Sta. 4

(21) MAY 21 2003

ENGINEERING DATA TRANSMITTAL

1. EDT 627610

2. To: (Receiving Organization)	3. From: (Originating Organization)	4. Related EDT No.:
C-106 Retrieval Project	ARES Corporation	N/A
5. Proj./Prog./Dept./Div.: C-106 Retrieval Project	6. Design Authority/Design Agent/Cog. Engr.: G. Janicek	7. Purchase Order No.: N/A

8. Originator Remarks:
Acid Dissolution Hydrodynamic Force Analysis transmitted for approval / release

9. Equip./Component No.: N/A

10. System/Bldg./Facility: 241-C-106

11. Receiver Remarks:

11A. Design Baseline Document? ☒ Yes ☐ No

12. Major Assm. Dwg. No.: N/A

13. Permit/Permit Application No.: N/A

14. Required Response Date: N/A

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	RPP-16251	N/A	0	ACID DISSOLUTION HYDRODYNAMIC FORCE ANALYSIS	N/A	1		

16. KEY

Approval Designator (F)	Reason for Transmittal (G)	Disposition (H) & (I)
E, S, Q, D OR N/A (See WHC-CM-3-5, Sec. 12.7)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION
(See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN
1	1	Design Authority G. Janicek	[signature]	5/16/03	S7-12	1	1	J. Bellomy	[signature]	5/20/03	~~R3-83~~ S7-12
1	1	Design Agent M. White	[signature]	5/15/03	ARES	1		~~TC Mackey~~			~~R3-83~~
1	1	Cog. Eng. C. Creze	[signature]	5/19/03	S7-65	1	2	PH Dorsh	[signature]	5/20/03	R3-83
1	1	Cog. Mgr. W. Thompson	[signature] for W Thompson	5/20/03	S7-65						
		QA									
		Safety									
		Env.									

18. M. White [signature] 5/15/03
Signature of EDT Originator — Date

19. Authorized Representative for Receiving Organization — Date

20. G. Janicek [signature] 5/16/03
Design Authority/ Cognizant Manager — Date

21. DOE APPROVAL (if required)
Ctrl No.
☐ Approved
☐ Approved w/comments
☐ Disapproved w/comments

Acid Dissolution Hydrodynamic Force Analysis

M.A. White
ARES Corp.
Richland, WA 99352
U.S. Department of Energy Contract DE-AC27-99RL14047

EDT/ECN: 627610 UC: N/A
Cost Center: N/A Charge Code: 501555
B&R Code: N/A Total Pages: ~~11~~ ~~23~~ 24

Key Words: 241-C-106, Calculation, Acid, Acid Dissolution, Waste Retrieval, M-08-13

Abstract: This calculation determines total force realized at the acid dissolution mixing educator assembly as a result of hydroynamic force and sluicer impingement. IDENTIFYER: M-08-13

5/21/03

Release Approval Date

MAY 2 1 2003
DATE: HANFORD RELEASE
STA: 4 ID: 21

Release Stamp

Approved For Public Release

ARES CORPORATION	CALCULATION COVER SHEET	Calculation No: 0193101.07-M-006

PROJECT TITLE/NUMBER: Tank 241-C-106 Waste Retrieval System / ARES Job # 0193101.07	CLIENT: CHG

CALCULATION TITLE:

Acid Dissolution Hydrodynamic Force Analysis

IDENTIFYER: M-08-13 PMD 5/20/03

PROBLEM STATEMENT OR OBJECTIVE OF THE CALCULATION:

The purpose of this calculation is to analyze the hydrodynamic forces associated with the in-tank piping feeding the tank fluid agitation eductor (sparger), as well as eductor induced forces. These forces will be used as input to the structural analysis of the support structure used for the acid dissolution assembly, and the acid dissolution assembly itself.

DOCUMENTS AFFECTED:

Revision	Affected Pages	Revision Description	Prepared by Name/Date	Reviewed by Name/Date	PM/PE Approval/Date
0	1-9	Original	B.E. Bielicki, P.E.	A. Hagensen	
1	All	Pipe and fitting design changes caused pressure and flow at eductor to change	B.E. Bielicki, P.E.	A. Hagensen	
2	All	Added RPP rev #, appendix info, and minor changes to text	B.E. Bielicki, P.E. B.E. Bielicki 5/15/03	A. Hagensen B.E. Bielicki For A. Hagensen per telecon 5/16/03	M. White M. White 5/16/03

1.0 Background and Purpose

Initially the pump assembly, which will provide recirculation flow to the eductor, will consist of two Flygt submersible pumps in series. These pumps will be run to failure, at which point a newly designed pump assembly employing Stancor pumps will be used. The flow rate and inlet pressure produced at the eductor (ref ARES calculation 0193101.07-M-004) is higher when utilizing the Stancor pumps (ref ARES calculation 0193101.07-M-005). Therefore values bounding the maximum pressure and flow rate determined in calculation 0193101.07-M-005 will be used in this analysis

The purpose of this calculation is to analyze the hydrodynamic forces associated with the in-tank piping feeding the tank fluid agitation eductor (sparger), as well as eductor induced forces. These forces will be used as input to the structural analysis of the support structure used for the acid dissolution assembly, and the acid dissolution assembly itself.

2.0 Criteria and Design Inputs

a. The eductor draws in 3 gallons of fluid for every gallon of motive fluid (see reference 'g').
b. The tank waste fluid specific gravity is 1.1 (see reference 'h').
c. The eductor has a ¾" orifice nozzle, a 1 ½" inlet, and a 2" outlet OD (see reference 'g').
d. Using the maximum values determined in reference 'e', the eductor inlet conditions are bounded at 120 gpm and 50 psig.
e. The bounding values in 'd' above, are based on the theoretical fluid flow discharge from nozzles per reference 'f'.

3.0 Methodology

Hand calculations will be utilized for this analysis, utilizing Mathcad ™ to facilitate the process.

4.0 Assumptions

Assumptions are as stated in the body of the calculations.

5.0 References

a. Drawing H-2-818549 rev. 1.
b. Drawing H-2-818551 rev. 1.
c. Project W320 Tank 241-C-106 Sluicing, Functional Design Criteria (WHC-SD-W320-FDC-001 Rev 2).
d. ARES calculation 0193101.07-M-004 (Flygt pump assembly).
e. ARES calculation 0193101.07-M-005 (Stancor pump assembly).
f. Hydraulic Institute Engineering Data Book, 2nd edition, 1990 (see appendix).
g. Vortex Ventures radial eductor vendor information (see appendix).
h. ARES Meeting Minutes, C-106 Acid Dissolution Options Evaluation, 3/6/03 (see appendix).

