

# AY-102 Tank 1/22<sup>nd</sup> Scaled Mixing & Transfer Demonstrations

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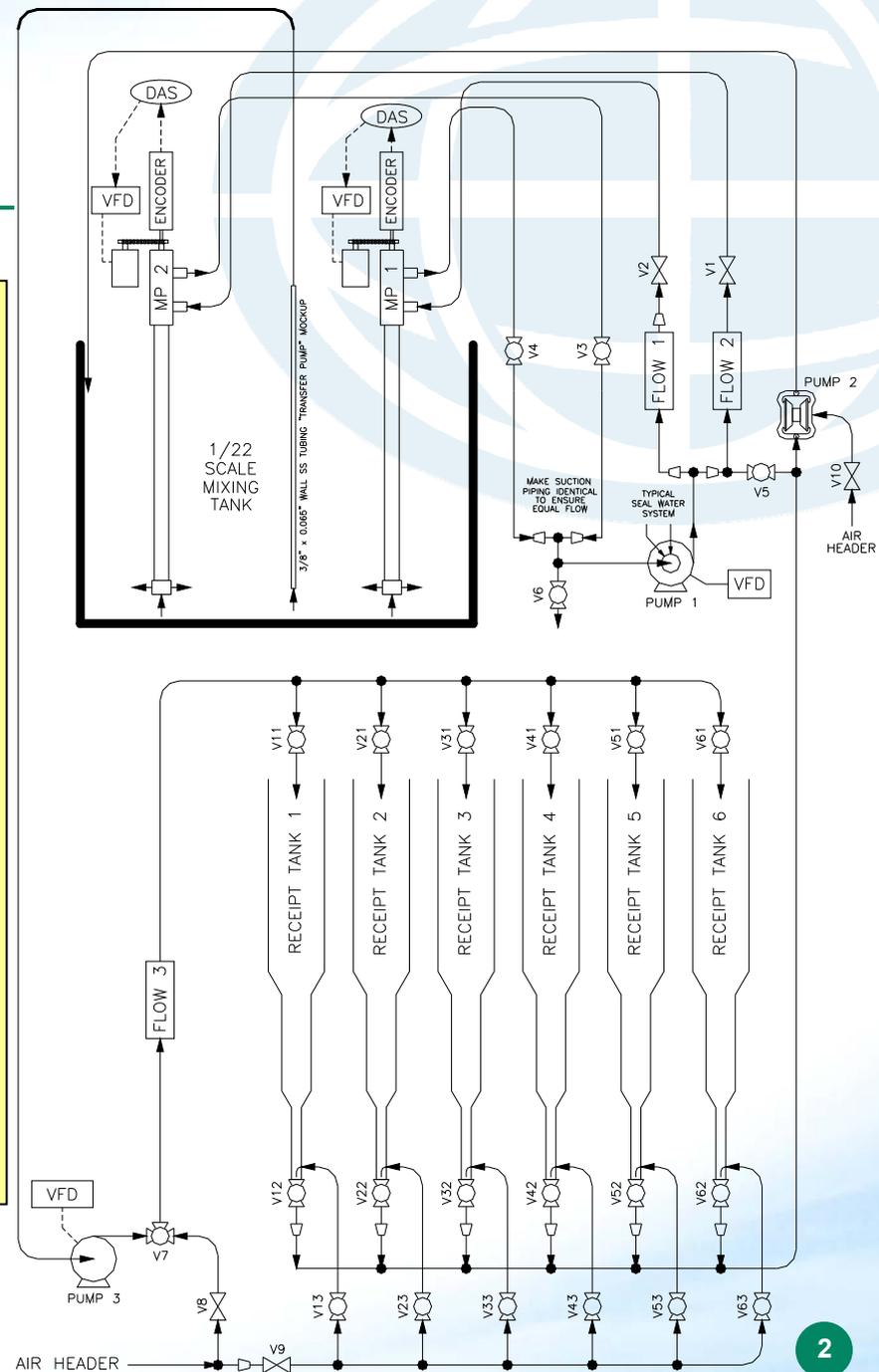
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# Schematic of Transfer Demonstration System

- 1/22<sup>nd</sup> Scale Transparent MDT
- Geometrically scaled obstructions
  - Designed for easy removal
- Gallagher® pump supplied MJP
- Moyno® transfer pump
  - Transfer @ 0.58 gpm
  - Transfer suction velocity: 3.95 ft/s
- Magnetic flow meters
- Six Receipt Tanks
  - 14.3 gal Batch
  - Transparent - solids determination
  - Spargers for RT mixing
- Two MJP 1/22<sup>nd</sup> scale

