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ISSUED BY
RPP-WTP PDC

RIVER PROTECTION PROJECT – WASTE TREATMENT PLANT

ENGINEERING SPECIFICATION

FOR

Seismic Qualification Criteria for Pressure Vessels

Content applicable to ALARA? ☐ Yes ☒ No

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Rev
N/A

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☐ N/A (alpha revision or revision 0)

NOTE: Contents of this document are Dangerous Waste Permit affecting.

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3	9/27/10	Mohan Arulampalam	Bart Makadia	Mike Seed	R T Carlstrom	J Julyk
2	14 Dec 03	R Simmons	C Slater	M Hoffmann	N/A	M Hoffmann for G Duncan
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Rev
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Revision History

Revision	Reason for Revision
0	Issued for Design
1	Rewritten, Issued for Use
2	Incorporated 24590-WTP-3PN-MV00-00003, Issued for Use
3	Incorporates Change Documents Listed in Section 8. Incorporated relevant requirements from Appendix L section of SRD Issued for Use. Document revised substantially and complete reading required.

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1 Scope

1.1 This specification covers pressure vessel seismic analysis criteria and supplements the requirements of the specifications listed in Section 2.3.

1.2 This document shall be used by the vessel equipment designer.

1.3 Any communication between the Seller and the Buyer regarding the interpretation or interim findings of design must be in accordance with the instructions provided in the purchase order.

2 Applicable Documents

2.1 General

2.1.1 Work shall be in accordance with the referenced codes, standards, and documents listed below, which are an integral part of this specification.

2.1.2 When specific chapters, sections, parts, or paragraphs are listed following a code, industry standard, or reference document, only those chapters, sections, parts, or paragraphs of the document are applicable and shall be applied. If a date or revision is not listed, the latest issue, including addenda, at the time of request for quote shall apply. When more than one code, standard, or referenced document covers the same topic, the requirements for all must be met with the most stringent governing.

2.2 Codes and Industry Standards

2.2.1 American Society of Mechanical Engineers, *Boiler and Pressure Vessel Code*

2.2.1.1 ASME Section VIII, Division 1, "*Rules for Construction of Pressure Vessels*"

2.2.1.2 ASME Section VIII, Division 2, *Rules for Construction of Pressure Vessels - Alternative Rules,* American Society of Mechanical Engineers *(Note: Code year not later than 2004 Edition with 2005 and 2006 Addenda).* Linearization of Stress Results for Stress Analysis *(ASME VIII Div 2, Annex 5.A, 2007 Edition, no Addenda)*

2.2.1.3 ASME Section II, Part D, "*Properties*"

2.2.2 UBC, *1997 Uniform Building Code*

2.2.3 AISC M016, *ASD Manual, of Steel Construction,"9th Edition*, American Institute of Steel Construction

2.2.4 DOE-STD-1020-94, Department of Energy, "*Natural Phenomena Hazards Design and Evaluation for the Department of Energy Facilities*", including change notice dated January 1996

2.2.5 ASME B31.3, *Process Piping*, 1996, American Society of Mechanical Engineers

2.2.6 ANSI/AISC N690, *Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities*, American Institute of Steel Construction

2.3 Project Documents

2.3.1 24590-WTP-3PS-SS90-T0001, *Engineering Specification for Seismic Qualification of Seismic Category I/II Equipment and Tanks*

2.3.2 24590-WTP-3PS-FB01-T0001, *Engineering Specification for Structural Design Loads for Seismic Category III and IV Equipment and Tanks*

2.3.3 24590-WTP-3PS-MV00-T0001, *Pressure Vessel Design and Fabrication*

3 Abbreviations and Definitions

Black Cell	Shielded cells for which no maintenance or entry is planned for the 40-year design life of the plant.
EQD	Equipment Qualification Data Sheet
Hard-to-Reach	Facility areas where piping and equipment is not designed for manual or remote access, replacement, or repair.
MDS	Mechanical Data Sheet
NPH	Natural Phenomena Hazard
Performance Category	Per DOE-STD-1020-94, each SSC is assigned a NPH Performance Category ranging from PC-0 through PC-4.
RPP-WTP	River Protection Project – Waste Treatment Plant
SC	Seismic Category
SC/SS	Safety Class / Safety Significant
SC-I, II, III, IV	Specifies the required seismic category of an equipment item. Refer to 24590-WTP-3PS-SS90-T0001 and 24590-WTP-3PS-FB01-T0001 for a more detailed explanation.
Seismic Loading	Seismic loading is defined in terms of a site-specified design response spectrum, also referred to as Design Basis Earthquake (DBE), or specified for the site by Uniform Building Code (UBC)
SSC	Structures, Systems and Components

4 Conflicts

4.1 In cases of conflicts between this specification and other drawings or specifications, the Seller shall call attention to the conflict and request an interpretation by the Buyer.

