TOTAL ENERGY SYSTEM FOR WATER REUSE AND CONCENTRATION OF MIXED WASTE WATERS

for

E G & G ROCKY FLATS
P.O. 83115M
SEPTEMBER 20, 1990

Prepared by

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for

LICON JOB ORDER 901

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OCTOBER 15, 1990

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EXECUTIVE SUMMARY

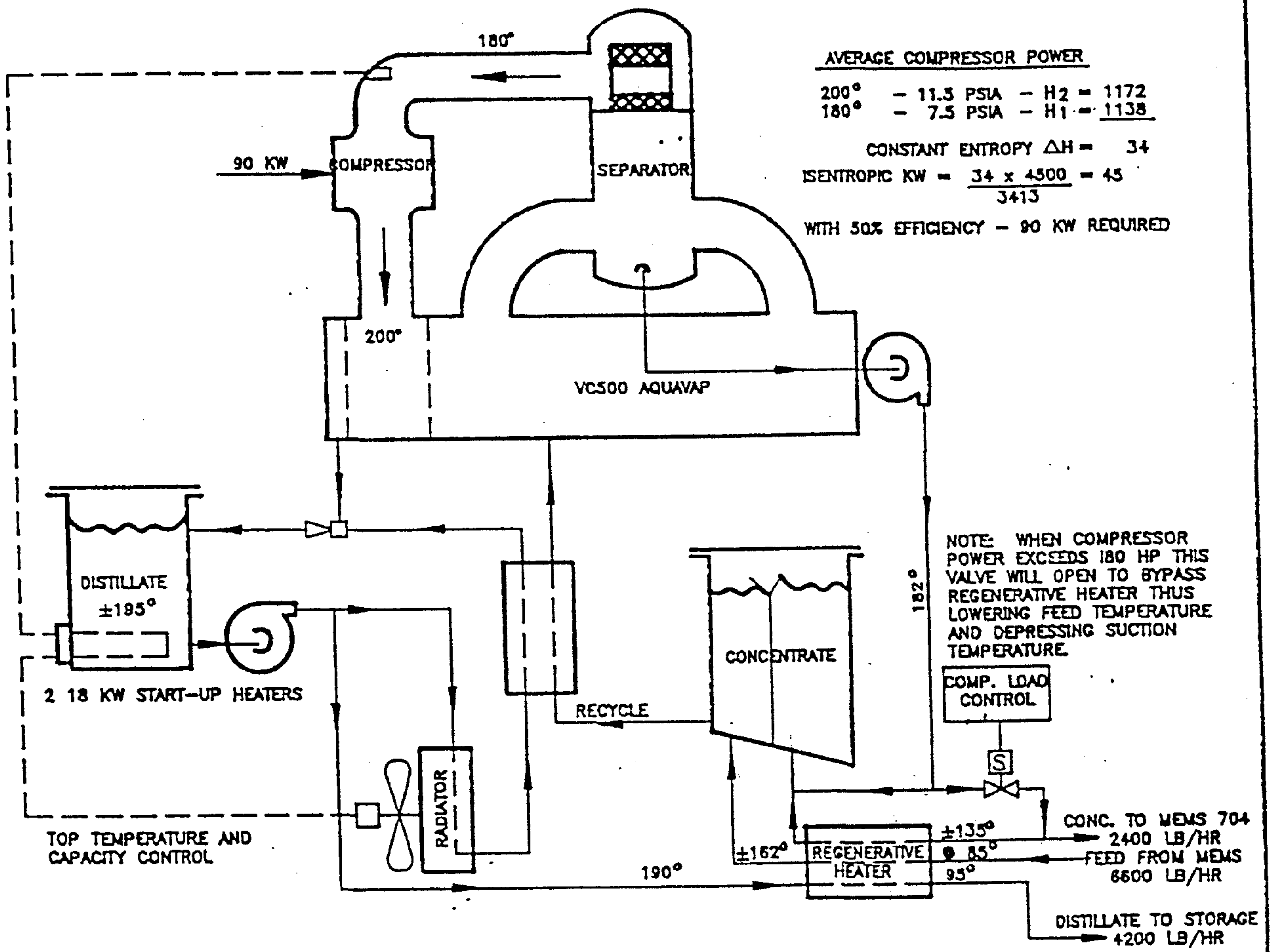
Mixed hazardous wastes with low level radioactivity presently stored at weapon sites in ponds and drums etc. can employ technologies funded by the Department of Energy, Office of Industrial Programs under contract DE-AC07-79CS40290 to dewater, reuse and concentrate industrial waste water in an energy effective way. Copies of the final report DE-86007851 are available from DOE Technical Information Center, Oak Ridge, TN. One of the heat pump designs developed under this contract is depicted in Figure 1. LICON has since expanded this effort with the application of the MEMS (Multiple Effect Multi Stage) distillation system, Figure 2, to further concentrate the waste and attain the mandate for waste minimization.

The recent energy crisis has added impetus to also minimize energy consumption. A total energy system depicted in Figure 3 can employ domestic natural gas to fuel internal combustion engines and furnish electric power to Figure 1. The heat that is normally wasted in power generation to the engine jackets and exhaust can be employed to operate the MEMS cycle depicted in Figure 2. All of the components of the total energy system are in active use with proven track records. Their combination can reduce both energy and capital cost of heretofore custom designed distillation plants by at least 50%.

In modular design, these LICON's (LIquid CONcentrators) not only save energy, their self sufficiency allows for trailer mounting for emergency deployment. They can furnish power to, and concentrate blow-down from, membrane processes such as reverse osmosis and electrodialysis or from ion exchange. Their production of high purity distillate, less than 75 ppm for reuse and their ability to concentrate liquid waste in excess of 500,000 ppm and in may cases recover precipitated salts provides an economical method of waste minimization. Further use can be made of the waste heat to dry the concentrated sludge to a powder.

The attached report covers the investigation of simulated Rocky Flats pond waters and established criteria to substantiate the quality of distillate and degree of concentration cited above. Evaluation of the test results would indicate that 10,000 ppm feed (pond average) could be reduced to 1/50th of the present volume and produce an excellent quality of distillate averaging less than 75 microsiemens and under more steady state conditions there were indications of being able to achieve less than 20 microsiemens with alkalinity control. Run off water averaging less than 5,000 ppm could be reduced by 1/100th. No data was taken to evaluate the effect of radioactivity.

TRANSVAP 750 – AQUAVAP VC500 HEAT BALANCE



HEAT TRANSFER RATE REUIRED WITH 2° BOILING POINT ELEVATION AND SEPARATION LOSES + 300 LB/HR DESUPERHEAT WATER

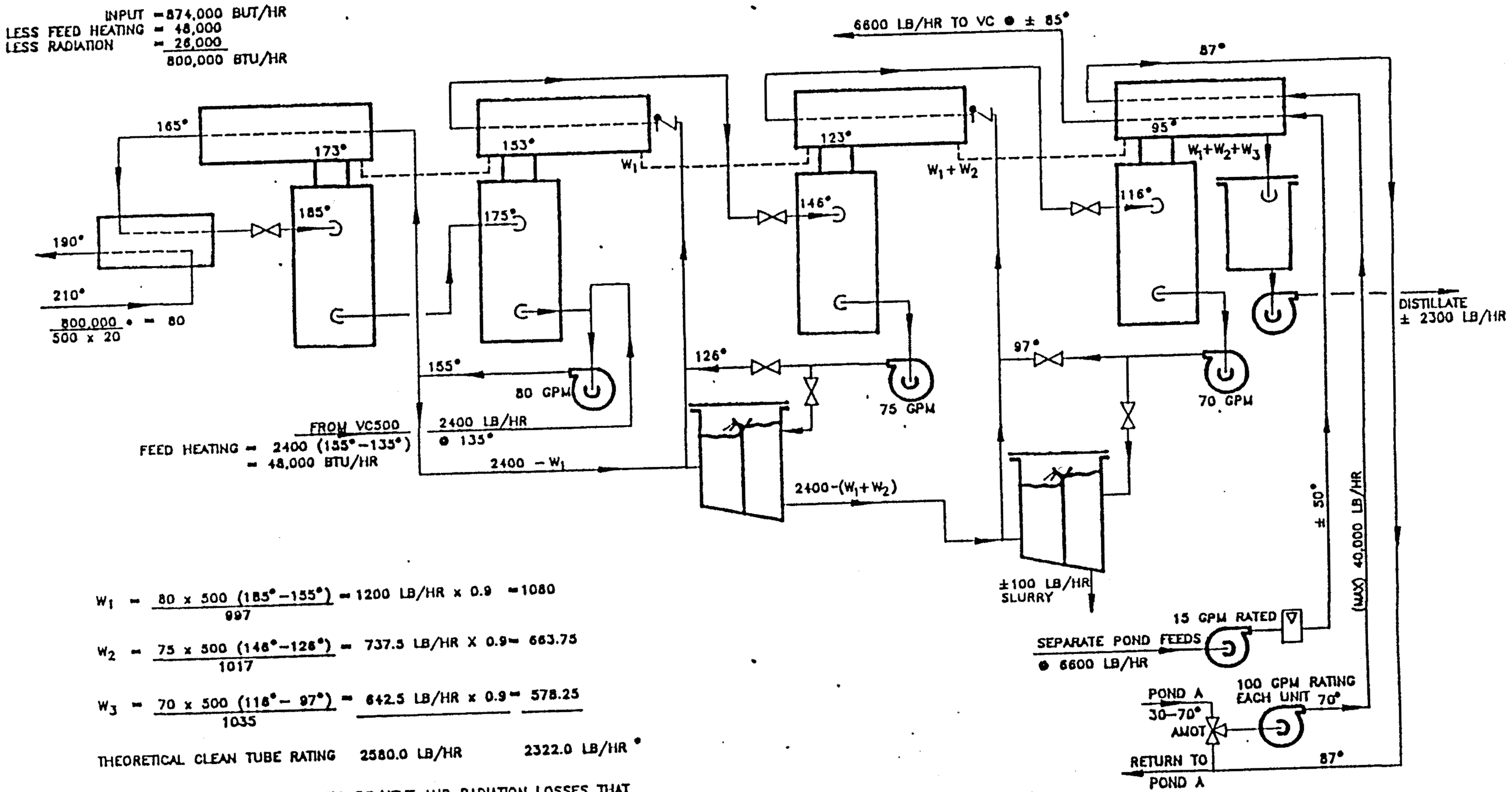
$$U_R = \frac{4,500,000}{18\,(\Delta T) \times 470\ \text{SQ.FT.}} = 530\ \text{BTU/HR/SQ.FT./}^\circ\text{F}$$

FEED HEATING REQUIRED = 6600(182–162)= 132,000 BTU/HR = 38.88 KW

DISCOUNTING RADIATION AND VENT LOSSES, RADIATOR WILL HAVE TO DISSIPATE MAXIMUM OF 50 KW

FIGURE 1
OCTOBER 4, 1990

HEAT BALANCE FOR AVERAGE CONDITIONS – TRANSVAP 750
MEMS 704 RATED 250 GPH



$W_1 = \dfrac{80 \times 500\ (185° - 155°)}{997} = 1200$ LB/HR x 0.9 = 1080

$W_2 = \dfrac{75 \times 500\ (146° - 126°)}{1017} = 737.5$ LB/HR X 0.9 = 663.75

$W_3 = \dfrac{70 \times 500\ (116° - 97°)}{1035} = 642.5$ LB/HR x 0.9 = 578.25

THEORETICAL CLEAN TUBE RATING 2580.0 LB/HR 2322.0 LB/HR *

* FROM EXPERIENCE, THERE WILL BE VENT AND RADIATION LOSSES THAT WILL REDUCE CAPACITY BY APPROXIMATELY 10%.

FIGURE 2
OCTOBER 5, 1990

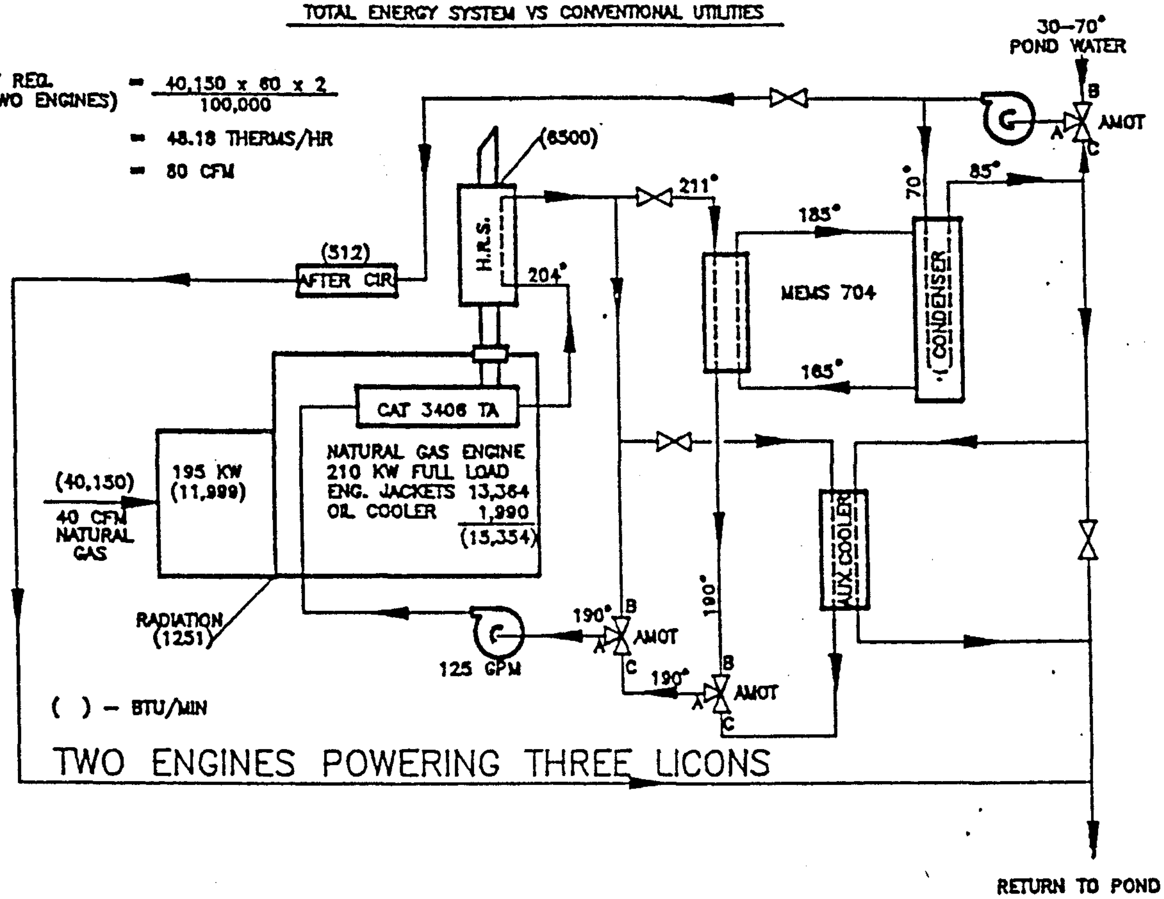
TRANSVAP 750 HEAT BALANCE PROPOSED FOR ROCKY FLATS

TOTAL ENERGY SYSTEM VS CONVENTIONAL UTILITIES

① ENERGY REQ. (FOR TWO ENGINES) $= \frac{40,150 \times 60 \times 2}{100,000}$

= 48.18 THERMS/HR

= 80 CFM



RECOVERABLE		NON RECOVERABLE ‡		LOSSES	AVERAGE POWER REQUIRED	
JACKETS	– 13,364	POWER	11,999	40,150 INPUT	VC–500	– 90 KW (COMP)
OIL COOLER	– 1,990	‡RADIATION	1,251	–21,854	MEMS	– 20
EXHAUST	– 6,500	‡AFTER CIR.	512	–13,762	AUXILIARIES	– 20
	21,854 BTU/MIN		13,762 BTU/MIN	4,534 BTU/MIN		130 x 3
	x 60 x 2					=390 KW
	3 | 2,622,480 BTU/HR RECOVERY					
	= 874,160 BTU/HR TO EACH MEMS					

