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4 ENGINEERING DATA TRANSMITTAL

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		Design Authority									
		Design Agent									
2	1	Cog.Eng. W.B. Barton	W B Barton	10/27/99	R2-11						
2	1	Cog. Mgr. N.W. Kirch	N W Kirch	10/27/99	R2-11						
2	1	QA R.R. True	R R True	10.28.99							
2	1	Safety C.P. Jackson	C P Jackson	10/28/99							
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Maximum First Transfer and Dilution Volumes for 241-SY-101

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Revision 0

MAXIMUM FIRST TRANSFER AND DILUTION VOLUMES FOR TANK 241-SY-101

W. B. Barton
Lockheed Martin Hanford Corporation

Date Published
October 1999

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Approved for public release; distribution is unlimited

Author W. Blair Barton Date 10/27/99 Checked by D.A. Reynolds Date 10/27/99

Maximum First Transfer and Dilution Volumes for 241-SY-101

Problem Statement: What is the maximum waste transfer and dilution quantities and locations which can be allowed in the first transfer of waste from SY-101 given the following constraints?

- The crust must float on the submerged waste (waste becomes less dense when diluted, eventually allowing crust to sink)
- No credit is taken for the top dilution
- Addition of water to the bulk slurry through the transfer pump must be able to refloat the crust base to above 295 inches.
- The margin between refloating to 295 inches and crust sinking must be at least 10,000 gallons
- The crust can not be thinned to less than 60 inches thick.

Solution: An EXCEL spreadsheet that models the dissolution and buoyancy effects of the transfer and dilution of SY-101 was developed based on equations derived in Reference 1. Pacific Northwest National Laboratory (PNNL) peer reviewed the spreadsheet as part of the document. In addition, D. A. Reynolds and W. B. Barton reviewed the model including the equations and compared the output results to expected results from other sources. This spreadsheet is used to do the calculations. The spreadsheet is available on the HLAN at \\AP007\Chardocs\SY-101\Crust model insol.XLS. A printout of the spreadsheet formula is attached.

The results of a series of calculations using different transfer volumes are presented in the following table.

Volume of waste transferred	Dilution required to sink the crust*	Dilution required to raise the crust to 295"*	Margin
133,000	78,889	77,989	900
120,000	80,865	76,268	4,597
110,000	82,385	75,052	7,333
100,000	83,625	72,547	11,363
100,000[1.0]	83,625	0	83,625
90,000	85,425	60,387	25,038

*All dilution calculations assume the water is introduced into the bulk slurry through the transfer pump at the 96 inch level and the waste below this level is not diluted. No credit is taken for the benefits of the water addition to the top of the crust.

[1] This shows the effect of crediting the 30,000 gallon top dilution. After the top dilution the base of the crust is at approximately 300 inches without any bottom dilution.

As can be seen by inspection of the table the margin is sensitive to the transfer volume. The required 10,000-gallon margin is reached at about 101,000 gallons transferred. Based on the

uncertainty in the model and the control instrumentation the volume is rounded to the nearest 10,000 gallons. Copies of the EXCEL spreadsheet associated with the 100,000-gallon transfer are attached as Cases 1, 2, and 3.

Based on the spreadsheet results the transfer limits are as follows.

- Maximum Waste transfer volume (undiluted waste out of SY-101) = 100,000 gallons
- Maximum water add to the top of the crust = 30,000 gallons
- Maximum water addition to the bulk slurry through the transfer pump or lower in the tank = 72,000 gallons

The margin between refloat and crust sinking is ~11,000 gallons. About 30 inches of crust (the free board and wet layers) are dissolved leaving ~90 inches of crust including the highest gas retaining regions.

These results meet the constraints and should be established as the safety limits for the initial transfer and back dilution of SY-101

The modeling is conservative in that:

- It takes no credit for the dissolution of the upper portions of the crust due to the top addition of water.
- It takes no credit for the buoyancy provided by the water added to the top of the crust.
- It assumes no mixing of the water injected to the bulk slurry through the transfer pump with the waste below the pump. Operation of the mixer pump will result in mixing this layer and thus suppressing the lowering of the bulk slurry density.
- Previous experience has shown that the crust can retain significant gas when only 60 inches thick and remain stable.

Discussion: An allowance must be made in the transfer volume for the potential effects of siphoning. Based on the analysis in reference 2, the transfer line cannot self start a siphon if the line is initially empty. A siphon can only occur when dilution water is available at the transfer pump, the pump discharge valve is open, and the line is full. The maximum siphon rate that could be experienced is 8 gallons per minute. It is assumed that the dilution water continues to flow for 8 hours after the transfer pump is stopped. This results in a maximum volume of waste transferred due to siphoning of 3840 gallons.

References

Stewart, C. W., 1999, *Buoyant Response of the SY-101 Crust to Transfer and Back Dilution*, PNNL-13066, Pacific Northwest National Laboratory, Richland, Washington.

HNF-4359, Rev. 0-E, 1999, *Engineering Design Calculations for the SY-101 RAPID Mitigation Project,* Lockheed Martin Hanford Corporation, Richland, Washington.

Author [illegible] Date 10/27/99 Checked by [illegible] Date 10/27/99

CRUST DISSOLUTION AND FLOATATION AFTER TRANSFER AND BA

INPUTS	
Crust thickness (cm)	310.00
Crust freeboard porosity	0.42
Crust freeboard saturation	0.6
Crust freeboard void fraction	0.34
Solids S.G. (undissolved)	2.2
Solids S.G. (dissolved)	2.2
Liquid S.G. at saturation	1.49
Crust submerged solids vol. fraction	0.36
Crust submerged void fraction	0.23
Bulk slurry void fraction	0.027
Bulk slurry solids vol. fraction	0.15
Crust area fraction	0.86
Vessel radius (cm)	1143
Degassed waste level (cm)	996.5
COMPUTED CONSTANTS	
Crust submerged degassed S.G.	1.75
Crust submerged bulk S.G.	1.34
Bulk slurry S.G.	1.553
Bulk slurry degassed S.G.	1.60
Crust freeboard non-void S.G.	1.98
Tank area (gal/cm)	1087
Super-porosity (rdnew-rdold)/rw	0.45
Tank area (m2)	410.4
INPUT VARIABLES	**BASE**
Diluent Added (gal)	
COMPUTED VARIABLES	
Crust freeboard bulk S.G.	1.0900
Average crust bulk S.G.	1.3032
Avg crust non-porous bulk S.G.	1.4052
Liquid Level below ref. (cm)	23.58
Waste level above ref. (cm)	26.35
Reference level (cm)	1070.2
ARCHIMEDES' MODEL	
Submergence in salt (cm)	260.07
Freeboard above salt (cm)	49.93
ARCHIMEDES' LEVELS	
Degassed Level (cm)	996.5
Surface level (cm)	1096.5
Sat. Liquid level (cm)	1046.6
WASTE LEVELS	
Top of crust (in)	431.7
Sat. Liquid Level (in)	412.0
Crust base (in)	309.7

