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Accession #: D196226049

Document #: SD-FF-RPT-004

Title/Desc:

ION EXCHANGE SYS [U-400] ESTIMATED WATER VOL FOR
CRITICALITY ANALYSIS

Pages: 9

57622

43

ENGINEERING DATA TRANSMITTAL

Page 1 of 1

1. EDT

608226

2. To: (Receiving Organization) J.E. Baker, FFTF Transition Technical Support		3. From: (Originating Organization) FFTF Engineering		4. Related EDT No.: N/A																																											
5. Proj./Prog./Dept./Div.: Transition Project/FFTF		6. Cog. Engr.: P.W. McGuinness		7. Purchase Order No.: N/A																																											
8. Originator Remarks: Requested to document estimated and measured Ion Exchange System Water Volume capacity. This document is being submitted for approval/release.				9. Equip./Component No.: U-400																																											
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(G)	(H)	17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)						(G)	(H)																																						
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1,2	1	Cog.Eng. P.W. McGuinness	<i>P.W. McGuinness</i>	11-8-95	N2-02																																										
1,2	1	Cog. Mgr. S.W. Hiller	<i>S.W. Hiller</i>	11-9-95	N2-02																																										
1,2	7	QA S.L. Mischke	<i>S.L. Mischke</i>	11-9-95	N2-11																																										
1,2	1	Safety J.N. Paglieri	<i>J.N. Paglieri</i>	11-9-95	N2-10																																										
18. P.W. McGuinness Signature of EDT Originator Date 11-8-95												19. S.W. Hiller Authorized Representative Date 11-9-95												20. S.W. Hiller Cognizant Manager Date 11-9-95												21. DOE APPROVAL (if required) Ctrl. No. 11-9-95 ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments											

RELEASE AUTHORIZATION

Document Number: WHC-SD-FF-RPT-004 Rev. 0

Document Title: ION EXCHANGE SYSTEM ESTIMATED WATER VOLUME FOR
CRITICALITY ANALYSIS

Release Date: 12/06/95

This document was reviewed following the
procedures described in WHC-CM-3-4 and is:

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

JC PERKINS

12/06/95

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SUPPORTING DOCUMENT

1. Total Pages 612

2. Title

Ion Exchange System Estimated Water Volume for Criticality Analysis

3. Number

WHC-SD-FF-RPT-004

4. Rev No.

0

5. Key Words

Ion, Exchange System, Water Volume, Criticality Analysis

6. Author

Name: P.W. McGuinness

P.W. McGuinness

Signature

Organization/Charge Code 18220/B193A

7. Abstract

The purpose of this document is to provide the bases necessary to support required "Safety Analyses".

8.

RELEASE STAMP

OFFICIAL RELEASE
BY WHC

DATE DEC 06 1995

Sta 22

Westinghouse
Hanford Company

Internal
Memo

From: IEMC & Refueling Mechanical Engineering 18220-PWM-019
Phone: 376-9221 N2-02
Date: November 1, 1995
Subject: ION EXCHANGE SYSTEM (U-400) ESTIMATED WATER VOLUME FOR CRITICALITY SAFETY

To: J. E. Baker N2-57
J. R. Vincent N2-02

cc: W. F. Brehm N2-56 D. L. Nielsen N2-53
D. W. Brown N2-30 J. N. Paglieri N2-10
S. W. Hiller N2-02 R. F. Richard HO-35
S. L. Mischke N2-11 IEMC&RME/PWM/lb

Although I had previously estimated an Ion Exchange (IX) System capacity of 350 gallons, based on data from TP-41-10-95-002 and revised calculations, I now estimate that the system capacity is approximately 380 gallons and that for conservatism, assume a total IX capacity of 415 gallons for Criticality Safety.

The IX water capacity is conservatively calculated to be 383 gallons (reference attached calculation pages). Two factors should be considered with this estimate. First, intermolecular water absorption by the resin beads was not considered. Secondly, any intermolecular absorbed water and a significant portion of the water in the interstitial voids between resin beads will not be available to drain into the IEM Cell under upset conditions and add to the volume of water considered in the criticality analysis.

The measured amounts of water added to the IX Unit during testing (all six resin tanks, filters, hoses, and connecting SRS piping) was 280 gallons on October 3, 1995, and 102 gallons on October 23, 1995. This data has a large tolerance (probably ± 15 gallons) due to the inaccuracy of recorded SRS tanks T-101 and T-102 water volumes. Therefore, the measured water added is 382 ± 15 gallons.

In summary, the IX water capacity is calculated conservatively at 383 gallons, although some of this water would probably not be available to the IEM Cell during an accident. The measured IX water capacity is between 367 and 397 gallons and probably nearer the lower number based on the conservative volume calculations. For conservatism, assume 415 gallons IX Unit capacity.

P. W. McGuinness
Ion Exchange System Cognizant Engineer
IEMC & Refueling Mechanical Engineering

kmc

Attachment

IX PHYSICAL WATER VOLUME CAPACITY CALCULATION

1A. Resin Tanks

Per Chem-Nuclear Systems, Inc., drawings C-334-D-3335 and C-334-0200-D01, and neglecting internal pipes and resin beads and approximating the elliptical heads with straight cylinders, the internal volume is:

$$\begin{aligned} & 54.499 \text{ in} \times 402.07 \text{ in}^2 \quad (24" \text{ pipe internal area from crane} \\ & \quad \text{handbook, p. B-19}) \\ & = 21,912.413 \text{ in}^3 \times \frac{1 \text{ gal}}{231 \text{ in}^3} \\ & = 94.85 \text{ gallons} \approx 95 \text{ gallons} \end{aligned}$$

