Enclosure 30 to TN E-29128

Public Version of Enclosure 22, Transnuclear Calculation MP197HB-0503, Revision 1

Non-PROPRIETARY Version

A]	<u></u>	Calculation No.:	MP197HB-0503
AREVA	Caloui	Form 3.2-1 ation Cover Sheet	Revision No.:	1
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DCR NO (if applicable): NUH09-008		PROJECT NAME: MP197	HB Transport Pa	kaging Design
PROJECT NO: 61003		CLIENT: Transnuclear, I	nc.	
CALCULATION TITLE:				
Decay Heat Equation for PWR and E Payloads for MP197HB	3WR Fuel	Assemblies and FQT	for the Variou	s DSC
SUMMARY DESCRIPTION:			<u> </u>	
1) Calculation Summary				
This calculation determines a Decay Heat Equation (cooling time for BWR and PWR fuel assemblies. Sep	DHE) for the o parate DHEs	calculation of decay heat as a fi are calculated for BWR and PV	unction of burnup, en VR fuel assemblies.	ichment and
This calculation also lists the Fuel Qualification Table interpolation is also performed to determine the maxil includes the calculated FQTs for the various DSCs in comparison.	mum dose rat	te at 2 meters from the side of t	he MP197HB transpo	rt package, it also
2) Storage Media Description				
Secure network server initially, then rec	lundant ta	pe backup.		
If original issue, is licensing review per T	IP 3,5 requ	uired?		
Yes 🔲 🛛 No 🖾 (explain below	N)			
This calculation is prepared to support a 10CFR7 Therefore, a 10CFR72.48 licensing review per TI	'1 transport P 3.5 is not	license application that will I applicable.	be reviewed and ap	proved by the NRC.
Software Utilized (subject to test require	ments of T	'IP 3.3):	V	ersion:
None				
Calculation is complete:				
Originator Name and Signature: Venkata Veniga	alla	Voured.	Da	ate: 04/02/60
Calculation has been checked for consis	tency, con	npleteness and correct	ness:	
Checker Name and Signature: Yevgeniy Ten	ekhin	lerge wy Tored	khin Da	nte: 04/02/10
Calculation is approved for use:	- NAT	hent		4/6/10
Project Engineer Name and Signature: 5. F	2. STRE	LITKER	Da	4/6/10 ate:

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0	03/31/09	Initial Issue	,			ALL	None
1	4/6/10	Addition of performance	FQTs based or e evaluation or	n shielding Ily		1-7, 11-13, 32-42.	Spreadshe s.zip
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Table 7-9 BWR Shielding FC	QT for the NUHOMS®-61BTH QT for the NUHOMS®-69BTH	Type 2 DSC	41
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None			

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1.0 PURPOSE

This calculation performs a decay heat calculation to determine the decay heat of PWR and BWR fuel assemblies for fuel qualification. The decay heat is calculated as a function of burnup, enrichment and cooling time and is presented in the form of a mathematical equation called decay heat equation (DHE). Separate DHEs are fitted for BWR and PWR fuel assemblies.

This calculation also lists the Fuel Qualification Tables (FQTs) for the various DSC payloads for the MP197HB Transportation Cask. The FQT listing and description is provided in Section 5.0.

Also, a set of FQTs based on shielding performance evaluation only is presented in Section 7.0 for comparison. The evaluation is performed in reference [2.7]. Note, such FQTS are referred to as SQTs (Shielding Qualification Tables) in the reference calculation.

An exponential interpolation is performed to determine compliance with the applicable dose rate limits at 2 meters from the side of the MP197HB transport package. This is documented in Section 6.0.

2.0 REFERENCES

Proprietary Information Withheld Pursuant to 10 CFR 2.390

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3.0		DESIGN INPUTS AND ASS	SUMPTIONS	
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	Proprietary Inf	ormation Withheld Pursuant	t to 10 CFR 2.390	
3.2	Design Inputs			
	Proprietary Inf	formation Withheld Pursuan	t to 10 CFR 2.390	
	1 1			
3.3	Assumptions			
				}

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4.0 ANALYSIS, RESUL	TS AND CONCLUSIONS		
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4.1 PWR De	ecay Heat Equ	uation		
as a function of	of burnup, enr	lysis was performed to obtain a ichment and cooling time. A ve sing a 9-parameter model. The	ery good fit was ol	otained based
The Decay He	eat (DH) in wa	tts is expressed as:		
	F1 = A DH = F1*I	\ + B*X1 + C*X2 + D*X1 ² + E*X Exp({[1-(1.8/X3)]*G}*[(X3-4.5)	X1*X2 + F*X2 ² ^H]*[(X2/X1) ^I]) + 20	1
where,				
F1	Intermediat	e Function		
X1		Burnup in GWD/MTU		
X2 X3	Initial Enric Cooling Tin	hment in wt. % U-235		
70	Cooling Th			
А	-44.8			
В	41.6			
С	-37.1			
D	0.611			
E F	-6.80 24.0			
г G	24.0 -0.575			
Н	0.169			
I	-0.147			
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Propri	etary Informa	ation Withheld Pursuant to 10	0 CFR 2.390	

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TRANSN	UCLEAR INC.		i age.	10 01 42
4.2 BWR	Decay Heat Equ	ation		
T.Z DVVI	Decay heat Lyu	allon		
as a functio	n of burnup, enric	ysis was performed to obtain chment and cooling time. A ing a 9-parameter model. T	very good fit was ol	otained based
The Decay	Heat (DH) in wat	ts is expressed as:		
		+ B*X1 + C*X2 + D*X1 ² + E		
	DH = F1*E	xp({[1-(1.2/X3)]*G}*[(X3-4.	5) ^H]*[(X2/X1) ^I]) + 10)
vhere,				
F1	Intermediate	Function		
X1		urnup in GWD/MTU		
X2		ment in wt. % U-235		
X3	Cooling Tim	e in Years		
А	-59.1			
В	23.4			
C	-21.1			
D	0.280			
E F	-3.52			
	12.4 -0.720			
G H	-0.720 0.157			
i i	-0.132			
			CFR 2.390	

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4.3 Decay Heat Verificatio	on		
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4.4 Conclusions

The decay heat input data has been utilized to determine separate decay heat equations for design basis BWR and PWR fuel assemblies. Sufficient margin for uncertainty is included to ensure that the calculated decay heat is conservative. The calculated decay heat equations are not valid for assembly cooling times less than 5 years.

The discussion and results for the fuel qualification for shielding are presented in Section 5.0.