EQUIVALENT COST OF STEAM WITH 85% BOILER EFFICIENCY $= \frac{2,622,480}{0.85 \times 100,000}$ = 30.85 THERMS/HR

EQUIVALENT COST OF ELECTRIC POWER = 390 KW x \$.08 = \$31.20 — 53.25 THERMS/HR ** / 84.10 THERMS/HR ①

* GAS COST @ 30.85 x \$.65/THERM = \$20.00
  \$51.20

ENGINE FUEL = 48.18 x \$.65 = \$31.32
\$19.88/HR SAVINGS

* (EQUIVALENT TO DIESEL OIL @ \$1.00/GALLON)

** (AT 25% STATION & TRANSMISSION EFFICIENCY)

$\frac{\text{INCREMENTAL COST OF ENGINES}}{\text{SAVINGS}} = \frac{\$85,000.}{19.88} = \frac{3772 \text{ HRS}}{168}$ = 25 1/2 WEEKS PAY BACK

NOTE 1 – THIS TOTAL ENERGY CONCEPT PROJECTS CUTTING ENERGY CONSUMPTION IN ALMOST HALF AND USES DOMESTIC NATURAL GAS

NOTE 2 A CONVENTIONAL FOUR EFFECT STEAM OPERATED PLANT WITH A PERFORMANCE RATIO OF 3 TO 1 WOULD CONSUME

$\frac{3 \times 750 \times 8.33 \times 1000}{3 \times 100,000 \times 0.8 \text{ (BOILER EFF)}}$ = 78.00 THERMS/HR

PLUS AUXILIARY ELECTRIC POWER OF 100 KW EQUIVALENT TO 13.65 THERMS/HR

91.65 THERMS/HR

FIGURE 3
OCTOBER 4, 1990

ENGINE COOLING WATER ARRANGEMENT

FOR TWO ENGINES RUNNING AND ONE STANDBY

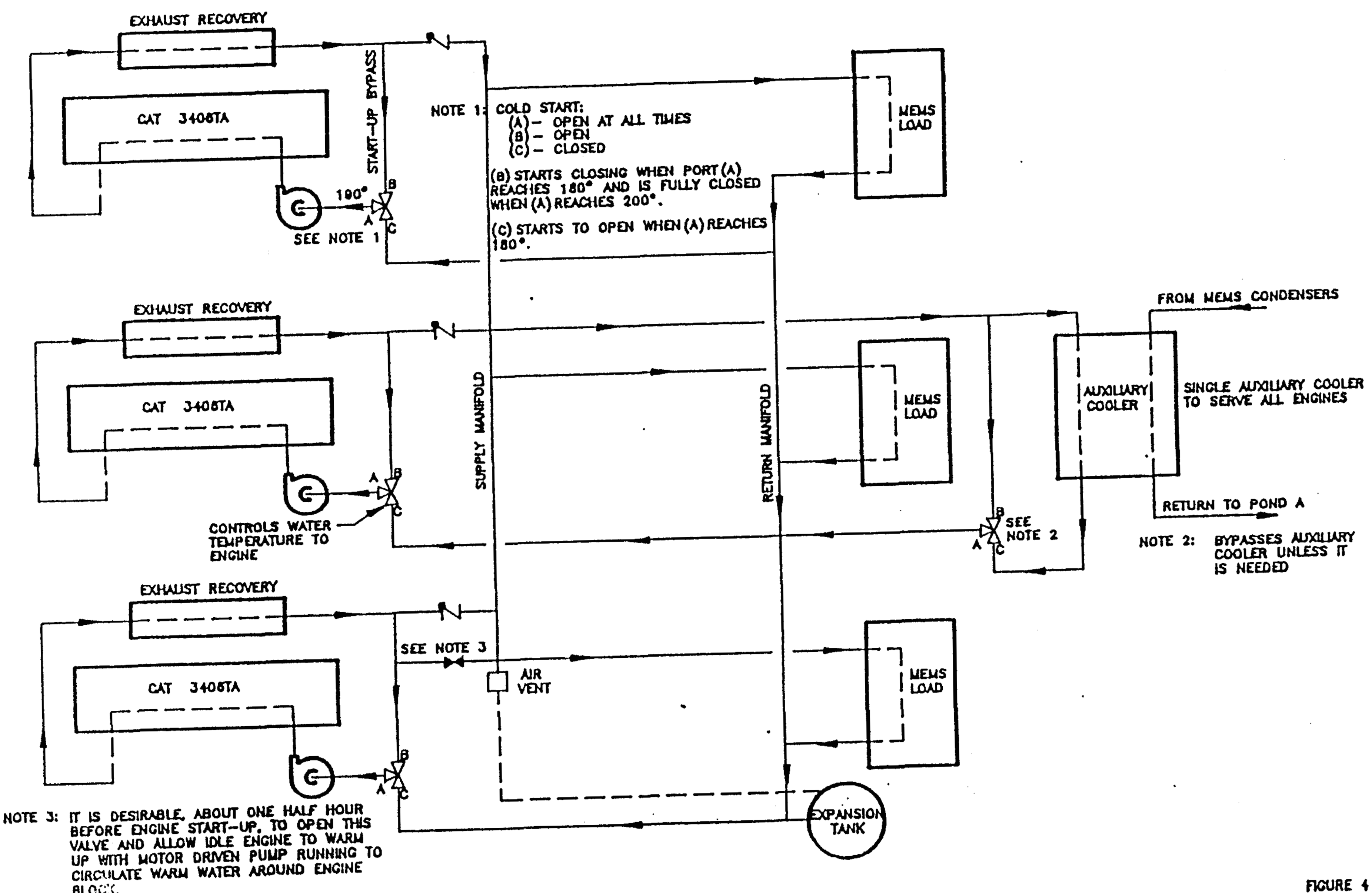


FIGURE 4
OCTOBER 10, 1990

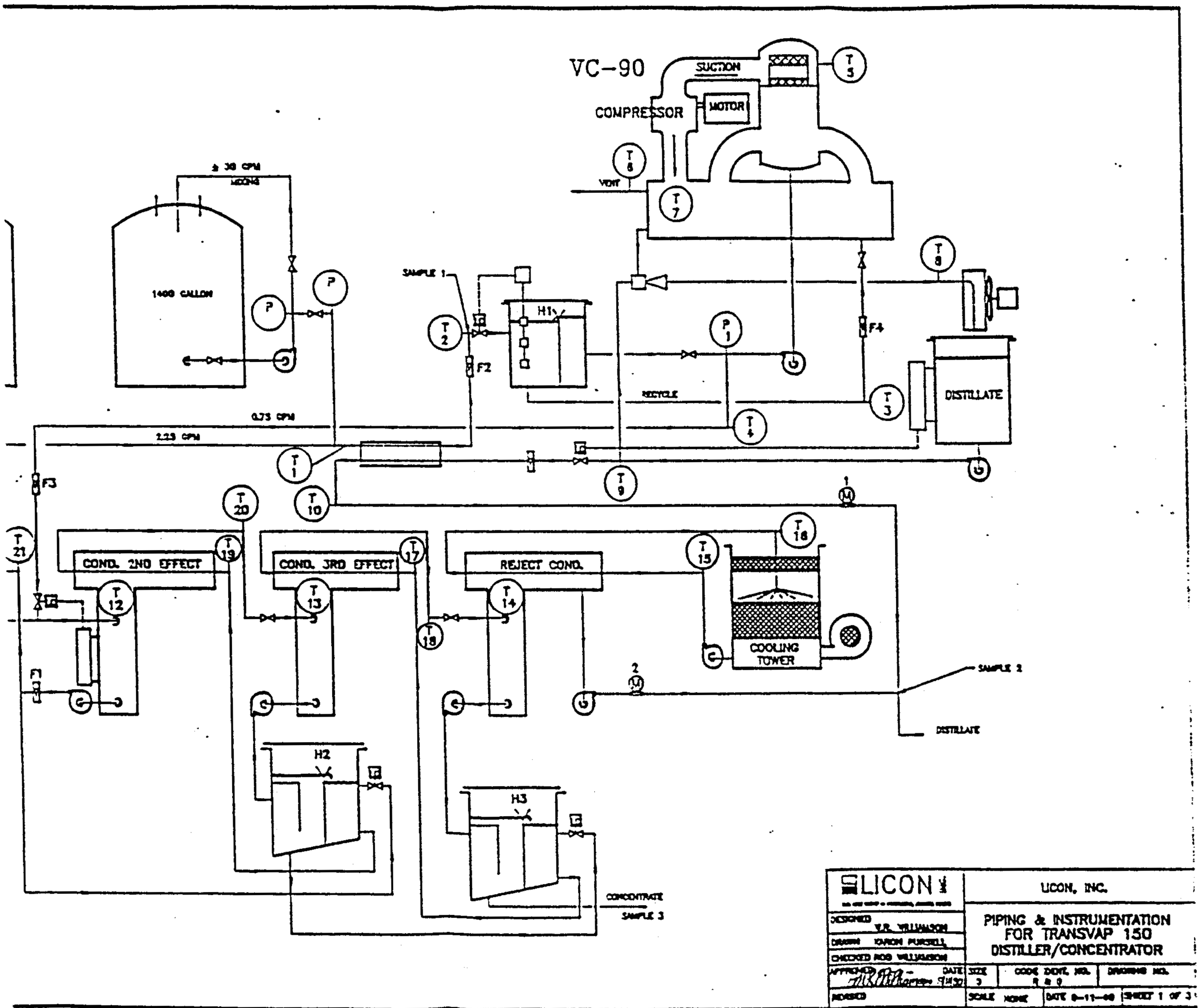
TEST SUMMARY USING SIMULATED ROCKY FLATS POND WATER

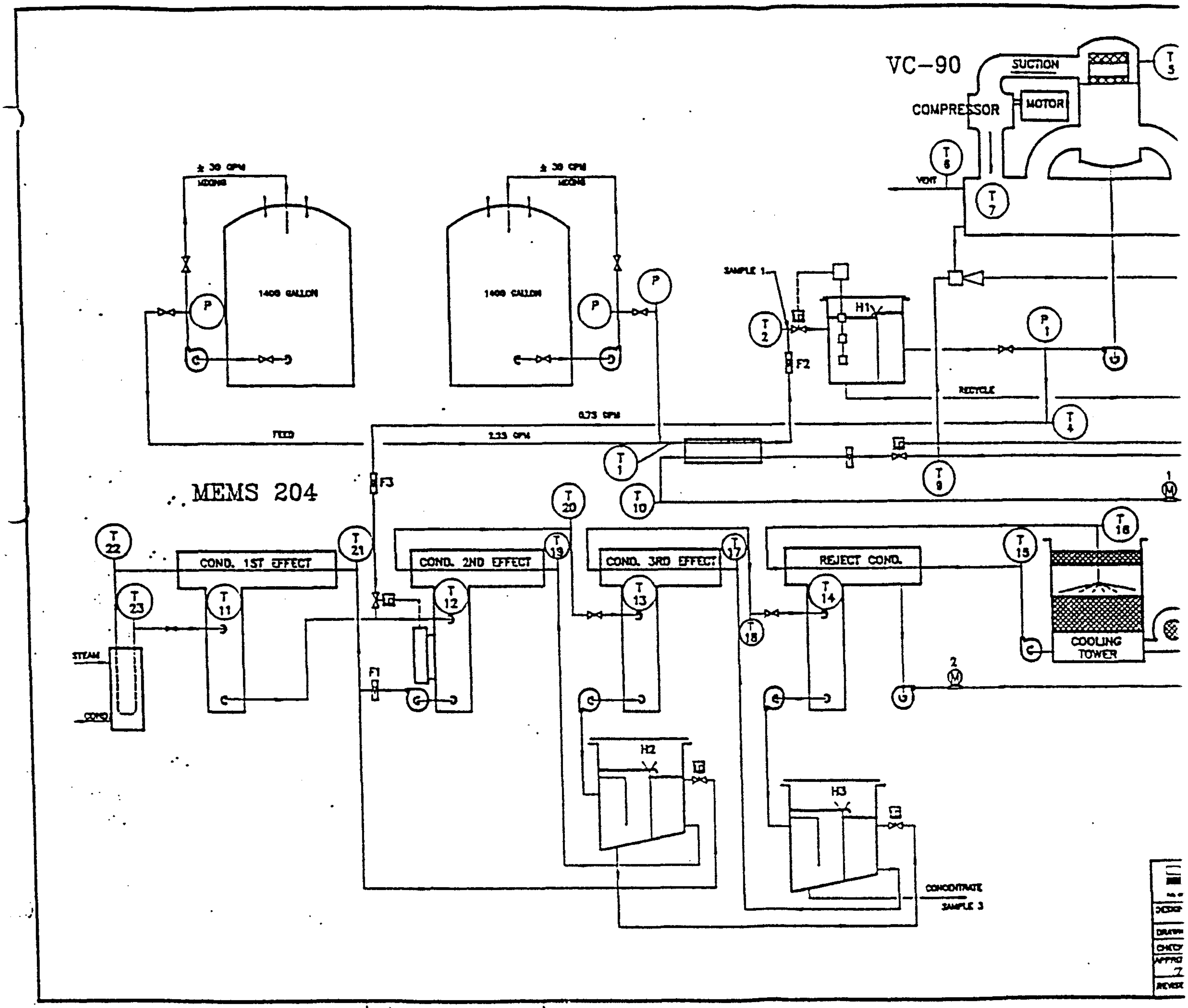
E G & G prepared a test agenda outline in the Appendix 'A' as 'LICON EVAPORATOR TEST REQUIREMENTS'. Anticipating problems in achieving the degree of concentration required, LICON prepared a supplement Appendix 'B' including a P & I diagram dated 10 September 1990 (Fig. No. 5).