TRANSFER AND BACK DILUTION PLAN	
Transfer volume (gal)	100000
Water/solids mass at equilibrium	0.789
Fraction of solids insoluble	0.4
Water injection height (in)	96
Dilution at injection point (gal)	72547
Dilution on top (gal)	0
WILL IT FLOAT?	**YES**
Remaining crust	Height (in)
Freeboard	20.0
Wet	12.0
Paste	80.0
Bubble slurry	10.0
total	122.0
Minimum slurry SG to float	**1.4018**
Slurry SG before flowdown - mixed	**1.5167**
Slurry SG before flowdown - strat	**1.4778**
Flowdown SG	**NONE**
Slurry SG after flowdown - mixed	**1.5167**
Slurry SG after flowdown - strat	**1.4778**
Flowdown Volume (m3)	0.0
Flowdown Mass (kg)	0
Flowdown SG	0.0000
WILL IT PUMP?	**YES**
New waste level (in)	417.0
New crust thickness (in)	122.0
New crust base elevation (in)	**295**
Mixer pump main inlet elevation (in)	**236**
Mixer pump slot inlet elevation (in)	**262**
80% of back dilution	58037.6
SG difference	0.075999
Base-Pump difference	33
Headspace (ft3)	35034
Hydrogen fraction	0.4
fraction LFL due to bubble slurry release	0.542230

← Volume to raise crust base to 295"

← Crust base

Case 1 Given 100,000 gallon transfer, how much dilution is required to raise the crust to 295 inches and will the crust float under these conditions?

Author Wm Blaine Barton Date 10/27/99 Checked by D A Reynolds Date 10/27/99

K DILUTION C STEWART Oct-99

CRUST VOID DISTRIBUTION

	Height (in)	void	Volume (m3)	Liq. mass (kg)	Sol. Mass (kg)	Tot. Mass (kg)	Insol. Mass (kg)
Freeboard	20		98.5	44436	90605	195444	60403
Bubble slurry	10	0.6	89.7	34198	17042	62601	11361
Paste	80	0.21	717.2	540328	269258	989091	179505
Wet	12	0.08	107.6	94386	47035	172778	31357
Total/Average Submerged	102	0.233	914.5	668913	333334	1224470	222223

TOTAL CRUST LAYER

	Height (in)	Volume (m3)	Liq. Mass (kg)	Sol. Mass (kg)	Total mass (kg	Insol. Mass (kg)
total	122	1012.9	713349	423939	1419914	282626

WATER TO DISSOLVE CRUST LAYERS

	Height (in)	Solid mass (kg	Water mass (k	water vol. (m3	water vol. (gal)
Bubble slurry	10	17042	13446	13.4	3551
Paste	80	269258	212444	212.4	56110
Wet	12	47035	37111	37.1	9801
total SUBMERGED	102	333334	263001	263	69462
freeboard	20	90605	71487	71.5	18881
TOTAL CRUST	122	423939	334488	334.5	88343

SLURRY LAYER BEFORE TRANSFER

	Height (in)	Volume (m3)	Liq. mass (kg)	Sol. Mass (kg)	Water vol. (gal	Insol. Mass (kg)
below injection point	96	1000.8	1233290	192808	40179	128539
injection point to crust base	213.7	2227.3	2744724	429100	89419	286067
slurry within crust	102	148.9	183452	28680	5977	19120
slurry within bubble slurry layer	10	14.6	17985	2812	586	1875
slurry within paste layer	80	116.8	143884	22494	4688	14996
slurry within wet layer	12	17.5	21583	3374	703	2249
TOTAL PRE-XFER SLURRY		3377.0	4161466	650588	135574	433726

TOTAL TANK BEFORE TRANSFER

Height (in)	Volume (m3)	Liq. mass (kg)	Sol. Mass (kg)	Tot. Mass (kg)	Insol. Mass (kg)
432	4389.9	4874815	1074527	6665693	716351

SLURRY LAYER AFTER TRANSFER

	Height (in)	Volume (m3)	Liq. mass (kg)	Sol. Mass (kg)	Insol. Mass (k	Tot. Solids (kg)
below injection point	96	1000.8	1233290	192808	128539	321347
injection point to crust base	177	1848.7	2278144	356157	237438	593595

SLURRY LAYER AFTER BACK DILUTE

	Height (in)	Volume (m3)	Liq. mass (kg)	Sol. Mass (kg)	Water mass (k	Insol. Mass (kg)
below injection point	96	1000.8	1233290	192808		128539
injection point to crust base	204	2123.4	2278144	356157	274680	237438

WATER FOR DISSOLUTION

	Volume (m3)	Volume (gal)	mass (kg)
water to dissolve solids below inj. Point	152.1	40179	152126
water to dissolve solids injection to bas	281.0	74218	281008
water to dissolve crust solids	334.5	88343	334488
water to dissolve slurry solids in crust	22.6	5977	22629
TOTAL DISSOLUTION	790.2	208716	790250

RESULTS OF DILUTION PLAN - FRACTION DISSOLVED

Top Dilution	Sol. Mass (kg)	water used (ga	water mass (k	Delta thick (in)	Matrix Insol. (	Freed Insol. (kg)
solids dissolved in freeboard	0	0	0	0	60403	0
solids dissolved in wet layer	0	0	0	0	33606	0
solids dissolved in paste layer	0	0	0	0	194501	0
excess water		0	0	0		
total	0	0	0	0	288510	0
Bottom Dilution						
solids dissolved in slurry (above)	348137	72547	274680	n/a	5347	232091
solids dissolved in bubble slurry	0	0	0	0	13236	0
solids dissolved in paste layer	0	0	0	0	194501	0
excess water		0	0	0.0		
total	348137	72547	274680	0	213083	232091