6.0 Results and Conclusion

The total hydrodynamic force acting on the waste retrieval eductor support assembly is 327 pounds. This force is in the opposite direction that the waste stream exits the eductor, and acts on the eductor support assembly which will be mounted at riser R7 in tank 241-C-106. This force will be used as an input for structural calculations performed as part of this project.

7.0 Calculations

See the subsequent pages of this calculation.

Fluid dynamic generated forces

Forces due to fluid dynamics will be calculated to determine the lateral loads induced on the vertical eductor support assembly. Head losses due to fluid flow will not be accounted for, which will generate conservatively larger reaction forces (because of the higher associated outlet pressures).

Eductor fluid dynamic generated forces

Flow enters from the side through the induction ports, laterally: these forces essentially balance each other and cancel (Fy=0, Fz=0, etc.). Therefore, only the forces in the x direction (due to the motive fluid) will be considered (see coordinate system superimposed upon the eductor vendor sketch in appendix). The forces associated with the 1 1/2" entrance of the eductor and the 2" outlet will be evaluated. The mass flow rate increases from the inlet of the eductor to the outlet due to the motive fluid drawing in the tank waste radially through the induction ports. Overall eductor reaction forces can be determined by considering the inlet and outlet flow conditions, which account for the motive fluid energy reduction as it draws the tank waste into the eductor. The eductor is designed to draw in approximately 3 gallons of fluid for every gallon of motive fluid.

Note that subscripts with 1 are associated with the inlet of the eductor, and subscripts with '2' are associated with the outlet of the eductor. See appendix sketch for eductor dimensions.

$SG := 1.1$

$\rho H20 := 62.4 \frac{lb}{ft^3}$

$\rho := SG \cdot \rho H20 \quad \rho = 68.64 \frac{lb}{ft^3}$

$d1 := 1.5\,in \qquad d2 := 2\,in$

$A1 := \pi \cdot \left(\frac{d1}{2}\right)^2 \quad A1 = 1.77\ in^2$

$A2 := \pi \cdot \left(\frac{d2}{2}\right)^2 \quad A2 = 3.14\ in^2$

$Q1 := 120 \, \frac{gal}{min}$ $\quad P1 := 50 \, \frac{lbf}{in^2}$

These values bound the results of the fluid calculations (reference ARES calculations 0193101.07-M-004 using the Flygt pumps and 0193101.07-M-005 using the Stancor pumps)

$Q1 = V1 \cdot A1 \qquad V1 := \frac{Q1}{A1}$

$V1 = 21.79 \, \frac{ft}{sec}$

$Q2 := 4 \cdot Q1$

$Q2 = 480 \, \frac{gal}{min}$ $\quad P2 := 0 \, \frac{lbf}{in^2}$

Based on 3 gallons fluid drawn in per every gallon of motive per eductor design (see appendix)

$Q2 = V2 \cdot A2 \qquad V2 := \frac{Q2}{A2}$

$V2 = 49.02 \, \frac{ft}{sec}$

$gc := 32.2 \, \frac{lb \cdot ft}{lbf \cdot sec^2}$

define 'x' as positive to the right

Momentum relationships (ref any fluid dynamics book):

$$\Sigma F = m \cdot a = m \cdot \frac{dv}{dt} = \frac{d}{dt}(m \cdot v) = mdot \cdot v = \rho \cdot Q \cdot (v)$$

$$\Sigma F = 0 = \rho \cdot Q \cdot (v) = mdot \cdot v = mdot2 \cdot (V2) - mdot1 \cdot (V1)$$

$$Fx - P2 \cdot A2 + P1 \cdot A1 = \frac{(\rho \cdot Q2 \cdot V2 - \rho \cdot Q1 \cdot V1)}{gc}$$

But the pressure of the eductor at the outlet is zero (and there is negligible hydrostatic head due to the small depth of submergence)

$$Fx + P1 \cdot A1 = \frac{(\rho \cdot Q2 \cdot V2 - \rho \cdot Q1 \cdot V1)}{gc}$$

$$Fx := \frac{-(P1 \cdot A1 \cdot gc - \rho \cdot Q2 \cdot V2 + \rho \cdot Q1 \cdot V1)}{gc}$$

$Fx = 10.98\ lbf$ Fx acts to the left on pumped fluid, or force exerted by pumped fluid on eductor to the right

Reducer fluid dynamic generated forces

The fluid dynamic forces associated with the two reducers cancel each because they reduce in opposite directions, and are both in the same 12' long, 2" schedule 80 pipe feeding the eductor.

Elbow fluid dynamic generated forces

The fluid dynamic induced forces from the elbow as it routes flow from the vertical leg to the horizontal toward the eductor will be evaluated. Only forces in the horizontal direction will be evaluated since stresses induced in the 2"x6" support structural will be negligible in this direction. The notation using '2' will indicate the outlet of the elbow. For conservatism, the pressure at the outlet of the elbow will be taken as that at the inlet of the eductor.

$d2 := 1.5 in$

$A2 := \pi \cdot \left(\frac{d2}{2}\right)^2$ $A2 = 1.77\ in^2$

$Q2 := Q1$ $Q2 = 120 \frac{gal}{min}$

$P2 := P1$ $P2 = 50 \frac{lbf}{in^2}$

Q2 = Q1 stated to use previous value noted as Q1, renamed to Q2 here, and likewise with P2 = P1

$Q2 = V2 \cdot A2 \qquad V2 := \dfrac{Q2}{A2}$

$V2 = 21.79 \dfrac{ft}{sec}$

$Rx - P2 \cdot A2 = \dfrac{(\rho \cdot Q2 \cdot V2)}{gc}$

$Rx := \dfrac{(P2 \cdot A2 \cdot gc + \rho \cdot Q2 \cdot V2)}{gc}$

$Rx = 100.77\ lbf$ Rx acts to the right on pumped fluid, or force exerted by pumped fluid on elbow to the left

Therefore the net force acting left on the vertical eductor support assembly is:

$Fnet := Rx - Fx$

$Fnet = 89.8\ lbf$

Existing sluicer fluid dynamic generated forces

The sluicer jet stream may impact the lower portion of the eductor support assembly. Assume the jet stream from sluicer remains a solid 1" diameter (this is very conservative considering the 65ft distance).