FQTs presented in Section 7.0 show minimum required cooling times for fuel assemblies in verious DSCs considered for transportation in MP197HB transport cask in order not to exceed regulatory restrictions on dose rates at normal and hypothetical accident conditions of transport. A comparison with the FQTs presented in Section 5.0 shows that the FQTs presented in Section 5.0 provide the bounding cooling times. Note, cooling times shown in Section 7.0 FQTs are rounded up to the nearest .0 or .5 decimal points. For example, 5.0, 6.1, 7.5 and 7.8 years are rounded up to 5.0, 6.5, 7.5 and 8.0 years, respectively.

The discussion and results for the dose rate interpolation calculations are presented in Section 6.0.

4.5 File Listing

Proprietary Information Withheld Pursuant to 10 CFR 2.390

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5.0 FUEL QUALIFICATION TABLES

The fuel qualification calculations for the various PWR and BWR spent fuel DSCs considered as authorized payload for the MP197HB cask are documented in reference [2.7]. The results of these calculations are simplified and summarized in the Fuel Qualification Tables (FQTs) shown herein. The FQTs provide the minimum required cooling times as a function of enrichment and burnup to ensure that the fuel assembly with those parameters meets the transportation dose rate criteria. The following Table provides a cross reference for the FQTs of all the DSC payloads for the MP197HB cask.

DSC	FUEL TYPE	FQT REFERENCE
24PT4	PWR	Table 5-1
32PT	PWR	Table 5-2
24PTH	PWR	Table 5-3
32PTH	PWR	Table 5-4
32PTH1	PWR	Table 5-5
37PTH	PWR	Table 5-6
61BT	BWR	Table 5-7
61BTH Type 1	BWR	Table 5-8
61BTH Type 2	BWR	Table 5-9
69BTH	BWR	Table 5-10

Extensive notes on the use of the FQTs for each DSC are provided at the end of the Table for each DSC or separately in the page immediately following the FQT. The notes for 61BTH Type 1 and Type 2 DSCs are combined and are shown after Table 5-9.

Further, a conservative simplification is effected by setting the minimum cooling time for the 61BT, 61BTH Type 1 and Type 2 DSCs and 24PT4 DSCs to 7 years with increments of 0.5 years. The minimum cooling time for the 69BTH DSC is set to 6 years with increments of 0.5 years. The minimum cooling time for the remaining DSCs is conservatively set to 10 years with increments of 0.5 years.

The minimum cooling times set in the FQTs ensures that the decay time utilized in the decay heat calcuations (based on the DHEs determined in this calculation) is "valid" (greater than or equal to 5 years) and appropriate.

The qualification for fuel assemblies in the 32PT / 32PTH1 / 32PTH and 37PTH DSCs, where burnup is credited, is based on utilizing a "minimum required" burnup as a function of enrichment and cooling time. Longer cooling times may be needed for qualification of these fuel assemblies. This qualification is not performed in this calculation.

Further, FQT's with actual cooling times based on the shielding performance evaluation only are presented in Section 7.0 for comparison. Such a shielding evaluation is presented in [2.7] for the various PWR and BWR DSCs considered for transportation in MP197HB cask.

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						(]	Aini		PWI m re					atic		abl	e fo					SC dise	char	ge)							
BU														Init	tial E	Enric	chm	ent													
(GWd/ MTU)	18	1.9	20	2.1	2.2	2.3	2.4	2.5	2.6	2.7	28	29	30						36	37	3.8	3.9	40	41	42	43	44	45	46	47	48
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20	7.0		7.0	7.0	7.0	7.0	7.0	70	7.0	7.0	7.0	7.0	7.0			7.0	7.0			7.0	7.0					\rightarrow	7.0	7.0	7.0	7.0	7.0
25		_		7.0	7.0	7.0	7.0	70	7.0	7.0	7.0	7.0	7.0	7.0	7.0		7.0		7.0	_							7.0	7.0	7.0	_	7.0
28			7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0			7.0	7.0	7.0	<u> </u>	7.0						7.0	7.0	7.0	7.0	7.0	7.0
30			7.0		7.0	7.0	7.0	7.0	7.0	7.0	7.0		7.0			7.0		7.0		7.0	7.0					7.0	7.0	7.0	7.0	7.0	7.0
32	7.5	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
34	8.5	8.5	8.0	7.5	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0			7.0			7.0	7.0	7.0	7.0	7.0	7.0
36	10.5	10.0	9.5	9.0	8.5	8.0	7.5	7.5	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
38	1962						9.000/19241# 1669-166	Republication and the second s	e paris	编制的	7.5	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
39				da dh	\$ 5 M	Ar te At	Cleanse i				8.0	7.5	7.5	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
40	62				ni otac Lingtan	i Aleitheo Z Veg Zelo (6	na an taon an t			(n. 11)))) 20 m/ 33	8.5	8.5	8.0	7.5	7.5	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	
41				法公司	he sising Haran	New North	n lei ini			i Gant	9.5		8.5			7.5	7.5	7.5	7.5	7.5	7.0		7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
42						- A1-040			「診		10.0	9.5	9.0	9.0	8.5	8.0		8.0	7.5	7.5						7.5	7.5	7.5	7.5	7.5	
43										i karistat Zhu - Mi		21.6) % (Tapific	》中 (1)	in de la composition de la composition Composition de la composition de la comp			8.5			8.0				8.0			8.0		7.5	_	7.5
44	风景			N	ot Ai	naly	zed					1.5.5 M 7 1	and the second	ne-einfi		9.5	9.0	8.5	8.5	8.5	8.5			8.5					8.0	_	8.0
45			and the second	anti-	1602FJ®	NACE BOARD	1. Carlos and a second	27.15 B.H		674	art. Tringel		anten la su nationen in	kiner staar Verkiner of e				ff shert in			_		_	_	_		8.5	_			8.5
48				art en stat Arten stat	ti Venisia di siste	n siday di 200	(Tester)					atta di	si plas	i jarmen			1,00000		1.10	No. China		11.0							<u> </u>	_	
51				No.	Serve as	WZ IN					it) i j		in a start	ny drawys Robieszen	1942 (* 1473) 1948 (* 1475)						_	13.0			_		_		_		12.5
54					norst sels. Norski sto	10-363Q) 2047-000					18		ender Viele Historie	Cipt splite Mentione							_	15.0			-			_		_	
57				Sec.	Alfa fi fi	a tar 2 s	1911.3 (A)			i in the		34 11 11 11	Sectory .	erre yaze si Gali gazi ale	eby srut			anta da Satsei		ing and Réaltaine							_	_	<u> </u>	_	13.5
60	1223	調測和		· · · · ·	seast third		的關係		必遵任		刻飞行		Stalika	(S. 16)A	施制。	6.399			的高度	國際資料	23.0	22.0	21.5	20.5 2	20.0	19.5	18.5	18.0	17.5	5 17.0	16.5

Notes:

