Portland General Electric Company
Trojan ISFSI
71760 Columbia River Hwy
Rainier, Oregon 97048

February 1, 2017
VPN-001-2017

Trojan ISFSI
Docket 72-17
License SNM-2509

ATTN: Document Control Desk
Director, Division of Spent Fuel Management
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Transmittal of Revision 14 to PGE-1069,
Trojan Independent Spent Fuel Storage Installation (ISFSI) Safety Analysis Report (SAR)

Pursuant to 10 CFR 72.70, this letter transmits Revision 14 to Portland General Electric Company's SAR for the Trojan ISFSI. Revision 14 includes changes to the SAR since the last submittal. The Attachment to this letter includes a brief description of the changes included with this revision. Text changes are identified in the SAR by margin bars adjacent to the changes and revision numbers in the page footers.

I hereby certify that Revision 14 accurately presents changes made since Revision 13 necessary to reflect information and analyses prepared pursuant to Commission requirements.

Controlled copy holders are to update their controlled copies per the instructions provided with the enclosure.

Any questions concerning this revision may be directed to Mr. Mark Tursa, of my staff, at (503) 556-7030.

Sincerely,

Brad Jenkins

Bradley Y. Jenkins
Vice President, Power Supply Generation

Attachment
Enclosure

NMSS20
NMSS26

c: Director, NRC Region IV, DNMS
Todd Cornett, Siting Division Administrator, ODOE
Controlled Copy Holders

Summary of Changes Incorporated into Revision 14 of PGE-1069, Trojan ISFSI SAR

The changes incorporated into Revision 14 of the Trojan ISFSI SAR were evaluated in accordance with 10 CFR 72.48 and a determination was made that prior NRC approval was not required. Changes summarized below are listed by the Licensing Document Change Request (LDCR) number.

LDCR 2015-001:

Implementation of Trojan ISFSI Safety Analysis Report changes associated with postulated drops of a partially loaded Trojan ISFSI multi-purpose canister (MPC) as a result of Holtec Information Bulletin (HIB) 62, Partial Loading of MPC's, Rev. 0.

Reason and Justification for Change

Holtec has addressed two scenarios where the drop analysis of a partially loaded MPC is affected. These scenarios are 1) Hypothetical Concrete Cask Overturning Event, and 2) MPC Drop into Concrete Cask or Transport Cask at the Trojan ISFSI Transfer Station. To address these scenarios, Holtec identified the bounding weight (i.e., lightest) of a partially loaded Trojan MPC and associated Concrete Cask total weight (Holtec letter to PGE via email titled, "Summary of Partially Loaded MPCs at the Trojan ISFSI", dated October 30, 2014). Holtec then showed that the resulting drop g-loads do not exceed (or approach) any limits. A third scenario mentioned in HIB-62 is the drop of the Holtec Transport Cask after being loaded with the MPC. As noted below (SAR Section 8.2.13.4), the Trojan ISFSI SAR already requires that this scenario be evaluated by Holtec prior to loading the Transport Cask.

For the first scenario (cask overturning), the acceptability of a partially loaded MPC is documented in the Holtec evaluation in Enclosure B. For the second scenario (MPC drop at the Transfer Station), Holtec revised the applicable drop calculation (HI-2022881, Rev. 4, Finite Element Analysis of the MPC Drop Accident Postulated at the Trojan Transfer Station. Holtec also summarized this result in letter email as described in above paragraph.

The safety analysis documented herein confirms that since the revised MPC g-loads do not exceed nor approach any g-load limit, the changes to Holtec Calculation HI-2022881, Rev. 4 and other changes resulting from the Holtec evaluation of a partially loaded Trojan MPC have no adverse impacts on the Trojan ISFSI or public health and safety.

Description of Changes due to the Holtec Evaluation of a Partially Loaded Trojan MPC

In Holtec Information Bulletin, HIB-62, Partial Loading of MPC's, Rev. 0, Holtec notes that under certain drop analyses that use a g-load as the acceptance criterion, the calculated g-loading will go up if the weight goes down. For Trojan the bounding (i.e., lightest) MPC was identified as an MPC with only 20 of 24 cells filled with spent fuel assemblies, with no assembly inserts. However, if an assembly has no inserts, it must include an assembly spacer when placed in the MPC cell (ref. Trojan SAR section 4.2.4.2.1.) Thus, using the weights in Holtec calculation HI-2012672, Evaluation of Weights and Volumes for Components of the Trojan ISFSI, Rev. 6, the bounding MPC was determined. Holtec showed that for the Hypothetical Concrete Cask Overturning Event the worst case g-load would increase by only 1.6% from 38g (high end of the g-load range of 32g to 38g) to approximately 38.6 g (38g increased by 1.6%). This is still well below the 60g limit.