$Qsluicer := 350 \dfrac{gal}{min}$ ref 'c'

$d2 := 1 in$ sluicer nozzle outlet diameter ref 'b'

$A2 := \pi \cdot \left(\dfrac{d2}{2}\right)^2 \qquad A2 = 0.79\ in^2$

$Qsluicer = V2 \cdot A2 \qquad V2 := \dfrac{Qsluicer}{A2}$

$V2 = 142.97\ \frac{ft}{sec}$ however V2 increases due to acceleration acting over the 14.5' drop in elevation (ref 'a')

$h := 14.5\,ft$

$V2max := \left(V2^2 + 2\cdot g\cdot h\right)^{\frac{1}{2}}$ $V2max = 146.2\ \frac{ft}{sec}$

Momentum relationships from before:

$$\Sigma F = m\cdot a = m\cdot\frac{dv}{dt} = \frac{d}{dt}(m\cdot v) = mdot\cdot v = \rho\cdot Q\cdot(v)$$

$$Fsluicer := \frac{\rho\cdot Qsluicer\cdot V2max}{gc}$$

$Fsluicer = 243.03\ lbf$

The sluicer is approximately 65' from R7

$L := 65\,ft$

$D := 14.5\,ft$ Where D = drop in elevation from outlet to point stream makes impact

$$\tan(\theta) = \frac{D}{L}$$

$\theta := atan\left(\frac{D}{L}\right)$ $\theta = 12.58\ deg$

So perpendicular force on eductor support assembly is:

$$FsluicePerp := Fsluicer \cdot \cos(\theta)$$

$$FsluicePerp = 237.2 \text{ lbf}$$

Therefore the total laterally induced force due to hydrodynamic loading is:

$$Ftotdyn := Fnet + FsluicePerp$$

$$Ftotdyn = 326.99 \text{ lbf}$$

Att: Bernie Ares (509) 946 9711

RPP-16251 REV 0

CALC# 0193101.07-M-006 SHEET A1/A12 REF 'f'

Fluid Flow

Discharge From Nozzles

The actual discharge from nozzles will vary from 90% to 95% of the theoretical discharge.

For hydraulic sluicing the following pressures at base of nozzles are recommended:

Light fine material and loose sandy soil .... 50 to 75 PSIG
Stiff loam overburden .... 100 to 125 PSIG
Hard clay .... 150 to 200 PSIG

The following amounts of water are recommended to move 1 cubic foot.

Heavy sand .... 20 cubic feet of water
Average quarry overburden, 8 to 10 cu ft of water

For sprinkling golf courses it is reasonably safe to figure 10 gallons per minute for each Green with 35 PSIA at hose valve outlet and 25 gallons per minute for each Fairway with 35 PSIA at hose valve outlet. The standard conditions are 100 feet of ¾ inch hose for Greens sprinklers and 100 feet of 1 inch hose for Fairways sprinklers. Use gate valves with a hose nipple at all outlets instead of the customary hose faucets on account of the friction loss in the hose faucets.