Test No. 1, September 13 1990

Pond A water was tested in accordance with above as detailed in the report in the Appendix 'C'. In essence, this test revealed how complex these pre-trial tests were going to be if we wanted to attain some indication of the concentration ratios to be expected in the field. The chloride readings made us suspicious of the chemical analysis done by the local testing laboratory, Analytic Technologies (1), so we had Rob Farrell of ChemTreat do some testing with his HACH KIT (2). See Table No. 1

Except for the Chloride differences in the Feed and the Concentrate there was some good correlation in the distillate analysis. If Analytic's TDS is correct and Farrell's conductivity is correct then the factor to convert from MS to TDS is 0.825 which in turn does not seem to apply to the distillate which is 2.93. In any event the distillate is good but the concentration ratio is low, and will require further modification of the test procedure. The chemical results are averages for the entire run in accordance with E G & G test requirements. The final concentration was actually closer to 10 to 1 - still not good enough. Listed in the attached detailed report Appendix 'C' are the modifications we made to attain higher concentration ratios including sampling pots to more closely track the distillate quality.


VC-90
SUCTION
COMPRESSOR
MOTOR
VENT
1400 GALLON
SAMPLE 1
H1
RECYCLE
DISTILLATE
0.75 GPM
F2
F3
F4
F1
COND. 2ND EFFECT
COND. 3RD EFFECT
REJECT COND.
COOLING TOWER
SAMPLE 2
DISTILLATE
H2
H3
CONCENTRATE
SAMPLE 3
LICON
LICON, INC.
PIPING & INSTRUMENTATION
FOR TRANSVAP 150
DISTILLER/CONCENTRATOR
DESIGNED
DRAWN
CHECKED
APPROVED
DATE
SIZE
REVISED
SCALE NONE
SHEET 1 OF 3



VC-90
SUCTION
COMPRESSOR
MOTOR
VENT
1400 GALLON
1400 GALLON
SAMPLE 1
H1
F2
RECYCLE
FEED
0.75 GPM
2.33 GPM
F3
MEMS 204
COND. 1ST EFFECT
COND. 2ND EFFECT
COND. 3RD EFFECT
REJECT COND.
COOLING TOWER
STEAM
COND
F1
H2
H3
CONCENTRATE
SAMPLE 3

LICON INC.

Revision 1

TEST NO. 1, JOB 901 - ROCKY FLATS SYNTHETIC POND A WATER

Summary of Test Results and Conclusions

Initial test required the following list of chemicals mixed in a 1400 gallon tank full of Pensacola city water during the evening of 12 September 1990, under the direction of engineers from Rocky Flats.

	lb/1000 Gal.	lb/1400 Gal.	Grams added
Calcium Nitrate [$Ca(NO_3)_2$ 3 H_2O]	2.5	3.5	1587.6
Sodium bicarbonate ($Na\ H\ CO_3$)	0.42	0.6	272
Potassium Chloride (KCI)	4.1	5.75	2608
Sodium Carbonate ($Na_2\ CO_3\ H_2O$)	0.1	0.14	63.5
Sodium Nitrate ($Na\ NO_3$)	4.2	5.9	2676
Magnesium Sulfate ($Mg\ SO_4$ 7 H_2O)	6.75	9.5	4309
Sodium Hydroxide (Na OH)			500

pH = 9.3

This initial test was started at 0700 on 13 September 1990. Both the VC 90 and the MEMS 204 were filled to operating levels requiring 400 gallons of the above solution. Start-up was somewhat erratic because the maximum amount of feed attainable was only 3 GPM even with the feed solenoids bypassed. When the VC came on line it was making in excess of 100 GPH and there was not enough blowdown to satisfy the demand of the MEMS unit which was also having problems with interrupted steam supply due to a faulty fire-eye. The VC 90 capacity was cut back slightly by lower the suction temperature adjustment to the compressor; also the MEMS top temperature was reduced and thus combined capacity was lowered from 200 GPH to the target capacity of 150 GPH (1/5th Rocky Flats size).

18 Sep 90

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The operators got used to compensating for the low feed rates and the run was successfully completed. By shutting down the VC and using its residue to feed the MEMS and then shutting down the MEMS when it reached critical low levels for adequate circulation, the residue was reduced from 400 gallons to less than 200. We then made some piping changes and rigged to pump out the top two stages to the third stage. The top two stages were rigged to operate on city water at 1400 hr. This procedure enabled us to dewater the 1400 gallons down to 104 gallons. Samples of the final residue were collected for chemical analysis. This initial test indicated the desirability of making the following changes to achieve greater concentration ratios and to acquire better distillate quality.

1. Since we were only able to acquire about 14 to 1 concentration ratio, the Rocky Flats engineers provided the following higher weight listing of chemicals for our next test.

	lb/1000 gal.	lb/1400 gal.
Calcium Nitrate	2.5	3.5
Sodium bicarbonate	5.0	7.0
Potassium Chloride	20.0	28.0
Sodium Carbonate	7.5	10.5
Sodium Nitrate	38.0	53.2
Magnesium Sulfate	30.0	42.0

pH = 7.5

2. The VC distillate was not as good as the MEMS distillate so we decided to try a single, denser mesh to replace our standard two stage lower density mesh. This change had been effective at Blue Bird Body where there are 2-VC 600's in operation on alkaline waste water.

3. Sampling pots similar to those used on the test of the VC 300 for Three Mile Island were added to the eductor suction of the VC 90 and to the fourth stage eductor suction of the MEMS 204. These were added to assure that there was no downstream contamination from regenerative heaters or pump seals. Any leakage at these sources however would be in the other direction since the distillate pressure is normally higher than the concentrate. Because of step 4 however we thought this would be a good idea and sampling under vacuum might provide a clue as to any gaseous carry-over.

4. A higher pressure feed pump was added to alleviate the problems associated with low feed rates.

[illegible] 18 Sept 90

5. The start-up procedure was changed. Only the VC 90 would be filled from the feed tank and then run at full capacity blowing as much of its resultant concentrate to the MEMS until the MEMS was full of VC concentrate. Only then would the MEMS be started and thus would be operating on higher density feed stock. This also would allow easier start-up since the MEMS would not be robbing heat from the VC while steady state conditions were being achieved.

cc: L. Eng - Rocky Flats
C. Hughes - Licon
R. Williamson - Licon

NOTE: This revision 1 corrects errors on page 2 of FAX sent to Mr. Eng 9.17.90

[handwritten initials] 18 Sept 90

LOG SHEET ON ROCKY FLATS POND WATER TESTS
JOB NO. 901

POND WATER A DATE: 9-13-90

TIME:	7:00	7:30	8:00	8:30	9:00	9:30	10:00	10:30	11:00
TEMPERATURES:									
T1 FEED SUPPLY	84	84	84	84	84	84	84	84	84
T2 FEED TO VC	134	201	130	130	137	136	119	140	141
T3 VC RECYCLE FEED	172	187	166	172	178	170	174	172	176
T4 BLOWDOWN TO MEMS	123	160	168	164	165	166	161	166	166
T5 VC SUCTION	148	176	172	170	175	174	171	170	171
T6 VC VENT	158	193	183	185	190	190	188	186	188
T7 VC CHEST	159	195	185	187	192	191	189	188	190
T8 VC EDUCTOR DISCH.	146	186	174	183	188	188	186	186	185
T9 VC DISTILLATE IN HX	142	175	165	179	182	183	180	181	180
T10 VC DIST. OUT HX	100	98	99	96	99	100	94	98	98
T11 1ST FLASH VAPOR	155	160	156	149	155	154	161	169	168
T12 2ND FLASH VAPOR	148	157	150	143	150	149	152	157	159
T13 3RD FLASH VAPOR	129	130	132	134	133	130	133	133	133
T14 4TH FLASH VAPOR	78	111	134	136	134	129	126	118	116
T15 COOLANT INLET	77	99	88	88	88	84	84	100	101
T16 COOLANT OUTLET	74	108	88	88	88	94	100	108	110
T17 4TH FLASH CONC.	90	111	123	121	130	120	124	116	116
T18 4TH FLASH FEED	101	127	132	133	133	128	131	128	129
T19 3RD FLASH CONC.	132	138	140	141	145	140	140	140	141
T20 3RD FLASH FEED	146	154	147	144	145	145	149	151	152
T21 2ND FLASH CONC.	147	156	150	142	143	145	154	156	156
T22 FEED TO HTR.	155	160	156	151	159	157	159	161	161
T23 OUTPUT FROM HTR.	161	178	167	155	155	161	165	168	170
F1 FIRST STAGE RECYCLE	40GPM	40GPM	15	22GPM	40	25GPM	40GPM	40	40GPM
F2 VC FEED RATE	1.0	3/4	3/4	3/4	1.3	3/4	1 3/4	3/4	3/4
F3 VC BLOWDOWN	.8	1.0	.4	1.0	0	1.3	1.0	1.0	1.2
F4 VC RECYCLE	2 3/4	3 3/4	3.5	3.5	3.5	3 3/4	4	3.5	3.5
H1 VC BRINE WEIR	1"	1"	1"	1"	3/4"	1"	1"	1"	1"
H2 3RD STAGE WEIR	2 1/4	2 1/4	2 1/4	2 1/4	2 3/4	3"	3"	3"	3"
H3 4TH STAGE WEIR	2 1/4	2 1/4	2 1/4	2 1/4	2 3/4	3"	3"	3"	3"
FEED TANK LEVEL		1000	875	825	725	675	625	550	450
M1 VC DISTILLATE 459	(9) 448	(37) 505	(57) 562	(40) 602	(44) 645	(57) 702	(47) 749	(28) 777	(57) 834
M2 MEMS DISTILLATE 15797	(2) 15799	(37) 15836	(43) 15879	(14) 15893	(31) 15924	(21) 15945	(34) 15979	(36) 16015	(50) 16065
M3 COMBINED DIST.	11	74	100	54	77	75	81	64	109
V VOLTAGE	475	475	475	475	475	475	475	475	475
A AMPS	40.3	37	34	55	53.[illegible]	53.4	55.9	[illegible]	35
KW KILOWATTS	32	21.3	19.5	36	36.2	36.2	37		

LOG SHEET FOR WATER SAMPLES

JOB ORDER 901

DATE: 9/13/90										
TIME:	7:00	7:00	7:30	8:00	8:30	9:00	9:30	10:00	10:30	11:00
POND A								A/Sc		
CONDUCTIVITY FEED #1		--		---	-			2.55		
DIST. #2	48	40	63	64.	53	61	56	64	76.1	64
CONC. #3	—	—	—	—	—	—				
pH FEED #1	9.3	9.2	9.3	9.4	8.9	8.9	9.1	9.1	9.0	9.0
DIST. #2				8.1	8.1	8.2	7.7	7.9	8.2	8.3
CONC. #3	9.3	9.2	9.1	9.0	8.5	8.2	8.6	8.7	8.7	8.7
POND BN										
CONDUCTIVITY FEED										
DIST.										
CONC.										
pH FEED										
DIST.										
CONC.										
POND BC										
CONDUCTIVITY FEED										
DIST.										
CONC.										
pH FEED										
DIST.										
CONC.										
POND BS										
CONDUCTIVITY FEED										
DIST.										
CONC.										
pH FEED										
DIST.										
CONC.										

Started Bring in Feed to Tanks at 5:30. Tank Filled By 6:15 Started Pulling Vacuum. Started Compressor at 6:37. Started Steam to Flash at 6:40. Took Approx. 300 Gal To Fill Tanks.

LOG SHEET ON ROCXY FLATS POND WATER TESTS
JOB NO. 901

POND WATER A

DATE: 9-13-90

TIME:	11:30	12:00	12:30	1:00	1:30	2:00	2:30	3:00	3:30	4:3
TEMPERATURES:										
T1 FEED SUPPLY	84	84	84	84	84					
T2 FEED TO VC	132	134	156	132	130					
T3 VC RECYCLE FEED	166	158	160	166	160					
T4 BLOWDOWN TO MEMS	162	160	159	157	159		160	—		
T5 VC SUCTION	165	164	164	165	165					
T6 VC VENT	180	178	179	180	148					
T7 VC CHEST	182	180	180	182	180					
T8 VC EDUCTOR DISCH.	179	178	177	177	177					
T9 VC DISTILLATE IN HX	174	176	173	179	173					
T10 VC DIST. OUT HX	96	96	94	94	94					
T11 1ST FLASH VAPOR	174	174	178	178	166	174	182	182	176	17
T12 2ND FLASH VAPOR	162	162	167	165	158	162	176	176	164	16
T13 3RD FLASH VAPOR	135	135	138	138	135	134	164	166	140	1
T14 4TH FLASH VAPOR	117	116	120	120	116	116	130	130	120	1
T15 COOLANT INLET	101	100	101	102	101	100	85	85	103	1
T16 COOLANT OUTLET	111	110	113	113	111	110	88	88	114	9
T17 4TH FLASH CONC.	116	116	120	120	117	118	[illegible]	163	121	11
T18 4TH FLASH FEED	130	129	134	134	129	129	[illegible]	162	133	1
T19 3RD FLASH CONC.	143	142	147	146	142	142	[illegible]	174	150	1
T20 3RD FLASH FEED	155	154	160	164	152	155	[illegible]	175	160	1
T21 2ND FLASH CONC.	161	160	165	165	158	160	[illegible]	176	165	16
T22 FEED TO HTR.	164	163	167	166	161	163	[illegible]	170	165	1
T23 OUTPUT FROM HTR.	171	171	178	174	172	171	[illegible]	174	173	1
F1 FIRST STAGE RECYCLE	40 GPM	40 GPM	40+ GPM	40+ GPM	25 GPM	40+ GPM		40+	40+	4
F2 VC FEED RATE	3 1/4	3 1/4	2 1/2	3 1/4	3 1/4	—		—	—	—
F3 VC BLOWDOWN	1.2	1.3	1.2	1.3	1.3	2		—	—	—
F4 VC RECYCLE	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	—		—	—	—
H1 VC BRINE WEIR	3/4"	3/4	1/2"	3/4"	3/4	—		—	—	—
H2 3RD STAGE WEIR	3"	3"	3"	3"	3"	3"		3"	3"	3
H3 4TH STAGE WEIR	3"	3"	3"	3"	3"	3"		3"	3"	3
FEED TANK LEVEL	375	325	225	150	75	0		—	—	—
M1 VC DISTILLATE 836	(42) 878	(47) 925	(38) 963	(31) 994	(42) 1036	(33) 1069	OFF	—	—	—
M2 MEMS DISTILLATE 16065	29 16094	51 16145	45 16190	51 16240	35 16275	34 16309	16346	16382	16392	1
M3 COMBINED DIST.	71	98	83	81	77	(67)				
V VOLTAGE	475	475	475	475	475	475				
A AMPS	32.4	52	32	51	51	—				
KW KILOWATTS										

LOG SHEET FOR WATER SAMPLES

JOB ORDER

DATE: 1/13/90										
TIME:	11:30	12:00	12:30	1:00	1:30	2:00	2:30	3:00	3:30	4:00
POND A										
TANK ms/cm CONDUCTIVITY FEED #1	2.56	2.67	2.67	2.57	2.57	—	—	—	—	—
Combined DIST. #2	50.0	52.5	51.5	46.2	51.3	21.8	—	—	—	—
ms/cm CONC. #3	6.73	8.00	9.45	10.65	11.87	9.97	13.83	14.41	16.19	19.14
pH FEED #1	8.9	8.9	8.9	8.8	8.8	—	—	—	—	—
Combined/DIST. #2	8.1	8.1	7.8	7.5	7.5	8.2	8.2	7.8	7.5	7.5
Flash CONC. #3	8.7	8.7	8.7	8.7	8.7	8.7	8.6	8.2	8.5	8.6
POND BN										
CONDUCTIVITY FEED										
DIST.										
CONC.										
pH FEED										
DIST.										
CONC.										
POND BC										
CONDUCTIVITY FEED										
DIST.										
CONC.										
pH FEED										
DIST.										
CONC.										
POND BS										
CONDUCTIVITY FEED										
DIST.										
CONC.										
pH FEED										
DIST.										
CONC.										