For the MPC drop at the Transfer Station, Holtec showed in HI-2022881, Rev. 4 (and summarized in Holtec letter email described above), that the g-load would have an insignificant increase of only 0.1% (54g to approximately 54.05g).

Description of and Reason for Changes to 10 CFR 72 Licensing Documents

The following changes and clarifications to Trojan ISFSI (10 CFR 72) licensing documents are necessary.

PGE-1069, "Trojan Independent Spent Fuel Storage Installation Safety Analysis Report with Holtec MPC," was reviewed to determine whether any changes were necessary. The results of this review are documented below and necessary changes noted.

SAR Chapter 4

Section 4.7.3.5 Mobile Cranes states:

> "In addition, the potential drop of a loaded MPC has been evaluated (Reference 26) as described in SAR Section 8.2.13."
>
> **Reference 26 is the Holtec calculation of the MPC drop at the Transfer Station. No change is needed here since it just references the drop evaluation.**
>
> Farther down in this section there is a summary of the results of the drop evaluation, and includes a reference to the deceleration of 54g, as follows:
>
> "5. The fuel assembly deceleration is 54g, which is below the 60g design basis deceleration."

As noted below in the discussion about SAR Section 8.2.13, the partially loaded MPC is very close to the weight used in the Holtec drop analysis such that the effect on deceleration is negligible. Therefore, there is no need to change wording in this section.

Reference 26 for SAR Chapter 4 will be updated from Revision 3 to Revision 4, as follows:

"26. Holtec Report No. HI-2022881, "Finite Element Analysis of the MPC Drop Accident Postulated at the Trojan Transfer Station," Revision ~~3~~ *4*,~~ July 16, 2002~~."

SAR Chapter 8

Section 8.2.3 Concrete Cask Overturning Event states in subsection 8.2.3.2, in part…

"The Concrete Cask and contained MPC with internals would experience a bounding deceleration of 32g to 38g due to impact with the pad."

A clarifying statement needs to be added to this section to acknowledge a slight increase in g-load for a partially loaded MPC, as follows:

"The Concrete Cask and contained MPC with internals would experience a bounding deceleration of 32g to 38g due to impact with the pad. *A partially loaded MPC (i.e., with as few as 20 of 24 cells filled) would experience a slight increase in deceleration to approximately 38.6g*. ~~This~~These deceleration value*s* *are* ~~is~~ much less than the design basis deceleration value of 60g for the Holtec MPC."

Section 8.2.13.3.3 MPC Drop Analysis states…

"To bound the physical problem, the following assumptions were made (Reference 16):

1. The loaded MPC is assumed to weigh 78,700 lbs in the analysis, which is the maximum allowed weight of the heaviest Trojan MPC-24E or MPC-24EF as indicated in Table 4.2-4."

A clarifying statement needs to be added here stating that to maximize the impact deceleration g-load, the model assumed the MPC contained 24 fuel assemblies but with no inserts or spacers as follows:

1. "The loaded MPC is assumed to weigh 78,700 lbs in the analysis, which is the maximum allowed weight of the heaviest Trojan MPC-24E or MPC-24EF as indicated in Table 4.2-4. *In the LS-DYNA model, a smaller weight of 69,765 lbs is*

conservatively used for the fully loaded MPC model to maximize the impact deceleration. This assumed 24 assemblies, but with no fuel inserts or spacers."