4.2 All deviations from this specification, the purchase order, or the drawings require the written approval of the Buyer.

5 Buyer's Responsibilities

5.1 The Buyer assigns the Seismic Category to each vessel.

5.2 The Buyer provides the Seismic Response Spectra where necessary to perform the seismic analysis.

6 Seller's Responsibilities

6.1 The Seller is responsible for the seismic analysis of the vessels according to the assigned Seismic Category. For Safety (SC/SS), Black cell and/or Hard-to-Reach Area vessels the analysis shall include dynamic loading resulting from seismic excitation while the vessel is operating under normal operating conditions. The Seller shall ensure that stresses in the vessel do not exceed those allowed, as defined in Section 7.4 for the vessel proper and reference 2.3.3 for the vessel supports, for the required loads and combinations thereof.

6.2 Depending on the Seismic Category of the vessel and its internal components, a finite element analysis may be required to determine the vessel stresses when subjected to operating and seismic loading. The software and implementation used for the analysis shall be in accordance with the quality assurance requirements defined in the purchase order.

6.3 The Seller shall obtain approval from the Buyer before nominating others to perform the design services.

7 Design Requirements

7.1 Seismic Category

7.1.1 The RPP-WTP Structures, Systems, and Components (SSC) are categorized as SC-I, II, III, or IV. The SC level is based upon the contents and the required functionality of the SSC following a seismic event. The Seismic Category defines the applicable analysis method and the acceptance criteria. The seismic analysis of SC-I and SC-II vessels and their supports shall be by the dynamic analysis method. The dynamic analysis shall be accomplished using the response spectrum, frequency domain, or time history approach. The seismic loads shall be considered acting simultaneously in three directions. A finite element model, which includes the mass of the contained liquid shall be used, or procedures described in Section

3.5.4 of ASCE 4-98, Seismic Analysis of Safety-Related Nuclear Structures and Commentary or Chapter 4 of BNL 52361, Seismic Design and Evaluation Guidelines for the Department of Energy High-Level Storage tanks and Appurtenances, shall be followed.

7.1.2 Seismic loading shall not be considered when performing the primary plus secondary stress range analysis required by Section VIII, Division 2, Appendix 4. In addition, seismic loading shall not be considered when performing a fatigue analysis required by Section VIII, Division 2, Appendix 5.

7.1.3 The acceptance criteria for all vessels within the Black Cells or Hard-to-Reach Areas shall be in accordance with Appendix 4 of ASME Section VIII, Division 2, using the allowable stress, S, from ASME Section VIII, Division 1 in lieu of the stress intensity, S_m of ASME section VIII, Division 2. As indicated in UG-23(c), seismic loads are combined with normal operating loads when applying the factor of 1.2 to the allowable stress. Seismic loading and wind loading or Multiple Overblow need not be considered to act simultaneously.

7.1.4 NPH Performance Categories for each SSC are assigned using criteria specified in DOE-STD-1020-94, and range from PC-0 through PC-4 depending on overall risk of the facility operation and the assigned function to the SSC. The following table summarizes the descriptions of the NPH Performance Categories as defined in DOE-STD-1020-94 and the correlation to Seismic Category:

Performance Category	Performance Goal Description	RPP-WTP Seismic Category (SC)
PC-0	No safety, mission, or cost considerations	SC-V
PC-1	Maintain occupant safety	SC-IV
PC-2	Occupant safety, continued operation with minimum interruption.	SC-III
PC-3	Occupant safety, continued operation, hazard confinement.	SC-II or SC-I
PC-4	Occupant safety, continued operation, confidence of hazard confinement.	Not required for this project

7.2 Design Code

7.2.1 The governing design code for the vessel proper is ASME Section VIII, Division 1. The loadings to be considered in designing the vessel shall include those listed in paragraph UG-22 of the code.

7.2.2 The governing design code for the vessel supports is as per 24590-WTP-3PS-MV00-T0001, *Pressure Vessel Design and Fabrication.*

7.3 Seismic Analysis

7.3.1 Internal components, supports, and piping systems shall be analyzed the same as the parent vessel unless otherwise noted. Requirements for internal piping and supports are provided in Reference 2.3.3.

Pulse Jet Mixers and Charge Vessels are to be designed to the same criteria as the parent vessel; requires no code stamping.