Rocky Flats, Col. 9/13/90 RICHARD W. BOOTHE

TIME	700	800	830	900	930	1000	1030	1100	1130	1200	1230
VC FEED PH	—	9.4	8.9	8.8	9.1	9.1	9.0	9.0	8.9	8.9	8.9
FLASH DIST/COND. µS/cm	27.6	31.3	—	23.3	17.7	15.9	11.1	11.1	7.1	5.5	5.4
FLASH DIST/PH	—	9.0	—	7.4	7.2	7.8	7.9	8.4	7.9	7.5	7.1
VC DIST /COND. µS/cm	58.7	54.6	—	34.9	38.9	37.0	39.3	46.3	43.8	47.1	48.5
VC DIST/PH	—	9.4	8.9	8.8	7.1	7.4	7.4	7.7	7.7	7.3	7.3
DIST/COMBINED COND µS/cm	40.0	64.0	53.0	61.0	56.5	64.0	76.1	64.8	50.0	52.5	51.5
DIST/COMBINED PH	—	—	8.1	8.2	7.7	7.9	8.2	8.3	8.1	8.1	7.8
FLASH CONC. PH	9.2	9.4	8.5	8.2	8.6	8.7	8.7	8.7	8.7	8.7	8.7
VC CONC. PH	9.2	9.0	8.4	8.2	8.2	8.2	8.2	8.3	8.3	8.2	8.3

TIME	100	130	* 200	230	300	330					
VC FEED PH	8.8	8.8	—	—	—	—					
FLASH DIST/COND.	4.1	5.1	5.1	8.0	15.9	179.2					
FLASH DIST/PH	7.5	7.6	8.0	8.2	7.8	7.5					
VC DIST /COND.	48.6	47.7	44.3	41.9	—	—					
VC DIST/PH	7.1	7.1	7.4	7.4	7.4	—					
DIST/COMBINED COND.	46.2	51.3	*21.8	—	—	—					
DIST/COMBINED PH	7.5	7.5	8.2	8.2	7.8	7.5					
FLASH CONC. PH	8.7	8.7	8.7	8.6	8.2	8.5					
VC CONC. PH	8.3	8.2	8.2	8.3	—	—					

* change over from VC to 4th Stage of Flash Unit
Combined Distillate conductivity down due to reduced flow/cut back to 1/3 gt

APPENDIX 'D'

TABLE 1
SUMMARY OF ANALYSIS BY ANALYTIC TECHNOLOGIES (1)

Performed on water samples taken on September 13, 1990
compared to ChemTreat Analysis done by Rob Farrell on October 2, 1990 (2)

PARAMETER	FEED (1)	FEED (2)	DIST (1)	DIST (2)	CONC (1)	CONC (2)	FILTERED (2)
P ALKALINITY	–	3	–	0	–	0	–
M ALKALINITY	128 *	47 *	19	17	–	179 *	50
TOTAL HARDNESS	–	403	–	3.9	–	1444	1454
pH	9.01	8.86	7.24	7.27	8.78	8.33	–
CALCIUM	81	79	BDL	1	165	297	290
CARBONATE	11 *	–	BDL	–	3 *	–	–
CHLORIDE	2387	374	2	–	829	1024	–
POTASSIUM	307	–	2	–	1000	–	–
MAGNESIUM	88	324 *	0.62	2.9 *	305	1147 *	1167 *
NITROGEN (NITRATE)	164	–	1.1	–	500	–	–
SODIUM	218	–	1.9	–	800	–	–
SULPHATE	496	–	4	–	1211	–	–
TDS	1898	–	12	–	6706	–	–
SS	3197	–	–	–	23	–	–
CONDUCTIVITY (MS) MICROSIEMENS	–	2300	–	4.1	–	–	–

* as $CaCO_3$

TEST NO. 2, September 14 and 15 1990

Summarizing the attached detailed test report, Appendix 'D'; it turned out that a very fortunate error was made in mixing the chemicals. The calcium and sodium amounts got switched and we actually handled fifteen times the amount of calcium that had been estimated for the ponds. Since the calcium has much lower solubility than sodium, this error furnished some very valuable information during the test.

We first noticed that the distillate water purity was to say the least, unacceptable and the rate of scaling on the heat transfer surfaces was alarming. We found that acid would remove the scale and the evolution of CO_2 indicated $CaCo_3$ scale, common in sea water evaporators and easily controlled by acid injection.

It was decided to continue the test on the remaining water using acid injection, as is done in sea water distillation. Again, fortunately the only acid we had in enough quantity was EDTA (HAMP-ENE ACID) or ethylenediaminetetraacetic acid. This acid was added at a rate of eight pounds per thousand gallons with the following unexpected results (serendipity).

1. The milky solution in all tanks became crystal clear

2. The VC distillate conductance fell rapidly from 350 MS (microsiemens) on the previous run without the acid, down to less than 10 MS.

3. The alkaline scale that had been deposited on the VC heat transfer surfaces was, as expected, being rapidly dissolved by the acidic conditions.

Rob Farrell of ChemTreat said he had observed similar phenomena as observation No. 2 in his feed treatment of boilers. When the alkalinity is reduced, he had noticed an improvement in steam quality but not to the remarkable degree observed here.

<u>TEST NO. 3, September 24, 25 and 26 1990</u>
See Appendix 'E' for Log Sheets

In order to attain a high enough concentration ratio it was decided to employ both storage tanks for a total of 2800 gallons and evaporate this quantity down as low as possible from mixture of the following chemicals per 1400 gallons:

Calcium Nitrate	3.5 lb
Sodium bicarbonate	7.0 lb
Potassium Chloride	28.0 lb
Sodium Carbonate	10.5 lb
Sodium Nitrate	53.2 lb
Magnesium Sulphate	42.0 lb
	144.2 lb

Initial testing started 24 September 1990 at 1000 hr. with above solution having a resultant pH of 9.7. Scale started to form on the VC heating bundle so we added 0.5 lb. EDTA to VC concentrate tank at 1200 hr. bringing pH down to 6.5 and bundle started to clean - pH was back to 8.5 at 1230 so we added another 0.5 lb. and brought pH back to 6.5. This demonstrated feasibility of cleaning while operating. Notice that delta T of compressor fell from 17° to 15° (T6-T5) after acidification and resultant cleaning. We shut down at 1310 awaiting arrival of E G & G engineers.

With E G & G engineers present we restarted the next day, the 25th at 1430 after adding 5 lb. of EDTA to 650 gallons remaining in tank No. 1 making a total of 6 lb. added to the original 1400 gallons and ran until 1830, when supply from tank 1 was exhausted.

Restarted the next day, the 26th at 1000 hr. after adding 9 lb. EDTA to 1400 gallons in tank 2, bringing the pH down from 9.7 to 8.1 but feed averaged 8.6 and gradually rose to 9.0 indicating poor mixing or a reaction in the tank. Operation continued until 2045 hr. when the entire 1400 gallons was processed and the VC could no longer operate because of low level in the VC concentrate tank. One of the readings that had plague us was the fact that the combined distillate readings were always higher than the individual readings from both the VC and the MEMS - we finally discovered at 1400 hr. that a drain line from the VC concentrate tank had a minute leak into the combined distillate line which we fixed and the combined dropped from 150 to 40 microsiemens with 30 in the VC. As the concentration increased, the VC rose to 70 and the combined was 70 with the flash at 10 microsiemens. Lower alkalinity would probably have improved the VC distillate but these readings were within specifications. The VC was shut down at 2040 hr. and its residue was blown down to the MEMS which continued to operate until 2100 hr. The conductivity of the supernatant by dilution ratio was 222,800 MS. on shutdown with an estimated residue of about 150 gallons in the system.

<u>TEST NO. 4, September 27 1990</u>

In order to attain still higher concentration some minor piping changes to the MEMS enabled us to drain the top two stages into the third and fourth stage concentrate tanks. We rigged the second stage eductor to a separate tank so that we could still monitor distillate quality at higher concentrations in the fourth stage flash.

The test was continued at 1200 hr. and the concentrate from the 2800 gallons was dewatered down to 85.44 gallons by 1500 hr. - a volume reduction of 32.75 to 1. The next day Rob Farrell checked the chloride ratio at 27.57 to 1. Some concentrate may have been lost in the transfer and we may have lost some Chloride. The concentrate in the fourth stage, again by dilution ratio, was 390,000 microsiemens and if we use the 0.825 factor we arrive at 320,000 ppm - a pretty good check. Also the ratio of Test No. 1 feed with 25.4 lb. of chemicals added provided TDS of 1898 and conductivity of 2300 MS would extrapolate with 144.2 lb. for test 3 to 10,775 ppm and 13,057 microsiemens - by proportionating, we calculated 13,600. If we average this at 13,330 MS and ratio it to 390,000 we have 29.25 - another good check 10,775 x 29.25 = 315,000 ppm. It should be safe to assume the concentrate was in the range of 300,000 ppm based on 10,000 ppm feed. There was still no great amount of precipitation and most important the supernatant was still pumpable. Table 2 lists the data recorded.

TEST NO. 5, October 1 1990

Since the concentrate was still pumpable we made some more piping changes to allow operating only the fourth stage of the MEMS with the 85 gallons of concentrate in the 4th stage tank. We expected some dramatic results to happen very quickly so we did not bother with taking logs. The following data was collected while evaporating at a rate of about 15 GPH.

	Dist. Cond.	Dist. pH	Conc. pH	Conc. Cond.
Start	17 MS		7.9	390,000 MS
	9 MS	9.1	7.3	587,000 MS
	21 MS	8.6	6.6	789,000 MS
Finish	36 MS	8.5	6.6	1,055,000 MS

TABLE 2
DATA RECORDED FOR TEST 4

SEPTEMBER 27, 1990

TIME	1200	1230	1300	1330	1400	1430	1500
3rd Stage pH	8.6	8.3	8.3	8.2	8.2	8.2	8.1
MS/cm-Cond	157,500		178,920		212,520		241,500
4th Stage pH	8.4	8.3	8.2	8.1	8.1	8.0	7.9
MS/cm-Cond	228,480		261,030		286,860		389,760
Dist. pH	9.9	8.8	7.7	7.2	7.5	7.3	6.7
MS/cm-Cond	0.53	0.12	0.06	0.02	0.07	±0.12	0.017
3rd Stage Ratio	12:1		13.64:1		16.20:1		18.5:1
4th Stage Ratio	17.5:1		19.89:1		21.86:1		30:1

Concentrate left in 4th stage tank — 85.44 Gallon residue

We were amazed how well the salts remained in solution or in fine suspension up to 800,000 MS but then the solution started to precipitate and we had to shut down. The supernatant was proportioned to be about one million microsiemens. The final volume was 20 gallons plus some lost in transfer.

Test No. 4 provided the criteria for immediately estimating results

Safe operation at 650,000 ppm

Maximum obtainable 825,000 ppm

Concentration Ratio w/10,000 ppm feed

Safe at $\frac{650,000}{10,775}$ = 60 to 1 ppm

Maximum $\frac{1,055,000}{13,300}$ = 80 to 1 cond.

Weight Analysis: The 20 gallons of concentrate weighed 256 pounds or a specific gravity of 1.5. Since 142.2 lb. of chemicals were added, the balance must be free water and or water of hydration. Weight wise the ratio is 90 to 1.

CONCLUSIONS AND RECOMMENDATIONS

Supplementing the Executive Summary, it is reasonable to conclude the following from the tests provided the synthetic pond water closely approximates actual conditions.

1. Control of alkalinity is vital from the standpoint of acquiring high purity distillate and the elimination of alkaline scales such as calcium carbonate and magnesium hydroxide. EDTA is recommended at a rate of at least 6 lb. per 1000 gallons but this rate may be reduced with the use of polymers which will involve field testing to optimize minimum injection rate.

2. If scaling or distillate impurity should occur the EDTA can be increased during operation. The second stage MEMS eductor will handle any gassing of CO_2 from the chemical reactions..

3. The EDTA evidently also aids in tying up the calcium and magnesium ions to prevent precipitation and allows concentration to proceed safety to as high as 60%. Further dewatering or drying can be accomplished with a pot dryer using additional heat from the engines by water washing the stack gases. If this is of interest please advise.

4. It can also be concluded that should other sites involve high calcium content these too can be handled but the concentration ratio may not be as high because of the lower solubility of calcium. Concentrate samples from test No. 2 has been saved for your chemical analysis, should you desire to investigate this further.

5. Modified test runs were made possible by eliminating the cost of needless chemical analysis. Simpler mechanical methods

that proved more fool proof were developed to quickly determine the concentration ratios and distillate purity. Samples have been saved and we recommend that your own laboratory do any chemical analysis you may require. If so, please advise shipping instructions - all together the volume of samples and [redacted] concentrate is about 50 gallons. The concentrates in particular may prove valuable for establishing cementing techniques.

APPENDIX 'A'

From Lewis Exp 9.6.90

LICON EVAPORATOR TEST REQUIREMENTS

VC50 in series with Mems 204

1. Test Time
   Four tests of 12 hours each, totaling 48 hours. These tests will be run September 12 through September 14.