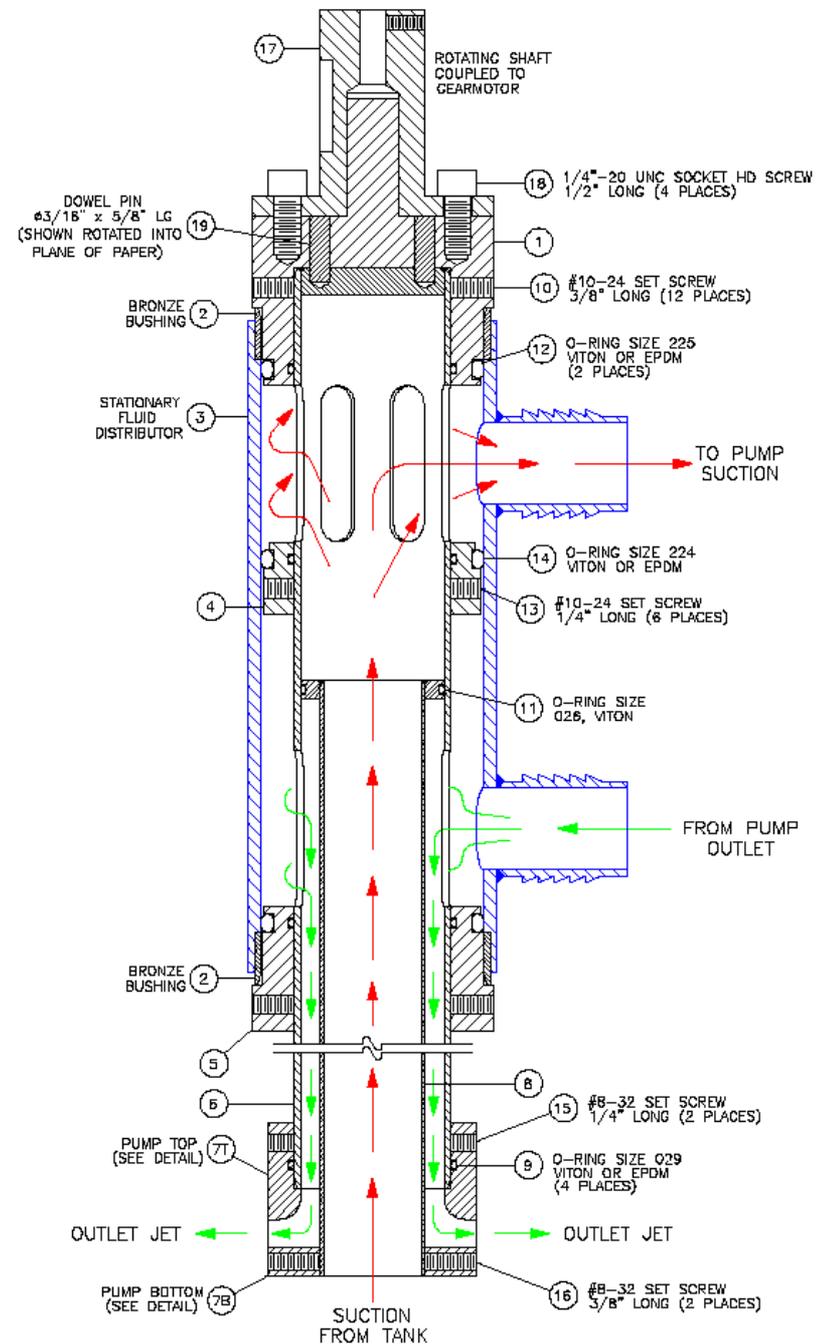


# 1/22<sup>nd</sup> Mixer Jet Pump

- Pumping drive force is external
- **Two 1/4" nozzles, 180 deg out**
- **MJP rotation, chain and sprocket**
- **Each MJP rotation independent**
- Tested at 0.5 rpm and 1.6 rpm rotation
- **Encoders/VFD and DAS control Synchronous phase angle**
  - 360° continuous rotation
  - Oscillating 190° sweep
  - MJP rotating in opposite direction
- **MJP flow rate**
  - 8 gpm** → 22.4 ft/s,  $U_o D = 0.504 \text{ ft}^2/\text{s}$
  - 7 gpm** → 19.5 ft/s,  $U_o D = 0.44 \text{ ft}^2/\text{s}$