IIID-1 —THEORETICAL DISCHARGE OF NOZZLES IN U.S. GALLONS PER MINUTE

TABLE 35

HEAD VELOCITY OF DISCH, FT/S ORIFICE SIZE PSIG FEET

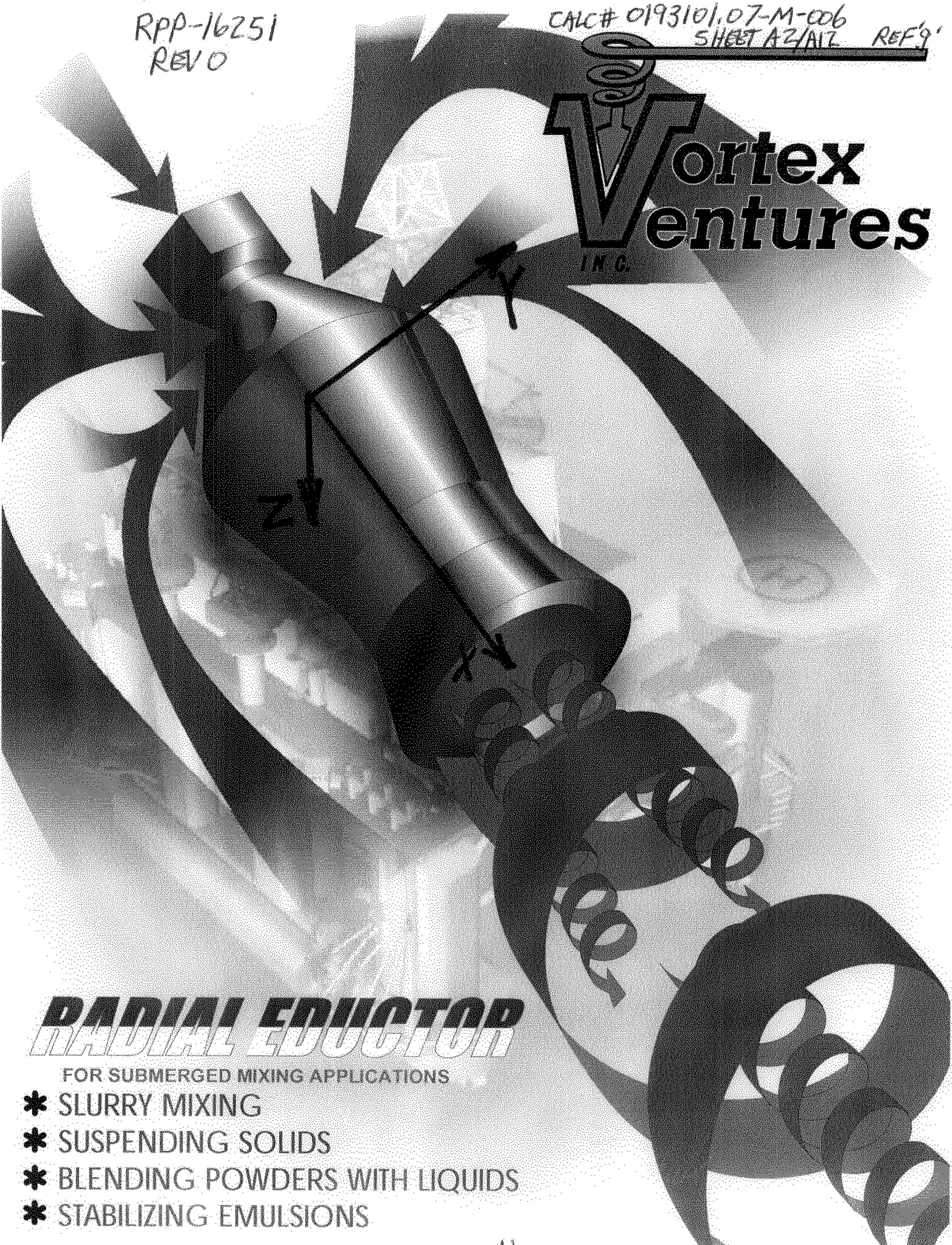
PSIG	Head Feet	Veloc. of Disch. Feet per Sec	1/16	1/8	3/16	1/4	3/8	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 1/2
10	23 1	38.6	0 37	1 48	3.32	5 91	13.3	23.6	36.9	53	72	94	120	148	179
15	34 6	47.25	0 45	1 81	4.06	7.24	16.3	28.9	45.2	65	88	118	147	181	219
20	46 2	54.55	0.52	2.09	4.69	8 35	18.8	33 4	52.2	75	102	134	169	209	253
25	57 7	61.0	0 58	2.34	5.25	9.34	21.0	37.3	58.3	84	114	149	189	234	283
30	69.3	66.85	0 64	2.56	5.76	10 2	23 0	40.9	63.9	92	125	164	207	256	309
35	80.8	72.2	0.69	2.77	6.21	11 1	24.8	44.2	69.0	99	135	177	224	277	334
40	92.4	77.2	0.74	2.96	6.64	11.8	26 6	47 3	73.8	106	145	189	239	296	357
45	103.9	81 8	0.78	3.13	7.03	12 6	28.2	50.1	78.2	113	153	200	253	313	379
50	115.5	86.25	0.83	3.30	7 41	13.2	29 7	52 8	82.5	119	162	211	267	330	399
55	127 0	90.5	0.87	3 46	7 77	13 8	31 1	55 3	86.4	125	169	221	280	346	418
60	138.6	94 5	0 90	3 62	8 12	14.5	32 5	57 8	90 4	130	177	231	293	362	438
65	150.1	98 3	0 94	3.77	8 45	15 1	33 8	60 2	94 0	136	184	241	305	376	455
70	161.7	102.1	0 98	3.91	8.78	15.7	35.2	62.5	97.7	141	191	250	317	391	473
75	173.2	105.7	1.01	4.05	9.08	16.2	36 4	64.7	101.0	146	198	259	327	404	489
80	184.8	109.1	1.05	4.18	9.39	16.7	37 6	66.8	104.0	150	205	267	338	418	505
85	196.3	112.5	1.08	4.31	9 67	17.3	38 8	68.9	108.0	155	211	276	349	431	521
90	207 9	115.8	1 11	4 43	9 95	17 7	39 9	70 8	111 0	160	217	284	359	443	536
95	219 4	119.0	1.14	4 56	10.2	18 2	41 0	72 8	114 0	164	223	292	369	456	551
100	230 9	122 0	1 17	4 67	10 5	18 7	42 1	74 7	117 0	168	229	299	378	467	565
105	242.4	125 0	1 20	4 79	10 8	19.2	43 1	76 5	120 0	172	234	306	388	479	579
110	254.0	128 0	1.23	4 90	11.0	19.6	44.1	78.4	122.0	176	240	314	397	490	593
115	265.5	130.9	1.25	5.01	11.2	20 0	45.1	80.1	125 0	180	245	320	406	501	606
120	277.1	133.7	1.28	5.12	11.5	20.5	46.0	81.8	128 0	184	251	327	414	512	619
125	288.6	136.4	1.31	5 22	11.7	20.9	47.0	83 5	130.0	188	256	334	423	522	632
130	300.2	139 1	1 33	5 33	12.0	21 3	48.0	85.2	133.0	192	261	341	432	533	645
135	311.7	141 8	1 36	5 43	12.2	21 7	48 9	86 7	136.0	195	266	347	439	543	656
140	323.3	144 3	1 38	5.53	12 4	22 1	49 8	88 4	138.0	199	271	354	448	553	668
145	334.8	146.9	1.41	5.62	12.6	22.5	50 6	89.9	140.0	202	275	360	455	562	680
150	346.4	149 5	1 43	5.72	12.9	22.9	51.6	91.5	143.0	206	280	366	463	572	692
175	404.1	161.4	1 55	6.18	13.9	24.7	55.6	98.8	154 0	222	302	395	500	618	747
200	461.9	172.6	1.65	6.61	14.8	26.4	59 5	106.0	165.0	238	323	423	535	660	799
250	577 4	193.0	1.85	7.39	16.6	29.6	66 5	118.0	185.0	266	362	473	598	739	894
300	692.8	211.2	2.02	8.08	18.2	32.4	72 8	129 0	202 0	291	396	517	655	808	977

Note—The actual quantities will vary from these figures, the amount of variation depending upon the shape of nozzle and size of pipe at the point where the pressure is determined. With smooth taper nozzles the actual discharge is about 94% of the figures given in the tables.

SOURCE: HYDRAULIC INSTITUTE ENGR DATA BOOK 2ND ED 1990

RPP-16251
REV 0

CALC# 0193101,07-M-006
SHEET A2/A12 REF'9'

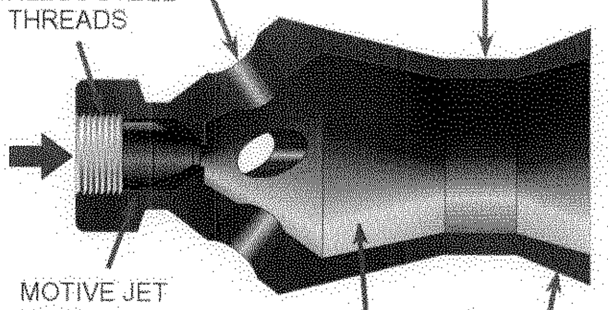


Vortex Ventures INC.

RPD-16251 REV. 0

CALC # 0193101.07-M-006 SHEET A3/A12 REF '9'

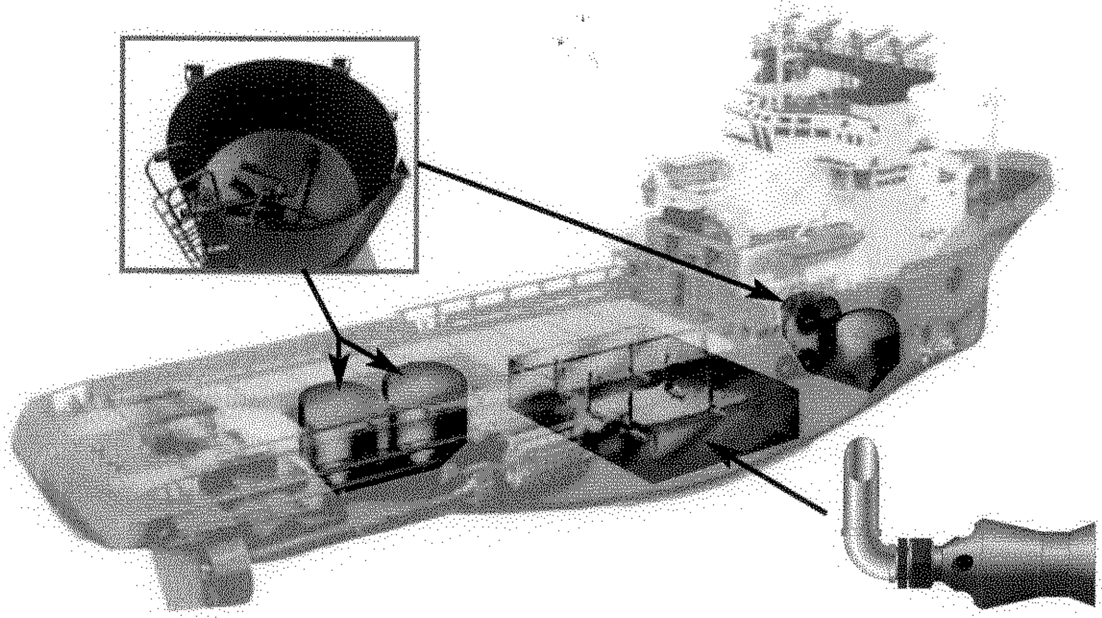
TANK MIXING EDUCTOR : RIG DRILLING FLUID SYSTEMS BLENDING PLANTS AND TRANSPORT VESSELS