An additional statement needs to be added following the paragraph that documents the MPC drop deceleration results to acknowledge that there are partially loaded MPCs at the Trojan ISFSI which would result in a slight increase in g-load in a drop scenario, as follows:

"Based on the results, the maximum deceleration of the dropped MPC was slightly less than 54g, which is less than the MPC design basis deceleration limit of 60g. *A partially loaded MPC (i.e., with as few as 20 of 24 cells filled) would experience a slight increase in deceleration. The bounding, partially loaded MPC with 20 cells filled conservatively assumes 20 fuel assemblies with no inserts, but with 20 spacers. This results in an MPC weight of 69,616 lbs, almost equal to the fully loaded deceleration model weight of 69,765 lbs noted above. Since the percentage difference is only 0.21%, the weight difference has a negligible effect on the deceleration results.* Therefore, the stored fuel assemblies will not be damaged due to the postulated MPC drop accident."

Section 8.2.13.4 Loaded Transport Cask Drop states…

"Section 9.7.5 establishes that a program provide the requirements governing handling or lifting fuel bearing components including Transport Casks. Handling/lifting of spent fuel or handling/lifting of loads over spent fuel are performed only in accordance with approved lift plans. An evaluation of consequences of a drop or handling accident shall be performed prior to initiating the handling/lifting activities." (emphasis added)

A clarifying statement needs to be added to the end of this section to ensure that the drop evaluation of the Transport Cask includes the bounding (i.e., lightest), partially loaded MPC, as follows:

"An evaluation of consequences of a drop or handling accident shall be performed prior to initiating the handling/lifting activities. *This evaluation shall include both the fully loaded and the bounding (i.e., lightest), partially loaded MPC as analyzed in Reference 16*."

Reference 16 for SAR Chapter 8 will be updated from Revision 3 to Revision 4, as follows:

"Holtec Report No. HI-2022881, "Finite Element Analysis of the MPC Drop Accident Postulated at the Trojan Transfer Station," Revision ~~3~~ *4,* ~~July 16, 2002.~~"

In addition, the need for a drop evaluation of the bounding, partially loaded MPC in a Transport Cask will be added to TIP 10, The Transfer Cask and Concrete Cask

Handling and Storage Program, and to TIP 30, Pad and Transfer Station Operations with respect to the drop of the Transport Cask during loading operations. See Review of Associated Implementing Procedures section below.

The drop analysis of the loaded Transport Cask is the responsibility of Holtec as part of the HI-STAR 100 transport cask system. The drop analyses are documented in the HI-STAR 100 SAR (HI-951251). HIB-62 states that "An ECO [engineering change order] will be created to revise the HI-STAR 100 SAR to include evaluations to qualify the system for a larger range of partially loaded MPCs." These evaluations will include the Trojan ISFSI bounding, partially loaded MPC in a HI-STAR 100 transport cask. However, since Holtec will require a license amendment to their HI-STAR 100 SAR it may be some time before it is implemented. The changes to TIP 10 and TIP 30 (below) and to the Trojan ISFSI SAR (above) will ensure that all bounding drop evaluations are completed prior to loading a Trojan MPC (fully loaded or partially loaded) into a Transport Cask.

LDCR 2016-002:

This change revises the ISFSI Safety Analysis Report (SAR), Section 9.8, ISFSI Decommissioning Plan, to delete the current detailed information and replace it with wording to refer to the new Topical Report, PGE-1082. The change also deletes Table 9.8-1, ISFSI Radiological Decommissioning Costs and affected References specified in SAR Section 9.10, References. In addition, this change makes corresponding changes to SAR, Section 9, Table of Contents.

Reason and Justification for Change

The ISFSI Safety Analysis Report, Section 9.8, ISFSI Decommissioning Plan, and Table 9.8-1, ISFSI Radiological Decommissioning Costs, currently contain detailed information that has been moved and integrated into the new Topical Report (PGE-1082) titled, Trojan ISFSI Preliminary Radiological Decommissioning Plan. The new Topical Report (PGE-1082) was prepared to satisfy the requirements of the revised rule 10 CFR 72.30, Financial Assurance and Recordkeeping for Decommissioning and applicable NRC guidance for implementing this rule in NUREG-1757, Volume 3, Revision 1, Consolidated Decommissioning Guidance, Financial Assurance, Recordkeeping, and Timeliness.

The new Topical Report (PGE-1082) was submitted (VPN-007-2012) to the NRC for review and approval on December 13, 2012 and was subsequently approved by the NRC on February 25, 2016. Concurrently, with this SAR change, the NRC approved Topical Report PGE-1082 is being issued as Revision 0 (Reference separate LDCR No. 2016-001).