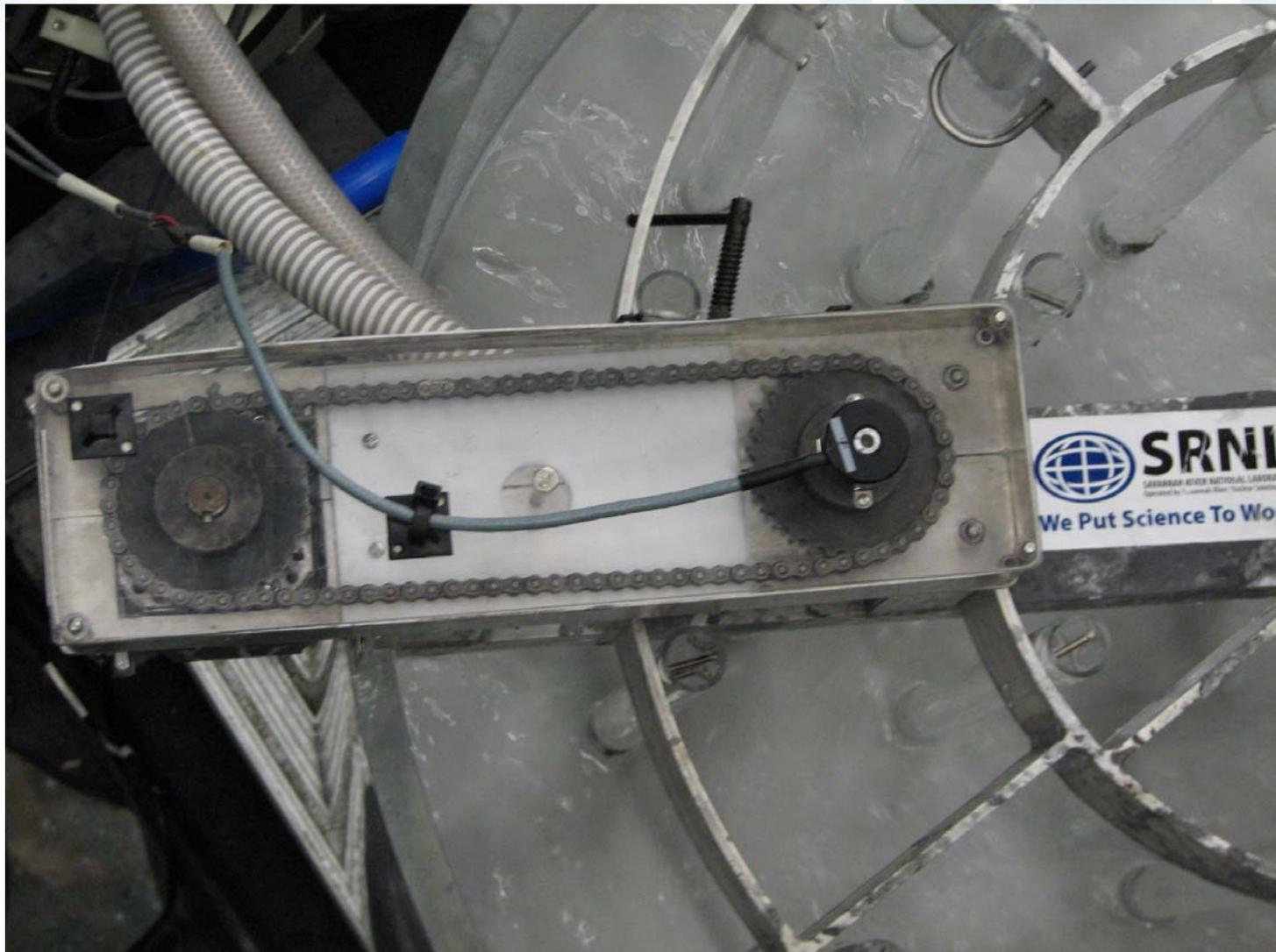


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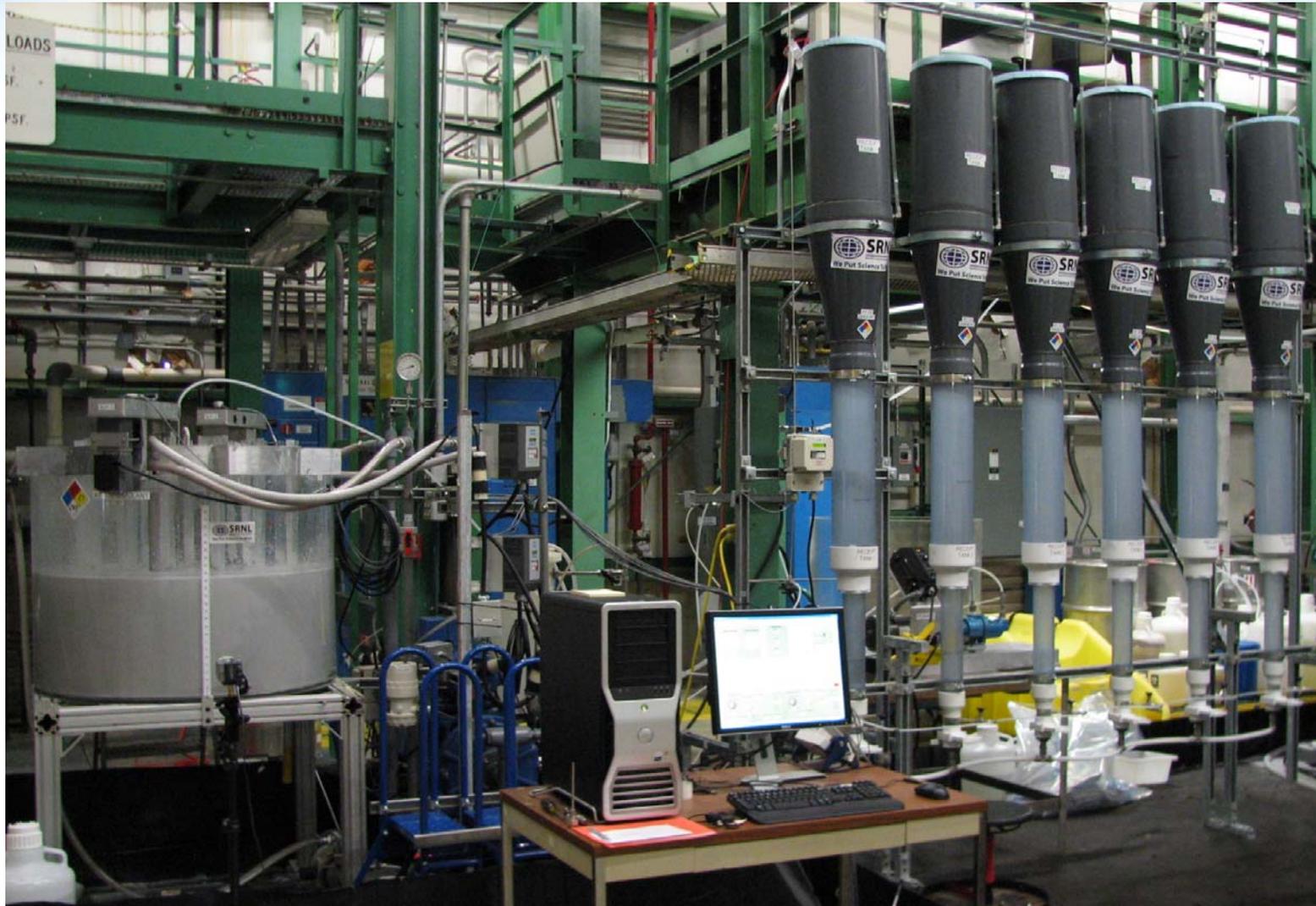


SCALED ROTATING MIXING PUMP  
REVISED 05-17-2010

# Drive Assembly for MJP Rotation



# Mixing & Transfer Demonstration System



# 1/22<sup>nd</sup> scale MDT, Settled Solids (Gibbsite/SiC)



## Phase II Testing

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### Testing with different particles and sizes

- 100  $\mu\text{m}$  SiC & 30  $\mu\text{m}$  Gibbsite (Phase I simulant)
- 20  $\mu\text{m}$  SiC & 30  $\mu\text{m}$  Gibbsite
- 135  $\mu\text{m}$  SS & 30  $\mu\text{m}$  Gibbsite

### Density of particles

- Gibbsite: 2,429  $\text{kg}/\text{m}^3$
- SiC: 3,217  $\text{kg}/\text{m}^3$
- SS: 8,000  $\text{kg}/\text{m}^3$