The Radial Eductor is designed from the Bernoulli Principle of; when pressure is high, velocity is low and inversely when velocity is high, pressure is low.

A pressurized motive fluid flow is converted to velocity opposite the nozzle orifice, creating a low pressure region that radially draws in a secondary fluid through the helical inductors from the surrounding fluid. The geometric arrangement of the inductors promotes a spinning flow as the secondary fluid interacts with the primary fluid in the mixing chamber of the radial eductor. Large and small scale vortices are generated, producing dispersion as the blended flow stream issues from the diffuser section of the Radial Eductor.

The Radial Eductor is a high volume EDUCTOR using the LOBESTAR® power jet to produce high turbulence. A centrifugal pump is used to pressurize the Radial Eductor. Static pressure is converted to high velocity as the slurry passes through the jet nozzle orifice. The high velocity causes a region of low pressure. The motive flow pumped through the jet nozzle draws in three times the volume pumped. Example: The flow rate of an RE-2 (2") Model has a 7/8" nozzle orifice is 116 gpm @ 40 psi. The total mixed fluid is 464 gpm. The motive flow rate of the jet nozzle draws three times it's volume through the inductors. This interaction prevents solids from settling at the bottom and the corners of the tank.



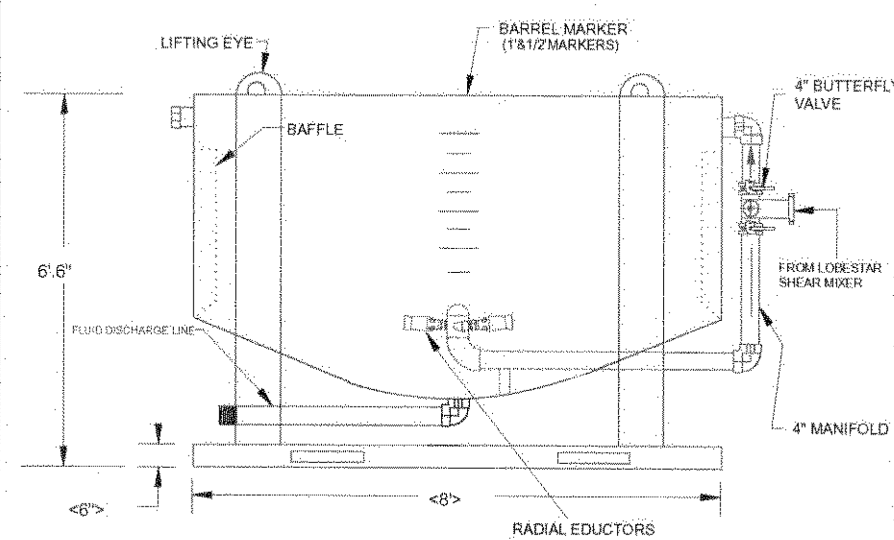
The delivery of drilling fluids to a rig site without loss of product is a dramatic savings in drilling fluid materials, rig time and man/hours exposure to toxic fumes during tank cleaning.

No more arriving at the rig site with part of the drilling fluid settled in the tank corners and on the tank floor. This can be a quadruple cost 1) rig time to get the mud weight back up to the desired density 2) cost for barite that you have already paid for once 3) boat company charges for cleaning out tanks 4) disposal cost.

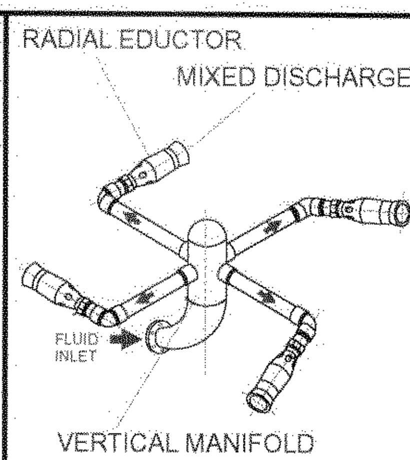
RPP-16251 CALC#0P3101.07-M-006
REV 0 SHEET A4/A12 REF 'g'

Vortex Ventures INC.

ROUND TANK WITH RADIAL EDUCTOR MANIFOLD ARRANGEMENTS

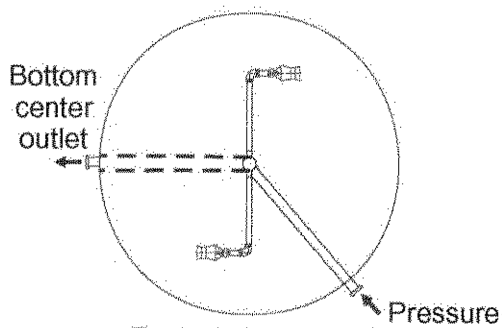


ELEVATED VIEW



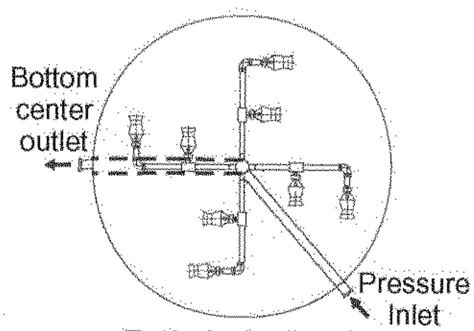
This configuration for round tanks allows for continuous mixing, suspends solids and rapid volume turnover.