2. Test Mode
   One test for each type of feed (Each type of feed must simulate the pond water of Pond 207A or Pond 207B North or centre or South). Feed rate for each test shall be ~~1.25 gpm normal up to 2 gpm maximum.~~ 2.25 ± 0.25 gpm

3. Sampling Frequency
   A feed sample shall be collected at the beginning of each test. Composite samples of distillate and concentrate stream shall be collected for each test and shall be made up by a series of four ounces sub-samples collected every 30 min.

4. Sample Distribution
   All sub-samples shall be collected in a ~~glass~~ polypropylene jar large enough, to hold 3/4 of a gallon in volume. Each composite sample shall be divided into two equal parts. One part is for LICON's analysis, the other part will be sent to Rocky Flats for references. All samples shall be placed in glass jars with teflon lined lids and clearly labeled.

Sample total	LICON	Rocky Flats
Feed	4	4
Composite Distillate	4	4
Composite Concentrate	4	4

5. Process Readings
   Conductivity, temperature, pressure, power input and output, and flow rate of feed and discharge, shall be recorded every 30 min. while tests are being run. Test summary report shall indicate the length of time to start up each system, at what point steady state was achieved, and intermitten changes of flow rate.

6. Analysis

Each sample taken from the feed, distillate, and concentration shall be analyzed for the following compounds.

Feed	Distillate	Concentrate
Alkalinity	Alkalinity	-
Carbonate	Carbonate	Carbonate
Nitrate	Nitrate	Nitrate
Sulfate	Sulfate	Sulfate
TDS	TDS	TDS
Calcium	Calcium	Calcium
Magnesium	Magnesium	Magnesium
Potassium	Potassium	Potassium
Sodium	Sodium	Sodium
pH	pH	pH
TSS	-	TSS

7. Feed Stream Preparation

Four types of waste water shall be prepared by LICON to simulate each of the four ponds at the Rocky Flats Plant. The Feed Stream shall be mixed continuously for a minimum of 8 hours prior to test and shall be mixed in feed tank during the test.

Each feed stream shall be prepared as follows:

To tap water add the following chemicals in the amount shown.

Chemicals	Lbs/1000 Gals of Water			
	Pond A	BN	BC	BS
Calcium Nitrate ($Ca(NO_3)_2 \cdot 3H_2O$)	2.5lb	7.5	.8	1.1
Magnesium bicarbonate ($MgHCO_3$)	2.7lb	2.5	4.1	4.1
Potassium Chloride (KCl)	4.1	1.1	9.1	10.5
Sodium Carbonate ($Na_2CO_3 \cdot H_2O$)	.1	5.2	4.7	1.1
Sodium Nitrate ($NaNO_3$)	4.2	10.4	16.8	8.7
Sodium Sulfate ($Na_2SO_4 \cdot 7H_2O$)	4.2	13.7	15.9	7.7
Sodium Chloride ($NaCl$)	-	4.8	-	-
pH	10-11	10-11	10-11	10-11

All pH adjustments shall be made with sodium hydroxide or hydrochloric acid.

Disposal of waste water shall be the responsiblity of LICON.

8. Deliverables
   Complete test equipment set up diagram and data form shall be delivered a minimum of 3 days prior to test for approval.

   Final report shall be delivered 3 working days following the completion of test activities.

   The final report shall include:
   1) brief system description

   2) observations

   3) collected data
      (i.e. conductivity, temperature, pressure, and flow rate)

   4) analytical results

   5) conclusions

9. Test Observations
   Rocky Flats personnel will observe at least one test start up ánd one test completion.

APPENDIX 'B'

PROCEDURE FOR TESTING POND WATER SIMULATION
AT ROCKY FLATS PER JOB ORDER
EMPLOYING LICON'S VC 90 AND MEMS 204

TEST NO. 1 — Pond A Water $17.8/8333 \times 10^6 = 2136$ ppm

Run both plants at design conditions, 175-180°F suction temperature in VC (T5) and 180-185°F top temperature (T23) when 1400 gallon tank is empty - shut down VC plant. Run MEMS until VC shell and tank are drained and continue running MEMS until Flash Chambers and tanks 3 and 4 are at lowest level possible. Shut down MEMS and drain all residue to collector tank.

TEST NO. 2 — Pond BC Water $51.4/8333 \times 10^6 = 6168$ ppm

Same as above.

TEST NO. 3 — Pond BS Water $33.2/8333 \times 10^6 = 3984$ ppm

Same as above.

TEST NO. 4 — Pond BN Water $45.2/8333 \times 10^6 = 5424$ ppm

Run same as Test 1 except pump residue in stages 1 and 2 to tanks 3 and 4.

TEST NO. 5 — Degree of Concentration Attainable

Repipe MEMS to use city water as feed to stages 1 and 2. Start MEMS using concentrate from collector tank to feed stage 3 tank and run until precipitation occurs in either or both tanks, 3 and 4.

APPENDIX 'C'

LICON INC

SEPTEMBER 20, 1990

ROCKY FLATS SYNTHETIC POND 'BC' WATER
TEST NO.2, JOB 901

Summary of Test Results, Conclusion and Projections

The modifications to the test procedure outlined in the previous report were helpful, enabling a smoother start up as evidenced by the attached log sheets taken 14 September 1990. The first disappointment was the poor quality of the VC product water which ranged 40 to 50 micro siemens during Test No. 1 was now ranging as high as 600 at the start and gradually dropped to 350 micro siemens. The natural conclusion was to condemn the new mesh.

A more serious situation however was developing with the MEMS-the recirculation rate around the top two stages was dropping rapidly from 40 GPM to 18 GPM in two hours of running. A sludge had been noticed forming in the first test and was forming much more rapidly in this test. The natural assumption was that this sludge was blocking the tubes in the heater. A shut down became necessary after the 1100 reading.

When the heater bundle was removed, we found a very heavy deposit of scale which was effectively removed by flooding the bayonet tubes with dilute 5% HCl. The reaction generated a large amount of frothing indicated the release of CO2 and identifying calcium carbonate - an alkaline scale common in sea water evaporators and easily controlled by acid injection.

Since there was still 600 gallons in the storage tank we decided to try acid injection. Fortunately we did no have enough HCl but we did have a considerable quantity of EDTA (HAMP-ENE ACID) which should tie up the calcium. We calculated we would need 8 lb. to treat 1000 gallons.

The next day we added 4.8 lb of this acid to the remaining 600 gallons; 4.6 oz. in the VC tank; 1.0 lb. to the 3rd stage MEMS tank and 0.6 lb. in the 4th stage tank. The milky solution in all tanks became crystal clear with addition of the EDTA. Test No. 2 was restarted at 0738 September 15, 1990 and we soon became aware that the distillate conductance was falling rapidly from a low of 350 micro siemens at the end of the previous aborted run. When the VC got up to operating temperatures and capacity at 0830 the sample pot was down to 33 micro siemen and the tank, 108 micro siemen -- by 1030 8 and 10. We actually recorded as low as 5 in the VC pot and 6.3 in the VC tank at shut-down 1320. The slight amount of scale that had formed on the tubes of the VC dissolved as did scale on the shell.

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The pH of the feed ranged at start from 3.3 rising to 4.4 at 1230. The pH of the VC distillate averaged about 4 due to CO_2 pick up from the breakdown of the HCO_3 to CO_2 with acid injection. the distillate from the fourth stage flash sample pot in the eductor suction ranged from 20 to 35 micro siemens and its pH was alkaline ranging from 8.7 to 9.2 since all of the CO_2 had been stripped in the VC.

The first results from Pioneer Laboratory indicated that the VC tank precipitate was principally calcium carbonate and since we already suspected the scale in the heater bundle was calcium carbonate we wondered where all the calcium was coming from? A check of the remaining chemicals soon established that a mistake had been made in that calcium nitrate and the sodium nitrate quantities had been reversed 53.2 lb. vs 3.5 lb. This test is therefore invalidated but it certainly taught us some valuable lessons about the chemistry, particularly the effect of alkalinity on water purity. It also revealed that we could attain the desired concentration ratio under the most adverse conditions. Because of the finite feed we employed the technic of operating the MEMS unit with city water in the upper stages - in this case the three top stages and modifications in the fourth stage concentrate tank permitted the residue to be reduced to 46 gallons, or with two stages as in Test No. 1 to 104 gallons. By simple arithmetic if we wanted to attain say 360,000 ppm from 12,000 ppm feed we would need a supply of 104 x 360,000/12,000 = 3120 gallons based on final two stage operation; and 46 x 360,000/12,000 = 1380 gallon of feed stock based on 46 gallons of residue and single stage operation.

Now that we have to repeat the test it would behoove us to mix up the chemicals previously listed into both tanks (2800 gallons). At start-up, both the VC and the MEMS should be fed in parallel for the first two hours, at which time the VC will have stabilized at about 24,000 ppm i.e.

> At start up the VC has 150 gallons of 12,000 ppm solution in the system and in the first two hours will evaporate about 3/4 its normal rate of 100 GPH or 150 gallons so 300 gallons of feed will be reduced to 150 gallons at twice the feed concentration. From here on the two plants will be fed in series at a rate of about 150 GPH; with the VC evaporating 90 GPH the concentrate will then stabilize at 30,000 ppm, and remain at this concentration for the balance of the test blowing down the 60 GPH and 30,000 ppm to the MEMS.

After operating to reduce the 2800 gallons to 400 gallons residue in 2400/150 = 16 hr. the VC must be shut down and the MEMS must continue to operate until the 150 gallons (about 2 hr.) from the VC is evaporated and then the concentrate of the MEMS residue (250 gallons) will average 134,400 ppm. The MEMS must then be shut down and the top two stages drained to the third and fourth stage tanks. Operation can then continue until the residue in the two tanks and both stages are reduced to 104 gallons (the minimum to

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keep pumps operating) and then the residue will average 323,000 ppm. If further concentration appears possible then the MEMS can be shut down again; the third stage and tank drained to fourth stage tank. The third stage can be rigged to operate on city water and the test continued down to 46 gallons where massive precipitation should occur.

In summary we would like to reiterate that this type of testing is not R & D as we understand is the interpretation at R.F. Feed stocks vary so widely at different sites that Licon makes their test units available to the potential customer so that the chemistry can be analyzed before field testing. Field testing is still necessary if the feed stock varies but these shop test provide valuable data for quickly optimizing the pretreatment necessary to get the best quality of distillate and the maximum concentration ratio. The adjustments that had to made to the plants were made purely to get maximum data from limited feed stock since we will have to store the sludge and probably dry it to dispose of it.

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LOG SHEET ON ROCKY FLATS POND WATER TESTS
JOB NO. 901

POND WATER RN | DATE: 9-14-95

TIME: 6:35 START (mains)	7:30	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30
TEMPERATURES:									
T1 FEED SUPPLY	88	89	89	89	89	90	89	90	
T2 FEED TO VC	149	134	134	135	137	180	150	190	
T3 VC RECYCLE FEED	179	170	180	180	176	177	185	183	
T4 BLOWDOWN TO MEMS	160	163	163	143	167	168	169	169	
T5 VC SUCTION	172	171	175	175	171	175	176	176	
T6 VC VENT	182	184	193	193	188	192	195	195	
T7 VC CHEST	189	187	196	196	190	194	198	198	
T8 VC EDUCTOR DISCH.	182	182	190	190	184	188	182	182	
T9 VC DISTILLATE IN HX	177	179	183	183	178	164	168	170	
T10 VC DIST. OUT HX	111	100	100	99	101	112	100	100	
T11 1ST FLASH VAPOR	↑			169	167	168	162	160	
T12 2ND FLASH VAPOR			↑	156	157	158	156	155	
T13 3RD FLASH VAPOR				129	130	134	134	131	
T14 4TH FLASH VAPOR			0	107	112	115	115	116	
T15 COOLANT INLET			M	91	99	99	86		
T16 COOLANT OUTLET				99	107	93	109	106	
T17 4TH FLASH CONC.				114	113	119	118	115	
T18 4TH FLASH FEED				125	126	133	128	125	
T19 3RD FLASH CONC.				135	139	142	142	134	
T20 3RD FLASH FEED				148	150	153	150	149	
T21 2ND FLASH CONC.				157	156	154	155	155	
T22 FEED TO HTR.				163	161	162	160	159	
T23 OUTPUT FROM HTR.			↓	171	170	170	170	173	
F1 FIRST STAGE RECYCLE	↓		40GPM	40GPM	40GPM	23GPM	18GPM	18GPM	
F2 VC FEED RATE	3	4	3	3	3 1/2	2 1/2	3	4	
F3 VC BLOWDOWN	1.5	1.8	1.5	~~2~~	1.6	1.2	.8	1.5	
F4 VC RECYCLE	3 1/2	2.5	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	
H1 VC BRINE WEIR GPM	1 3/4	2 1/4	2 1/4	2 1/4	2 1/4	2	2 1/4	2 1/4	
H2 3RD STAGE WEIR GPM	—	—	—	20GPM	20GPM	20	20	20	
H3 4TH STAGE WEIR	—	—	—	20GPM	20GPM	20	20	20	
FEED TANK LEVEL 1475	1400	1225	?	1050	(100) 950	(100) 850	775	(75) 700	
M1 VC DISTILLATE 1196	—	1268		(74) 1342	(53) 1395	(68) 1463	(33) 1496	(39) 1535	
M2 MEMS DISTILLATE 16514	—	~~0~~	~~0~~	(11) 16525	(36) 16561	(45) 16606	(33) 16639	(31) 16670	
M3 COMBINED DIST.	—	77	?	85	89	113	66	70	
V VOLTAGE	475	475	475	475	475	475	475	475	
A AMPS				61	58	37	54.8	37	
KW KILOWATTS									

Handwritten notes (vertical, in margins of 7:30 and 8:30 columns): "Start of MEMS"

LOG SHEET FOR WATER SAMPLES

JOB ORDER 901

DATE: 9/14/90											
TIME:		7:30	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	
POND A											
CONDUCTIVITY	FEED										
	DIST.										
	CONC.										
pH	FEED										
	DIST.										
	CONC.										
POND BN											
CONDUCTIVITY	FEED Sample #4	10.64	10.67	10.72	10.65	10.65					
Comb.	DIST. #5	0.66	0.89	0.93	0.64	0.63					
	CONC. #6	—	—		23000+	16.49					
pH	FEED #4	7.5	7.6	7.6	7.6	7.7					
Comb.	DIST. 5	7.4	7.3	7.5	7.8	8.0					
	CONC. 6				8.1	7.8					
POND BC											
CONDUCTIVITY	FEED										
	DIST.										
	CONC.										
pH	FEED										
	DIST.										
	CONC.										
POND BS											
CONDUCTIVITY	FEED										
	DIST.										
	CONC.										
pH	FEED										
	DIST.										
	CONC.										

Start Compressor at 6:35. went down [illegible] water at 6:50. Start Back up. Took Sample of [illegible] Tank [illegible]. Start up. Conduct/ 10.61 mS/cm & PH 7.5. [illegible] [illegible] off until V.C. is up to Temp.