RESULTS OF DILUTION PLAN - NEW TANK CONFIGURATION

	New height (in)	Matrix Sol. Mass (kg)	Matrix liq. Mass (kg)	Diss. Sol. Mass (kg)	Freed liq. Mass. (kg)	Water mass (k	Matrix Insol. (	Freed Insol. (kg)
Freeboard	20.0	90605	44436				60403	0
Wet	12.0	50409	115969				33606	0
Paste	80.0	291752	684212				194501	0
Bubble slurry	10.0	19853	52183				13236	0
Slurry inject to base	199.0	8020	51299	348137	2226845	274680	5347	232091
Slurry below injection	96.0	192808	1233290	0	0	0	128539	0
Dissolved layers	0.0	0	0	0	0	0	0	0
New slurry inject to base	199.0	8020	51299	348137	2226845	274680	5347	232091
TOTAL	417.0	653447	2181390	348137	2226845	274680	435631	232091
TOTAL TANK MASS (kg)	6352222	6352222		1001584	4408235			667723
(check sum of mass)	6352222	6352222		1001584	4408235			667723

Case 1. Continued

Author Wm Blaine Barton Date 10/27/99 Checked by D A Reynolds Date 10/27/99

CRUST DISSOLUTION AND FLOATATION AFTER TRANSFER AND BA

INPUTS	
Crust thickness (cm)	310.00
Crust freeboard porosity	0.42
Crust freeboard saturation	0.6
Crust freeboard void fraction	0.34
Solids S.G. (undissolved)	2.2
Solids S.G. (dissolved)	2.2
Liquid S.G. at saturation	1.49
Crust submerged solids vol. fraction	0.36
Crust submerged void fraction	0.23
Bulk slurry void fraction	0.027
Bulk slurry solids vol. fraction	0.15
Crust area fraction	0.86
Vessel radius (cm)	1143
Degassed waste level (cm)	996.5
COMPUTED CONSTANTS	
Crust submerged degassed S.G.	1.75
Crust submerged bulk S.G.	1.34
Bulk slurry S.G.	1.553
Bulk slurry degassed S.G.	1.60
Crust freeboard non-void S.G.	1.98
Tank area (gal/cm)	1087
Super-porosity (rdnew-rdold)/rw	0.45
Tank area (m2)	410.4
INPUT VARIABLES	**BASE**
Diluent Added (gal)	
COMPUTED VARIABLES	
Crust freeboard bulk S.G.	1.0900
Average crust bulk S.G.	1.3032
Avg crust non-porous bulk S.G.	1.4052
Liquid Level below ref. (cm)	23.58
Waste level above ref. (cm)	26.35
Reference level (cm)	1070.2
ARCHIMEDES' MODEL	
Submergence in salt (cm)	260.07
Freeboard above salt (cm)	49.93
ARCHIMEDES' LEVELS	
Degassed Level (cm)	996.5
Surface level (cm)	1096.5
Sat. Liquid level (cm)	1046.6
WASTE LEVELS	
Top of crust (in)	431.7
Sat. Liquid Level (in)	412.0
Crust base (in)	309.7

TRANSFER AND BACK DILUTION PLAN	
Transfer volume (gal)	**100000**
Water/solids mass at equilibrium	0.789
Fraction of solids insoluble	0.4
Water injection height (in)	96
Dilution at injection point (gal)	**83625**
Dilution on top (gal)	**0**
WILL IT FLOAT?	**YES**
Remaining crust	Height (in)
Freeboard	20.0
Wet	12.0
Paste	73.1
Bubble slurry	0.0
total	105.1
Minimum slurry SG to float	**1.4767**
Slurry SG before flowdown - mixed	**1.5159**
Slurry SG before flowdown - strat	**1.4770**
Flowdown SG	**NONE**
Slurry SG after flowdown - mixed	**1.5173**
Slurry SG after flowdown - strat	**1.4784**
Flowdown Volume (m3)	144.6
Flowdown Mass (kg)	222339
Flowdown SG	1.5372
WILL IT PUMP?	**YES**
New waste level (in)	414.4
New crust thickness (in)	105.1
New crust base elevation (in)	**309**
Mixer pump main inlet elevation (in)	**236**
Mixer pump slot inlet elevation (in)	**262**

← Dilution volume to neutral buoyancy

80% of back dilution	66900
SG difference	0.000376
Base-Pump difference	47
Headspace (ft3)	35976
Hydrogen fraction	0.4
fraction LFL due to bubble slurry release	0.000000

← Note: Specific Gravity difference essentially zero. Crust is neutrally buoyant.

Case 2 Given 100,000 gallon transfer, how much dilution water can be added before the crust will sink?

Author [illegible] Date 10/27/99 Checked by [illegible] Date 10/27/99

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CRUST VOID DISTRIBUTION

	Height (in)	void	Volume (m3)	Liq. mass (kg)	Sol. Mass (kg)	Tot. Mass (kg)	Insol. Mass (kg)
Freeboard	20		98.5	44436	90605	195444	60403
Bubble slurry	10	0.6	89.7	34198	17042	62601	11361
Paste	80	0.21	717.2	540328	269258	989091	179505
Wet	12	0.08	107.6	94386	47035	172778	31357
Total/Average Submerged	102	0.233	914.5	668913	333334	1224470	222223

TOTAL CRUST LAYER

	Height (in)	Volume (m3)	Liq. Mass (kg)	Sol. Mass (kg)	Total mass (kg	Insol. Mass (kg)
total	122	1012.9	713349	423939	1419914	282626

WATER TO DISSOLVE CRUST LAYERS

	Height (in)	Solid mass (kg	Water mass (k	water vol. (m3	water vol. (gal)
Bubble slurry	10	17042	13446	13.4	3551
Paste	80	269258	212444	212.4	56110
Wet	12	47035	37111	37.1	9801
total SUBMERGED	102	333334	263001	263	69462
freeboard	20	90605	71487	71.5	18881
TOTAL CRUST	122	423939	334488	334.5	88343

SLURRY LAYER BEFORE TRANSFER

	Height (in)	Volume (m3)	Liq. mass (kg)	Sol. Mass (kg)	Water vol. (gal	Insol. Mass (kg)
below injection point	96	1000.8	1233290	192808	40179	128539
injection point to crust base	213.7	2227.3	2744724	429100	89419	286067
slurry within crust	102	148.9	183452	28680	5977	19120
slurry within bubble slurry layer	10	14.6	17985	2812	586	1875
slurry within paste layer	80	116.8	143884	22494	4688	14996
slurry within wet layer	12	17.5	21583	3374	703	2249
TOTAL PRE-XFER SLURRY		3377.0	4161466	650588	135574	433726