It is noted that new Topical Report (PGE-1082) contains a description of the ISFSI facility; a projected decommissioning schedule; a detailed site-specific cost estimate for radiological

decommissioning; co-owners' funding plans; co-owners' financial assurance instrument information; co-owners' certifications of financial assurance; and recordkeeping for radiological decommissioning in more detail than that in ISFSI SAR Section 9.8 and Table 9.8-1.

Therefore, to eliminate redundancy, the current detailed information in SAR Section 9.8 and Table 9.8-1 is being deleted and replaced with wording to refer to the Topical Report, PGE-1082.

Revision 14 to PGE-1069
Trojan Independent Spent Fuel Storage Installation (ISFSI) Safety Analysis Report (SAR)

Revised pages are to be replaced as follows:

REMOVE	**INSERT**
Table of Contents	
Pages xiii through xxviii	Pages xiii through xxvii
Section 4	
Page 4-72	Page 4-72
Section 8	
Page 8-15	Page 8-15
Pages 8-38 through 8-40	Pages 8-38 through 8-40
Page 8-43	Page 8-43
Section 9	
Pages 9-15 through 9-21	Pages 9-15 through 9-17
Table 9.8-1	Deleted

LIST OF TABLES

LIST OF TABLES

LIST OF TABLES

TABLE **TITLE**

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES

LIST OF FIGURES

LIST OF FIGURES

LIST OF EFFECTIVE PAGES

Page Number	**Revision**
Table of Contents i	7
Table of Contents ii and iii	4
Table of Contents iv	12
Table of Contents v through vii	9
Table of Contents viii	4
Table of Contents ix and x	7
Table of Contents xi	4
Table of Contents xii	8
Table of Contents xiii through xxvii	14
1-1 through 1-6	4
1-7	6
Figure 1.1-1	4
Figure 1.3-1	2
Appendix 1.A	4
Drawing 3969	2
Drawing 3970	5
PGE-002	2
Drawing 3971	2
2-1	7
2-2	6
2-3	13
2-4	7
2-5 through 2-7	2
2-8 through 2-10	8
2-11	7
2-12 through 2-15	8
2-16	2
2-17	7
2-18	8
2-19	7
2-20	5
2-21	8
2-22 through 2-27	2
2-28	5
2-29	6
2-30 through 2-33	2

LIST OF EFFECTIVE PAGES

Page Number	Revision
2-34	7
2-35 and 2-36	2
2-37	6
2-38 through 2-42	2
2-43	4
2-44	8
2-45	2
2-46	6
2-47	2
Table 2.1-1	0
Table 2.1-2	0
Table 2.2-1	2
Table 2.7-1	2
Figure 2.1-1	4
Figure 2.1-2	7
Figure 2.1-3	4
Figures 2.1-4 through 2.1-6	0
Figures 2.2-1 and 2.2-2	0
Figures 2.3-1 through 2.3-6	0
Figure 2.4-1	0
Figure 2.4-2	8
3-1 through 3-5	4
3-6	6
3-7 through 3-14	4
3-15	5
3-16	4
3-17	5
3-18 through 3-21	12
3-22	2
3-23	11
3-24	2
3-25	5
Table 3.1-1	0
Tables 3.1-2 and 3.1-3	2
Table 3.1-4	0
Tables 3.2-1 through 3.2-3	0
Tables 3.2-4 and 3.2-5	2

LIST OF EFFECTIVE PAGES

Page Number	Revision
Table 3.2-6	0
Tables 3.6-1 and 3.6-2	2
4-1 through 4-6	4
4-7 through 4-20	9
4-21	5
4-22 through 4-24	4
4-25 and 4-26	5
4-27 and 4-28	4
4-29 through 4-34	5
4-35	4
4-36 and 4-37	5
4-38 through 4-42	4
4-43	12
4-45 through 4-48	4
4-49	8
4-50 through 4-57	9
4-58	10
4-59 through 4-61	9
4-62 through 4-66	4
4-67	8
4-68 through 4-71	4
4-72	14
4-73	10
Tables 4.2-1 and 4.2-2	2
Table 4.2-3, Page 1	8
Table 4.2-3, Pages 2 through 4	2
Table 4.2-3, Page 5	11
Tables 4.2-4 and 4.2-5	2
Table 4.2-6	0
Tables 4.2-7 and 4.2-8	2
Table 4.2-9	3
Table 4.2-10	0
Table 4.2-11	2
Tables 4.2-12 and 4.2-13	3
Tables 4.2-14 through 4.2-16	2
Table 4.7-1	0
Table 4.7-2	8