Rocky Flats, Col. 9/14/90 RICHARD W. BOOTHE

TIME	620	730	800	830	900	930	1000	1030	1100	1130	120[illegible]
4 - VC FEED PH	7.5	7.5	7.6	7.6	7.6	7.7	8.1	8.1	9.6		
FLASH DIST/COND.		ms/cm 0.91	ms/cm 0.71	ms/cm 0.77	ms/cm 0.41	ms/cm 0.51	ms/cm 0.38	ms/cm 0.33	ms/cm 0.26		
FLASH DIST/PH		7.6	7.6	7.6	8.7	7.9	8.1	8.3	8.5		
VC DIST /COND.		ms/cm 0.55	ms/cm 0.59	ms/cm 0.59	ms/cm 0.50	ms/cm 0.47	ms/cm 0.32	ms/cm 0.37	ms/cm .515		
VC DIST/PH		7.0	6.9	6.9	7.1	7.2	7.9	7.8	8.4		
#5 - DIST/COMBINED COND.		ms/cm 0.66	ms/cm 0.59	ms/cm 0.93	ms/cm 0.64	ms/cm 0.63	ms/cm 0.47	ms/cm 0.67	ms/cm 0.42		
#5 - DIST/COMBINED PH		7.4	7.3	7.5	7.8	9.0	8.5	8.9	8.9		
#6 - FLASH CONC. PH					8.1	7.8	7.8	7.7	7.8		
VC CONC. PH		7.5	7.5	7.5	7.4	7.4	7.5	7.5	7.8		
#4 - (Tank) Feed Conduct.	ms/cm 10.64	ms/cm 10.67	ms/cm 10.67	ms/cm 10.72	ms/cm 10.65	ms/cm 10.65	ms/cm 10.57	ms/cm 10.62	ms/cm 10.53		
#6 - Flash Conc Conduct!	ms/cm				ms/cm 20000+	ms/cm 16.49	ms/cm 18.56	20000+	20000+		

Note! Combined Dist readings until 900 were only VC distillate. 900 readings include Flash Distillate

Note! 935 caustic added to feed Tank / raise PH

Note! 10:40 caustic added to Feed Tank

C/T Dist/Cond OUT

	PH	Cond
[illegible]	8.3	0.47 ms/cm
[illegible]	8.3	0.46
[illegible]0	8.3	0.46
30		
[illegible]00		
[illegible]30		

LOG SHEET ON ROCKY FLATS POND WATER TESTS

JOB NO. 901

POND WATER BN — DATE: 9-15-

TIME:	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30
TEMPERATURES:									
T1 FEED SUPPLY	91	92	92	92	94	94	94	94	94
T2 FEED TO VC	149	169	156	146	143	131	160	148	138
T3 VC RECYCLE FEED	186	186	178	189	183	173	188	166	183
T4 BLOWDOWN TO MEMS	82	102	160	168	169	166	164	169	167
T5 VC SUCTION	175	176	175	177	176	170	176	175	176
T6 VC VENT	195	198	195	198	195	188	196	192	194
T7 VC CHEST	198	200	197	200	198	190	198	194	192
T8 VC EDUCTOR DISCH.	182	189	185	189	187	184	184	181	183
T9 VC DISTILLATE IN HX	166	180	172	173	174	176	179	167	172
T10 VC DIST. OUT HX	116	116	109	106	105	105	118	116	106
T11 1ST FLASH VAPOR	↑	↑	180	170	163	131	160	168	166
T12 2ND FLASH VAPOR			168	158	155	131	150	156	156
T13 3RD FLASH VAPOR			135	136	133	124	126	127	129
T14 4TH FLASH VAPOR			120	120	117	121	111	111	111
T15 COOLANT INLET				105	103	96	100	100	
T16 COOLANT OUTLET			111	117	111	93	108	109	107
T17 4TH FLASH CONC.			117	120	116	120	112	117	112
T18 4TH FLASH FEED			129	131	126	121	122	122	122
T19 3RD FLASH CONC.			140	144	140	131	135	135	131
T20 3RD FLASH FEED			160	155	150	129	145	146	145
T21 2ND FLASH CONC.			165	158	150	125	149	155	156
T22 FEED TO HTR.			176	162	154	123	151	158	148
T23 OUTPUT FROM HTR.	↓	↓	176	161	153	115	150	157	155
F1 FIRST STAGE RECYCLE	40GPM	40GPM	40GPM	46GPM	40GPM	40GPM	40GPM	40GPM	40
F2 VC FEED RATE	2	2	2 3/4	2.45	2 3/4	3.0	2	3	3
F3 VC BLOWDOWN	0	0	.8	.8	0	1.0	.8	1.0	1.0
F4 VC RECYCLE	3	3	2 3/4	3	2 3/4	3.1	2 3/4	2 3/4	3"
H1 VC BRINE WEIR	1"	1"	1"	1 1/4"	1 1/4"	1"	1"	1"	1"
H2 3RD STAGE WEIR	—	—	3"	3"	3"	3"	3"	3"	3"
H3 4TH STAGE WEIR	—	—	3"	3"	3"	3"	3"	3"	3"
FEED TANK LEVEL 675	625	575	500	425	350	275	200	150	100
M1 VC DISTILLATE	1609	(46) 1655	(47) 1702	(51) 1753	(46) 1799	(44) 1843	(57) 1900	(54) 1954	(29) 1983
M2 MEMS DISTILLATE	16696	— (26)	16722	(53) 16775	(52) 16827	(13) 16840	(29) 16869	(25) 16894	(13) 16907
M3 COMBINED DIST.		46	74	103	98	63	(86)	79	42
V VOLTAGE	475		475	475	475	475	475	475	475
A AMPS	61.5		60.5	59.2	58.3	58.2	38.1	56	57
KW KILOWATTS									
PF POWER FACTOR	.82		.85	.85	.85	.85	.87	.85	.85

LOG SHEET FOR WATER SAMPLES

JOB ORDER 901

DATE: 9/15/90										
TIME:	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	1:00
POND A										
CONDUCTIVITY FEED										
DIST.										
CONC.										
pH FEED										
DIST.										
CONC.										
POND BN										
CONDUCTIVITY FEED #4 (mS/cm)	11.01	10.82	10.92	10.58	10.90	10.84	10.80	10.85	10.90	
DIST. #5	1.57 mS/cm	147.5 µS/cm	0.21 mS/cm	0.23 mS/cm	91.7 µS/cm	28.0 µS/cm	31.8 µS/cm	20.8 µS/cm	0.23 mS/cm	
CONC. #6	—	—	20000+	20000+	20000+	20000+	20000+	20000+	20000+	
pH FEED #4	3.3	3.4	3.4	3.6	3.—	3.6	3.8	3.8	4.4	
DIST. #5	5.9	5.4	6.2	4.9	5.9	6.0	6.2	5.3	6.2	
CONC. #6	—	—	7.0	7.5	7.3	7.3	7.2	7.2	7.1	
POND BC										
CONDUCTIVITY FEED										
DIST.										
CONC.										
pH FEED										
DIST.										
CONC.										
POND BS										
CONDUCTIVITY FEED										
DIST.										
CONC.										
pH FEED										
DIST.										
CONC.										

Change Dist in 1+2 Stage Together at 12:00.
3+4 Stage Together

LOG SHEET ON ROCKY FLATS POND WATER TESTS

POND WATER 3W   9/15/90   JOB NO. 9/17/90   DATE: 9-15-90

TIME:	1:00	1:30		10:30	11:30	2:00	2:30	3:00	3:30	
TEMPERATURES:		[illegible]			[illegible]					
T1 FEED SUPPLY	92									
T2 FEED TO VC	174									
T3 VC RECYCLE FEED	185									
T4 BLOWDOWN TO MEMS	156									
T5 VC SUCTION	176									
T6 VC VENT	198									
T7 VC CHEST	200									
T8 VC EDUCTOR DISCH.	186									
T9 VC DISTILLATE IN HX	172									
T10 VC DIST. OUT HX	101									
T11 1ST FLASH VAPOR	168			184	178	174	178			
T12 2ND FLASH VAPOR	156			178	162	162	165			
T13 3RD FLASH VAPOR	119			139	133	136	133			
T14 4TH FLASH VAPOR	102			112	101	103	103			
T15 COOLANT INLET	99			107	87	90	88			
T16 COOLANT OUTLET	101			99	99	101	99			
T17 4TH FLASH CONC.	100			111	100	104	100			
T18 4TH FLASH FEED	110			131	123	126	122			
T19 3RD FLASH CONC.	123			145	137	145	136			
T20 3RD FLASH FEED	132			165	155	158	155			
T21 2ND FLASH CONC.	155			170	162	165	165			
T22 FEED TO HTR.	156			180	168	172	173			
T23 OUTPUT FROM HTR.	158			183	178	182	175			
F1 FIRST STAGE RECYCLE	406	—		406 gpm	406 gpm	406 gpm	406 gpm			
F2 VC FEED RATE	3	—		—	—	—	—			
F3 VC BLOWDOWN	1.0			—	—	—	—			
F4 VC RECYCLE	3	—		—	—	—	—			
H1 VC BRINE WEIR	1"	—		—	—	—	—			
H2 3RD STAGE WEIR	3"			3"	3"	3"	3"			
H3 4TH STAGE WEIR	3"			3"	3"	3"	3"			
FEED TANK LEVEL	[illegible]	—		—	—	—	—			
M1 VC DISTILLATE 1982	2039	—		—	—	—	—			
M2 MEMS DISTILLATE 16907	16921	16950		17051	17100	17123	17131			
M3 COMBINED DIST.	70				[illegible]	23	8			
V VOLTAGE	475									
A AMPS	37									
KW KILOWATTS										
PF POWER FACTOR	.7									

Rocky Flats, Col. 9/15/90 RICHARD W. BOOTHE

	TIME	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	1:00	1:30
#4	VC FEED PH	3.3	3.4	3.4	3.6	3.5	3.6	3.8	3.8	4.4	7.8	
	FLASH DIST/COND. ms/cm	0.31	0.21	µS/cm 132.1	µS/cm 71.1	µS/cm 57.7	µS/cm 57.1	µS/cm 41.5	µS/cm 43.7	µS/cm 47.1	ms/cm 1.40	ms [illegible]
	FLASH DIST/PH	8.7	6.0	6.8	6.9	6.8	6.7	6.8	7.2	7.1	7.2	7.[illegible]
	VC DIST /COND. µS/cm	53.3	17.1	15.2	9.9	7.1	13.0	6.8	6.3	6.8		
	VC DIST/PH	5.4	5.1	5.1	4.8	4.4	4.6	4.7	4.9	5.0	7.2	
#5	DIST/COMBINED COND ms/cm	ms/cm 1.02	µS/cm 147.5	µS/cm 0.21	ms/cm 0.23	µS/cm 91.7	µS/cm 35.0	µS/cm 57.8	µS/cm 208	ms/cm 0.23	ms/cm 0.46	ms 1.[illegible]
#5	DIST/COMBINED PH	5.9	5.4	6.2	4.9	5.9	6.0	6.2	5.3	6.2	6.8	6.[illegible]
#6	FLASH CONC. PH			7.0	7.5	7.3	7.3	7.2	7.2	7.1	7.0	6.[illegible]
	VC CONC. PH	5.5	4.4	4.1	3.7	3.7	3.7	3.6	3.7	3.8		
#4	(Tank) Feed Conductivity (ms/cm)	11.01	10.82	10.86	10.88	10.90	10.84	10.80	10.85	10.90	10.97	
#6	Flash Conc. Conductivity (ms/cm)			20000+	20000+	20000+	20000+	20000+	20000+	20000+	20000+	200[illegible]

VT

	PH	Cond
:30	7.6	0.68 ms/cm
:00	7.5	0.44 ms/cm
:30	7.4	0.29 ms/cm
:00	7.2	0.21 ms/cm
:30	7.1	164.2 µS/cm
1:00	7.1	132.9 µS/cm
:30	6.8	93.5 µS/cm
2:00	6.9	73.2 µS/cm
:30	7.0	151.7 µS/cm
:00	7.1	0.37 ms/cm
:30		

Dist from sample pot Flash

	PH	Cond
930	8.7	30.9 µS/cm
1000	8.9	35.4 µS/cm
10:30	9.0	34.5 µS/cm
11:00	8.8	17.5 µS/cm
11:30	9.2	17.9 µS/cm
12:00	9.1	18.5 µS/cm
12:30	9.1	25.6 µS/cm
1:00	8.8	25.4 µS/cm
1:30	8.7	23.7 µS/cm

Rocky Flats, Col. 9/15/90 RICHARD W. BOOTHE

TIME	2:00	2:30	3:00	3:30	4:00						
VC FEED PH											
FLASH DIST/COND.	1.03 ms/cm										
FLASH DIST/PH	6.9										
VC DIST /COND.											
VC DIST/PH											
#5 DIST/COMBINED COND.	1.07 ms/cm										
#5 DIST/COMBINED PH	7.0										
#6 FLASH CONC. PH	1.1										
VC CONC. PH											
#4 (Tank) Feed Conductivity											
#6 Flash Conc. Conductivity ms/cm	20100+										

Flash
Dist. Sample pot

PH	Cond
8.0	23.8 μs/cm

APPENDIX 'E'