- BU = Assembly average burnup.
- Use burnup and enrichment to lookup minimum cooling time in years. Licensee is responsible for ensuring that uncertainties in fucl enrichment and burnup conservatively applied in determination of actual values for these two parameters.
- For reconstituted fuel assemblies with irradiated stainless steel rods, increase the cooling time by 1 year for fuel assemblies in the 12 peripheral locations of the canister with cooling times less than 10 years. No adjustment of cooling time is required for fuel assemblies in other locations or for those that have cooled for more than 10 years.
- Round burnup UP to next higher entry, round enrichments DOWN to next lower entry.
- Fuel with an initial enrichment either less than 1.8 or greater than 4.85 wt.% U-235 is unacceptable for transport.
- Fuel with a burnup greater than 60 GWd/MTU is unacceptable for transport.
- Fuel with a burnup less than 10 GWd/MTU is acceptable for transport after 7-years cooling.
- Example: An assembly with an initial enrichment of 4.65 wt. % U-235 and a burnup of 41.5 GWd/MTU is acceptable for transport after a 7.5-year cooling time as defined by 4.6 wt. % U-235 (rounding down) and 42 GWd/MTU (rounding up) on the qualification table (other considerations not withstanding).

-	TRA	-				INC	•							Ca	alc	u	at	io	n								atio isio) .:			MF	9197 15	'HB 0 of 4		93	
									(n T		e foi	r NI					' DS disci		;e)										
BU														As	semb	ly Av	erage	e init	ial U	-235	Enric	hmei	nt, wt	%													
GWD/ MTU	1.1	1.2	1.4	1.6	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0
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						_																		_			10.0							-			
20																						_	_				10.0										
25										_											_						10.0							\rightarrow			
28	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0 ·	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
30	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
32	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
34	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
36	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
38	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
39	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
40	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
41	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
42	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
43	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
44	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
45	11.5	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

- BU = Assembly average burnup. •
- Use burnup and enrichment to lookup minimum cooling time in years. Licensee is responsible for ensuring that uncertainties in fuel enrichment and burnup conservatively applied in determination of actual values for these two parameters.
- For reconstituted fuel assemblies with irradiated stainless steel rods, increase the cooling time by 1 year for fuel assemblies in the 16 peripheral locations of the canister with • cooling times less than 10 years. No adjustment of cooling time is required for fuel assemblies in other locations or for those that have cooled for more than 10 years.
- Round burnup UP to next higher entry, round enrichments DOWN to next lower entry. •
- Fuel with an initial enrichment either less than 2.0 or greater 5.0 wt.% U-235 is unacceptable for Transport. ٠
- Fuel with a burnup greater than 45 GWd/MTU is unacceptable for transport. ٠
- Fuel with a burnup less than 10 GWd/MTU is acceptable for transport after 10-years cooling. ۰
- Example: An assembly with an initial enrichment of 4.85 wt. % U-235 and a burnup of 41.5 GWd/MTU is acceptable for transport after a 10-year year cooling time as defined by ٠ 4.8 wt. % U-235 (rounding down) and 42 GWd/MTU (rounding up) on the qualification table (other considerations not withstanding).

AREVA TRANSNUCLEAR INC.	Calculation	Calculation No.: Revision No.: Page:	MP197HB-0503 0 16 of 42
	Table 5-3 PWR Fuel Qualification Table for NUHOMS [®] (Minimum required years of cooling time after react)		
M10 10 10.0 <t< td=""><td>0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10</td><td>$\begin{array}{c} 3 \ 3.4 \ 3.5 \ 3.6 \ 3.7 \ 3.8 \ 3.9 \ 4.0 \ 4.1 \ 4.2 \\ 0 \ 10.$</td><td>$\begin{array}{ c c c c c c c c c c c c c c c c c c c$</td></t<>	0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10	$\begin{array}{c} 3 \ 3.4 \ 3.5 \ 3.6 \ 3.7 \ 3.8 \ 3.9 \ 4.0 \ 4.1 \ 4.2 \\ 0 \ 10.$	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$
56 57 57 1000 mm or constraints on other of the second s		17.0 16.5 15.5 14.0 13.0 12.5 11.5 11.0 18.5 17.5 16.5 15.5 15.0 14.5 13.5 12.5 12.0 19.5 18.5 17.5 17.0 16.0 15.0 14.5 13.5 12.5 12.0 20.5 19.5 18.0 17.0 16.0 15.0 14.5 14.0 13.0 20.5 19.5 19.0 18.0 17.0 16.0 15.5 15.0 14.0 13.0 21.5 20.5 20.0 19.0 18.0 17.0 16.0 15.5 15.0 14.0 21.5 21.5 20.0 19.0 18.0 17.5 16.0 15.0 16.0 15.0 22.5 21.5 21.0 20.0 19.5 18.5 17.5 17.0 16.0	11.5 10.5 10.0 10.0 10.0 10.0 10.0 10.0

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• BU = Assembly average burnup.

• Use burnup and enrichment to lookup minimum cooling time in years. Licensee is responsible for ensuring that uncertainties in fuel enrichment and burnup conservatively applied in determination of actual values for these two parameters.

- For reconstituted fuel assemblies with irradiated stainless steel rods, increase the cooling time by 1 year for fuel assemblies in the 12 peripheral locations of the canister with cooling times less than 10 years. No adjustment of cooling time is required for fuel assemblies in other locations or for those that have cooled for more than 10 years.
- Round burnup UP to next higher entry, round enrichments DOWN to next lower entry.
- Fuel with an initial enrichment either less than 0.7 or greater than 5.0 wt.% U-235 is unacceptable for Transport.
- Fuel with a burnup greater than 62 GWd/MTU is unacceptable for transport.
- Fuel with a burnup less than 10 GWd/MTU is acceptable for transport after 10-years cooling.
- Example: An assembly with an initial enrichment of 4.85 wt. % U-235 and a burnup of 41.5 GWd/MTU is acceptable for transport after 10-year cooling time as defined by 4.8 wt. % U-235 (rounding down) and 42 GWd/MTU (rounding up) on the qualification table (other considerations not withstanding).