TOTAL TANK BEFORE TRANSFER	Height (in)	Volume (m3)	Liq. mass (kg)	Sol. Mass (kg)	Tot. Mass (kg)	Insol. Mass (kg)
	432	4389.9	4874815	1074527	6665693	716351

SLURRY LAYER AFTER TRANSFER

	Height (in)	Volume (m3)	Liq. mass (kg)	Sol. Mass (kg)	Insol. Mass (k	Tot. Solids (kg)
below injection point	96	1000.8	1233290	192808	128539	321347
injection point to crust base	177	1848.7	2278144	356157	237438	593595

SLURRY LAYER AFTER BACK DILUTE

	Height (in)	Volume (m3)	Liq. mass (kg)	Sol. Mass (kg)	Water mass (k	Insol. Mass (kg)
below injection point	96	1000.8	1233290	192808		128539
injection point to crust base	208	2165.3	2278144	356157	316624	237438

WATER FOR DISSOLUTION

	Volume (m3)	Volume (gal)	mass (kg)
water to dissolve solids below inj. Point	152.1	40179	152126
water to dissolve solids injection to bas	281.0	74218	281008
water to dissolve crust solids	334.5	88343	334488
water to dissolve slurry solids in crust	22.6	5977	22629
TOTAL DISSOLUTION	790.2	208716	790250

RESULTS OF DILUTION PLAN - FRACTION DISSOLVED

Top Dilution	Sol. Mass (kg)	water used (ga	water mass (k	Delta thick (in)	Matrix Insol. (	Freed Insol. (kg)
solids dissolved in freeboard	0	0	0	0	60403	0
solids dissolved in wet layer	0	0	0	0	33606	0
solids dissolved in paste layer	0	0	0	0	194501	0
excess water		0	0	0		
total	0	0	0	0	288510	0
Bottom Dilution						
solids dissolved in slurry (above)	356157	74218	281008	n/a	0	237438
solids dissolved in bubble slurry	19853	4137	15664	-10	0	13236
solids dissolved in paste layer	25288	5270	19952	-7	177643	16858
excess water		0	0	0.0		
total	401298	83625	316624	-17	177643	267532

RESULTS OF DILUTION PLAN - NEW TANK CONFIGURATION

	New height (in)	Matrix Sol. Mass (kg)	Matrix liq. Mass (kg)	Diss. Sol. Mass (kg)	Freed liq. Mass. (kg)	Water mass (k	Matrix Insol. (	Freed Insol. (kg)
Freeboard	20.0	90605	44436				60403	0
Wet	12.0	50409	115969				33606	0
Paste	73.1	266464	624908				177643	0
Bubble slurry	0.0	0	0				0	0
Slurry inject to base	199.5	0	0	356157	2278144	281008	0	237438
Slurry below injection	*96.0*	192808	1233290	0	0	0	128539	0
Dissolved layers	13.9	0	0	45141	111488	35616	0	30094
New slurry inject to base	213.4	0	0	401298	2389632	316624	0	267532
TOTAL	414.4	600286	2018604	401298	2389632	316624	400191	267532
TOTAL TANK MASS (kg)	6394166	6394166		1001584	4408235			667723
(check sum of mass)	6394166	6394166		1001584	4408235			667723

Author Wm Blaine Barton Date 10/27/99 Checked by D A Reynolds Date 10/27/99

CRUST DISSOLUTION AND FLOATATION AFTER TRANSFER AND BA

INPUTS	
Crust thickness (cm)	310.00
Crust freeboard porosity	0.42
Crust freeboard saturation	0.6
Crust freeboard void fraction	0.34
Solids S.G. (undissolved)	2.2
Solids S.G. (dissolved)	2.2
Liquid S.G. at saturation	1.49
Crust submerged solids vol. fraction	0.36
Crust submerged void fraction	0.23
Bulk slurry void fraction	0.027
Bulk slurry solids vol. fraction	0.15
Crust area fraction	0.86
Vessel radius (cm)	1143
Degassed waste level (cm)	996.5
COMPUTED CONSTANTS	
Crust submerged degassed S.G.	1.75
Crust submerged bulk S.G.	1.34
Bulk slurry S.G.	1.553
Bulk slurry degassed S.G.	1.60
Crust freeboard non-void S.G.	1.98
Tank area (gal/cm)	1087
Super-porosity (rdnew-rdold)/rw	0.45
Tank area (m2)	410.4
INPUT VARIABLES	**BASE**
Diluent Added (gal)	
COMPUTED VARIABLES	
Crust freeboard bulk S.G.	1.0900
Average crust bulk S.G.	1.3032
Avg crust non-porous bulk S.G.	1.4052
Liquid Level below ref. (cm)	23.58
Waste level above ref. (cm)	26.35
Reference level (cm)	1070.2
ARCHIMEDES' MODEL	
Submergence in salt (cm)	260.07
Freeboard above salt (cm)	49.93
ARCHIMEDES' LEVELS	
Degassed Level (cm)	996.5
Surface level (cm)	1096.5
Sat. Liquid level (cm)	1046.6
WASTE LEVELS	
Top of crust (in)	431.7
Sat. Liquid Level (in)	412.0
Crust base (in)	309.7

TRANSFER AND BACK DILUTION PLAN	
Transfer volume (gal)	100000
Water/solids mass at equilibrium	0.789
Fraction of solids insoluble	0.4
Water injection height (in)	96
Dilution at injection point (gal)	72000
Dilution on top (gal)	30000
WILL IT FLOAT?	**YES**
Remaining crust	Height (in)
Freeboard	0.0
Wet	0.0
Paste	79.2
Bubble slurry	10.0
total	89.2
Minimum slurry SG to float	1.3491
Slurry SG before flowdown - mixed	1.5169
Slurry SG before flowdown - strat	1.4780
Flowdown SG	1.4621
Slurry SG after flowdown - mixed	1.5102
Slurry SG after flowdown - strat	1.4715
Flowdown Volume (m3)	289.0
Flowdown Mass (kg)	422546
Flowdown SG	1.4621
WILL IT PUMP?	**YES**
New waste level (in)	411.7
New crust thickness (in)	89.2
New crust base elevation (in)	323
Mixer pump main inlet elevation (in)	236
Mixer pump slot inlet elevation (in)	262
80% of back dilution	57600
SG difference	0.128893
Base-Pump difference	61
Headspace (ft3)	36966
Hydrogen fraction	0.4
fraction LFL due to bubble slurry release	0.513886

← Crust thickness
← Crust base

Case 3 Given 100,000 gallon transfer, what is the net effect of the recommended transfer?