LIST OF EFFECTIVE PAGES

Page Number	Revision
Table 4.8-1	2
Figures 4.2-1a and 4.2-1b	2
Figure 4.2-4	0
Figures 4.2-5 and 4.2-5a	9
Figure 4.2-6a	0
Figure 4.2-6b	0
Figures 4.2-8 through 4.2-16	2
Figures 4.7-1 and 4.7-2	2
Figure 4.7-3	0
Figure 4.7-6	2
Figures 4.7-8 through 4.7-11	2
Figures 4.7-12 through 4.7-13a	3
5-1	4
5-2	12
5-3 through 5-6	4
5-7	6
5-8	4
6-1	4
7-1 and 7-2	4
7-3 through 7-10	5
7-11	6
7-12 through 7-14	5
7-15 and 7-16	7
7-17 and 7-18	4
7-19	7
7-20	4
7-21	6
7-22	4
7-23 through 7-33	7
Tables 7.2-1 through 7.2-3	2
Table 7.2-4	0
Tables 7.2-5 through 7.2-10	2
Table 7.2-11	7
Tables 7.2-12 through 7.2-14	2
Tables 7.3-1 through 7.3-9	2
Table 7.4-1	2
Table 7.4-2	7

LIST OF EFFECTIVE PAGES

Page Number	Revision
Table 7.4-3	4
Table 7.4-4	7
Figure 7.2-1	0
Figures 7.3-1 through 7.3-11	2
8-1	6
8-2	4
8-3	6
8-4 through 8-6	5
8-7	7
8-8 and 8-9	6
8-10	5
8-11	6
8-12 through 8-14	4
8-15	14
8-16 through 8-24	4
8-25	7
8-26 through 8-28	4
8-29 and 8-30	5
8-31	8
8-32	4
8-33 and 8-34	7
8-35	8
8-36 and 8-37	4
8-38 through 8-40	14
8-41 and 8-42	8
8-43	14
Tables 8.0-1 and 8.0-2, Page 1 of 2	2
Table 8.0-2, Page 2 of 2	8
Table 8.1-1	2
Tables 8.1-3 and 8.1-4	2
Tables 8.2-1 and 8.2-2	2
Tables 8.2-3 and 8.2-4	0
Table 8.2-5	2
Table 8.2-6	7
Table 8.3-1	8
Figures 8.1-1 and 8.1-2	2
Figures 8.2-1 through 8.2-4	2

LIST OF EFFECTIVE PAGES

16. Holtec International, "Topical Report on the HI-STAR/HI-STORM Thermal Model and its Benchmarking with Full-Size Cask Test Data," Report HI-992252, Rev. 1

17. Holtec International, HI-STAR 100 Cask System FSAR, Report HI-2012610, Rev. 0, March 2001.

18. USNRC Interim Staff Guidance ISG-15, "Materials Evaluation," January 2001.

19. Reid, R. C., Prausnitz, J. M., and Poling, B. E., "The Properties of Gases & Liquids," McGraw-Hill Book Co., 4th Edition, (Page 514)

20. NUREG-1536, "Standard Review Plan for Dry Cask Storage Systems," January 1997.

21. Johnson, A. B., and Gilbert, E. R., "Technical Basis for Storage of Zircaloy-Clad Spent Fuel in Inert Gases," PNL-4835, September 1983.

22. HI-STORM 100 License Amendment Request 1014-1, Rev. 2, July 2001, as supplemented.

23. "Final Safety Analysis Report for the HI-STORM 100 Cask System," NRC Docket No. 72-1014, Holtec Report HI-2002444, Revision 1.

24. Natrella, M. G., Experimental Statistics, National Bureau of Standards Handbook 91, August 1963.

25. Cano, J. M., Caro, R., and Martinez-Val, J.M., "Supercriticality Through Optimum Moderation in Nuclear Fuel Storage," Nuclear Technology, Vol. 48, May 1980.

26. Holtec Report No. 2022881, "Finite Element Analysis of the MPC Drop Accident Postulated at the Trojan Transfer Station," Revision 4.