LICON TRANSVAP 150
LOG SHEET ON ROCKY FLATS POND WATER TESTS
JOB NO. 901

POND WATER B [illegible] | DATE: 9/24

TIME: 9:30	10:00	10:30	11:00	11:30	12:00	12:30	1:00	1:30	2:00
TEMPERATURES:									
T1 FEED SUPPLY	82	82	82	82	82	83	83		
T2 FEED TO VC	154	150	157	160	128	140	120		
T3 VC RECYCLE FEED	188	186	179	180	168	176	164		
T4 BLOWDOWN TO MEMS	84	84	84	84	166	162	168		
T5 VC SUCTION	167	174	175	176	167	170	169		
T6 VC VENT	184	173	191	193	182	187	184		
T7 VC CHEST	187	191	193	195	188	190	186		
T8 VC EDUCTOR DISCH.	193	172	178	180	180	192	176		
T9 VC DISTILLATE IN HX	161	159	167	171	173	173	165		
T10 VC DIST. OUT HX	97	102	109	106	96	100	94		
T11 1ST FLASH VAPOR	182	180	180	178	182		174		
T12 2ND FLASH VAPOR	169	169	169	164	170	[illegible]	166		
T13 3RD FLASH VAPOR	126	130	126	128	126	[illegible]	129		
T14 4TH FLASH VAPOR	64	107	107	108	107	[illegible]	122		
T15 COOLANT INLET	58	86	86	70	83	[illegible]	82		
T16 COOLANT OUTLET	60	100	97	74	93	[illegible]	88		
T17 4TH FLASH CONC.	91	111	105	115	105	[illegible]	112		
T18 4TH FLASH FEED	110	122	121	127	121	[illegible]	125		
T19 3RD FLASH CONC.	136	142	134	131	134	[illegible]	141		
T20 3RD FLASH FEED	156	153	158	152	155	[illegible]	154		
T21 2ND FLASH CONC.	165	164	166	164	168	[illegible]	165		
T22 FEED TO HTR.	176	172	175	171	176	[illegible]	170		
T23 OUTPUT FROM HTR.	192	182	185	181	187		176		
F1 FIRST STAGE RECYCLE	40 GPM	40 GPM	40 GPM	40	.40		.40		
F2 VC FEED RATE	3 1/2	3 1/2	3	3	3		3		
F3 VC BLOWDOWN	—	—	—	—	1.6		1.6		
F4 VC RECYCLE	3	3 1/2	3	3	3		3		
H1 VC BRINE WEIR	1 1/4"	1 1/4"	1"	1'	1"		1"		
H2 3RD STAGE WEIR	3"	3"	3"	3"	3"		3"		
H3 4TH STAGE WEIR	3"	3"	3"	3"	3"		3"		
FEED TANK LEVEL 1100	1075	1000	925	850	775	725	775		
M1 VC DISTILLATE 2032	2072	(41) 2133	(54) 2187	(58) 2245	(46) 2291	(38) 2329	(31) 2360		
M2 MEMS DISTILLATE 17238	same	(37) 17275	(35) 17310	(28) 17338	(33) 17371	(7) 17378	(22) 17400		
M3 COMBINED DIST.	30	78	89	82	81	45	53		
V VOLTAGE	475	475		475	475		475		
A AMPS	59.6	56.3	33.2	20.2	58		56.6		

LOG SHEET FOR WATER SAMPLES

JOB ORDER 901

		930	1000	1030	1100	1130	1200	1230	100
DATE: 9/24/90									
TIME:		930	1000	1030	1100	1130	1200	1230	100
POND A									
CONDUCTIVITY	FEED							Acidifying @ 1230 after the readings	
	DIST.								
	CONC.								
pH	FEED								
	DIST.								
	CONC.								
POND BN									
CONDUCTIVITY	FEED #4	13.99	14.01	14.04	14.07	14.07	14.08	14.11	14.10
	DIST. #5		0.44	0.18	0.28	0.28	0.25	0.58	0.29
	CONC. #6		16.94	17.07	18.19	19.32	20+	20+	20+
pH	FEED #4	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7
	DIST. #5		6.0	5.5	6.0	5.5	6.0	6.5	6.3
	CONC. #6		8.1	7.9	7.8	7.7	7.8	7.6	7.7
POND BC									
CONDUCTIVITY	FEED								
	DIST.								
	CONC.								
pH	FEED								
	DIST.								
	CONC.								
POND BS									
CONDUCTIVITY	FEED								
	DIST.								
	CONC.								
pH	FEED								
	DIST.								
	CONC.								

All Conductivity measured mS/cm

POND Water BN

Rocky Flats, Col 9/24/90 Richard W. Boothe

	TIME	930	1000	1030	1100	1130	1200	1230	100	130	200	230
#4	VC FEED PH	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7			
	FLASH DIST/COND. Tank	0.12	0.67	0.42	0.28	0.20	0.14	0.12	0.10			
	FLASH DIST/PH "	8.0	7.1	6.3	6.4	6.3	6.4	7.8	7.1			
	VC DIST /COND. Tank	0.10	0.07	0.06	0.05	0.05	0.06	0.05	0.06			
	VC DIST/PH "	5.7	5.5	5.2	5.3	5.1	5.4	5.3	5.4			
#5	DIST/COMBINED COND.		0.44	0.18	0.28	0.28	0.25	0.58	0.29			
#5	DIST/COMBINED PH		6.0	5.5	6.0	5.5	6.0	6.5	6.3			
#6	FLASH CONC. PH		8.1	7.9	7.8	7.7	7.8	7.6	7.7			
	VC CONC. PH Tank		8.0	8.4	8.6	8.6	8.8	6.5	8.6			
#4	(Tank) Feed (Cond.)	13.99	14.01	14.04	14.07	14.07	14.08	14.11	14.10			
#6	Flash Concentrate (Cond.)		16.94	17.07	18.19	19.32	20000+	20000+	20000+			
#1	VC Dist Sample Pot (Cond.)	0.02	0.02	0.02	0.03	0.04	0.05	0.11	0.04			
#1	VC Dist Sample Pot (PH)	8.0	8.2	7.4	7.6	7.5	7.4	6.3	7.7			
#2	Flash DIST Sample Pot (Cond)		0.13	0.07	0.06	0.05	0.04	0.04	0.03			
#2	Flash DIST Sample Pot (PH)		8.9	8.9	7.9	8.8	7.0	7.9	7.2			
	VC Conc. Tank (Cond)		20000+	20000+	20000+	20000+	20000+	20000+	20000+			

All conductivity measured ms/cm

200 .5# EDTA added to VC concentrate Tank.

pH @ 12:20. 6.5 @ 12:30 8.5

2:20 VC shut down L/W/heater

2:21 VC Back on Line

12:35 added .5# EDTA to VC Conc. tank
PH @ 1235 6.5

235 VC shutdown H/L

238 VC Back online

250 VC sample pot (cond.) 0.04 ms/cm (PH) 7.2

310 VC + Flash unit shut down By Danny, No further testing today!

500 VC Conc high side - 43 mS some precipitate (Mg OH ?)
4th Stage Flash - 26 mS " " (Mg OH?)

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LICON TRANSVAP 150
LOG SHEET ON ROCKY FLATS POND WATER TESTS
JOB NO. 901

POND WATER *RW TANK #1* DATE: *9/25/*

TIME: *2:00*	2:30	3:00	3:30	4:00	4:30	5:00	5:30	6:00	6:30	7
TEMPERATURES:										
T1 FEED SUPPLY	84	84	84	84		84	84	85	85	
T2 FEED TO VC	120	128	162	130		108	154	152	152	
T3 VC RECYCLE FEED	182	176	174	179		159	177	172	178	
T4 BLOWDOWN TO MEMS	134	134	127	135		164	160	158	163	
T5 VC SUCTION	170	170	171	174		165	174	168	176	
T6 VC VENT	190	190	198	194		184	194	187	196	
T7 VC CHEST	192	192	200	196		186	196	189	198	
T8 VC EDUCTOR DISCH.	180	180	187	177		180	188	183	189	
T9 VC DISTILLATE IN HX	170	169	162	163		172	177	176	186	
T10 VC DIST. OUT HX	93	101	118	95		94	138	124	110	
T11 1ST FLASH VAPOR	170	170	183	180		169	162	165	166	
T12 2ND FLASH VAPOR	162		175	171		161	153	157	158	
T13 3RD FLASH VAPOR	135		140	148		134	131	129	131	
T14 4TH FLASH VAPOR	72		134	124		129	127	125	125	
T15 COOLANT INLET	62		66			80	76	76	78	
T16 COOLANT OUTLET	66		78			88	81	82	85	
T17 4TH FLASH CONC.	90		134	144		125	125	122	123	
T18 4TH FLASH FEED	100		138	147		131	129	127	128	
T19 3RD FLASH CONC.	142		155	156		145	132	132	140	
T20 3RD FLASH FEED	151		172	160		154	144	145	146	
T21 2ND FLASH CONC.	160		174	166		160	155	156	157	
T22 FEED TO HTR.	164		180	171		166	160	162	163	
T23 OUTPUT FROM HTR.	163		187	175		171	165	168	169	
F1 FIRST STAGE RECYCLE	40 gpm	40 gpm	40	40		40	40	40	40	
F2 VC FEED RATE	2.5	2.5	3	3		3	3	3	3	
F3 VC BLOWDOWN	1.6	1.6	1.6	1.6		1.6	1.6	1.6	1.6	
F4 VC RECYCLE	3	3	3	3		3	3	3	3	
H1 VC BRINE WEIR	1"	1"	1"	1"		1"	1"	1"	1"	
H2 3RD STAGE WEIR	3"	3"	3"	3"		3"	3"	3"	3"	
H3 4TH STAGE WEIR	3"	3"	3"	3"		3"	3"	3"	3"	
FEED TANK LEVEL	550	500	450	400	350	300	250	200	150	
M1 VC DISTILLATE	2393	2440	2494	2530	2577	2610	2652	2686	2720	
M2 MEMS DISTILLATE	17419	17427	17434	17447	17460	17479	17490	1749[illegible]	17519	
M3 COMBINED DIST.	—	55	64	49	60	52	53	34	63	
V VOLTAGE	475	475	475	475		475	475	475	475	
A AMPS	53.3	40.3	45.1	52.7		55.1	50.2	40	41.3	
KW KILOWATTS										

LOG SHEET FOR WATER SAMPLES

JOB ORDER 901

Rocky Flats, Col. Tank #1

DATE: 9/25/90										
TIME:	230	3:00	330	400	430	500	530	6:00	630	
POND A										
CONDUCTIVITY FEED										
DIST.										
CONC.										
pH FEED										
DIST.										
CONC.										
POND BN										
CONDUCTIVITY FEED #4	14.27	14.29	14.29	14.19	14.18	14.09	14.01	14.03	14.04	
DIST. #5	0.06	0.93	0.04	0.07	0.97	1.14	0.09	0.39	0.20	
CONC. #6	20,000+	20,000+	20,000+	(30,000)	20,000+	(42,000)	(58,000)	(47,000)	20,000+	
pH FEED #4	8.7	8.8	7.9	7.3	7.9	6.9	7.5	8.2	8.4	
DIST. #5	5.6	6.0	5.1	5.3	5.9	6.2	5.5	5.8	5.7	
CONC. #6	6.8	7.2	7.5	7.8	7.8	7.8	7.8	8.0	8.0	
POND BC										
CONDUCTIVITY FEED										
DIST.										
CONC.										
pH FEED										
DIST.										
CONC.										
POND BS										
CONDUCTIVITY FEED										
DIST.										
CONC.										
pH FEED										
DIST.										
CONC.										

JOB NO. 901

POND WATER RW TANK #1 DATE: 9/25/9

TIME: 2:00	2:30	3:00	3:30	4:00	4:30	5:00	5:30	6:00	6:30	7
TEMPERATURES:										
T1 FEED SUPPLY	84	84	84	84		84	84	85	85	
T2 FEED TO VC	120	128	162	130		108	154	152	152	
T3 VC RECYCLE FEED	182	176	174	179		159	177	172	178	
T4 BLOWDOWN TO MEMS	134	134	127	135		164	160	158	163	
T5 VC SUCTION	170	170	171	174		165	174	168	176	
T6 VC VENT	190	190	198	194		184	194	187	196	
T7 VC CHEST	192	192	200	196		186	196	189	198	
T8 VC EDUCTOR DISCH.	180	180	187	177		180	188	183	189	
T9 VC DISTILLATE IN HX	170	169	162	163		172	177	176	186	
T10 VC DIST. OUT HX	93	101	118	95		94	138	124	110	
T11 1ST FLASH VAPOR	170	170	183	180		169	162	165	166	
T12 2ND FLASH VAPOR	162		175	171		161	153	157	158	
T13 3RD FLASH VAPOR	135		140	148		134	131	129	131	
T14 4TH FLASH VAPOR	72		134	124		129	127	125	125	
T15 COOLANT INLET	62		66			80	76	76	78	
T16 COOLANT OUTLET	66		78			88	81	82	85	
T17 4TH FLASH CONC.	90		134	144		125	125	122	123	
T18 4TH FLASH FEED	100		138	147		131	129	127	128	
T19 3RD FLASH CONC.	142		155	156		145	132	132	140	
T20 3RD FLASH FEED	151		172	160		154	144	145	146	
T21 2ND FLASH CONC.	160		174	166		160	155	156	157	
T22 FEED TO HTR.	160		180	171		166	160	162	163	
T23 OUTPUT FROM HTR.	163		187	175		171	165	168	169	
F1 FIRST STAGE RECYCLE	40 gpm	40 gpm	30	40		40	40	40	40	
F2 VC FEED RATE	2.5	2.5	3	3		3	3	3	3	
F3 VC BLOWDOWN	1.6	1.6	1.6	1.6		1.6	1.6	1.6	1.6	
F4 VC RECYCLE	3	3	3	3		3	3	3	3	
H1 VC BRINE WEIR	1"	1"	1"	1"		1"	1"	1"	1"	
H2 3RD STAGE WEIR	3"	3"	3"	3"		3"	3"	3"	3"	
H3 4TH STAGE WEIR	3"	3"	3"	3"		3"	3"	3"	3"	
FEED TANK LEVEL	550	500	450	400	350	300	250	200	150	
M1 VC DISTILLATE	2393	(47) 2440	(54) 2494	(36) 2530	(47) 2577	(33) 2610	(42) 2652	(34) 2686	(34) 2720	
M2 MEMS DISTILLATE	17419	(8) 17427	(7) 17034	(13) 17447	(13) 17460	(19) 17479	(11) 17490	17498	17519	
M3 COMBINED DIST.	—	55	64	49	60	52	53	34	63	
V VOLTAGE	475	475	475	475		475	475	475	475	
A AMPS	53.9	40.3	45.1	62.7		55.1	50.2	40	41.[illegible]	
KW KILOWATTS										

