Application for Amendment 1 to CoC 72-1027
for the
TN-68 Dry Storage Cask

Part A

Description, Justification, and Evaluation of Amendment 1 Changes

1.0 Introduction

The purpose of this application for Amendment 1 to CoC 72-1027 is to revise the allowable contents of the TN-68 according to the following table, and to reduce the cask spacing on the storage pad from 16 to 14 feet on center.

	Current	Proposed
Maximum burnup, GWd/MTU	40	60
Minimum cooling time, year	10	7
Maximum total decay heat, kW	21.2	30
Lattice average enrichment wt % U235	3.7 max	4.70 max
Damaged fuel	none	8 assemblies

The increase in burnup and heat load and the decrease in cooling time are based on revised structural, thermal, shielding, criticality, and confinement analyses of the existing TN-68 design. The proposed expanded envelope of fuel burnup, decay heat, and cooling time does not apply to 7x7 fuel, which will continue to be subject to the current limits. The design basis fuel assembly for shielding, thermal, and confinement source terms is an 8x8 lattice with 48 GWd/MTU burnup, 2.6 wt % U235 enrichment, and 7 years cooling, as developed in Chapter 5 of the application.

The following physical changes are included to accommodate higher enrichment and damaged fuels:

(a) end caps are added to fuel compartments for damaged fuel,
(b) the basket hold-down ring is modified to accommodate the end caps, and
(c) the specified neutron absorbing materials are revised, including increased B10 areal density for higher enrichment fuels.

The appropriate design analyses are provided for the damaged fuel modifications, and for the damaged fuel itself.

The thermal and criticality analyses also support alternate construction of the neutron absorber plates, including paired aluminum / absorber plates, and replacement of the absorber at the basket periphery by aluminum without boron.

The TN-68 thermal design basis is revised to conform to Interim Staff Guidance Memo ISG-11 rev 3. The damaged fuel design basis conforms to ISG-1 rev 1 except that the fuel end caps do not provide the fuel handling capability described in the ISG. This is justified by the limitation that only fuel that can be handled by normal means will be accepted, and by the structural analysis of the fuel provided in the application that shows it will maintain its integrity under conditions bounding normal and off-normal storage.

The design basis for criticality safety is modified to delete analysis of the accidental loading of a 5% enriched fuel assembly for the baskets with higher boron content. The evaluation of this accident is not required by any regulations or guidance, and it is not credible given the rigorous administrative controls on fuel loading, which are emphasized in the revised SAR chapter on operations. A revised evaluation of this accident is retained in Chapter 11 of the FSAR.

2.0 Description of the Changes to the Certificate of Compliance

TN proposes the deletion of Condition 9 of the CoC, which specifies requirements for alternate composite materials used as a neutron absorber in the basket. Limitations on the characteristics of such materials are proposed as a new Technical Specification 4.4, included with the design features invoked by Condition 7 of the CoC.

3.0 Description of Changes to the Technical Specifications

Part B of this submittal is a proposed revision of the TN-68 Technical Specifications. The proposed changes are indicated by italic text, and are summarized in the attached Table 3-1.

4.0 Description of Changes to the FSAR

Part C of this submittal is a proposed revision of the TN-68 FSAR rev 2. The changes with respect to the TN-68 FSAR are indicated by revision bars in the border, except for changes in Chapter 12, Technical Specification Bases, which are indicated by both italics and revision bars. The proposed changes are summarized in the attached Table 4-1.