A AREVA	Calculation	Calculation No.: Revision No.:	MP197HB-0503 0		
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	Table 5-4				
	PWR Fuel Qualification Table for NUHOM	S [®] -32PTH DSC			
	(Minimum required years of cooling time after re	actor core discharge)			
BU GWD/ a la cla a la ala ala ala ala	Assembly Average Initial U-235 Enrichme				
MTU 0.3 0.6 0.9 1.0 1.1 1.2 1.3 1.4 1.	5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 3.0 3.1 3.2	3.3 3.4 3.5 3.6 3.7 3.8 3.9 4.0 4.1 4.2	4.3 4.4 4.5 4.6 4.7 4.8 4.9 5.0		
10 10.0 10.0 10.0 10.0 10.0 10.0 10.0 1	.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 1	0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10	10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0		
	.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 1				
20 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10	0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10				
	.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 1				
	0 10 0 0 10 0 0 10 0 0 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0				
	.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 1				
	0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10				
	0 10 0				
	2.5 11.5 10.5 10.0 10.0 10.0 10.0 10.0 10				
<u> </u>	1.0 13.0 11.5 10.5 10.0 10.0 10.0 10.0 10.0 10				
	5.5 15.5 14.5 13.5 12.0 11.0 10.0 10.0 10.0 10.0 10.0 10.0				
41 42 43	10.010.010.010.010.010.0	0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10	10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0		
		0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10			
44	· · · · · · · · · · · · · · · · · · ·	0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10			
45 Not A	Analyzed	0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10	10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0		
40 47		510.010.010.010.010.010.010.010.010.010.			
10		5 10.5 10.0 10.0 10.0 10.0 10.0 10.0 10.			
49	12.5 12.5 12	5 11.5 10.5 10.0 10.0 10.0 10.0 10.0 10.			
50	13.5 13.5 13. 14.5 14.5 14.	5 13.0 12.0 11.0 10.0 10.0 10.0 10.0 10.0 10			
51	· "你们,你们不知道你们你,你们你你们你们你们你们你们你们,你们,你们你们你们你们你们你们你们你们	0 14.0 13.0 12.0 11.5 10.5 10.0 10.0 10.0 10.0 10.0 10			
52	15.515.	0 15.0 14.0 13.5 12.5 11.5 10.5 10.0 10.0 10.0 10.0			
		5 16.0 15.5 14.5 13.5 12.5 12.0 11.0 10.0 10.0 10.0 5 17.0 16.5 15.5 14.5 14.0 13.0 12.0 11.5 10.5 10.0			
		<u>╅╼─┽╍┈╀┉┉┽┉╬┲╼</u> ╋ <u>╼┥╼</u> ╅┉╇╾┯┿╍			
56	$\frac{1}{19}$	5 19.0 19.0 18.0 17.0 16.0 15.5 14.5 13.5 12.5 12.0			
57	a na serie de la companya de la comp Esta companya de la c	20.0 19.0 18.0 17.5 16.5 15.5 14.5 14.0 13.0	12.0 11.5 11.5 11.0 11.0 11.0 11.0 11.0		
58		21.0 20.5 19.5 18.5 17.5 16.5 16.0 15.0 14.0			
55 57 58 59 60		22.021.520.519.519.018.017.016.015.5			
60 60	a na ana amin'ny faritr'o amin'ny faritr'o amin'ny faritr'o amin'ny faritr'o amin'ny faritr'o amin'ny faritr'o	23.5 22.5 22.0 21.0 20.0 19.0 18.0 17.5 16.5	15.5 15.0 14.0 13.5 13.0 13.0 13.0 13.0		

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- BU = Assembly average burnup.
- Use burnup and enrichment to lookup minimum cooling time in years. Licensee is responsible for ensuring that uncertainties in fuel enrichment and burnup conservatively applied in determination of actual values for these two parameters.
- For reconstituted fuel assemblies with irradiated stainless steel rods, increase the cooling time by 1 year for fuel assemblies in the 16 peripheral locations of the canister with cooling times less than 10 years. No adjustment of cooling time is required for fuel assemblies in other locations or for those that have cooled for more than 10 years.
- Round burnup UP to next higher entry, round enrichments DOWN to next lower entry.
- Fuel with an initial enrichment either less than 0.3 or greater than 5.0 wt.% U-235 is unacceptable for Transport.
- Fuel with a burnup greater than 62 GWd/MTU is unacceptable for transport.
- Fuel with a burnup less than 10 GWd/MTU is acceptable for transport after 10-years cooling.
- Example: An assembly with an initial enrichment of 4.85 wt. % U-235 and a burnup of 41.5 GWd/MTU is acceptable for transport after 10-year cooling time as defined by 4.8 wt. % U-235 (rounding down) and 42 GWd/MTU (rounding up) on the qualification table (other considerations not withstanding).

	Calculation	Calculation No.: Revision No.: Page:	MP197HB-0503 0 20 of 42
TRANSNUCLEAR INC.		raye.	
	Table 5-5		
	PWR Fuel Qualification Table for NUHOMS [®]	-32PTH1 DSC	
	(Minimum required years of cooling time after rea	ctor core discharge)	
	(~·		
BU	Assembly Average Initial U-235 Enrichment	. wt. %	
GWD/ MTU 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1	.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 3.0 3.1 3.2 3	3.3 3.4 3.5 3.6 3.7 3.8 3.9 4.0 4.1 4.2	4.3 4.4 4.5 4.6 4.7 4.8 4.9 5.0
	0.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0	0.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0	10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0
	0.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0		
	0.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0		
	0.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0		
	0.010.010.010.010.010.010.010.010.010.0		
	0.010.010.010.010.010.010.010.010.010.0		
34	0.010.010.010.010.010.010.010.010.010.0		
36	0.5 10.0 10.0 10.0 10.0 10.0 10.0 10.0 1	0.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0	10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0
	3.0 12.0 1 1.0 10.0 10.0 10.0 10.0 10.0 1		
	4.5 13.5 12.0 11.0 10.0 10.0 10.0 10.0 10.0 10.0		
	5.5 14.5 13.5 12.5 11.5 10.5 10.0 10.0 10.0 10.0 10.0 10		
41 42		0.010.010.010.010.010.010.010.010.010.0	
43		0.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0	
44	10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0	0.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0	10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0
45 Not	1998 200 1997	0.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0	
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- BU = Assembly average burnup.
- Use burnup and enrichment to lookup minimum cooling time in years. Licensee is responsible for ensuring that uncertainties in fuel enrichment and burnup conservatively applied in determination of actual values for these two parameters.
- For reconstituted fuel assemblies with irradiated stainless steel rods, increase the cooling time by 1 year for fuel assemblies in the 16 peripheral locations of the canister with cooling times less than 10 years. No adjustment of cooling time is required for fuel assemblies in other locations or for those that have cooled for more than 10 years.
- Round burnup UP to next higher entry, round enrichments DOWN to next lower entry.
- Fuel with an initial enrichment either less than 0.7 or greater than 5.0 wt.% U-235 is unacceptable for Transport.
- Fuel with a burnup greater than 62 GWd/MTU is unacceptable for transport.
- Fuel with a burnup less than 10 GWd/MTU is acceptable for transport after 10-years cooling.
- Example: An assembly with an initial enrichment of 4.85 wt. % U-235 and a burnup of 41.5 GWd/MTU is acceptable for transport after 10-year cooling time as defined by 4.8 wt. % U-235 (rounding down) and 42 GWd/MTU (rounding up) on the qualification table (other considerations not withstanding).

