

**Attachment 5**

**To**

**GNRO-2007/00061**

**GGNS Calculation M6.7.013, Rev. 1**

<b>CALCULATION COVER PAGE</b>		<div style="display: flex; justify-content: space-between;"> <span>(1) DRN No.</span> <span>Page(s) 12</span> </div> <div style="display: flex; justify-content: space-between;"> <span>(2) Initiating Doc.:</span> <span>ER-GG-1999-0217</span> </div> <div style="margin-top: 5px;"> <input type="checkbox"/> DRN Superseded:  <input type="checkbox"/> DRNs Voided:  <input type="checkbox"/> Calculation Superseded/Voided:  <input checked="" type="checkbox"/> As-Built/No ICN Required  <input type="checkbox"/> Pending/ICN Required (Verify current status in IDEAS.)         </div>	
<input checked="" type="checkbox"/> CALCULATION <input type="checkbox"/> DRN		(3) Reason For Pending Status: (ER, T.S., Change, etc.)	
(4) Calculation No: M6.7.013		(5) Revision: 1	
(6) Title: CONDENSATE STORAGE TANK RESERVE CAPACITY			
(7) System(s): P11		(8) Component/Equipment Identifier:	
(9) Safety Code: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> Quality <input type="checkbox"/> No	(10) Calc Code: <small>(ANO/GGNS Only)</small> <b>MechSys</b>	1P11A002	
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(11) 10CFR50.59 Review:		(12) Structure: (Optional)	
<input checked="" type="checkbox"/> Addressed in : <b>ER-GG-1999-0217</b> <input type="checkbox"/> Attached <input type="checkbox"/> No LBD Impact		Bldg.	Elev.
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(16) Name/Signature/Date  Alex Howard Responsible Engineer		<div style="display: flex; justify-content: space-between;"> <span>Robert W Fuller / 3-27-06</span> <span>(17) Name/Signature/Date</span> </div> Robert Fuller <input checked="" type="checkbox"/> Design Verifier <input type="checkbox"/> Reviewer <input type="checkbox"/> Checker (Only As-Built DRNs Included in Revision) <input type="checkbox"/> Comments Attached	
		(18) Name/Signature/Date  3/27/06 Supervisor/Approval <input type="checkbox"/> Comments Attached	



## CALCULATION SHEET

CALCULATION NO. M6.7.013SHEET ii OF 6  
REV. 1**CALCULATION  
REFERENCE SHEET**CALCULATION NO: M6.7.013  
REVISION: 1**I. DRNs INCORPORATED:**

- 1.
- 2.
- 3.
- 4.
- 5.

II Relationships:	Sht	Rev	Input Doc	Output Doc	Impact Y/N	DRN/ Tracking No.
1. ER-GG-1999-0217	0	0	<input checked="" type="checkbox"/>	<input type="checkbox"/>	N	
2. C-143.0-N1P11A002-1.3-2-3			<input checked="" type="checkbox"/>	<input type="checkbox"/>	N	
3. C-143.0-N1P11A002-1.3-17-2			<input checked="" type="checkbox"/>	<input type="checkbox"/>	N	
4. C-143.0-N1P11A002-1.3-16-2			<input checked="" type="checkbox"/>	<input type="checkbox"/>	N	
5. C-143.0-N1P11A002-1.3-18-2			<input checked="" type="checkbox"/>	<input type="checkbox"/>	N	
6. J-1660B	0	4	<input checked="" type="checkbox"/>	<input type="checkbox"/>	N	05-1560
7. SDC-E22	0	2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	N	
8. SDC-E51	0	2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	N	
9. MC-Q1E22-00010	0	1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	N	

**III. CROSS REFERENCES:**

- 1.
- 2.
- 3.

**IV. SOFTWARE USED:**

Title: \_\_\_\_\_ Version/Release: \_\_\_\_\_ Disk/CD No. \_\_\_\_\_

**DISK/CDS INCLUDED:**

Title: \_\_\_\_\_ Version/Release \_\_\_\_\_ Disk/CD No. \_\_\_\_\_

**V. OTHER CHANGES:**



# CALCULATION SHEET

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CALCULATION NO. M6.7.013

REV. 1

Revision	Record of Revision
0	Initial issue.
1	Determines available CST volume at a level of 18 feet (TS level) above bottom of tank as well as 18.9 feet (HPCS/RCIC reserve volume), 22 feet (low alarm), 25 feet (normal level), and 29.1 feet (high alarm) above bottom of tank.