### Supernate: 87 gal batch

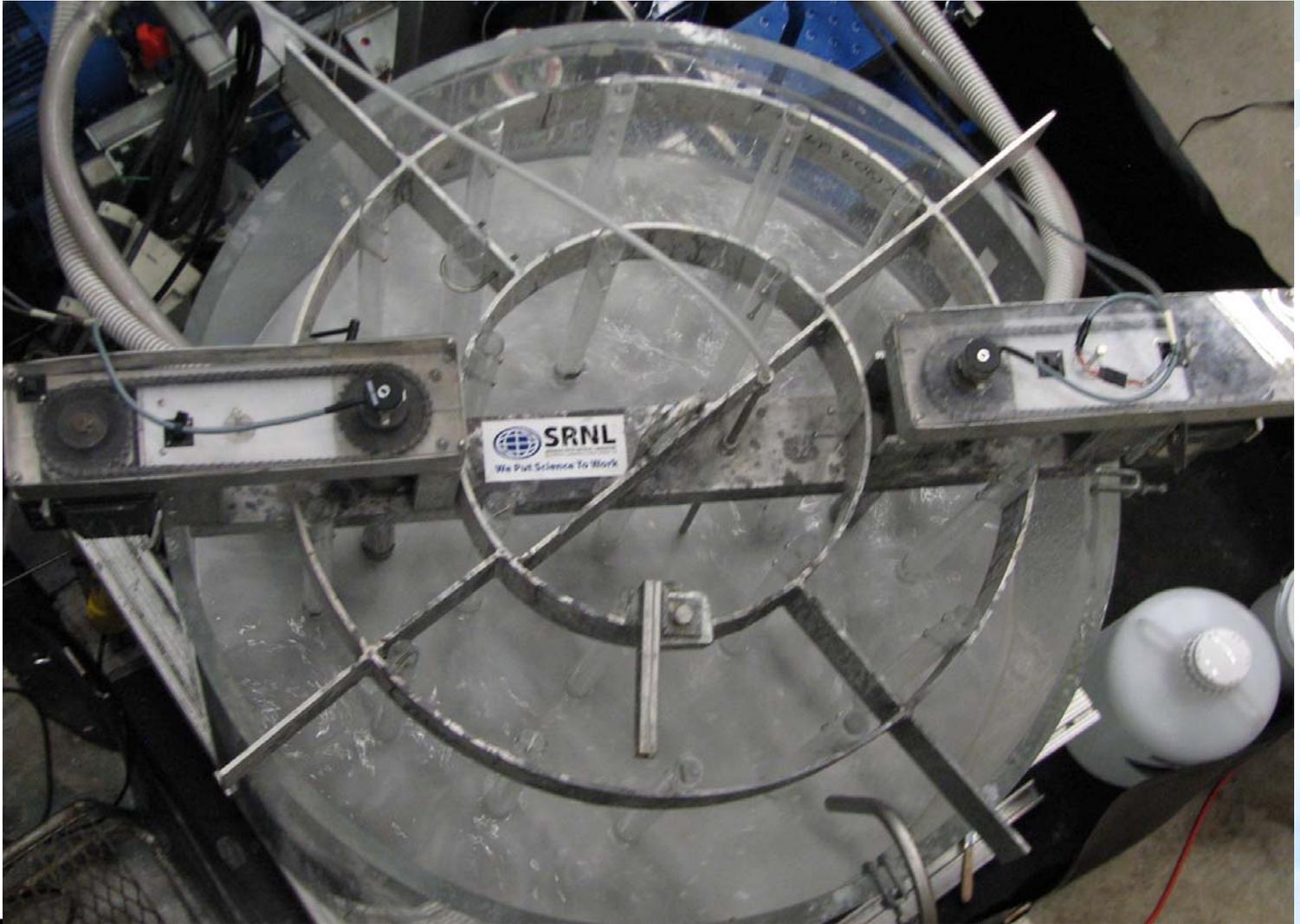
- Density: 1,289  $\text{kg}/\text{m}^3$
- Viscosity: 2.55 cP

**Weight % of solids: 14 wt%**

# Test Matrix for Transfer Demonstrations, Phase II

Test #	Particle Size (microns)	MJP Synchroni- zation	MJP Cycle	MJP Angle (degrees)	MJP Speed (rpm)
1	100 SiC	opposite	osc - 190	90/270	0.5
2	100 SiC	same	osc - 190	0/180	0.5
3	100 SiC	same	osc - 190	90/270	1.6
4	100 SiC	opposite	con - 360	90/270	1.6
5	100 SiC	opposite	con - 360	0/180	0.5
6	100 SiC	opposite	osc - 190	0/180	1.6
7	100 SiC	same	con - 360	0/180	1.6
8	100 SiC	same	con - 360	90/270	0.5
9	20 SiC	opposite	con - 360	0/180	1.6
10	20 SiC	same	con - 360	90/270	1.6
9 *	135 SS	opposite	con - 360	0/180	1.6
10 *	135 SS	same	con - 360	90/270	1.6
11	135 SS	opposite	osc - 190	0/180	0.5
12	135 SS	opposite	osc - 190	90/270	1.6
13	135 SS	same	osc - 190	0/180	1.6
14	135 SS	opposite	con - 360	90/270	0.5
15	135 SS	same	osc - 190	90/270	0.5
16	135 SS	same	con - 360	0/180	0.5