Top View



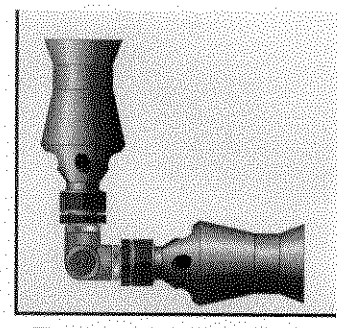
Typical storage tank configuration

Top View

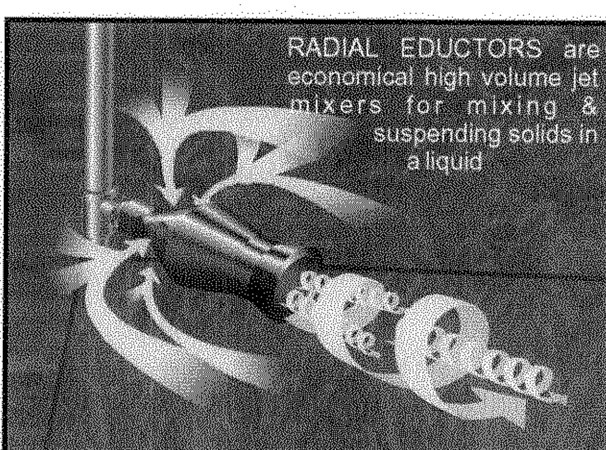


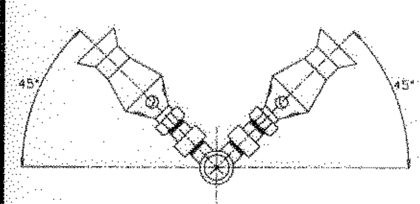
Typical mixing tank configuration

Top View



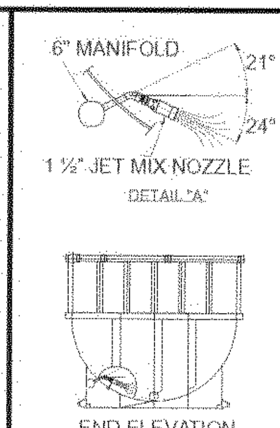
Tank corner installation





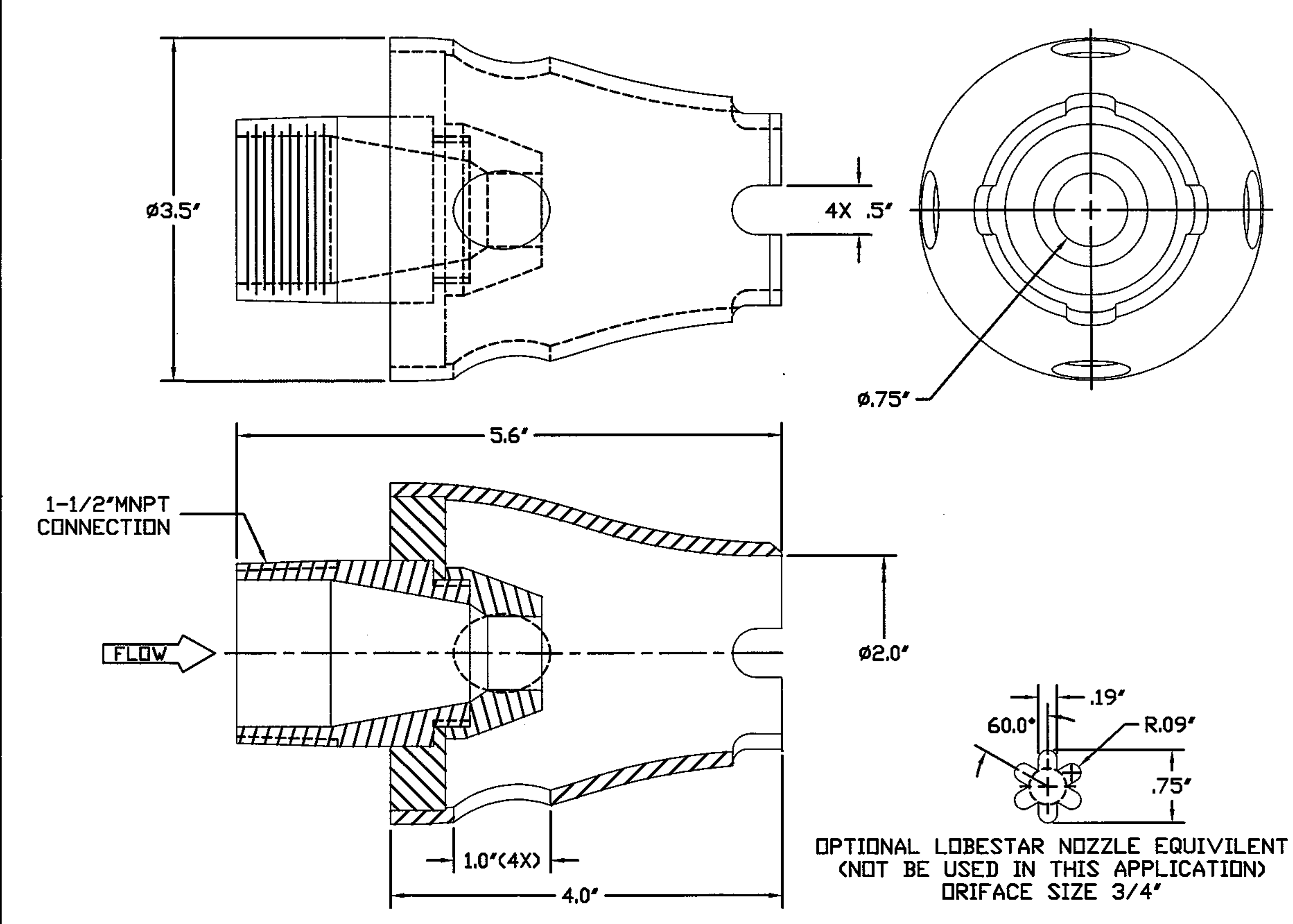
HORIZONTAL MANIFOLD W/RADIAL EDUCTOR @ 45°

CONFIGURATIONS FOR RECTANGULAR AND SQUARE TANKS



RPP-16251
REV. 0

CALC# 0193101.07-M-006
SHEET A5/A12 REF '9'



Drawn By DR3	Date 03/27/03	Chk'd.	Date	Material STAINLESS STEEL	WEIGHT: 5 LBS.
Vortex Ventures 6950 Portwest Drive #100 Houston, TX. 77024 WWW.VORTEXVENTURES.COM Phone: 713-869-2393 Fax: 713-869-2396	Title 1.5" RADIAL EDUCTOR W/ MODIFIED PORTS Page 1 of 1			Copyright 2002 This drawing is not to be reproduced or modified in any way without expressed written consent from V.G. Lott-Vortex Ventures, Inc.	Drawing No. RE-SS1.5-M1

RPP-16251
REV. 0

CALC# 0193101.07-M-006
SHEET A6/A12 REF. 'h'