AREVA TRANSNUCLEAR INC.	Calculation	Calculation No.: Revision No.: Page:	MP197HB-0503 0 22 of 42
	Table 5-6 PWR Fuel Qualification Table for NUHOMS (Minimum required years of cooling time after real		
15 10.0 1	Assembly Average Initial U-235 Enrichmer 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 3.0 3.1 3.2 10.0	IL, WL, % 3.3 3.4 3.5 3.6 3.7 3.8 3.9 4.0 4.1 4.2 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$
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• BU = Assembly average burnup.

• Use burnup and enrichment to lookup minimum cooling time in years. Licensee is responsible for ensuring that uncertainties in fuel enrichment and burnup conservatively applied in determination of actual values for these two parameters.

- For reconstituted fuel assemblies with irradiated stainless steel rods, increase the cooling time by 1 year for fuel assemblies in the 16 peripheral locations of the canister with cooling times less than 10 years. No adjustment of cooling time is required for fuel assemblies in other locations or for those that have cooled for more than 10 years.
- Round burnup UP to next higher entry, round enrichments DOWN to next lower entry.
- Fuel with an initial enrichment either less than 0.7 or greater than 5.0 wt.% U-235 is unacceptable for Transport.
- Fuel with a burnup greater than 62 GWd/MTU is unacceptable for transport.
- Fuel with a burnup less than 10 GWd/MTU is acceptable for transport after 10-years cooling.
- Example: An assembly with an initial enrichment of 4.85 wt. % U-235 and a burnup of 41.5 GWd/MTU is acceptable for transport after 10-year cooling time as defined by 4.8 wt. % U-235 (rounding down) and 42 GWd/MTU (rounding up) on the qualification table (other considerations not withstanding).

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(GWd/ MTU	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4
10	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
15	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
20	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
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28			<u> (71)</u>		7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
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34				, in the second s	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
36	N	ot An	alvze	d 🛛	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
38		A de la d	(Titati I		7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
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Notes:

- Use burnup and enrichment to lookup minimum cooling time in years. Licensee is responsible for ensuring that uncertainties in fuel enrichment and burnup are conservatively applied in determination of actual values for these two parameters.
- Round burnup UP to next higher entry, round enrichments DOWN to next lower entry.
- Fuel with an initial enrichment less than 1.4 and greater than 4.4 wt.% U-235 is unacceptable for transportation.
- Fuel with a burnup greater than 40 GWd/MTU is unacceptable for transportation.
- Fuel with a burnup less than 10 GWd/MTU is acceptable for transportation after 7 years cooling.
- For reconstituted fuel assemblies with irradiated stainless steel rods, increase the cooling time by 1 year for fuel assemblies in the 24 peripheral locations of the canister with cooling times less than 10 years. No adjustment of cooling time is required.
- Example: An assembly with an initial enrichment of 4.15 wt. % U-235 and a burnup of 31.5 GWd/MTU is acceptable for transport after a 7-year year cooling time as defined by 4.1 wt. % U-235 (rounding down) and 32 GWd/MTU (rounding up) on the qualification table (other considerations not withstanding).

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										Fuel 1m re	-				Fabl	e fo		JHC																
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15	7.0	7.0	7.0	_	7.0	7,0		7.0	_				_	_	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
20	7.0	7.0	7.0		7.0	7.0	7.0	7.0	_						7.0	7.0	7.0	7.0	7.0	7.0		7.0	7.0	7.0	7.0	7.0	7.0	7.0		7.0	7.0	7.0	7.0	7.0
23	7.0	7.0	7.0	7.0	7.0	7.0		7.0	_		7.0			7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
25	7.0	7.0	7.0		7.0	7.0	7.0	7.0	_			_		7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
28	7.0	7.0	7.0		7.0	7.0	7.0	7.0	<u> </u>			_	_	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0 7.0	7.0 7.0	7.0	7.0	7.0 7.0	7.0
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36	1			7.0	7.0	7.0	<u> </u>	_	_	_				_	7.0	7.0	7.0	7.0	7.0		7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0		7.0	7.0	7.0	7.0	7.0
38				7.0	7.0	7.0		7.0	_		7.0			7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
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42 43	-122						lege-par second			7.0	7.0	7.0		-	7.0	7.0	7.0	7.0	7.0 7.0	7.0	7.0	7.0	7.0	7.0	7.0 7.0	7.0 7.0	7.0	7.0 7.0	7.0 7.0	7.0 7.0	7.0 7.0	7.0	7.0 7.0	7.0
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46				2 (1947) 2 (1947)	i di Kata					12.0	11.0	10.5	10.0	9.0	8.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
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53										22.0			_	-	_		14.5			11.5		10.5		8.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.0
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55]					<u>sti</u> k der Gebeure				24.5	23.5	22.5	21.5	20.5			17.0	16.5	15.0		_			10.0	10.0		8.5	8.0	7.5	7.5	7.5	7.5	7.5	7.5
56										26.0	_	24.0	_		_			17.5	16.5	15.5	14.5	13.5		11.5	10.5		9.5	8.5	8.0	8.0	8.0	8.0	8.0	8.0
57										27.5							20.0		18.0		15.5	15.0	_	13.0	12.0		11.0	10.0		8.5	8.5	8.0	8.0	8.0
58										28.5		_			_		21.5		19.0	18.0		16.0			13.0		11.5	10.5	10.0	9.5	8.5	8.5	8.5	8.5
<u>59</u> 60									10.7	30.0		28.0			_		22.5 24.0	<u> </u>		19.5	18.5	17.5 19.0		15.5 17.0	14.5	13.5 15.0	12.5		10.5 12.0	10.5	9.5 10.5	9.0 10.0	9.0 9.0	8.5 9.0
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10	7.0	7.0		_		_	_	7.0	7.0	7.0	7.0	7.0	2.8	7.0	7.0	7.0	7.0	3.3	3.4 7.0	3.5	3.D 7.0	3.7 7.0	7.0	3.9 7.0	7.0	4.1 7.0	4.2 7.0	4.3	7.0	4.5	4.6	4.7	4.8 7.0	4.9 7.0	5.0
10	7.0	7.0	7.0			_		7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
20	7.0	7.0	7.0		7.0	_		7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
23	7.0	7.0	<u> </u>		-	_	_	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
25	7.0	7.0				_		7.0	7.0	7.0	7.0	7.0	7.0	1	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0		7.0	7.0	7.0
28	7.0	7.0	<u> </u>	_	-	_	_	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	· · · · · · · · · · · · · · · · · · ·	7.0	7.0	7.0
30	7.0	7.0	7.0		_	_		7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0 7.0	7.0
32		a velte		7.0				7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0 7.0	7.0 7.0	7.0 7.0	7.0	7.0	7.0	7.0	7.0	7.0 7.0	7.0 7.0	7.0	7.0		7.0	7.0	7.0 7.0
<u>34</u> 36			1	7.0		_		7.0	7.0	7.0	7.0	7.0	7.0 7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
38	i tanga			7.0			-	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
39	Sectorial Concession			7.0	-	_		7.0	7.0	_	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
40	134	61.71							(Spot	135	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
41]										7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
42											7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0		7.0	7.0	7.0
43		44.385 1742						22			7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0		7.0	7.0	7.0
44	10001								n de la seconda de seconda de la seconda de		7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0 7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0 7.0	7.0	7.0	7.0	7.0 7.0	7.0	7.0 7.0
45 46			ki rej	a i s						dis in	7.0	7.0	7.0 7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0 7.0	7.0 7.0	7.0	7.0	7.0	7.0	7.0 7.0	7.0 7.0	7.0	7.0	7.0	7.0		7.0	7.0	7.0
40	1.47								218.4		8.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	-	7.0	7.0	7.0
48	188		<u> </u>				-			Merical Merical	8.5	8.5	7.5	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
49			ļ	N/	ot A	nah	1/7/	54		1.2	10.5	9.0	8.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	-	7.0	7.0	7.0
50				inc	лМ	nai	у∠¢	Ju		17 Survey	10.5	10.0	9.0	9.0	8.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
51]		Line nee	Provention of the Party	Strawers.	T starse into an	e littler er	1 333 Tarre	Constant of Longer of		11.5	11.0	11.0	10.0	8.5	7.5	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0		7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
52				17.470.5 19 1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1				ajach National		1997 (A) 1997 (A)	13.5			11.0		_	8.5	7.5	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
53											14.5	13.5	12.5	11.0	10.5	10.5	9.5	8.5	7.5	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
54									5.965 A	de la com	16.0		13.5		11.5	11.0	10.5		8.5	7.5	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0		7.0	7.0	7.0
55										19.77	17.0			14.0	- · · ·			11.0	10.0	9.0 10.5	8.5	7.5 8.5	7.0	7.0	7.0 7.0	7.0 7.0	7.0	7.0 7.0	7.0 7.0	7.0	7.0	7.0	7.0	7.0 7.0	7.0 7.0
<u>56</u> 57								196		2016) 19 19	18.5 19.5	17.0		15.5			-		_	10.5	9.5 10.5	8.5 9.5	7.5	8.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0		7.0	7.0	7.0
<u>57</u> 58		947年1月 1月19日日 1月19日日	n na sta N N S	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	新聞 第二章		18 M				21.0	20.0		<u> </u>	<u> </u>	14.5			_	12.0		9.5		9.0	8.0	7.5	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
59		5 P. (24)	NO 183		2. 1 1						22.5	21.0			· · ·				14.5	13.5			10.5	10,5	9.5		7.5	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
60	Photo in the	ten self	in the	1 Me Con	8. A.S.S.					和公司	23.5			20.5	<u> </u>	_	17.5			14.5	_	_	11.5		10.5		8.5	8.0	7.5	7.0	7.0	7.0	7.0	7.0	7.0
61].	5 % (A)									25.0	24.0	22.5	21.5	21.0	19.5	18.5	17.5	17.0	16.0	15.0	13.5	13.0	12.0	11.0	11.0	10.0	9.5	8.5	7.5	7.0	7.0	7.0	7.0	7.0
62	96 (97) 86 (97)	a derret Weinster		e de Alia Gel de			9266) 1. XX				26.0	25.0	24.0	23.0	22.0	21.0	20.0	19.0	18.0	17.0	16.0	15.0	14.5	13.5	12.5	11.5	10.5	10.5	9.5	8.5	7.5	7.0	7.0	7.0	7.0