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REV. 1

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### 1.0 PURPOSE

The purpose of this calculation is to determine the available usable Condensate Storage Tank volume at a level of 18 feet, 18.9 feet, 22 feet, 25 feet, and 29.1 feet from the bottom of the tank and the time to the suction swap or vortexing for various HPCS/RCIC pump flow rates.

### 2.0 CONCLUSION

This calculation provides the available Condensate Storage Tank volume at a level of 18 feet, 18.9 feet, 22 feet, 25 feet, and 29.1 feet from the bottom of the tank and the time to suction swap or vortexing (setpoint for suction swap "Disabled") for various HPCS/RCIC pump flow rates. The results are listed in Table I.

**Table I: Usable CST Volume for HPCS/RCIC (time before suction swap or vortexing, assuming continuous flow)**

FLOW (gpm)	Setpoint* (ft)	18 ft* TS Level	18.9 ft* stand pipe level (HPCS/RCIC reserve volume)	22 ft* low alarm	25 ft* min normal level	29.1 ft* high alarm
800 (RCIC)	Disabled (See Note)	169,000 gal (3.5 hr)	177,000 gal (3.7 hr)	206,000 gal (4.3 hr)	235,000 gal (4.9 hr)	273,000 gal (5.7 hr)
7115 (HPCS)	Disabled (See Note)	145,000 gal (20 min)	154,000 gal (22 min)	183,000 gal (26 min)	211,000 gal (30 min)	250,000 gal (35 min)
8175 (HPCS)	Disabled (See Note)	137,000 gal (17 min)	145,000 gal (18 min)	174,000 gal (21 min)	203,000 gal (25 min)	241,000 gal (29 min)
8975 (HPCS/RCIC)	Disabled (See Note)	130,000 gal (14 min)	138,000 gal (15 min)	168,000 gal (19 min)	196,000 gal (22 min)	234,000 gal (26 min)
800	4.0	135,000 gal (2.8 hr)	143,000 gal (3.0 hr)	172,000 gal (3.6 hr)	200,000 gal (4.2 hr)	239,000 gal (5.0 hr)
800	5.0	125,000 gal (2.6 hr)	134,000 gal (2.8 hr)	163,000 gal (3.4 hr)	191,000 gal (4.0 hr)	230,000 gal (4.8 hr)
7115	5.0	107,000 gal (15 min)	115,000 gal (16 min)	145,000 gal (20 min)	173,000 gal (24 min)	211,000 gal (30 min)
8175	5.0	100,000 gal (12 min)	109,000 gal (13 min)	138,000 gal (17 min)	166,000 gal (20 min)	204,000 gal (25 min)
8975	5.0	94,000 gal (10 min)	103,000 gal (11 min)	132,000 gal (15 min)	160,000 gal (18 min)	199,000 gal (22 min)





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\*Indicated level; actual level is 1'-1" higher. Usable volume does not specifically include an allowance for instrumentation/setpoint uncertainty. The effect is expected to be small and bounded by the conservatism in the assumed instrumentation response times and valve stroke times.

**Note: Evaluation of usable CST volume before vortexing begins (transfer switch disabled or fails).**

### 3.0 INPUT AND DESIGN CRITERIA

1. Condensate Storage Tank (CST) set point levels are in accordance with Drawing J-1660B, DRN 05-1560.
2. The minimum reserve volume level given by Technical Specification 3.5.2.2 is  $\geq 18$  feet.
3. The design criteria for the High Pressure Core Spray (HPCS) pump flow rate given by SDC-E22, is 7115 gpm with the reactor vessel pressure 200 psi above the pressure at source of suction, with a maximum runout flow into the reactor with a pressure vessel of 14.7 psia of 8175 gpm.
4. The design normal flow rate for the Reactor Core Isolation Cooling (RCIC) pump is 800 gpm.
5. The values for friction loss, minimum CST level instrumentation response time and valve stroke time, and potential vortex level above vortex breaker are derived in Engineering Calculation MC-Q1E22-00010, Rev 1.
6. All CST measurements are derived from Specification C-143.0, N1P11A002.