Author Wm Blaine Barton Date 10/27/99 Checked by [illegible] Date 10/27/99

K DILUTION C STEWART Oct 99

CRUST VOID DISTRIBUTION

	Height (in)	void	Volume (m3)	Liq. mass (kg)	Sol. Mass (kg)	Tot. Mass (kg)	Insol. Mass (kg)
Freeboard	20		98.5	44436	90605	195444	60403
Bubble slurry	10	0.6	89.7	34198	17042	62601	11361
Paste	80	0.21	717.2	540328	269258	989091	179505
Wet	12	0.08	107.6	94386	47035	172778	31357
Total/Average Submerged	102	0.233	914.5	668913	333334	1224470	222223

TOTAL CRUST LAYER

	Height (in)	*Volume (m3)*	*Liq. Mass (kg)*	*Sol. Mass (kg)*	*Total mass (kg*	*Insol. Mass (kg)*
total	122	1012.9	713349	423939	1419914	282626

WATER TO DISSOLVE CRUST LAYERS

	Height (in)	Solid mass (kg	Water mass (k	water vol. (m3	water vol. (gal)
Bubble slurry	10	17042	13446	13.4	3551
Paste	80	269258	212444	212.4	56110
Wet	12	47035	37111	37.1	9801
total SUBMERGED	102	333334	263001	263	69462
freeboard	20	90605	71487	71.5	18881
TOTAL CRUST	122	423939	334488	334.5	88343

SLURRY LAYER BEFORE TRANSFER

	Height (in)	Volume (m3)	Liq. mass (kg)	Sol. Mass (kg)	Water vol. (gal	Insol. Mass (kg)
below injection point	96	1000.8	1233290	192808	40179	128539
injection point to crust base	213.7	2227.3	2744724	429100	89419	286067
slurry within crust	102	148.9	183452	28680	5977	19120
slurry within bubble slurry layer	10	14.6	17985	2812	586	1875
slurry within paste layer	80	116.8	143884	22494	4688	14996
slurry within wet layer	12	17.5	21583	3374	703	2249
TOTAL PRE-XFER SLURRY		3377.0	4161466	650588	135574	433726

TOTAL TANK BEFORE TRANSFER

Height (in)	Volume (m3)	Liq. mass (kg)	Sol. Mass (kg)	Tot. Mass (kg)	Insol. Mass (kg)
432	4389.9	4874815	1074527	6665693	716351

SLURRY LAYER AFTER TRANSFER

	Height (in)	Volume (m3)	Liq. mass (kg)	Sol. Mass (kg)	Insol. Mass (k	Tot. Solids (kg)
below injection point	96	1000.8	1233290	192808	128539	321347
injection point to crust base	177	1848.7	2278144	356157	237438	593595

SLURRY LAYER AFTER BACK DILUTE

	Height (in)	Volume (m3)	Liq. mass (kg)	Sol. Mass (kg)	Water mass (k	Insol. Mass (kg)
below injection point	96	1000.8	1233290	192808		128539
injection point to crust base	203	2121.3	2278144	356157	272609	237438

WATER FOR DISSOLUTION

	Volume (m3)	Volume (gal)	mass (kg)
water to dissolve solids below inj. Point	152.1	40179	152126
water to dissolve solids injection to bas	281.0	74218	281008
water to dissolve crust solids	334.5	88343	334488
water to dissolve slurry solids in crust	22.6	5977	22629
TOTAL DISSOLUTION	790.2	208716	790250

RESULTS OF DILUTION PLAN - FRACTION DISSOLVED

Top Dilution	Sol. Mass (kg)	water used (ga	water mass (k	Delta thick (in)	Matrix Insol. (	Freed Insol. (kg)
solids dissolved in freeboard	90605	18881	71487	-20	0	60403
solids dissolved in wet layer	50409	10505	39773	-12	0	33606
solids dissolved in paste layer	2950	615	2327	-1	192535	1966
excess water		0	0	0		
total	143963	30000	113587	-33	192535	95976
Bottom Dilution						
solids dissolved in slurry (above)	345512	72000	272609	n/a	7097	230341
solids dissolved in bubble slurry	0	0	0	0	13236	0
solids dissolved in paste layer	0	0	0	0	192535	0
excess water		0	0	0.0		
total	345512	72000	272609	0	212867	230341

RESULTS OF DILUTION PLAN - NEW TANK CONFIGURATION

	New height (in)	Matrix Sol. Mass (kg)	Matrix liq. Mass (kg)	Diss. Sol. Mass (kg)	Freed liq. Mass. (kg)	Water mass (k	Matrix Insol. (	Freed Insol. (kg
Freeboard	0.0	0	0				0	60403
Wet	0.0	0	0				0	33606
Paste	79.2	288802	677295				192535	1966
Bubble slurry	10.0	19853	52183				13236	0
Slurry inject to base	198.8	10645	68089	345512	2210055	272609	7097	230341
Slurry below injection	96.0	192808	1233290	0	0	0	128539	0
Dissolved layers	27.7	0	0	143963	167323	111260	0	0
New slurry inject to base	226.6	10645	68089	489475	2377378	383869	7097	230341
TOTAL	411.7	512109	2030858	489475	2377378	386196	341406	326317
TOTAL TANK MASS (kg)	6463738	6463738		1001584	4408235			667723
(check sum of mass)	6463738	6463738		1001584	4408235			667723

Attachment: Print out of EXCEL Spreadsheet Formula View (3 pages)