27. NRC Bulletin 96-04, "Chemical, Galvanic, or Other Reactions in Spent Fuel Storage and Transportation Casks," July 5, 1996.

28. Barkatt, et. al., "Radiolysis of Aqueous Media and its Effect in Leaching Processes of Nuclear Waste Disposal Materials," Nuclear Technology, 60, 218 (1983).

29. R. A. VanKonynenburg and P. G. Curtis, "Scoping Corrosion Tests on Candidate Waste Storage Basket Materials for the Yucca Mountain Project," Lawrence Livermore National Laboratory, August 1995.

30. Holtec Report No. HI-2012676, "Thermal-Hydraulic Calculations for Trojan ISFSI Completion Project," Revision 8.

Results

Based on the analysis, it has been concluded that only minor damage to the Concrete Cask would occur due to impact with the pad. The Concrete Cask and contained MPC with internals would experience a bounding deceleration of 32g to 38g due to impact with the pad. A partially loaded MPC (i.e., with as few as 20 of 24 cells filled) would experience a slight increase in deceleration to approximately 38.6g. These deceleration values are much less than the design basis deceleration value of 60g for the Holtec MPC. As discussed in the Holtec HI-STAR FSAR, this deceleration load would not result in damage to the spent fuel. Therefore, it was concluded that these components are capable of withstanding the impact loads and would remain intact.

8.2.3.3 Accident Dose Calculation

This event is a beyond design basis event. There are no radiological releases or adverse radiological consequences from this event.

8.2.4 TORNADO

This event involves the potential effects of a tornado on the ISFSI.

8.2.4.1 Cause of Accident

This event would be the result of a tornado generated at or near the ISFSI.

8.2.4.2 Accident Analysis

The Trojan ISFSI is located in an area classified by Regulatory Guide 1.76 (Design Basis Tornado) as a Region III. The Trojan ISFSI Concrete Cask is designed for a Regulatory Guide 1.76 area classified as Region I which requires the Concrete Cask to withstand loads associated with the most severe meteorological conditions including extreme wind and tornado. Tornado design parameters used to evaluate the suitability of the Concrete Cask include tornado winds, wind generated pressure differentials, and tornado generated missiles. A comparison of design requirements is shown in Table 8.2-3.

The methods used to convert the tornado and wind loadings into forces on the Concrete Cask are based on NUREG-0800, Section 3.3.1 -Wind Loadings, and Section 3.3.2 -Tornado Loadings. Loads due to tornado generated missiles are based on NUREG-0800, Section 3.5.3 -Barrier Design Procedures.

8.2.4.2.1 Wind Loads

The tornado wind velocity is transformed into an effective pressure applied to the Concrete Cask using procedures delineated in ANSI A58.1, "Building Code Requirements for Minimum Design

8.2.13.3.3 MPC Drop Analysis

A postulated MPC drop accident during inter-cask transfer operations at the Trojan ISFSI Transfer Station was analyzed (Reference 16) to demonstrate that: (1) the fuel assemblies will not be damaged such that retrievability would be adversely affected; (2) the MPC confinement integrity and the shell stability will be maintained; (3) the MPC fuel basket structure will not be subjected to unduly large deformations; and (4) the criticality control elements (Boral) will stay in place. The MPC was assumed to drop vertically from a height of 249 inches onto the bottom of the Concrete Cask cavity, which rests atop the Transfer Station embedded impact limiter. The base of the impact limiter is conservatively assumed fixed in all directions in order to simulate a rigid foundation.

The postulated MPC drop event was analyzed as a transient, nonlinear problem involving a number of structural components in dynamic contact. The finite-element method was used to conduct the numerical simulation for the drop event to obtain a conservative damage estimation. The impact damage is evaluated in terms of impact deceleration, stress, and deformation in the structural members involved in the impact.

A commercial computer code developed by the Livermore Software Technology Corporation and QA validated by Holtec International, LS-DYNA, was used to numerically model the impact problem. LS-DYNA is the same computer code used for dynamic analyses described in the HI-STORM 100 System FSAR.