### 4.0 ASSUMPTIONS

1. All calculations for flow rate and time assume continuous flow.
2. Normal CST level is 25-29 feet.
3. The CST standpipes are right circular cylinders.

### 5.0 METHOD OF ANALYSIS

The available usable volume in the CST is a function of CST initial and set point level, instrumentation and valve response time, and piping friction losses. For any given initial CST level, the available usable volume in the CST is the amount of water above the actual vortex breaker after the HPCS/RCIC suction valve opens minus the volume of water displaced by the CST standpipes.



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### 6.0 CALCULATIONS

Given a diameter of 40 ft (Ref 1), the volume of the CST per foot is:

$$\frac{\pi \cdot D^2}{4} = \frac{\pi \cdot (40\text{ft})^2}{4} = 9400.3 \frac{\text{gal}}{\text{ft}}$$

Now calculate the height at which a reserve volume of 170,000 gallons is provided.

$$\text{ReserveVol} = \frac{170000\text{gal}}{9400.3 \frac{\text{gal}}{\text{ft}}} = 18.08\text{ft}$$

Factor in the level of the vortex breaker (0.75 feet), and the level required for a reserve volume of 170,000 gallons is:

$$\text{ReserveVol}_{\text{Height}} = 18.08\text{ft} + 0.75\text{ft} = 18.83\text{ft} \\ \sim 18.9 \text{ feet}$$

The actual level of the vortex breaker is the difference between the instrument level zero and the level of the vortex breaker, or:

$$\begin{aligned} \text{Level of vortex breaker} &= 9'' \\ \text{Instrument zero level} &= 1'-1'' \end{aligned}$$

$$\text{Vortex}_{\text{Level}} = 13\text{in} - 9\text{in} = 0.33\text{ft}$$

The height of each of the standpipes is the difference between the centerline height of the standpipe and the cross-sectional radius of the standpipe, minus instrument error. The height of the 12 inch diameter standpipe is:

$$\text{Height}_{12\text{stdpipe}} = (5.22\text{ft} - 0.531\text{ft} - 1.083\text{ft}) = 3.61\text{ft}$$

The height of the 10 inch diameter standpipe is:

$$\text{Height}_{10\text{stdpipe}} = (5.22\text{ft} - 0.448\text{ft} - 1.083\text{ft}) = 3.69\text{ft}$$

Engineering Calculation MC-Q1E22-00010, Rev 1, calculates the friction loss (FL), minimum CST level instrumentation response time and valve stroke time ( $RT_{\min}$ ), and potential vortex level above vortex breaker (VTX) for the HPCS/RCIC pump at rated flow, shown in Table II.



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FLOW (gpm)	FL (ft)	RT <sub>min</sub> (ft)	VTX (ft)
800	0.041	0.0675	N/A
7115	2.738	0.811	2.504
8175	3.592	0.932	3.746
8975	4.313	1.000	4.177

Table II. Flow Data from Engineering Calculation MC-Q1E22-00010, Rev 1

The CST contains four standpipes (3-12" diameter standpipes and 1-10" diameter standpipe) which displace a known volume of usable water. This displaced volume is accounted for by calculating the expected volume per standpipe for a given indicated level, accounting for instrument zero. The volume of each standpipe is calculated as a right circular cylinder using the nominal cross-sectional area (Reference 4). With the low level set points disabled, the displaced volume for each the 3-12 inch diameter standpipes and the 1-10 inch standpipe is:

$$\text{Volume}_{12\text{displaced}} = 3 \cdot (\pi \cdot R_{12\text{stdpipe}}^2) \cdot H_{12\text{stdpipe}} + 3 \cdot (\pi \cdot R_{12\text{stdpipe}}^2) \cdot W_{\text{stdpipe}}$$

$$\text{Volume}_{10\text{displaced}} = (\pi \cdot R_{10\text{stdpipe}}^2) \cdot H_{10\text{stdpipe}} + (\pi \cdot R_{10\text{stdpipe}}^2) \cdot W_{\text{stdpipe}}$$

$$\text{TotalVolume}_{\text{displace}} = \text{Volume}_{12\text{displaced}} + \text{Volume}_{10\text{displaced}}$$