Table 3-1: Summary of Proposed Changes to the Technical Specifications

TS	Description of change	Justification for change
1.1	Revise definition of intact fuel	Conformance to ISG-1 rev 1, to address damage other than cladding damage
2.1.1A	Add damaged fuel to allowable contents with limitations, including reference to new Figure 2.1.1-1 showing location of damaged fuel compartments	To meet user need; supported analysis in Part C of this submittal
2.1.1C	Add equivalent reload fuel by manufacturers other than GE	To meet user need; equivalent reload fuel that meets the limits in the table that follows would be bounded by the safety analysis
2.1.1C	Increase U content of generation 3 fuel from 0.1896 to 0.1923	Correction of error. Maximum MTU based on number of fueled rods, pellet OD, active fuel length and theoretical density is: $(0.95)(10.96 \text{ g/cc})(49)(\pi/4)(1.212 \text{ cm})^2 (370.84 \text{ cm}) (238/270) = 0.1923$
2.1.1E	Limit Table 2.1.1-1 to 7x7 fuel only	Prior safety analysis and fuel characteristics will continue to apply to 7x7 fuel
2.1.1F	Reference new flowchart, Figure 2.1.1-2, for selection of 8x8, 9x9, and 10x10 fuel	To meet user need; expanded envelope of radiological characteristics for these fuels is supported by analysis in Part C of this submittal
2.1.1G	Was 2.1.1 E; delete decay heat limit	Decay heat limit is embedded in the fuel selection Table 2.1.1-1 and Figure 2.1.1-1, and its specification here is redundant
2.1.1G	Replace enrichment limit with reference to new Table 2.1.1-2	To meet user need, allowing higher enrichment fuels; lattice-average enrichment limit will be dependent on the B10 areal density used in the basket; supported by criticality analysis (chapter 6) in Part C of this submittal

Table 3-1: Summary of Proposed Changes to the Technical Specifications
continued

TS	Description of change	Justification for change
3.1.1 & 3.1.2	Change surveillance frequency (time limit for vacuum drying and helium backfill)	The design basis limit of 400°C in the fuel cladding is never reached below 25.25 kW, and is reached in 37 hours of vacuum drying at 30 kW. Neutron absorber plate thermal expansion limits are reached after 30 hours of vacuum drying at 30kW, and never reached at or below 22 kW. The ultimate time limit for introduction of helium is currently 48 hours. Time limits are reduced accordingly at or above 22 kW, and extended to “prior to next operation” below 22 kW.
3.1.1 & 3.1.2	Change Action A.1 note “until helium is removed” to “until a gas other than helium is introduced into the cask”	The note is intended, as made clear in the TS Bases, to refer to letting air into the cask, not to evacuating helium from the cask.
3.1.1 thru 3.1.5	Change ultimate required action from “remove fuel from cask” to “return to pool” before transport operations or “return to unloading facility” after transport operations	Once the cask is in the pool, the fuel is in a safe condition; there may be recourses, e.g., seal replacement, available to the licensee to correct the problem rather than unloading.
3.1.1 thru 3.1.3	Increase completion times for some required actions after the helium atmosphere is established in the cask	The current limits are arbitrary; once a helium atmosphere is established in the cask, there is no safety basis for the time limits during loading operations. They are increased to provide flexibility to the user.
4.1.1	Replace areal density with reference to new Table 2.1.1-2	See above, TS 2.1.1G
4.1.3	Add sentence that Section II appendix D properties from later years may be used for design	Current material properties from the 2000 addendum are used in the amendment 1 application.

Table 3-1: Summary of Proposed Changes to the Technical Specifications continued

TS	Description of change	Justification for change
4.1.3	Add sentence that ASME code requirements apply only to important to safety items	Clarification
4.1.3	Revise code alternates Table 4.1-1	Clarifications, mostly that exceptions that apply to materials suppliers, stamping, QA, etc., for confinement vessel (NB) also apply to basket (NG)
4.2.1	Change spacing on storage pad from 16 to 14 feet on center; allow for spacing as close as 12 feet depending on site-specific evaluations	To meet user need, supported by thermal analysis in Part C of this submittal
4.4	Add specification limits for metal matrix composites used as neutron absorbers in basket	The amendment application proposes a revised basis for acceptance of alternate materials, to assure continuity of supply. This TS provides bounding characteristics so that the ability to substitute alternate materials is not open-ended.
5.2.3	Revise surface dose rate limits	Corresponding to high burnup design basis fuel
5.2.3	Delete thickness of optional external shield ring	Extraneous information, a level of detail not appropriate to the Technical Specifications