# Mixing Top View, Test 14 SS



# MJP Flow Pattern, Underside of Mixing Tank



## Video, MJP Jet Mixing on Tank Bottom



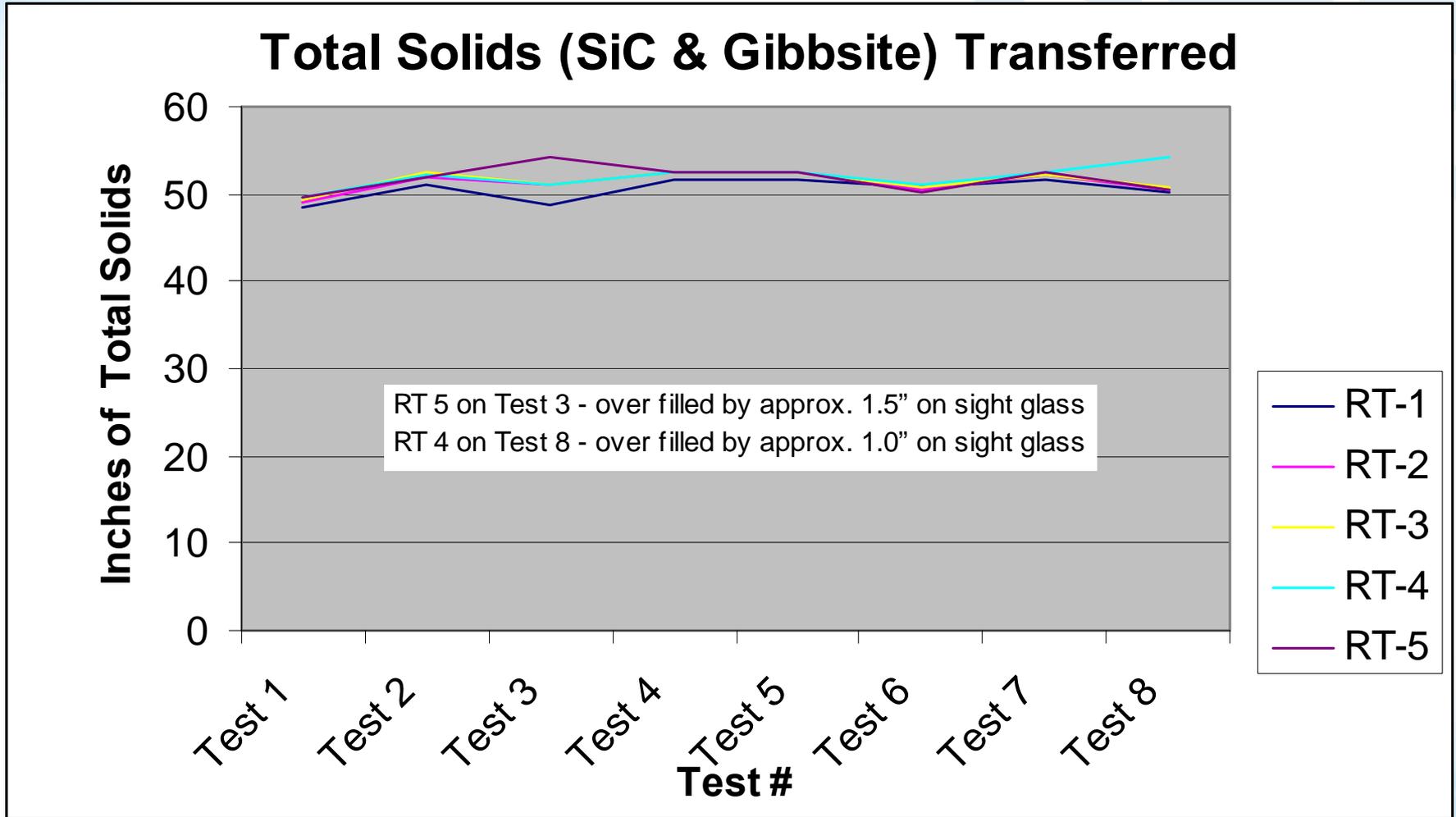
# Comparing 1-Day Solids Settling in Receipt Tanks

	Receipt Tank 1, inches	Receipt Tank 2, inches	Receipt Tank 3, inches	Receipt Tank 4, inches	Receipt Tank 5, inches	Receipt Tank 6, inches
Test 1	48 9/16	49 1/8	49 3/8	49 5/8	49 5/8	39 7/8
Test 2	51 1/8	52	52 3/8	52 1/4	52	30 5/8
Test 3	48 7/8	51 3/16	51	51 1/8	54.375 **	32 3/8
Test 4	51 9/16	52 1/2	52 9/16	52 1/2	52 9/16	30 5/8
Test 5	51 3/4	52 3/8	52 7/16	52 1/2	52 3/8	35 9/16
Test 6	50 3/4	50 1/2	50 7/8	51 1/16	50 1/4	45
Test 7	51 3/4	52 1/8	52 1/4	52 1/2	52 3/8	46
Test 8	50 5/16	50 5/8	50 11/16	54.375 **	50 7/16	48 11/16
Test 9	40.5 ***	38 3/4	38 3/4	38 7/8	38 27/40	36 3/8
Test 10	36 27/40	37 1/4	37 3/8	37 9/16	37 5/16	37 3/8
Test 10 Repeat	40 15/16	41 1/4	41 3/8	41 3/8	41 1/4	41 1/4
Test 9	38 3/4	39 3/16	39 7/16	39 11/16	39 13/16	38 1/16
Test 10	42 1/2	43 1/2	44 3/16	43 7/8	43 3/4	42 1/4
Test 11 ++	32 7/8	33 1/16	33 3/16	33 5/16	33 1/8	32 1/4
Test 12	52 11/16	53 11/16	54 1/8	54 1/8	53 5/8	47 3/4
Test 13 ---	41 11/16	42 3/4	43 3/16	43 5/16	43 3/16	39 1/16
Test 14 ---	43 7/8	44 3/4	45 1/8	45 1/4	45 1/8	40 1/4
Test 15 ---	50 1/4	50 3/4	51 3/8	50 7/8	50 1/2	40 1/8
Test 16 ---	49 3/8	50	50	49 15/16	50 1/16	47