where:  $H_{12\text{stdpipe}}$  is the height of the 12 inch diameter standpipe's vertical section accounting for instrument zero and indicated level (see Row 1, Table I) minus the potential vortex level (Table II)

$$H_{12\text{stdpipe}} = (I_{\text{Level}} - 3.615 - \text{VTX})$$

$H_{10\text{stdpipe}}$  is the height of the 10 inch diameter standpipe's vertical section accounting for instrument zero and indicated level (see Row 1, Table I) minus the potential vortex level (Table II)

$$H_{10\text{stdpipe}} = (I_{\text{Level}} - 3.698 - \text{VTX})$$

$W_{\text{stdpipe}}$  is the height of the standpipe's horizontal section (1.469 ft)

$R_{12\text{stdpipe}}$  is the cross-sectional radius of the 12 inch standpipe (0.531 ft)

$R_{10\text{stdpipe}}$  is the cross-sectional radius of the 10 inch standpipe (0.448 ft)



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Therefore, the total usable volume in the CST with the low level set points *disabled* is:

$$Vol_{CST} = (I_{Level} - VTX) \cdot 9400.3 \frac{\text{gal}}{\text{ft}} - \text{TotalVolume}_{\text{displace}}$$

where:  $I_{Level}$  is the indicated level (Row 1, Table I)

$VTX$  is the potential vortex level above vortex breaker (Table II)

Similarly, with the low level set points *enabled*, the displaced volume for each the 3-12 inch diameter standpipes and the 1-10 inch standpipe is:

$$\text{Volume}_{12\text{displaced}} = 3 \cdot \left( \pi \cdot R_{12\text{stdpipe}}^2 \right) \cdot H_{12\text{stdpipe}} + 3 \cdot \left( \pi \cdot R_{12\text{stdpipe}}^2 \right) \cdot W_{\text{stdpipe}}$$

$$\text{Volume}_{10\text{displaced}} = \left( \pi \cdot R_{10\text{stdpipe}}^2 \right) \cdot H_{10\text{stdpipe}} + \left( \pi \cdot R_{10\text{stdpipe}}^2 \right) \cdot W_{\text{stdpipe}}$$

$$\text{TotalVolume}_{\text{displace}} = \text{Volume}_{12\text{displaced}} + \text{Volume}_{10\text{displaced}}$$

where:  $H_{12\text{stdpipe}}$  is the height of the 12 inch diameter standpipe's vertical section accounting for instrument zero and indicated level (see Row 1, Table I)

$$H_{12\text{stdpipe}} = (I_{Level} - 3.615 - SP - FL + RT_{\min})$$

$H_{10\text{stdpipe}}$  is the height of the 10 inch diameter standpipe's vertical section accounting for instrument zero and indicated level (see Row 1, Table I)

$$H_{10\text{stdpipe}} = (I_{Level} - 3.698 - SP - FL + RT_{\min})$$

$W_{\text{stdpipe}}$  is the height of the standpipe's horizontal section (1.469 ft)

$R_{12\text{stdpipe}}$  is the cross-sectional radius of the 12 inch standpipe (0.531 ft)

$R_{10\text{stdpipe}}$  is the cross-sectional radius of the 10 inch standpipe (0.448 ft)

Therefore, the total usable volume in the CST with the low level set points *enabled* is:

$$Vol_{CST} = [I_{Level} + \text{Vortex}_{\text{Level}} - (SP + FL - RT_{\min})] \cdot 9400.3 \frac{\text{gal}}{\text{ft}} - \text{TotalVolume}_{\text{displace}}$$

where:  $I_{Level}$  is the indicated level (Row 1, Table I)

$\text{Vortex}_{\text{Level}}$  is the actual vortex level (0.333 ft)



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SP is the CST low level set point for HPCS/RCIC suction transfer (Column 2, Table I)

FL/RT<sub>min</sub> are taken from Table II for various flow rates

TotalVolume<sub>displace</sub> is the total volume displaced by all four standpipes

The time allowed before swapping to HPCS/RCIC or vortexing is calculated by dividing the usable CST volume by the flow rate for a given mode (HPCS pump, RCIC pump, combination of both).

$$\text{Time} = \frac{\text{Vol}_{\text{CST}}}{\text{Flowrate}}$$

Results of various pump flow rates and CST initial and set point levels is provided in Table I in the CONCLUSION section.