Table 3-2: Summary of Proposed Changes to the TN-68 FSAR

Chapter	Description of Change
1	Revise description of contents, revise fuel cladding temperature limits, revise cask serial number marking to include basket type indication; add damaged fuel end caps to cask features, operations descriptions, and drawings; revise other drawings as required to conform to new analyses; revise cask pitch from 16 to 14 feet
2	Revise description of spent fuel to be stored, revise reported temperatures based on new analysis, revise basis for cladding temperature limits to ISG-11 rev 3, revise criticality analysis description
3	Materials properties and allowables at new temperatures. Properties from on ASME Section II, appendix D, 2000 addendum. Hydrogen generation analysis revised to consider increase surface area from paired aluminum & neutron absorber plates. Methods of structural analysis are unchanged.
3A	Revise cask structural analysis for materials properties and stress allowables at new temperatures.
3B	Revise basket structural analysis for materials properties and stress allowables at new temperatures.
3C	Revise basket modal analysis for materials properties at new temperatures.
3D	Tipover analysis unchanged
3E	Revise fracture toughness analysis for materials properties at new temperatures.
4	Revise calculation models to provide more accurate thermal analysis for higher heat load. See Table 3-3 for comparison of current thermal models and those in the amendment application. Revise radiation view factor for decreased cask pitch. Add evaluation of damaged fuel. The normal condition thermal model is included as a proprietary supplement to the application.
4A	New proprietary appendix to develop parametric formula for decay heat. Applicable to higher burnup design basis fuel, not to 7x7 fuel.
5	Retain fuel qualification table for 7x7, 40 GWd/MTU, 10 year cooled fuel. Develop design basis for all other fuel, and prepare new source term and shielding calculations and fuel qualification flowchart. Replace SAS4 with MCNP for near field dose calculations. Replace homogenized fuel and basket with explicit modeling of basket with homogenized fuel. Develop two methods for far field dose rate calculations to provide flexibility for licencees.

Table 3-2: Summary of Proposed Changes to the TN-68 FSAR
continued

Chapter	Description of Change
6	The most reactive lattice determination, uniform enrichment model validation, and determination of most reactive geometry remain unchanged. New model for final criticality safety evaluation, determination of enrichment limits as a function of B10 areal density in the neutron absorber plates, evaluation of neutron absorber thickness, and damaged fuel criticality evaluation. Rerun benchmarks for updated software and cross section libraries. Delete accidental loading of 5% enriched fuel as design basis accident, but retain some results for information to support evaluation in Chapter 11.
6A	Revise Appendix 6A (structural integrity of undamaged fuel cladding under accident accelerations) for the higher burnup design basis fuel conditions
6B	New Appendix 6B for structural analysis of damaged fuel.
7	No change to the description of the confinement system. Revise pressure calculations based on temperature results of Chapter 4; retain equilibrium pressure of 2.2 atm abs. Backfill pressure 2.0 atm abs in TS 3.1.2 remains valid. Revise confinement calculations for new design basis source term; retain existing method. Revise latent seal failure case three for the new source term input from higher burnup design basis fuel; other latent seal failure evaluations remains unchanged.
8	Add minor operations changes requested by the user, steps to verify basket type, and steps to use damaged fuel end caps.
9	Acceptance criteria unchanged except for complete rewrite of section on neutron absorbers, with the intention of moving toward consistency with the draft ASTM C26 work item WK936.
9A	Appendix 9A (Radial Neutron Shield Material) unchanged.

Table 3-2: Summary of Proposed Changes to the TN-68 FSAR
continued

Chapter	Description of Change
10	No change to ALARA considerations or radiation protection features. Revise long distance dose rate evaluation for new source input from higher burnup design basis fuel. Existing operations dose rate estimates based on 7x7 fuel remain. Provide a scaling factor for operations with higher burnup design basis fuel. Add data from actual operations.
11.	Revise temperatures, time, pressures, and dose rate consequences based on results of analyses in Chapters 4, 5, and 7 for high burnup design basis fuel. Delete criticality analysis for accidental loading of 5% enriched fuel, and revise evaluation of this accident to be based on administrative controls and margin of safety.
12	Revise bases for Technical Specifications
13	No change
14	Revise to indicate that activation calculation is based on 7x7, 40 GWD, 10 year cooled fuel, not the high burnup design basis fuel. A new calculation is not necessary considering the low level of activation.