ARES CORPORATION

MEETING MINUTES

DATE:	March 6, 2003	**TIME:**	12:30	**FILE:** 03RL0318
MEETING	X	**T-CON**		**PHONE NO.**

SUBJECT: **C-106 Acid Dissolution Options Evaluation**

LOCATION: 2704HV/G108A

PARTICIPANTS

Name No.	Company	Phone
Jeff Huisingh	ARES Corporation	946-3300
Chris Burke	CH2M Hill	372-3305
Keith Carpenter	CH2M Hill	372-2452
Mike Flasch	CH2M Hill	373-4473
Ken Anderson	CH2M Hill	373-9193
David Parkman	CH2M Hill	373-3462
Bill Grams	CH2M Hill	373-7308
John Propson	CH2M Hill	372-0455
Blaine Barton	CH2M Hill	376-5118
Jim Bellomy	CH2M Hill	372-1673
Mike White	ARES Corporation	946-3300
Monika Feldman	ARES Corporation	946-3300
John Payne	Babcock Service	372-1107
Eric Shen	ARES Corporation	946-3300

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019301.07 Job File (RL & BG)
Eric Shen
Jeff Huisingh
Mike White
Monica Feldmann

RLF/LB

PREPARED BY: Eric Shen **DATE PREPARED** 3/10/03

for [signature] 5-20-03 per telecon
SIGNATURE

The purpose of this meeting was to establish the requirements for the C-106 Acid Dissolution Waste Retrieval Project, identify existing conditions, address open questions, list assumptions, and discuss options for implementing the acid dissolution process. The following are a summary of the discussions and actions identified during the meeting.

Requirements

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The following are the significant requirements identified for this project. The detailed requirements applicable to this project can be found in RPP-11567, Level 2 Specification for a Waste Retrieval System for Single Shell Tank 241-C-106.

Requirements:

- Reduce waste volume to the minimum of (1) 360 cubic feet or (2) the limits of the technology(ies) employed
- Observe flammable gas limits
- Do not damage tank
- Do not damage existing equipment or provide for replacement in design
- Observe dome/riser load limits
- Do not create fugitive emissions (e.g., via tank over pressurization)
- Retrieval equipment must be capable of being recovered in the event of its failure
- Leak detection may require modifications to ensure that the methods for monitoring material balance and leak detection in the new design are adequate. (Do not need to provide other methods of LDMM.)
- Equipment external to the tank should be portable and re-deployable.
- In-tank equipment is to be left in place at the end of the job.
- To facilitate maintainability, the maximum component diameter is 52". Equipment can be disassembled to meet this requirement.
- Above ground equipment shall be reusable on other tanks (e.g., hoses, wiring, and cables shall be above ground, yellow-jacketed rather than buried).
- No decon capability is required
- 500 mrem/yr/person design exposure limit (ARES' **action** to confirm this value in the Level 2 Spec)
- Provide a means of agitation or recirculation to create fluid movement. (Lab work suggests this capability is needed. Lab used a mixer speed of approximately 1 rpm.)
- Minimize waste generation (AY-102 has 275 kgal space available)
- Incorporate provisions into the design that minimize drain back into the retriever tank.
- Minimize use of A & C pits if possible. (They are the hottest radiologically.)
- All pit-installed equipment shall be installed remotely.
- The design needs to include ability to flush transfer lines
- Personnel safety considerations should follow the requirements spelled out in the authorization basis documents for caustic addition.

<u>Background</u>

Blaine Barton provided the following background on the acid dissolution process and performance characteristics. This information includes the most recent results from the 222S laboratory acid dissolution analysis:

- The acids under consideration for the acid dissolution process are 1 molar oxalic acid or 2 molar nitric acid mixed with 1 molar oxalic acid.
- The acid/waste solution will have the following properties:
  -

- Specific gravity- <1.1
- Viscosity- 1-2 cp, max below 5 cp
- pH- <1 to 2.8

- The pH needs to be maintained below 4 during waste transfers
- The acid dissolution process is as follows:
  - Remove all existing supernatant from the tank
  - Using the sluicing equipment, knock down the piles located in the tank to reduce the quantity of acid needed to cover the waste. The goal is to uniformly distribute the waste in the tank.
  - Removal all free liquids in the tank and introduce acid into the tank. In the case of oxalic acid, a vigorous reaction is expected which releases CO_2. The soak time for this initial introduction is 1 day, after which, it will be pumped to the receiver tank and neutralized.
  - Follow on acid additions will continue in 15,000 gallon acid dumps into the tank (a truck load is 5,000 gallons). The estimated acid to waste ratio is 20 to 1. Subsequent to the initial acid soak, all follow on acid additions will be allowed to soak for 1 week before pump out.
- Agitation of the acid pool is required to facilitate the acid-waste reaction. The goal is to be able to slowly agitate the entire acid pool. Agitation is not required during transfer periods.
- Based upon initial lab results, it will be important for the pump and transfer system to pickup and transport suspended solid material. It is not expected that acid dissolution will dissolve all the solid waste.
- All neutralization shall be performed at the receiver tank and the provisions for neutralization shall be covered by CHG.
- Following the last acid soak and pump out, the tank shall be rinsed with a ½ molar caustic solution.

General Discussion

- Aerosol generation during the acid dissolution process was raised as a concern. The focus of this concern resided in two areas; impacts to the ventilation system and impacts to the tank dome and flashing.
  - CHG is evaluating the issues of HEPA filter loading
  - Acid is not expected to attack the filter media
- For process monitoring, a pH meter is required and a method to monitor tank level, ENRAF. The ENRAF cannot tolerate contact with the acid.
- No temperature control is required, beyond what is already in place, during retrieval and transfer.
- There are areas in the tank that should not be exposed to the acid; tank dome and the lead flashing.
- CHG can insert plug gauges to determine usable diameters in the C-106 risers, if the work is performed in the next two weeks (ARES to provide request by next Monday).
- The operation window is 10 weeks.
- The minimum transfer velocity is 6 ft/sec. However, if the need to transfer solids is not mandatory, the transfer velocity may be reduced. (In a subsequent meeting, additional clarification was provided. The need to transfer solids is a goal and not a requirement. The

requirement is to specify equipment that can be made available or procured in 8 weeks.)

- ARES to assume that the waste piles have been knocked down as an initial condition in the tank. CHG will use the sluicing system to knock down the waste piles.
- The sluicing pump is failed. CHG plans to use a portable pump to supply water to the sluicer.
- Cameras suitable for in tank use will be provided by CHG. However, ARES needs to show where the cameras are to be placed in the design.
- CHG would like to use the existing equipment to failure and have new equipment built to the new design available for immediate installation. The other option is to replace existing equipment with the equipment designed for acid dissolution before the start of the acid addition.
- The existing 304L flex jumpers need to be evaluated for compatibility for use with oxalic acid.
- Electrical capacity will not be an issue for C-106 acid dissolution. The retrieval of the C-200 series tanks is expected to follow C-106 retrieval. In the event of an overlap, C-106 will be given priority.