To bound the physical problem, the following assumptions were made (Reference 16):

1. The loaded MPC is assumed to weigh 78,700 lbs in the analysis, which is the maximum allowed weight of the heaviest Trojan MPC-24E or MPC-24EF as indicated in Table 4.2-4. In the LS-DYNA model, a smaller weight of 69,765 lbs is conservatively used for the fully loaded MPC model to maximize the impact deceleration. This assumed 24 assemblies but with no fuel inserts or spacers.

2. The concrete discontinuity at the bottom of the Concrete Cask due to the air inlets is not considered in the analysis. This is a simplifying and conservative assumption, since the existence of air inlets actually helps to absorb more impact energy and hence to reduce the deceleration of the MPC.

3. The reinforced concrete foundation is assumed to be rigid and, therefore, is not modeled. Instead the bottom of the impact limiter is fixed against translation in all three directions. This assumption makes the impact target stiffer than the actual Transfer Pad since the model is incapable of absorbing energy through the concrete foundation.

A quarter-symmetric finite element model was developed based on the actual configuration of the Trojan MPC-24E. The MPC lid and baseplate were modeled with solid elements. A $^{1}/_{16}$-inch radial gap was included in the model between the MPC lid and shell. Shell elements were used to model the MPC shell. The MPC shell was discretized using very fine grids, especially at the connection regions with the lid and the baseplate. The MPC fuel basket was also modeled in detail reflecting the actual cell configuration. In order to incorporate the potential for internal impacts between the MPC fuel basket and the MPC enclosure vessel, the fuel basket and its contents were simulated as discrete masses with appropriate contact stiffnesses defined at the potential impact interfaces. To accurately represent the mass distribution inside the MPC, the stored fuel assemblies were individually modeled as rectangular solids based on the enveloping dimensions of a Westinghouse 17 x 17 PWR assembly. The weight density of the fuel assemblies is set so that the total weight of the loaded MPC equals 78,700 lbs, as reported in Table 4.2-4. This modeling approach bounds the fuel assembly types currently in use at Trojan.

For simplicity, only the lower portion of the Concrete Cask, which consists of the inner steel liner and the outer concrete, was modeled. As a result, the upper portion of the cask could not absorb any impact energy, thereby making the analysis more conservative.

The finite element model of the impact limiter includes the 3-inch thick top plate, the impact foam, and the thin stainless steel shell. A specific LS-DYNA material model together with the manufacturer's performance data was used to characterize the behavior of the impact limiter.

Finally, appropriate boundary conditions were applied to the symmetric surfaces of the LS-DYNA model. In addition, twenty-eight contact interfaces were defined among the modeled structural components.

Based on the results, the maximum deceleration of the dropped MPC was slightly less than 54g, which is less than the MPC design basis deceleration limit of 60g. A partially loaded MPC (i.e., with as few as 20 of 24 cells filled) would experience a slight increase in deceleration. The bounding, partially loaded MPC with 20 cells filled conservatively assumes 20 fuel assemblies with no inserts, but with 20 spacers. This results in an MPC weight of 69,616 lbs, almost equal to the fully loaded deceleration model weight of 69,765 lbs noted above. Since the percentage difference is only 0.21%, the weight difference has a negligible effect on the deceleration results. Therefore, the stored fuel assemblies will not be damaged due to the postulated MPC drop accident. The maximum Von Mises stress in the shell was calculated to be 24,092 psi, which is well below the failure stress of the material (65,200 psi at 450°F from Table 3.1.14 of the HI-STAR FSAR). Therefore, the MPC confinement integrity is maintained after the postulated drop accident. In addition, a review of the analysis results of the MPC shell does not identify any gross deformation or buckling in the shell. The maximum stress intensities at critical locations (such as the MPC lid-to-shell weld) are well within the Level D service condition limits specified in the ASME Code.

The calculated maximum stress of the MPC fuel basket is 20,838 psi, which is well below the material failure stress (55,450 psi at 725°F, from Table 3.1.14 of HI-STAR FSAR), and also significantly smaller than the critical buckling stress (49,220 psi, from Section 3.4.4.3.1.3 of the HI-STAR FSAR). The analysis results demonstrate that MPC fuel basket will not be subjected to unduly large deformation. Finally, a review of the sheathing weld stress analysis documented in Appendix 3.M of the HI-STAR FSAR indicates that the sheathing weld shear stress is only 3,956 psi under a 60g vertical load. Therefore, the criticality control elements (Boral) of the MPC fuel basket will stay in place in the postulated drop event.