# Test 9 With Stainless Steel Particles (1 day settling)



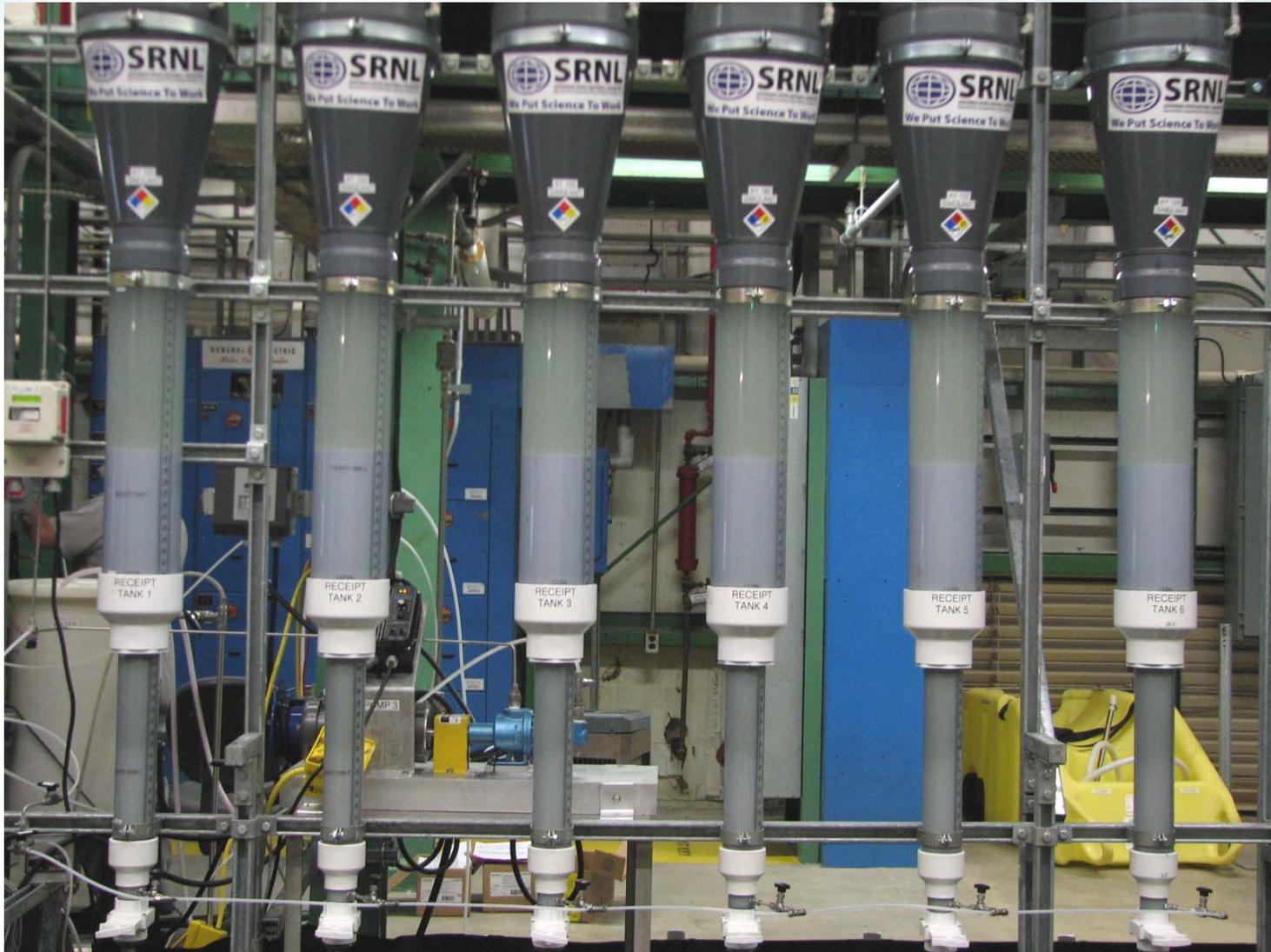
# Total Settled Solids (SiC and Gibbsite) Transferred