7.3.2 The seismic criteria for SC-I and SC-II vessels are contained in the 24590-WTP-3PS-SS90-T0001. Vessel seismic calculations will be based on the provided nozzle loads and estimated piping tributary mass (typically based on the deadweight vertical nozzle load).

7.3.3 The seismic loads for SC-III and SC-IV vessels shall be determined according to 24590-WTP-3PS-FB01-T0001. Factors for UBC equations are given in Section 4.0 of that specification.

7.3.4 The seismic analysis of SC-I and SC-II vessels and their supports shall be by the dynamic analysis method identified in specification 24590-WTP-3PS-SS90-T0001 and 24590-WTP-3PS-MV00-T0001. A finite element model, which includes the mass of the contained liquid, shall be used. The equivalent static analysis method described in Section 6.1.2 of 24590-WTP-3PS-SS90-T0001 is not permitted.

7.3.5 The seismic analysis of SC-III and SC-IV vessels and their supports shall be performed in accordance with specification 24590-WTP-3PS-FB01-T0001 and 24590-WTP-3PS-MV00-T0001.

7.4 Maximum Allowable Stresses and Acceptance Criteria for the Vessel Proper

7.4.1 **Maximum Allowable Tensile Stress** - The maximum allowable tensile stress, S, for the material of construction of the vessel shall be as specified in ASME Section II, Part D, and Subpart 1.

7.4.2 **Maximum Allowable Longitudinal Compressive Stress** - The maximum allowable longitudinal compressive stress used in the vessel design shall meet the requirements of paragraph UG-23(b) of the ASME Section VIII, Division 1.

7.4.3 **Maximum General Primary Membrane Stress** - The wall thickness of a vessel shall be determined such that the induced maximum general primary membrane stress does not exceed the maximum allowable stress in tension for any combination of loadings listed in paragraph UG-22 of ASME Section VIII, Division 1 that induce primary stresses and are expected to occur simultaneously during normal operation of the vessel.

7.4.4 **Combined Primary Membrane plus Primary Bending Stress** - The combination of loads as discussed in Section 7.4.3 shall not induce a combined maximum primary membrane stress plus primary bending stress across the vessel wall thickness, that exceeds 1.5 times the maximum allowable stress value in tension.

7.4.5 **Combination of Seismic Loadings with Other Loadings** - For the combination of seismic loading with other loadings in UG-22, the wall thickness of a vessel shall be determined such that the general primary membrane stress shall not exceed 1.2 times the permitted maximum allowable stress, as defined in 7.4.1, 7.4.2, 7.4.3 or 7.4.4. Seismic loading and wind loading or Multiple Overblow need not be considered to act simultaneously. As indicated in UG-23(c), seismic loads are combined with normal operating loads when applying the factor of 1.2 to the allowable stress.

Note that ASME Section VIII, Division 1, UG-23(d) is silent relative to any stresses other than General Primary Membrane, i.e., it does not address the same types of stresses (Local Primary Membrane, Primary Membrane plus Primary Bending) in the detail addressed in Section VIII, Division 2. Local Primary Membrane stress is discussed in ASME Section VIII, Division 2, Paragraph AD-140(c) and is limited to $1.5kS_m$, as is Primary Bending stress (AD-140(d)). Table AD-150.1 of ASME Section VIII, Division 2, then provides guidance for "k" under Design and other conditions. In accordance with that Table and in accordance with the commitment to use S vs. S_m, a factor of 1.2 times the permitted allowable stress in 7.4.4 above shall be used for Local Primary Membrane or Primary Bending evaluations that include seismic loading (i.e., 1.2 x 1.5 x S).

7.4.6 Deleted

7.4.7 The acceptance criteria for safety class or safety significant vessels outside Black Cells and Hard-to-Reach Areas shall be in accordance with Appendix 4 of ASME Section VIII, Division 2, using the allowable stress, S, from ASME Section VIII, Division 1 in lieu of the design stress intensity, S_m, of ASME Section VIII, Division 2.

7.4.8 The acceptance criteria for non-safety vessels outside Black Cells and Hard-to-Reach Areas shall be in accordance with ASME Section VIII, Division 1, using the allowable stress, S, from ASME Section VIII, Division 1.

8 Revision History (Internal Use Only)

NOTE: Asterisk (*) denotes a new entry for this revision of the Specification

8.1 Design Changes Incorporated by Design

24590-WTP-3PN-MV00-00003

8.2 Design Changes Incorporated by Reference

* 24590-WTP-SDDR-MS-08-00079