<u>Receiver Tank Options</u>-

A critical consideration in the selection of a receiver tank is the volume of available space needed to support acid dissolution based waste retrieval. The following is the estimated volume required:

- 200 kgal- acid dissolution process
- 10 kgal- caustic tank wash
- 10 kgal- waste solids to be removed
- 20 kgal- residual supernatant in the tank
- 15 kgal- transfer line flushes
- <u>15 kgal-</u> initial sluicing for waste leveling (this volume is probably too low)
  270 kgal Total

The receiver tank options are listed below along with the pros and cons associated with the use of each tank. This assessment is meant to assist the CHG/ARES team in understanding the scope and requirements associated with the selection of a receiver tank. (In a subsequent CHG meeting, AN-106 was selected as the receiver tank in place of AY-102.)

AY-102- (Baseline approach defined in the RFP)

<u>PROs:</u>

- The transfer lines exist
- Expected to be the lowest cost approach
- Projected to be the shortest schedule
- Requires the least number of pit entries

<u>CONs:</u>

- Heat loading can become an issue with addition and neutralization of acid waste

- ORP approval may be a challenge, since the tank has already been sampled for WTP waste feed
- Space available is limited and rough calculations show that available capacity is marginal for waste volumes projected without contingency. The available tank space in AY-102 is 275 kgal.
- The 4" transfer line will present transfer challenges; higher transfer flow rates, greater volumes required for line flushes, back drain mitigation/prevention, etc.

AY-101-

PROs:

- Space available is more than adequate
- No ORP approval required
- Less impact on ventilation system during line blowout (more tank volume buffers blowout air)

CONs:

- 2 pit entries more than AY-102 will be required
- Preparation of AY-101 is dependent upon two other projects being able to complete on schedule
- 4" transfer line
- Higher cost projected for this approach
- Longer schedule anticipated

AN-106-

PROs:

- Existing 2" transfer line will require small flow rates
- The transfer route is shorter
- Equipment has multiple end users
- Tank space is adequate
- No ORP approval is required

AN-106- (Cont)

CONs:

- More field work required (additional HIHTL)
- Longer schedule anticipated
- Higher cost projected
- Requires restart of C-103
- Interfaces with W-314 project
- Drain back into C-103 needs to be addressed

Agitation Options

The following options were identified for the agitation of the acid in C-106. The primary objective of the agitation is to ensure a stagnant layer is not formed at the acid/waste boundary interface and hence reduce the dissolution rate. The agitation required is characterized as being a slow agitation over the entire tank.

Agitation Selection Criteria-

- Schedule for delivery of equipment and approval for use within project schedule
  - 8 weeks for equipment delivery
- Ability to move solids (maybe)
- Fits within the available risers
- Does not add to the waste volumes
- Ability to agitate the waste

Agitation Concepts-

1. Internal distribution nozzles that spray or direct streams of recirculated acid into or onto the acid pool
2. In-tank mixing system, such as mixer paddles or mixer pumps
3. Sluicing nozzle is used to direct recirculated acid to various locations in the tank
4. Airjets are used to inject air into the acid pool to stimulate acid circulation
5. Water lance/jets are used to inject water into the acid pool
6. Sonic vibrator similar to a concrete vibrator use to agitate acid pool

Note: Concept 5 was discarded because of the significant impacts of adding water which dilutes the acid and adds to the waste inventory. Concept 6 was also discarded, because it was felt that the agitation would be limited and not stimulate break up of the stagnant boundary layer.

Action Items-

1. Provide ARES a copy of C-106 waste characteristics and profile report- John Propson
2. Contact Dan Reynolds to obtain references concerning the experience from the Russians, SRL, West Valley, and potentially INEL with acid dissolution of defense wastes in underground tanks.
3. ARES to perform a pros/cons evaluation to determine whether the strategy of using the existing equipment to failure or immediately installing the acid dissolution equipment, is the favored approach.
4. CHG will provide cut sheet and specification information on the preferred pH meter- Jim Bellomy.
5. ARES to evaluate the existing components that will be exposed to acid and determine whether materials compatibility issues require resolution.
6. CHG to provide ARES with photos and/or videos of the pits of interest to the acid dissolution project (C-106 and receiver tank)- Jim Bellomy.
7. ARES to evaluate agitation options as part of the conceptual design.
8. 500 mrem/yr/person design exposure limit (ARES' **action** to confirm this value in the Level 2 Spec)
9. ARES to specify riser plug gauging requirements by 3/10.

Analytical Calculations Checklist

Subject: Acid Dissolution Hydrodynamic Force Analysis

Originator: B.E. Bielicki **Date:** 05/15/03

Checker: A. Hagensen **Date:** 05/15/03

Design Review Checklist for Simple Designs/ Simple Design Changes (Routine Engineering Change Notices)

Documents/Engineering Change Notices Reviewed:

Calculation 0193101.07-M-006 Rev 1

Affected Document(s) (Optional)

Yes	No	N/A	
[✓]	[ ]	[ ]	Were the design inputs correctly selected?
[✓]	[ ]	[ ]	Area assumptions necessary to perform the design activity adequately described and reasonable?
[✓]	[ ]	[ ]	Where necessary, are the assumptions identified for subsequent reverifications when the detailed design activities area completed?
[✓]	[ ]	[ ]	Was an appropriate design method used?
[✓]	[ ]	[ ]	Were the design inputs correctly incorporated into the design?
[✓]	[ ]	[ ]	Is the design out put reasonable compared to design inputs?
[✓]	[ ]	[ ]	Are the necessary design input and verification requirements for interfacing organizations specified in the design documents or in supporting procedures or instructions?

Checklist Completed By: B.E. Bielicki for A. Hagensen per telecon **Date:** 5/15/03

Subcontractor Calculation Review

Page ii of ii

Subject: C-106 Acid Dissolution WRS

The subject document has been reviewed by the undersigned.
The checker reviewed and verified the following items as applicable.

Documents Reviewed: Tank 241-C-106 Waste Retrieval System Hydrodynamic Force Analysis

Analysis Performed By: ARES Corporation

- Design Input
- Basic Assumptions
- Approach/Design Methodology
- Consistency with item or document supported by the calculation
- Conclusion/Results Interpretation
- ______________________________

Checker (printed name, signature, and date) Paul H. Dorsh [signature] 5/20/03

Organizational Manager (printed name, signature and date) [signature] for WT Thompson 5/20/03

J. R. Bellomy [signature] 5/20/03