	A	B	C	D
1				
2		**CRUST DISSOLUTION AND FLOATATION AFTER TRANSFER AND BACK DILUTION**		
3				
4	**INPUTS**		**TRANSFER AND BACK DILUTION PLAN**	
5	Crust thickness (cm)	310.00	**Transfer volume (gal)**	**100000**
6	Crust freeboard porosity	0.42	Water/solids mass at equilibrium	0.789
7	Crust freeboard saturation	0.6	Fraction of solids insoluble	0.4
8	Crust freeboard void fraction	0.34	Water injection height (in)	9
9	Solids S.G. (undissolved)	2.2	**Dilution at injection point (gal)**	**72547**
10	Solids S.G. (dissolved)	2.2	**Dilution on top (gal)**	**0**
11	Liquid S.G. at saturation	1.49	**WILL IT FLOAT?**	**"=IF(D18<D20,"YES",IF(D18>D19,"NO","PROBABLY NOT"))**
12	Crust submerged solids vol. fraction	0.36	Remaining crust	Height (in)
13	Crust submerged void fraction	0.23	Freeboard	"=F64
14	Bulk slurry void fraction	0.027	Wet	"=F65
15	Bulk slurry solids vol. fraction	0.15	Paste	"=F66
16	Crust area fraction	0.86	Bubble slurry	"=F67
17	Vessel radius (cm)	1143	total	"=SUM(D13:D16)
18	Degassed waste level (cm)	996.5	**Minimum slurry SG to float**	**"=IF(SUM(F64:F67)>0,(K6*F64/F6 + K9*F65/F9 + K8*F66/F8 + K7*F67/F7 + M64 + M65 + M66)/(H6*F64/F6 + H9*F65/F9 + H8*F66/F8 + H7*F67/F7 + (M64 + M65 + M66)*0.001/B9)*0.001,"NO CRUST")**
19	**COMPUTED CONSTANTS**		**Slurry SG before flowdown - mixed**	**"=(G68 + H68 + I68 + J68 + K68 + L68 + M68)/(F68*0.0254*B27)*0.001**
20	Crust submerged degassed S.G.	"=((1-$B$12)*$B$11 + $B$12*$B$9)	**Slurry SG before flowdown - strat**	**"=D19*1.52/1.56**
21	Crust submerged bulk S.G.	"=$B$20*(1-$B$13)	**Flowdown SG**	**"=IF(D10"=0,"NONE",(I70 + J70 + K70 + M70)/(F70*0.0254*B27)*0.001)**
22	Bulk slurry S.G.	"=(1-$B14)*((1-$B15)*$B11 + $B15*$B9)	**Slurry SG after flowdown - mixed**	**"=(G68 + H68 + I68 + J68 + L68 + M68 + K68 + D25)/(F68*0.0254*B27 + D24)*0.00**
23	Bulk slurry degassed S.G.	"=(1-$B15)*$B11 + $B15*$B9	**Slurry SG after flowdown - strat**	**"=D22*1.52/1.56**
24	Crust freeboard non-void S.G.	"=($B6*$B7*$B11 + (1-$B6)*$B9)*(1-$B$8)/(1-B26)	Flowdown Volume (m3)	"=(M70/B9 + I70/B10 + J70/B11 + K70)*0.001
25	Tank area (gal/cm)	"=PI()*($B$17*0.01)^2*0.01*35.314*7.5	Flowdown Mass (kg)	"=I70 + J70 + K70 + M70
26	Super-porosity (rdnew-rdold)/rw	"=(1-$B$8)*$B$6*(1-$B$7) + $B$8	Flowdown SG	"=IF(D24>0,D25/D24*0.001,0)
27	Tank area (m2)	"=PI()*(37.5*0.3048)^2	**WILL IT PUMP?**	**"=IF(D30>D31,"YES",IF(D30<D31,"NO","PROBABLY NOT"))**
28	**INPUT VARIABLES**	**BASE**	New waste level (in)	"=F72
29	Diluent Added (gal)		New crust thickness (in)	"=D17
30	**COMPUTED VARIABLES**		**New crust base elevation (in)**	**"=D28-D29**
31	Crust freeboard bulk S.G.	"=(1-$B6)*($B6*$B7*$B11 + (1-$B5)*$B9)	**Mixer pump main inlet elevation (in)**	**236**
32	Average crust bulk S.G.	"=($B21*B38 + B31*B39)/$B5	**Mixer pump slot inlet elevation (in)**	**262**
33	Avg crust non-porous bulk S.G.	"=($B21*B38 + $B24*B39*(1-$B26))/(B38 + B39*(1-$B26))	80% of back dilution	"=0.8*D9
34	Liquid Level below ref. (cm)	"=($B5-B38)*$B16*(1-$B26)	SG difference	"=D20-D18
35	Waste level above ref. (cm)	"=$B5-B38-B34	Base-Pump difference	"=D30-D32
36	Reference level (cm)	"=B41 + $B13*B38*$B15 + $B14/((1-$B14)*(B41-B38*(1-$B13)*$B16-B39*(1-$B26)*$B16)	Headspace (ft3)	"=188490-358*D28
37	**ARCHIMEDES' MODEL**		Hydrogen fraction	0.4
38	Submergence in salt (cm)	"=$B5*B31/(B31 + $B22-$B21)	fraction LFL due to bubble slurry release	"=D16/F7*G7*H7*35.314*D37/D35/0.04
39	Freeboard above salt (cm)	"=$B5-B38		
40	**ARCHIMEDES' LEVELS**			
41	Degassed Level (cm)	"=$B18		
42	Surface level (cm)	"=B36 + B35		
43	Sat. Liquid level (cm)	"=B36-B34		
44	**WASTE LEVELS**			
45	Top of crust (in)	**"=B42/2.54**		
46	Sat. Liquid Level (in)	"=B43/2.54		
47	Crust base (in)	**"=B45-$B5/2.54**		

Attachment: Printout of EXCEL Spreadsheet Formula View (cont.)