# Test 10 Settled Solids SiC 20 $\mu\text{m}$ (2 day of Settling)



# Test 10 Settled Solids SiC 20 $\mu\text{m}$ (1 day of settling)



# Comparing Dense Solids Settling in RTs (@ 20 min)

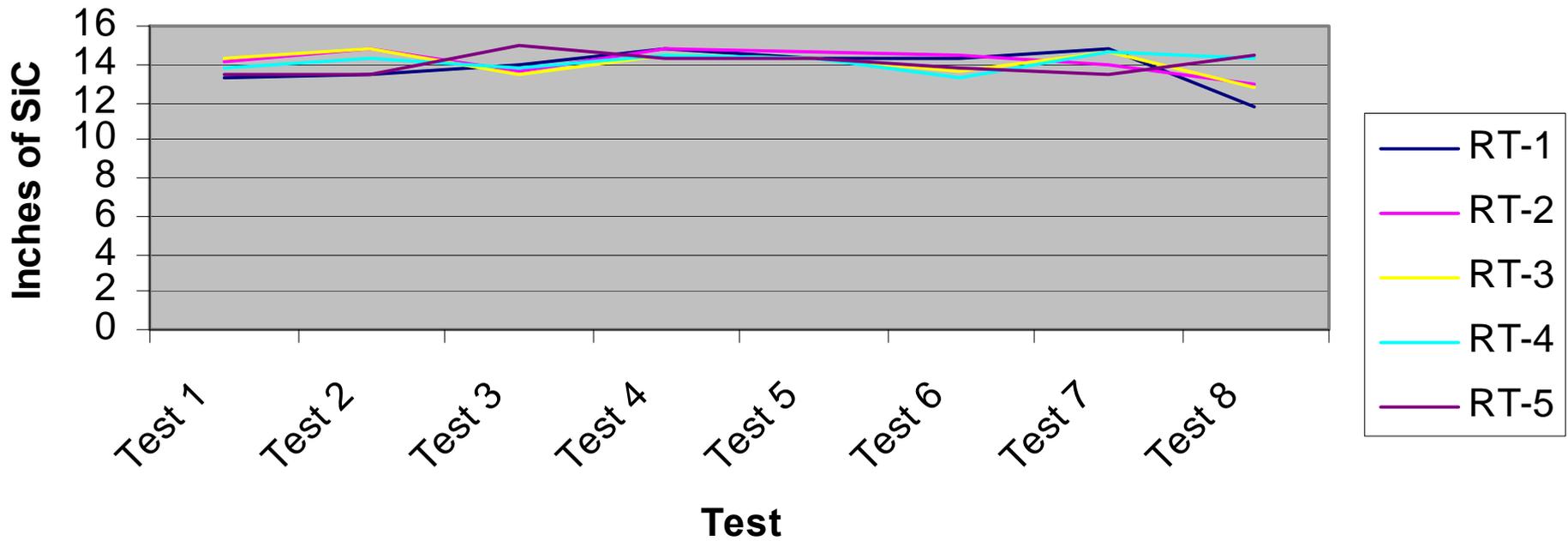
	Receipt Tank 1, inches	Receipt Tank 2, inches	Receipt Tank 3, inches	Receipt Tank 4, inches	Receipt Tank 5, inches	Receipt Tank 6, inches
Test 1, SiC	13 5/16	14 1/16	14 3/8	13 3/4	13 1/2	9 1/2
Test 2, SiC	13 1/2	14 7/8	14 3/4	14 1/4	13 1/2	4 1/2 ++
Test 3, SiC	14	13 9/16	13 1/2	13 3/4	15	4 ++
Test 4, SiC	14 7/8	14 7/8	14 1/2	14 1/2	14 1/4	4 1/2 ++
Test 5, SiC	14 3/8	14 5/8	14 3/8	14 3/8	14 1/4	6 ++
Test 6, SiC	14 1/4	14 1/2	13 9/16	13 1/4	13 3/4	-
Test 7, SiC	14 7/8	14	14 5/8	14 5/8	13 3/8	8 3/4
Test 8, SiC	11 3/4	12 7/8	12 3/4	14 3/8	14 7/16	12 3/8
## Test 9						
## Test 10						
## Test 10 repeat						
Test 9, ss	10 7/8	11 3/4	11 7/8	12 1/8	12 1/2	11 1/2
Test 10, ss	8 3/8	8 11/16	8 3/4	9 1/16	10	10 5/8
Test 11, ss	9 5/16	9 5/8	9 9/16	9 13/16	9 13/16	9 13/16
Test 12, ss	8 1/2	8 1/8	8	8 1/2	8 15/16	9 3/4
Test 13, ss	8 1/4	8 15/16	9 1/8	9 1/4	9	9 1/4
Test 14, ss	8 1/4	8 1/2	8 5/8	9 1/16	9 1/2	9 1/4
Test 15, ss	7 1/2	7 1/4	7 1/2	8	8 15/16	9 1/8
Test 16, ss	8 1/8	8 3/4	9 1/16	9 1/4	9 1/4	8 3/4

# Dense SS Particles Settled to Bottom of RTs, Test 9



# SiC 100 $\mu\text{m}$ Particles Settled to Bottom of Receipt Tanks

## SiC Settled in RT After 20 min



## Conclusions From Phase II Demonstrations

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- **16 Tests conducted, the solids transferred to each Receipt Tank were consistent for the first five batches**
- **Low liquid level in the MDT - poor mixing for the 6<sup>th</sup> batch**
- **Large particles fell out immediately after MJJ jet passed**
- **Large dense particles transferred from MDT to RTs well**
  - contents were never homogenously mixed
- **Flow rate to MJJ, biggest impact on solids transfer**
- **Simulants mixed better at slow MJJ rotation**
- **Changing a test parameter may have had a small impact on total solids transferred from the MDT on a given test, but the data indicates that there is essentially no impact on the solids transferred batch to batch for a given test**