1B. Total number of tanks = 6

Total conservative resin tank volume = $6 \times 95 = 570$ gallons

2A. Filter Housing Volumes

Per scaling of drawing C-334-D-3338 and field measurements, the filter housing appears to be a 40" long 8" schedule 40 pipe which would have an internal volume of:

$$\begin{aligned} & 40" \times 50.03 \text{ in}^2 \\ & = 2001.2 \text{ in}^3 \times \frac{1 \text{ gal}}{231 \text{ in}^3} \\ & = 8.44 \text{ gallons} \end{aligned}$$

2B. Filter Piping Volume (per drawing C-334-D-3342)

Outlet spool length = $12" + 55.75" + 9.8125"$

= 77.5625" of $1\frac{1}{2}"$ pipe

Inlet spool length = $13.75" + 8.0628" + 9.8125"$

= 31.625" of $1\frac{1}{2}"$ pipe

"Bypass" spool $\approx 37" + (2 \times 8") = 53"$ of $1\frac{1}{2}"$ pipe

Total length of pipe $\approx 162.1875"$

$$\text{Volume} = 162.1875" \times 2.036 \text{ in}^2 \times \frac{1 \text{ gal}}{231 \text{ in}^3}$$

= 1.43 gallons

IX PHYSICAL WATER VOLUME CAPACITY CALCULATION

2C. Totals

Total volume per filter = $1.43 + 8.44 = 9.87$ gallons

Total volume for two filters = $2 \times 9.87 = 19.74$ gallons

3. Resin Tank Manifolds (Chem-Nuclear Systems, Inc., drawing C-334-D-3335)

3A. 1½" Pipe

Total length $\approx 70.75" + 6.0 + 6.5 + [6 \times (4.9375 + 7.5)]$
 $+ [2 \times (56.5 - 39.75)] + [4 \times ((34.75/\sin 70^\circ) - 20")]$
 $= 259.3"$

Volume $\approx 259.3" \times 2.036 \text{ in}^2 \times \frac{1 \text{ gal}}{231 \text{ in}^3}$
 $= 2.29$ gallons

3B. Connecting Hoses (1.5" I.D.)

Lengths = $(2 \times 39.75") + (4 \times 20")$
 $= 159.5"$

Area = $\frac{\pi}{4} (1.5")^2 = 1.767 \text{ in}^2$

Volume = $159.5" \times 1.767 \text{ in}^2 \times \frac{1 \text{ gal}}{231 \text{ in}^3} = 1.22$ gallons

3C. Totals

Total volume per three (3) resin tank cluster
 $= 1.22 + 2.29 = 3.51$ gallons

Total IX Unit = $2 \times 3.51 \text{ gal} = 7.02$ gallons

4. Connecting Hoses (Ref. Chem-Nuclear Systems, Inc., drawing C-334-A-3337)

Note: Hoses #4, #5, & #8 are not used or installed.

Total lengths:

$12' + 15' + 16' + 27' + 19' = 88' = 1,068$ inches

ID = 1.5", Area = 1.767 in^2

Total volume = $1,068" \times 1.767 \text{ in}^2 \times \frac{1 \text{ gal}}{231 \text{ in}^3} = 8.17$ gallons

IX PHYSICAL WATER VOLUME CAPACITY CALCULATION

5. New SRS Piping (to and from IX Unit)

5A. T-102 to IX Inlet Flange (Pipe lengths from Ted Nichol)

135' of 1", schedule 40 pipe = 1,620"

15 equivalent 90° L.R. elbow, $L \approx 15 \times 1.18" = 17.67"$

Ten 5D bends, $L = 10 \times 15.71 = 157.1"$

Total length = 1,794.77 inches

Volume = $1,794.77 \times 0.864 \text{ in}^2 \times \frac{1 \text{ gal}}{231 \text{ in}^3} = 6.71 \text{ gallons}$

5B. IX Unit Flange to T-101

155' of 1" schedule 40 pipe = 1,860"

Volume = $1,860" \times 0.864 \text{ in}^2 \times \frac{1 \text{ gal}}{231 \text{ in}^3} = 6.96 \text{ gallons}$

5C. Total Piping

$6.96 + 6.71 = 13.67 \text{ gallons}$

6. Resin Volume Calculation

Per Chem-Nuclear Systems, Inc., documents, 10 ft^3 of resin was added to each of six (6) resin tanks. The estimated void fraction is calculated below so that the solid fraction of resin may be subtracted from the IX water capacity calculation.

Theoretically, if resin bead were of uniformly circular diameter and stacked cubically, the solid fraction would be:

$$\frac{\frac{4}{3} \pi R^3}{(2R)^3} = \frac{\frac{4}{3} \pi}{8} = \frac{\pi}{6}$$

where R = resin sphere radius

= .524 or 52.4%

This is conservatively low, because naturally spherical resin beads would form a hexagonal array (more closely packed) and non-homogeneous resin beads like we have in tanks #5 and 6 and perhaps also #1, 2, 3, and 4 would have an even higher packing density. Conservatively assume total resin volume is:

$$6 \times 10 \times 0.524 \times 7.48052 \text{ gal/ft}^3 = 235.19 \text{ gallons}$$

IX PHYSICAL WATER VOLUME CAPACITY CALCULATION

7. Summary and Total

Six resin tanks volumes	=	570.00 gallons
Pre- and postfilter	=	19.74 gallons
Two (2) resin tank manifolds	=	7.02 gallons
Five (5) IX connecting hoses	=	8.17 gallons
SRS connecting piping	=	13.67 gallons
Correction for resin volume	=	-235.19 gallons
<hr/>		
Conservative IX unit water volume	=	383.41 gallons
(does not include factor for water absorption)		

Calculation performed by

P. W. McGuinness

11-1-95
Date

Independent verification by

D. L. Nielsen

11-7-95
Date