	E	F	G	H	I	J	K	L	M
1									
2		C STEWART	Oct-99						
3									
4	CRUST VOID DISTRIBUTION								
5		Height (in)	void	Volume (m3)	Liq. mass (kg)	Sol. Mass (kg)	Tot. Mass (kg)	Insol. Mass (kg)	
6	Freeboard	20		"=F6*0.0254*B27*(1-B8)*B16*(B6*B7 + (1-B6))	"=F6*0.0254*B27*(1-B8)*B6*B7*B16*B11*1000	"=(1-D7)*F6*0.0254*B27*(1-B8)*(1-B6)*B16*B9*1000	"=I6 + J6 + L6	"=J6*D$7/(1-D$7)	
7	Bubble slurry	10	0.6	"=B$27*F7*0.0254*B$16	"=(1-G7)*(1-B$12)*B$11*1000*H7	"=(1-D7)*(1-G7)*B$12*B$9*1000*H7	"=I7 + J7 + L7	"=J7*D$7/(1-D$7)	
8	Paste	80	0.21	"=B$27*F8*0.0254*B$16	"=(1-G8)*(1-B$12)*B$11*1000*H8	"=(1-D7)*(1-G8)*B$12*B$9*1000*H8	"=I8 + J8 + L8	"=J8*D$7/(1-D$7)	
9	Wet	12	0.08	"=B$27*F9*0.0254*B$16	"=(1-G9)*(1-B$12)*B$11*1000*H9	"=(1-D7)*(1-G9)*B$12*B$9*1000*H9	"=I9 + J9 + L9	"=J9*D$7/(1-D$7)	
10	Total/Average Submerged	"=F7 + F8 + F9	"=(F7*G7 + F8*G8 + F9*G9)/F10	"=H7 + H8 + H9	"=I7 + I8 + I9	"=J7 + J8 + J9	"=K7 + K8 + K9	"=L7 + L8 + L9	
11	TOTAL CRUST LAYER								
12		Height (in)	Volume (m3)	Liq. Mass (kg)	Sol. Mass (kg)	Total mass (kg)	Insol. Mass (kg)		
13	total	"=F6 + F7 + F8 + F9	"=H10 + H6	"=I10 + I6	"=J10 + J6	"=H13 + I13 + K13	"=L10 + L6		
14									
15	WATER TO DISSOLVE CRUST LAYERS								
16		Height (in)	Solid mass (kg)	Water mass (kg)	water vol. (m3)	water vol. (gal)			
17	Bubble slurry	"=F7	"=J7	"=J7*$D$6	"=H17/1000	"=CONVERT(H17,"l","gal")			
18	Paste	"=F8	"=J8	"=J8*$D$6	"=H18/1000	"=CONVERT(H18,"l","gal")			
19	Wet	"=F9	"=J9	"=J9*$D$6	"=H19/1000	"=CONVERT(H19,"l","gal")			
20	total SUBMERGED	"=F17 + F18 + F19	"=G17 + G18 + G19	"=H17 + H18 + H19	"=I17 + I18 + I19	"=J17 + J18 + J19			
21	freeboard	"=F6	"=J6	"=J6*D$6	"=H21/1000	"=CONVERT(H21,"l","gal")			
22	TOTAL CRUST	"=F20 + F21	"=G20 + G21	"=H21 + H20	"=I20 + I21	"=J20 + J21			
23	SLURRY LAYER BEFORE TRANSFER								
24		Height (in)	Volume (m3)	Liq. mass (kg)	Sol. Mass (kg)	Water vol. (gal)	Insol. Mass (kg)		
25	below injection point	"=D8	"=F25*0.0254*B27	"=G25*(1-B$14)*(1-B$15)*B$11*1000	"=(1-D$7)*G25*(1-B$14)*B$15*B$9*1000	"=CONVERT(I25*D$6,"l","gal")	"=I25*D$7/(1-D$7)		
26	injection point to crust base	"=B47-F25	"=F26*0.0254*B27	"=G26*(1-B$14)*(1-B$15)*B$11*1000	"=(1-D$7)*G26*(1-B$14)*B$15*B$9*1000	"=CONVERT(I26*D$6,"l","gal")	"=I26*D$7/(1-D$7)		
27	slurry within crust	"=F10	"=F27*0.0254*B27*(1-B16)	"=G27*(1-B$14)*(1-B$15)*B$11*1000	"=(1-D$7)*G27*(1-B$14)*B$15*B$9*1000	"=CONVERT(I27*D$6,"l","gal")	"=I27*D$7/(1-D$7)		
28	slurry within bubble slurry l	"=F17	"=F28/F$27*G$27	"=F28/F$27*H$27	"=F28/F$27*I$27	"=CONVERT(I28*D$6,"l","gal")	"=I28*D$7/(1-D$7)		
29	slurry within paste layer	"=F18	"=F29/F$27*G$27	"=F29/F$27*H$27	"=F29/F$27*I$27	"=CONVERT(I29*D$6,"l","gal")	"=I29*D$7/(1-D$7)		
30	slurry within wet layer	"=F19	"=F30/F$27*G$27	"=F30/F$27*H$27	"=F30/F$27*I$27	"=CONVERT(I30*D$6,"l","gal")	"=I30*D$7/(1-D$7)		
31	TOTAL PRE-XFER SLURRY		"=G25 + G26 + G27	"=H25 + H26 + H27	"=I25 + I26 + I27	"=CONVERT(I31*D$6,"l","gal")	"=K25 + K26 + K27		
32	TOTAL TANK BEFORE TRANSF	Height (in)	Volume (m3)	Liq. mass (kg)	Sol. Mass (kg)	Tot. Mass (kg)	Insol. Mass (kg)		
33		"=F26 + F25 + F27 + F21	"=G31 + G13	"=H31 + H13	"=I31 + I13	"=J13 + H31 + I31 + K31	"=K31 + K13		
34	SLURRY LAYER AFTER TRANSFER								
35		Height (in)	Volume (m3)	Liq. mass (kg)	Sol. Mass (kg)	Insol. Mass (kg)	Tot. Solids (kg)		
36	below injection point	"=F25	"=G25	"=G36*(1-B$14)*(1-B$15)*B$11*1000	"=(1-$D$7)*G36*(1-B$14)*B$15*B$9*1000	"=I36*$D$7/(1-$D$7)	"=I36 + J36		
37	injection point to crust base	"=G37/B$27/0.0254	"=G26-CONVERT(D5*0.001,"gal","l")	"=G37*(1-B$14)*(1-B$15)*B$11*1000	"=(1-$D$7)*G37*(1-B$14)*B$15*B$9*1000	"=I37*$D$7/(1-$D$7)	"=I37 + J37		
38	SLURRY LAYER AFTER BACK DILUTE								
39		Height (in)	Volume (m3)	Liq. mass (kg)	Sol. Mass (kg)	Water mass (kg)	Insol. Mass (kg)		
40	below injection point	"=F36	"=G36	"=H36	"=I36		"=J36		
41	injection point to crust base	"=G41/B$27/0.0254	"=G37 + CONVERT(D9*0.001,"gal","l")	"=H37	"=I37	"=CONVERT(D9,"gal","l")	"=J37		
42	WATER FOR DISSOLUTION								
43		Volume (m3)	Volume (gal)	mass (kg)					
44	water to dissolve solids belo	"=H44/1000	"=CONVERT(I36*D$6,"l","gal")	"=I36*D6					
45	water to dissolve solids inject	"=H45/1000	"=CONVERT(I37*D$6,"l","gal")	"=I37*D6					
46	water to dissolve crust solids	"=H46/1000	"=J22	"=I13*D$6					
47	water to dissolve slurry solids	"=H47/1000	"=J27	"=I27*D6					

Attachment: Printout of EXCEL Spreadsheet Formula View (Cont.)