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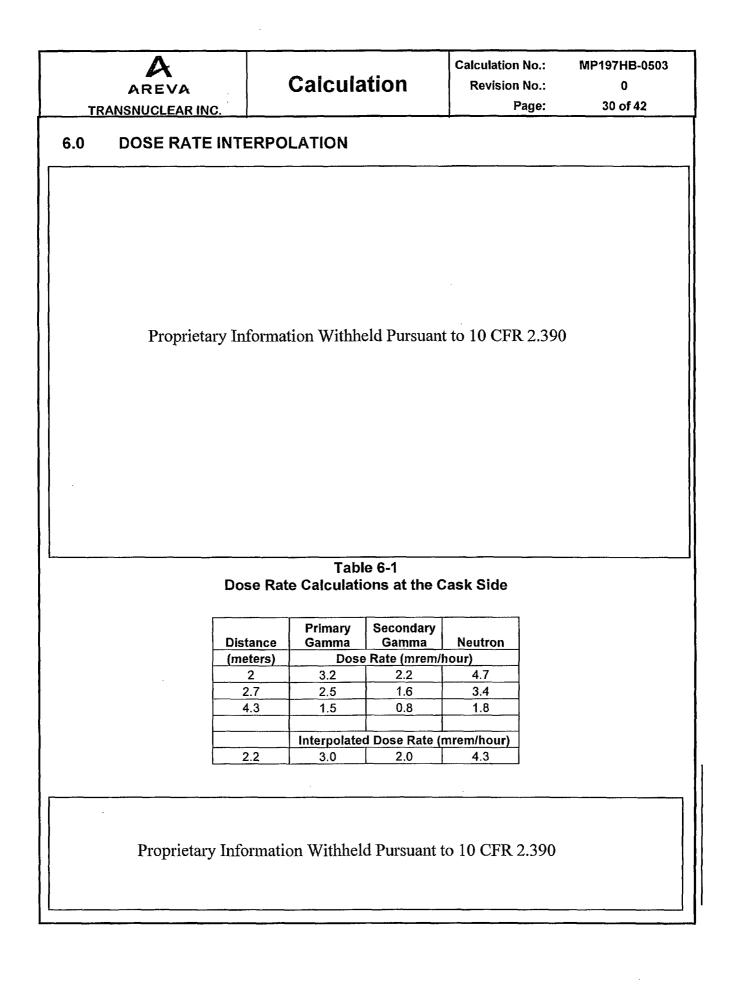
- Burnup = Assembly Average burnup.
- Use burnup and enrichment to lookup minimum cooling time in years. Licensee is responsible for ensuring that uncertainties in fuel enrichment and burnup are correctly accounted for during fuel qualification.
- Round burnup UP to next higher entry, round enrichments DOWN to next lower entry.
- Fuel with a lattice average initial enrichment less than 0.9 or greater than 5.0 wt.% U-235 is unacceptable for transportation.
- Fuel with a burnup greater than 62 GWd/MTU is unacceptable for transportation.
- Fuel with a burnup less than 10 GWd/MTU is acceptable for transportation after 7-years cooling.
- For reconstituted fuel assemblies with irradiated stainless steel rods, increase the cooling time by 1 year for fuel assemblies in the 24 peripheral locations of the canister with cooling times less than 10 years. No adjustment of cooling time is required for fuel assemblies in other locations or for those that have cooled for more than 10 years.
- The cooling times for failed, damaged and intact assemblies are identical.
- Example: An assembly with an initial enrichment of 4.85 wt. % U-235 and a burnup of 41.5 GWd/MTU is acceptable for transport after a 7-year year cooling time as defined by 4.8 wt. % U-235 (rounding down) and 42 GWd/MTU (rounding up) on the qualification table (other considerations not withstanding).

