). Such physical design features are derived from the applicable project level design criteria (e.g., safety envelope documents) for the facility.

5.1 Reinforced Concrete Design

5.1.1 SC-I and SC-II reinforced concrete structures shall be designed in accordance with the following:

- Strength Design Method in accordance with ACI 349 (Ref. 2.1.2).
- Seismic proportioning and detailing shall be per the provisions of ACI 318 (Ref. 2.1.1) Chapter 21 pertaining to structures in "High" seismic risk regions.
- Seismic proportioning and detailing may also include the provisions of Section 21.6.1 of ACI 349 (Ref 2.1.2) (Height / Length criteria). Height is defined as the total height of the wall and length as the length of the wall.
- In addition to the provisions of Sections 21.6.6.3 and 21.7.5.3 of ACI 318 (Ref 2.1.1) boundary elements are not required when the concrete compressive strain, resulting from the worst case loading

Attachment 2

Forecast Schedule for Fireproofing Calculations

Attachment 2
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Forecast Schedule for Fireproofing Calculations in Accordance with the Updated Fireproofing Design Criteria, Based on the Current Waste Treatment and Immobilization Plant Baseline Schedule

- Low-Activity Waste Facility
  - Calculations complete - August 2007
- Analytical Laboratory Facility
  - Calculations complete - October 2007
- Pretreatment Facility
  - Revise previously issued calculations - November 2007
  - Calculations for El. 98'-0" - May 2008
  - Calculations for Roof structure - February 2009
- High-Level Waste Facility
  - Revise previously issued calculations - August 2007
  - Calculations for El. 37'-0" - August 2007
  - Calculations for El. 58'-0" - September 2008
  - Calculations for El. 72' -0" - March 2008
  - Calculations for Roof structures - August 2008