	E	F	G	H	I	J	K	L	M
48	TOTAL DISSOLUTION	"=F44 + F45 + F46 + F47	"=G44 + G45 + G46 + G47	"=H44 + H45 + H46 + H47					
49	RESULTS OF DILUTION PLAN - FRACTION DISSOLVED								
50	Top Dilution	Sol. Mass (kg)	water used (gal)	water mass (kg)	Delta thick (in)	Matrix Insol. (kg)	Freed Insol. (kg)		
51	solids dissolved in freeboard	"=CONVERT(MIN($D$10,J21),"gal","l")/$D$6	"=MIN(D10,J21)	"=F51*D$6	"=-F6*F51/G21	"=L6-K51	"=L6*F51/G21		
52	solids dissolved in wet layer	"=CONVERT(MIN($D$10-G51,J19 + J30),"gal","l")/$D$6	"=MIN(D10-G51,J19 + J30)	"=F52*D$6	"=-F52/(G19 + I30)*F19	"=L9 + K30-K52	"=(L9 + K30)*F52/(I30 + G19)		
53	solids dissolved in paste layer	"=CONVERT(MIN($D$10-G51-G52,J18 + J29),"gal","l")/$D$6	"=MIN(D10-G51-G52,J18 + J29)	"=F53*D$6	"=-F53/(G18 + I29)*F18	"=L8 + K29-K53	"=(L8 + K29)*F53/(I29 + G18)		
54	excess water		"=D10-G51-G52-G53	"=CONVERT(G54,"gal","l")	"=H54/1000/B$27/0.0254				
55	total	"=F51 + F52 + F53	"=G51 + G52 + G53	"=F55*D$6	"=I51 + I52 + I53	"=J51 + J52 + J53	"=K51 + K52 + K53		
56	Bottom Dilution								
57	solids dissolved in slurry (abo	"=CONVERT(MIN($D$9,G45),"gal","l")/$D$6	"=MIN(D9,G45)	"=F57*D$6	n/a	"=J37-K57	"=J37*F57/I37		
58	solids dissolved in bubble slur	"=CONVERT(MIN($D$9-G57,J17 + J28),"gal","l")/$D$6	"=MIN(D9-G57,J17 + J28)	"=F58*D$6	"=-F58/(G17 + I28)*F17	"=L7 + K28-K58	"=(L7 + K28)*F58/(G17 + I28)		
59	solids dissolved in paste layer	"=CONVERT(MIN($D$9-G57-G58,J18 + J29-G53),"gal","l")/$D$6	"=MIN(D9-G57-G58,J18 + J29-G53)	"=F59*D$6	"=IF(G18 + I29-F53>0,-F59/(G18 + I29-F53)*(F18 + I53),0)	"=L8 + K29-K53-K59	"=IF(I29 + G18-F53>0,(L8 + K29-K53)*F59/(I29 + G18-F53),0)		
60	excess water		"=D9-G57-G58-G59	"=CONVERT(G60,"gal","l")	"=H60/1000/B$27/0.0254				
61	total	"=F57 + F58 + F59	"=G57 + G58 + G59 + G60	"=H57 + H58 + H59 + H60	"=I58 + I59 + I60	"=J57 + J58 + J59	"=K57 + K58 + K59		
62	RESULTS OF DILUTION PLAN - NEW TANK CONFIGURATION								
63		New height (in)	Matrix Sol. Mass (kg)	Matrix liq. Mass (kg)	Diss. Sol. Mass (kg)	Freed liq. Mass. (kg)	Water mass (kg)	Matrix Insol. (kg)	Freed Insol. (kg)
64	Freeboard	"=F21 + I51	"=G21-F51	"=I6*G64/G21				"=L6-M64	"=L6*F51/G21
65	Wet	"=F19 + I52	"=G19 + I30-F52	"=(I9 + H30)*G65/(I30 + G19)				"=L9 + K30-M65	"=(L9 + K30)*F52/(I30 + G19)
66	Paste	"=F18 + I53 + I59	"=G18 + I29-F53-F59	"=(I8 + H29)*G66/(I29 + G18)				"=(L8 + K29)*G66/(I29 + G18)	"=(L8 + K29)*F53/(I29 + G18)
67	Bubble slurry	"=F17 + I58	"=G17 + I28-F58	"=(I7 + H28)*G67/(G17 + I28)				"=(L7 + K28)*G67/(G17 + I28)	0
68	Slurry inject to base	"=F37*(1-F57/I37) + (M68/B9 + I68/B10 + J68/B11 + K68)/B27/0.0254*0.001	"=I37-F57	"=H37*G68/I37	"=F57	"=H37-H68	"=H57 + H60	"=J37-M68	"=J37*F57/I37
69	Slurry below injection	"=F25	"=I40	"=H40-J69	0	0	0	"=J36	0
70	Dissolved layers	"=(M70/B9 + I70/B10 + J70/B11 + K70)*0.001/B27/0.0254	0		"=F51 + F52 + F53 + F59 + F58 0	"=I6-H64 + I9 + H30-H65 + I8 + H29-H66 + I7 + H28-H67	"=H51 + H52 + H59 + H58 + H54	0	"=IF(I29 + G18-F53>0,(L8 + K29-K53)*F59/(I29 + G18-F53),0) + (L7 + K28)*F58/(G17 + I28)
71	New slurry inject to base	"=F68 + F70	"=G68	"=H68	"=I70 + F57	"=J70 + H37-H68	"=K70 + K68	"=L68 + L70	"=M68 + M70
72	TOTAL	"=SUM(F64:F70)	"=SUM(G64:G69)	"=SUM(H64:H69)	"=F55 + F61	"=J68 + J69 + J70	"=CONVERT(D9 + D10,"gal","l")	"=L64 + L65 + L66 + L67 + L68 + L69 + L70	"=M64 + M65 + M66 + M67 + M68 + M69 + M70
73	TOTAL TANK MASS (kg)	"=G72 + H72 + I72 + J72 + H55 + H61 + L72 + M72	"=I73 + J73 + M73 + K72		"=G72 + I72	"=H72 + J72			"=L72 + M72
74	(check sum of mass)	"=J13 + H27 + I27 + K27 + H36 + I36 + J36 + H37 + I37 - J37 + H55	"=I74 + J74 + M74 + K72		"=I13 + I27 + I36 + I37	"=H13 + H27 + H36 + H37			"=K40 + K41 + K27 + K13

DISTRIBUTION SHEET

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Distribution	Process Control	Date 10/27/99
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RPP-5344, Rev. 0, "Maximum First Transfer and Dilution Volumes for 241-SY-101"		ECN No. N/A

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