In conclusion, the consequences of the postulated free-fall drop accident of a loaded MPC from a HI-TRAC Transfer Cask into a HI-STAR 100 Transport Cask or Concrete Cask at the Transfer Station satisfy the acceptance criteria.

8.2.13.3.4 Accident Dose Calculation

There are no radiological releases or adverse radiological consequences from this event.

8.2.13.4 <u>Loaded Transport Cask Drop</u>

A vertical or horizontal drop of a loaded Transport Cask is speculated to occur during transfer to a heavy-haul trailer or rail car prior to the installation of transportation packaging impact limiters.

Section 9.7.5 establishes that a program provide the requirements governing handling or lifting fuel bearing components including Transport Casks. Handling/lifting of spent fuel or handling/lifting of loads over spent fuel are performed only in accordance with approved lift plans. An evaluation of consequences of a drop or handling accident shall be performed prior to initiating the handling/lifting activities. This evaluation shall include both the fully loaded and the bounding (i.e., lightest) partially loaded MPC as analyzed in Reference 16.

In accordance with the program described in Section 9.7.5, an evaluation to criteria equivalent to those specified in NUREG-0612 will be performed of the entire fuel transfer and loading process. Handling of the Transport Cask at the ISFSI could utilize increased safety factors in the rigging to preclude drops or impact limiters to mitigate the effects of drops prior to installation of the transportation packaging.

16. Holtec Report No. HI-2022881, "Finite Element Analysis of the MPC Drop Accident Postulated at the Trojan Transfer Station," Revision 4.

17. Holtec Report No. HI-2012676, "Thermal-Hydraulic Calculations for Trojan ISFSI Completion Project," Revision 8.

18. Holtec Report No. HI-2012677, "Trojan ISFSI Site Boundary Confinement Analysis," Revision 5.

9.8 ISFSI DECOMMISSIONING PLAN

The Trojan ISFSI Preliminary Radiological Decommissioning Plan (PGE-1082) contains the detailed plan for implementing 10 CFR 72.30, Financial Assurance and Recordkeeping for Decommissioning (Reference 1). This plan contains information on proposed practices and procedures for the decontamination of the site and facilities and for disposal of residual radioactive materials after all of the spent fuel has been removed from the Trojan site, in order to provide reasonable assurance that the decontamination and decommissioning of the ISFSI at the end of its useful life will provide adequate protection to the health and safety of the public.

The plan includes a description of the facility; a projected decommissioning schedule; a detailed site-specific cost estimate for radiological decommissioning; co-owners' funding plans; co-owners' financial assurance instrument information; co-owners' certifications of financial assurance; and recordkeeping for radiological decommissioning.

9.9 NUCLEAR LIABILITY INSURANCE

The NRC requires that PGE maintain a minimum of $100 million in nuclear liability insurance coverage, as described in Indemnity Agreement No. B-78, "until all the radioactive material has been removed from the location and transportation of the radioactive material from the location has ended as defined in subparagraph 5(b), Article I" (Reference 8), or until the Commission authorizes the termination or modification of such financial protection. It is noted that the site location described in Item 4 of the attachment to the indemnity agreement means the original 10 CFR 50 license site boundaries. This requirement to maintain a minimum of $100 million in nuclear liability insurance coverage must remain in the Trojan ISFSI Safety Analysis Report unless prior NRC approval is received for its elimination or for a reduction in coverage amount (Reference 8).

9.10 REFERENCES

1. Code of Federal Regulations, Title 10, Part 72.30, "Financial Assurance and Recordkeeping for Decommissioning."
2. Deleted in Revision 12.
3. Deleted in Revision 12.
4. Deleted in Revision 9.
5. Deleted in Revision 12.
6. PGE-8010, "Portland General Electric (PGE) Nuclear Quality Assurance Program for Trojan Independent Spent Fuel Storage Installation (10 CFR 72) Operations and Radioactive Material Packaging and Transportation (10 CFR 71) Activities," a.k.a., Trojan Nuclear Quality Assurance Program.
7. Deleted in Revision 13.
8. U.S. Nuclear Regulatory Commission letter, "Termination of Trojan Nuclear Plant Facility Operating License No. NPF-1," dated May 23, 2005.