TRA			EV.		NC.								U	a	CI		ati	01								Rev	risio	n No Pag						0 of 42	2	
							la		BV	VRI	Tuel	Ou	Iali	fica	atio			ole 5 e foi		-	TUTE	[ON	 1S ^{®.}	-69B	тн	DS	c									
												-												core												
BU, GWD	/								VIII		111 10	Ju												wt 9		nui j	50)									
MTU	<u> </u>	1.2	1.5	2.0	2.1	2.	2 2.3	3 2.4	2	5 2	6 2.	7 2		2.9				2 3								4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0
10	6.0	6.0	6.0	6.0	6.0	6.			_	.0 6.			_	6.0	6.0	6.) 6	.0 6	i.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0		6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
20	6.0	6.0	6.0	6.0	6.0	6.	_		-	.0 6.	_	_	_	6.0	6.0	_	_			6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
30	6.0	6.0	6.0	6.0	6.0	6.	_	_	_	.0 6.		_		6.0	6.0	_				6.0	6.0	6.0	6.0	6.0	6.0			6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
31				6.0	6.0 6.0	6.			_	0 6.		_		6.0 6.0	6.0 6.0					6.0 6.0	6.0 6.0	6.0 6.0	6.0 6.0	6.0 6.0	6.0 6.0	6.0 6.0	6.0 6.0	6.0 6.0	6.0 6.0	6.0 6.0	6.0 6.0	6.0 6.0	6.0 6.0	6.0 6.0	6.0 6.0	6.0 6.0
35 39				6.0	6.0	6.			_					6.0	6.0	_				6.0 6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
40										5 5. 82 6.				6.0	6.0	-			_	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
42								É.	199	6				6.0	6.0		_	_		6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
44	1								1.01.0-0 (35.94)	6.		_		6.0	6.0	6.) 6	.0 6	.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
45									// (405)) (- 2726) (7.	5 6.	5 6	5.5	6.0	6.0	6.0) 6	.0 6	.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
46]								e of si e drage	8.	_	5 (6.5	6.5					6.5	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
47								2.544	i ge	9.		_		7.0	6.5	_	_			6.5	6,5	6.5	6.5	6.5	6.5	6.5		6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
48										10		_		8.0	7.0		_		_	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
49		100							16-45 7-46		.0 10	_		9.0	8.0		_			7.0	7.0	7.0	7.0 7.0	7.0	7.0	6.5	6.5 7.0	6.5	6.5	6.0 6.0	6.0 6.0	6.0 6.0	6.0 6.0	6.0 6.0	6.0 6.0	6.0 6.0
<u>50</u> 51									4. s pr		.0 11	_		10.0	9.0 10.0		_			7.0 7.5	7.0	7.0	7.0	7.0	7.0	7.0	-	7.0	6.5 7.0	7.0	6.5	6.0	6.0	6.0	6.0	6.0
52											.0 13		\rightarrow	11.5	10.0	_			_	8.0	7,5	7.5	7.5	7.5	7.5	7.5		7.5	7.0	7.0	6.5	6.0	6.0	6.0	6.0	6.0
53										2231	.0 15			13.0	12.0	_	_			9.0	8,0	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.0	6.5	6.0	6.0	6.0
54		<u>к</u> Г								17	0 16	-		14.0		_				10.0	9.0	8.0	8.0	8.0	8.0	8.0	8.0	7.5	7.5	7.5	7.5	7.5	7.5	6.5	6.0	6.0
55]			Not	Ana	-ha	7 0d		16.20	18	.5 17	.5 1	6.5	15.5	14.5	5 13	5 12	2.5 1	1.5	10.5	10.5	9.5	8.5	8.0	8.0	8.0	8.0	8.0	8.0	8.0	7.5	7.5	7.5	7.0	6.0	6.0
56				NO	Ana	aiya	zeu		の設定	20	.0 19		-	17.0								10.5	9.5	9.0	8.5	8.5		8.0	8.0	8.0	8.0	8.0	7.5	7.5	7.5	7.0
57									(特别) (注意)		.0 20	_	_	18.0	· ·	_		_				11.0	11.0	-	9.0	8.5		8.5	8.5	8.5	8.5	8.5	8.5	8.0	8.0	7.0
58			ntowny			6.952	700	Textes	16法	22	.5 21			19.5	18.5	-						12.5	11.5		10.5		_	9.0	8.5	8.5	8.5	8.5	8.5	8.5	8.0	7.5
59							107.12	e fergia	25400		.5 22			20.5	19.5	_	_		_		14.5	13.5 15.0	12.5		11.0		9.5	9.0	9.0	9.0 9.5	9.0 9.5	9.0 9.0	9.0 9.0	9.0 9.0	9.0 9.0	8.5 9.0
60 61	12.62	1929						ndear de Sterret	ener inte	20	.0 24			22.0	-	_			_	17.0	17.0	15.0	14.0		13.5	_	_	10.0	10.5	9.5	9.5	9.0	9.0	9.0	9.0	9.0
62	13.912				e si di. Si si di				1200	27	.0 25			24.5	23.5		5 21		0.5			17.5	16.5					12.0	11.0	11.0	10.0	10.0		10.0	9.5	9.5
63	14.8							高品版												14.24-	de Cyton		16.5		15.5	·	_	13.0	12.0	11.5	10.5	10.5			10.5	10.5
64]									2012 2013 2014 2017 2017 2017 2017 2017 2017		ine inte											19.0	18.0	17.0	16.0	15.0	14.5	13.5	12.5	12.0	11.0	10.5	10.5	10.5	10.5
65					Sec. Sec.					. ci (p.s.	4 (189 ⁻¹ .))	194 S.4	1.125						e i vit Naska	it of F			20.0	-	18.0			15.5	15.0	14.0	13.0	12.5	11.5		11.0	11.0
66	1.54							1.64				10 10	n Marti Nicesco						ing is the				21.0	20.0	19.0	·	17.5		16.0	15.0	14.5			·	11.5	11.5
67							er (1995) 1993 - 1995 1993 - 1995	化生产		14.5			e di tali Notes	an a	eranda Alexandre								22.5	21.5	20.5		<u> </u>	18.0	17.5	16.5	15.5	15.0	14.0		12.5	12.0
68							ang Kali Mang Kali						1 (24) // 1710 / 12		Ni ang a Ng ang a							11 - 19 11 - 19	23.5	22.5	21.5	<u> </u>	<u> </u>	19.5	18.5	17.5	17.0	16.0	15.5	14.5		13.0
<u>69</u> 70							in gran Sainte Maria	apa pada Katalapa							ister S Deserves				秘教 。				24.0 25.0					20.5	20.0	19.0 20.5	18.0 19.5	17.5 18.5	16.5 18.0		15.5	14.5
	origit 2018	an pangangan Ang pangangangan Ang pangangangangangan Ang pangangangangangan Ang pangangangangan Ang pangangangan Ang pangangangan Ang pangangangan Ang pangangangan Ang pangangangan Ang pangangangan Ang pangangangan Ang pangangangan Ang pangangan Ang pangangangan Ang pangangan Ang pangangangan Ang pangangangan Ang pangangangan Ang pangangan Ang pangangan Ang pangangan Ang pangangan Ang pangangan Ang pangangan Ang pangangan Ang pangangan Ang pangangan Ang pangangangan Ang pangangangangan Ang pangangangangangangangan Ang panganganganganganganganganganganganganga	建合成的合金	and the factor	a ng Singgan ng Singga Singgan ng Singgan ng Si			的问题的	1997-19	san sa sa	904 66	动的影	90% A	9999 B		an a	的时代	和印刷符制	<u>ess</u> maria	97. WSK/2	潮的熱等於	1	23.0	24.5	124.0	43.3	14.5	41.3	21.0	20.5	19.5	10.5	10.0	L17.0	10.5	2.0.0