Table 3-3: Comparison of Current Thermal Analyses
with Amendment Application Thermal Analyses

	FSAR, Rev.2	Amendment 1
Fuel effective conductivity	10x10 is defined as the bounding fuel with the lowest effective conductivity based on Wooton-Epstein correlation	A complete finite element study of BWR fuels shows that the 8x8/63-1 fuel assembly has the lowest transverse conductivity
Normal storage conditions	3D FE model, ANSYS 5.3 using shell elements for the basket and rails, and solid elements for cask components, gaps between the rails and cask inner shell, and gaps between the rails and the basket.	3D FE model, ANSYS 6.0 using solid elements for the all the basket and cask components as well as the gaps between the adjacent shells and plates.
	The model includes only the length of neutron shield shell with an adiabatic boundary condition at each end	The model includes the cask components from the protective cover plate to the cask bottom plate as well as the concrete pad and the soil underneath the pad. The heat dissipation through the concrete pad to ground is 2.3% of the total heat load.
	Effective conductivity is used to consider the heat transfer through the basket plates.	Effective conductivity is not used for the cask or basket components. They are modeled with nominal design dimensions.
	Homogenized fuel region has a mesh of 5x5	Homogenized fuel region has a mesh of 10x10
	A 0.125" gap is modeled between the rails and the cask inner shell.	An average hot gap of 0.13", corresponding to the nominal cold gap of 0.17" specified on the SAR drawing, is modeled between the rails and the cask inner shell.
	A 0.125" gap is modeled between the rails and basket periphery.	A contact resistance gap of 0.01" is modeled between the rails and the basket periphery, consistent with the bolted connection.
	Poison plates modeled as 0.3" thick	Poison plates modeled as 0.31" thick (nominal dimension)
	Material properties from ASME 1995 and 1996 addenda.	Properties from ASME 2000 addenda.
	Poison plate conductivity is temperature dependent and is less than 150 W/m-K	Poison plate conductivity is 165 W/m-K
	The average of the maximum basket and the cask wall temperatures is used as the cavity gas temperature.	The cavity gas temperature is calculated using the volumetric average temperature of the helium and fuel cladding elements within the cask cavity via ANSYS commands "ETABLE"

Table 3-3: Comparison of Current Thermal Analyses
with Amendment Application Thermal Analyses
continued

	FSAR, Rev.2	Amendment 1
Fire and cask buried accident conditions	Two FE models are used; a 3D cask cross section model and a 2D lid-seal region model	Two FE models, but both models are 3D, developed by selecting the nodes and elements from the normal condition model.
	The air gap between the cask lid and cask body, and between the resin disc and the lid, is 0.07”.	These are modeled as 0.01” air gaps. The smaller gap provides less protection against the radiation from the protective cover to the cask lid.
	Fire temperature is assumed to be 1550°F	Fire temperature is 1475°F from 10 CFR 71, consistent with NUREG-1536
	The 2D model is not used for the buried cask analysis. The lid seal temperature is set equal to the maximum cask inner shell temperature at the hottest cross section.	The lid-seal region model is also used for the buried cask analysis to determine the cask seal temperatures.
Vacuum drying	The fire accident cask cross section model is used to analyze the vacuum drying transient for 21.2 kW	Same for 30 kW
	Initial temperature is 115°F, equal to the maximum pool temperature	The maximum pool temperature is 125°F. Initial temperature for vacuum drying is calculated based on heatup prior to draining.
	Ambient temperature assumed to be 115°F	Same
	The full cask model is used for steady state runs with lower heat loads-	Same
	Transient after introduction of helium is not evaluated	Backfilling the cask with helium 30 hours after the start of the vacuum drying process is evaluated.