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- Burnup = Assembly Average burnup.
- Use burnup and enrichment to lookup minimum cooling time in years. Licensee is responsible for ensuring that uncertainties in fuel enrichment and burnup are correctly accounted for during fuel qualification.
- Round burnup UP to next higher entry, round enrichments DOWN to next lower entry.
- Fuel with a lattice average initial enrichment less than 0.9 (or less than the minimum provided above for each burnup) or greater than 5.0 wt.% U-235 is unacceptable for transportation.
- Fuel with a burnup greater than 70 GWd/MTU is unacceptable for transportation.
- Fuel with a burnup less than 10 GWd/MTU is acceptable for transportation after 6-years cooling.
- For reconstituted fuel assemblies with irradiated stainless steel rods, increase the cooling time by 1 year for fuel assemblies in the 24 peripheral locations of the canister with cooling times less than 10 years. No adjustment of cooling time is required for fuel assemblies in other locations or for those that have cooled for more than 10 years.
- The cooling times for failed, damaged and intact assemblies are identical.
- Example: An assembly with an initial enrichment of 4.85 wt. % U-235 and a burnup of 41.5 GWd/MTU is acceptable for transport after a 6-year cooling time as defined by 4.8 wt. % U-235 (rounding down) and 42 GWd/MTU (rounding up) on the qualification table (other considerations not withstanding).



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summary, dose rate at 2 m at the vehicle is approximat em/hour.	eters from the edge of the ve ely 8" farther from the surfac	whicle along the cask e of the ILs is, less t	side, assuming han 9.37

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7.0 FQTS BASED ON SHIELDING PERFORMANCE ONLY

The fuel qualification based on a shielding performance evaluation only is documented in reference [2.7] for the various PWR and BWR spent fuel DSCs considered as authorized payload for the MP197HB cask. The results of such qualification are summarized in the Fuel Qualification Tables (FQTs) shown herein. The FQTs provide the minimum required cooling times in order not to exceed regulatory restrictions on dose rates at normal and hypothetical accident conditions as a function of enrichment and burnup. The following Table provides a cross reference for fuel assemblies in various DSC types.

DSC	FUEL TYPE	FQT REFERENCE
24PT4	PWR	Table 7-1
32PT	PWR	Table 7-2
24PTH	PWR	Table 7-3
32PTH	PWR	Table 7-4
32PTH1	PWR	Table 7-5
37PTH	PWR	Table 7-6
61BT	BWR	Table 7-7
61BTH Type 1	BWR	Table 7-8
61BTH Type 2	BWR	Table 7-9
69BTH	BWR	Table 7-10

Note, cooling times shown in Section 7.0 tables are rounded up to the nearest .0 or .5 decimal points. For example, cooling times like 5.0, 6.1, 7.5 and 7.8 years are rounded up to 5.0, 6.5, 7.5 and 8.0 years, respectively.

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		Table 7-10		
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Additional Items	, Not Related to the RAI	, Which Caused SAR Changes
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ltem Number	Item	Discussion	SAR Areas Affected
1	Editorial changes	Quality technical and editorial reviews of the SAR revealed instances where changes are warranted involving spelling, verb tense, punctuation, consistency, etc.	Various SAR pages and drawings, per Enclosure 36
2	Fabricability changes	Minor changes are incorporated into the SAR pages and drawings for improving fabricability, based on additional feedback from the fabricator.	Various SAR pages and drawings, per Enclosure 36
3	Criticality Sensitivity Analysis	NRC staff requested a sensitivity analysis for the effect of specific power on criticality.	SAR Page A.6-10 SAR Page A.6-12d (Section A.6.2.7.4) SAR Page A.6-12e (Section A.6.2.7.4) SAR Page A.6-31 (New Reference 30) SAR Page A.6-69 (Table A.6-16) SAR Page A.6-94 (Table A.6-36)
4	61BTH DSC Basket Shims	A design change to the 61BTH Part 72 design allows basket shims and slightly changes thermal analysis results. Those results are updated in the MP197 SAR.	Page A.3-149 (Table A.3-10) Page A.3-150 (Table A.3-11) Page A.3-157 (Table A.3-18)
5	69BTH Design Change	Based on additional feedback from the fabricator, a design change was made involving basket cell dimensions for the 69BTH DSC. As a result, criticality analysis computer files in the SAR were updated.	Section A.6.5.2.7.1 (replaced input file listing) Section A.6.5.2.7.2 (replaced input file listing)
6	MP197HB Cask Bolt Torque	The cask bolt torque range is revised for operational flexibility.	SAR Pages A.2.13.2-2 A.2.13.2-3 A.2.13.2-14 A.2.13.2-32 A.2.13.2-33 A.2.13.2-38 (SAR Figure A.2.13.2-1) A.2.13.2-39 (SAR Figure A.2.13.2-2)
7	ASTM Material Equivalency for the MP197HB Cask Fabrication	Based on recent discussions with the NRC staff regarding this subject on the TN-40HT Part 72 amendment application, TN decided that the ASTM equivalent material specification from other national standards will not be used for MP197HB cask fabrication. Therefore, the ASTM material equivalency in drawing MP197HB-71-1002 Note # 6 is deleted from Sheet 2 of 2, and Note # 6 is now used to denote other information.	SAR Drawing MP197HB-71-1002 Sheet 2 of 2