JOB NO. 901

POND WATER *RW Tank #1* DATE: *9/25/9*

TIME: *2:00*	*2:30*	*3:00*	*3:30*	*4:00*	*4:30*	*5:00*	*5:30*	*6:00*	*6:30*	*7*
TEMPERATURES:										
T1 FEED SUPPLY	84	84	84	84		84	84	75	85	
T2 FEED TO VC	120	128	162	130		108	154	152	152	
T3 VC RECYCLE FEED	182	176	174	179		159	177	172	178	
T4 BLOWDOWN TO MEMS	134	134	127	135		164	160	158	163	
T5 VC SUCTION	170	170	171	174		165	174	168	176	
T6 VC VENT	190	190	198	194		184	194	187	196	
T7 VC CHEST	192	192	200	196		186	196	189	198	
T8 VC EDUCTOR DISCH.	180	180	187	177		180	188	183	189	
T9 VC DISTILLATE IN HX	170	169	162	163		172	177	176	186	
T10 VC DIST. OUT HX	93	131	118	95		94	138	124	110	
T11 1ST FLASH VAPOR	170	170	183	180		169	162	165	166	
T12 2ND FLASH VAPOR	162		175	171		161	153	157	158	
T13 3RD FLASH VAPOR	135		140	148		134	131	129	131	
T14 4TH FLASH VAPOR	72		134	124		129	127	125	125	
T15 COOLANT INLET	62		66			80	76	76	78	
T16 COOLANT OUTLET	66		78			88	81	82	85	
T17 4TH FLASH CONC.	90		134	144		125	125	122	123	
T18 4TH FLASH FEED	100		138	147		131	129	127	128	
T19 3RD FLASH CONC.	142		155	156		145	132	132	140	
T20 3RD FLASH FEED	151		172	160		154	144	145	146	
T21 2ND FLASH CONC.	160		174	166		160	155	156	157	
T22 FEED TO HTR.	164		180	171		166	160	162	163	
T23 OUTPUT FROM HTR.	163		187	175		171	165	168	169	
F1 FIRST STAGE RECYCLE	40 GPM	40 GPM	40	40		40	40	40	40	
F2 VC FEED RATE	2.5	2.5	3	3		3	3	3	3	
F3 VC BLOWDOWN	1.6	1.6	1.6	1.6		1.6	1.6	1.6	1.6	
F4 VC RECYCLE	3	3	3	3		3	3	3	3	
H1 VC BRINE WEIR	1"	1"	1"	1"		1"	1"	1"	1"	
H2 3RD STAGE WEIR	3"	3"	3"	3"		3"	3"	3"	3"	
H3 4TH STAGE WEIR	3"	3"	3"	3"		3"	3"	3"	3"	
FEED TANK LEVEL	550	500	450	400	350	300	250	200	150	
M1 VC DISTILLATE	2393	(47) 2440	(54) 2444	39/ 2530	(47) 2577	(33) 2610	43/ 2652	34/ 2686	34/ 2720	
M2 MEMS DISTILLATE	17419	8 17427	7 17434	13 17447	(13) 17460	19 17479	11 17490	17490	29/ 17519	
M3 COMBINED DIST.	—	55	64	49	60	52	53	34	63	
V VOLTAGE	475	475	475	475		475	475	475	475	
A AMPS	53.3	40.3	45.1	52.7		55.9	50.2	40	41.[illegible]	
KW KILOWATTS										

Rocky Flats, Col 9/24/90 Richard W. Boothe

TIME	930	1000	1030	1100	1130	1200	1230	100	130	200	230
#4 VC FEED PH	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7			
FLASH DIST/COND. Tank	0.12	0.67	0.42	0.28	0.20	0.14	0.12	0.10			
FLASH DIST/PH "	8.0	7.1	6.3	6.4	6.3	6.4	7.8	7.1			
VC DIST /COND. Tank	0.10	0.07	0.06	0.05	0.05	0.06	0.05	0.06			
VC DIST/PH "	5.7	5.5	5.2	5.3	5.1	5.4	5.3	5.4			
#5 DIST/COMBINED COND.		0.44	0.18	0.28	0.28	0.25	0.58	0.29			
#5 DIST/COMBINED PH		6.0	5.5	6.0	5.5	6.0	6.5	6.3			
#6 FLASH CONC. PH		8.1	7.9	7.8	7.7	7.8	7.6	7.7			
VC CONC. PH Tank		8.0	8.4	8.6	8.6	8.8	6.5	8.6			
#4 (Tank) Feed (Cond.)	13.99	14.01	14.04	14.07	14.07	14.08	14.11	14.10			
#6 Flash Concentrate (Cond.)		16.94	17.07	18.19	19.32	20000+	20000+	20000+			
#1 VC Dist Sample Pot (Cond)	0.02	0.02	0.02	0.03	0.04	0.05	0.11	0.04			
#1 VC Dist Sample Pot (PH)	8.0	8.2	7.4	7.6	7.5	7.4	6.3	7.7			
#2 Flash DIST Sample Pot (Cond)		0.13	0.07	0.06	0.05	0.04	0.04	0.03			
#2 Flash DIST Sample Pot (PH)		8.9	8.9	7.9	8.8	7.0	7.9	7.2			
VC Conc. Tank (Cond)		20000+	20000+	20000+	20000+	20000+	20000+	20000+			

All conductivity measured ms/cm

200 .5# EDTA added to VC concentrate Tank.

pH @ 12:20. 6.5 @ 12:30 8.5

2:20 VC shut down L/W/heater

2:21 VC Back on Line

12:35 added .5# EDTA to VC Conc. tank
pH @ 1235 6.5

235 VC shut down H/L

238 VC Back on line

250 VC sample pot (cond.) 0.04 ms/cm (PH) 7.2

310 VC + Flash unit shut down By Danny, No further testing today!

500 VC Conc high side - 43 mS some precipitate (MgOH?)
4th Stage Flash - 26 mS " " (MgOH?)

93

Rocky Flats, Col. 9/25/90 Pond 3N Tank-1 (Heidi) Richard W. Boothe

	TIME	230	300	330	400	430	500	530	600	630	700	730
	VC FEED PH	8.7	8.8	7.9	7.3	7.9	6.9	7.5	8.2	8.4		
	FLASH DIST/COND.	2.13	1.89	2.90	2.84	1.99#	1.30	2.83	0.64	0.45		
	FLASH DIST/PH	6.7	7.1	6.7	6.8	6.4	6.7	6.7	6.4	6.4		
	VC DIST /COND.	0.05	0.05	0.04	0.04	0.05	0.04	0.04	0.05	0.05		
	VC DIST/PH	5.2	5.1	5.2	5.2	5.3	5.3	5.4	5.6	5.5		
#5	DIST/COMBINED COND.	0.06	0.93	2.04	0.07	0.97#	1.14	0.09	0.39	0.20		
#5	DIST/COMBINED PH	5.6	6.0	5.1	5.3	5.9	6.2	5.5	5.8	5.7		
#6	FLASH CONC. PH	6.8	7.2	7.5	7.8	7.8	7.8	7.8	8.0	8.0		
	VC CONC. PH	8.4	8.5	8.5	8.5	8.7	8.6	8.7	8.8	8.8		
4	Tank Feed (Cond.)	14.27	14.29	14.29	14.19	14.18	14.09	14.01	14.03	14.04		
6	Flash Concentrate (Cond.)	off scale 20,000+	off scale	off scale	off scale 30.0	off scale	off scale 42	off scale 48	off scale 47	off scale		
	VC DIST Sample Pot (Cond.)	0.02	0.03	0.03	0.03	0.03	0.02	0.02	0.03	0.03		
	VC DIST Sample Pot (PH)	7.6	7.1	7.6	7.9	7.5	7.4	7.5	7.6	7.7		
	Flash DIST Sample Pot (Cond.)	0.30	0.18	1.10+	0.21	0.11#	0.04	0.02	0.03	0.03		
	Flash DIST Sample Pot (PH)	6.7	6.8	8.8	6.7	6.6	6.8	6.5	7.0	7.1		
	VC Concentrate Tank (Cond.)	off scale 40 [illegible]	off scale	off scale	off scale	off scale	off scale 51	off scale	off scale 38	off scale		

All Conductivity measured ms/cm

+ Last Boiler - Carry-over.

( ) VC Conc High Side @ 1700 = 51 ms

Flash badly contaminated because of boiler failures and CO_2 build-up due to acid reaction see pot readings
Hooked up separate auxiliary eductor to 2nd Stage Flash

3rd Stage Flash Conc 62mS @ 1730 78ms @ 1800 85ms @ 1830
4th " " 48ms " " 45ms @ 1800 47 " " "

DATE: 1-20-[illegible]

TIME: 9:30	10:00	10:30	11:00	11:30	12:00	12:30	1:00	1:30	2:00
TEMPERATURES:									
T1 FEED SUPPLY	77	77	77	77	77	77	77	77	77
T2 FEED TO VC	142	175	137	154	146	142	131	131	166
T3 VC RECYCLE FEED	173	179	169	178	173	167	167	167	176
T4 BLOWDOWN TO MEMS	150	165	165	167	168	166	166	166	164
T5 VC SUCTION	170	176	170	175	175	170	169	169	175
T6 VC VENT	189	198	191	197	196	190	189	189	197
T7 VC CHEST	191	201	192	199	197	191	190	190	199
T8 VC EDUCTOR DISCH.	183	186	182	189	184	178	180	180	187
T9 VC DISTILLATE IN HX	176	180	172	180	175	176	172	172	174
T10 VC DIST. OUT HX	88	94	90	92	92	92	90	90	110
T11 1ST FLASH VAPOR	Began Mems On Line at 10:00 Reading	168	177	180	178	177	176	176	176
T12 2ND FLASH VAPOR		160	161	167	165	165	164	164	165
T13 3RD FLASH VAPOR		115	123	132	132	127	128	128	129
T14 4TH FLASH VAPOR		106	114	123	118	115	120	120	118
T15 COOLANT INLET		83	80	83	88	87	85	85	84
T16 COOLANT OUTLET		92	99	93	103	100	95	95	96
T17 4TH FLASH CONC.		95	109	120	117	115	116	116	116
T18 4TH FLASH FEED		109	120	129	127	123	125	125	125
T19 3RD FLASH CONC.		120	126	139	140	136	134	134	134
T20 3RD FLASH FEED		139	142	151	151	150	150	150	150
T21 2ND FLASH CONC.		160	161	166	165	165	162	162	162
B T22 FEED TO HTR.		162	164	166	165	165	165	165	165
A T23 OUTPUT FROM HTR.		174	171	173	172	172	171	171	171
F1 FIRST STAGE RECYCLE	40	40	40	40	40	40	40	40	40
F2 VC FEED RATE	3½	3½	3½	3½	3½	3½	3½	3½	3½
F3 VC BLOWDOWN	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
F4 VC RECYCLE	2¼	3½	3½	3½	3½	3½	3½	3½	3½
H1 VC BRINE WEIR	1"	1"	1"	1"	1"	1"	1"	1"	1"
H2 3RD STAGE WEIR	3"	3"	3"	3"	3"	3"	3"	3"	3"
H3 4TH STAGE WEIR	3"	3"	3"	3"	3"	3"	3"	3"	3"
FEED TANK LEVEL	1250	1200	1150	1050	980	900	835	770	718
M1 VC DISTILLATE 20965	20993	43 21036	43 21079	47 21126	44 21170	45 21215	38 21258	46 21304	35 21339
M2 MEMS DISTILLATE 17552	–	8 17560	25 17585	30 17615	26 17641	33 17674	30 17704	29 17733	17 17750
M3 COMBINED DIST.		51	68	77	70	78	65	85	52
V VOLTAGE	475	475	475	475	475	475	475	475	475
A AMPS	58.5	41	40.9	39	57.3	38.2	58.9	59.1	41.2
KW KILOWATTS									
PF POWER FACTOR	.8½	.7	.7	.7	[illegible]	[illegible]			

TIME:	2:30	3:00	3:30	4:00	4:30	5:00	5:30	6:00	6:30	
TEMPERATURES:										
T1 FEED SUPPLY	87				80	82	82	82	82	
T2 FEED TO VC	134				144	142	142	150	152	
T3 VC RECYCLE FEED	166				170	167	168	167	167	
T4 BLOWDOWN TO MEMS	164				166	166	170	167	166	
T5 VC SUCTION	170				170	170	173	170	170	
T6 VC VENT	189				192	192	194	192	192	
T7 VC CHEST	190				194	194	198	194	194	
T8 VC EDUCTOR DISCH.	179				186	181	182	184	184	
T9 VC DISTILLATE IN HX	174				176	170	170	172	169	
T10 VC DIST. OUT HX	90				112	92	92	92	92	
T11 1ST FLASH VAPOR	176				178	171	171	172	172	
T12 2ND FLASH VAPOR	165				168	165	165	166	167	
T13 3RD FLASH VAPOR	127				127	128	128	130	130	
T14 4TH FLASH VAPOR	122				113	117	117	117	118	
T15 COOLANT INLET	85				86	86	86	86	86	
T16 COOLANT OUTLET	92				98	98	98	101	100	
T17 4TH FLASH CONC.	115				111	114	114	116	116	
T18 4TH FLASH FEED	124				122	124	124	127	127	
T19 3RD FLASH CONC.	135				133	136	136	138	138	
T20 3RD FLASH FEED	150				150	148	148	150	152	
T21 2ND FLASH CONC.	165				165	164	164	165	166	
B T22 FEED TO HTR.	165				165	164	164	165	166	
A T23 OUTPUT FROM HTR.	171				173	172	172	174	174	
F1 FIRST STAGE RECYCLE	40				40	40	40	40	40	
F2 VC FEED RATE	3½				3½	3½	3½	3½	3½	
F3 VC BLOWDOWN	1.6				1.6	1.6	1.6	1.6	1.6	
F4 VC RECYCLE	3				3	3	3½	3½	3½	
H1 VC BRINE WEIR	1"				1"	1"	1"	1"	1"	
H2 3RD STAGE WEIR	3"				3"	3"	3"	3"	3"	
H3 4TH STAGE WEIR	3"				3"	3"	3"	3"	3"	
FEED TANK LEVEL	643				558	484	421	343	283	
M1 VC DISTILLATE	(40) 21379	21419			21458	(48) 21506	(38) 21543	(40) 21585	(37) 21622	
M2 MEMS DISTILLATE	(35) 17785	17814			17860	(26) 17886	(24) 17910	(38) 17948	17971	
M3 COMBINED DIST.	75				85	74	63	78	60	
V VOLTAGE	475				475	475	475	475	475	
A AMPS	61.1				40.1	59.9	59	39.8	38.5	
KW KILOWATTS										
PF POWER FACTOR	.872	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

Blow Feed To Condenser @ 3:50

Down until 4:00

POND WATER RW-TANK

DATE: 9-26-9[illegible]

TIME:	7:00	7:30	8:00	8:30	9:00
TEMPERATURES:					
T1 FEED SUPPLY	82	83	83	84	Shut Down [illegible] 8:45
T2 FEED TO VC	154	180	180	190	
T3 VC RECYCLE FEED	168	171	178	175	
T4 BLOWDOWN TO MEMS	169	166	166		
T5 VC SUCTION	172	174	171	175	
T6 VC VENT	93	197	194	198	
T7 VC CHEST	95	199	196	199	
T8 VC EDUCTOR DISCH.	181	187	187	194	
T9 VC DISTILLATE IN HX	170	178	180	186	
T10 VC DIST. OUT HX	94	101	100	98	↓
T11 1ST FLASH VAPOR	174	171	170	170	166
T12 2ND FLASH VAPOR	168	164	163	163	160
T13 3RD FLASH VAPOR	130	131	131	130	128
T14 4TH FLASH VAPOR	118	118	118	118	120
T15 COOLANT INLET	86	86	88	89	89
T16 COOLANT OUTLET	100	101	101	102	96
T17 4TH FLASH CONC.	117	117	117	117	117
T18 4TH FLASH FEED	126	127	126	126	122
T19 3RD FLASH CONC.	140	140	140	140	136
T20 3RD FLASH FEED	155	147	146	146	145
T21 2ND FLASH CONC.	170	165	162	160	160
T22 FEED TO HTR.	167	165	164	164	162
T23 OUTPUT FROM HTR.	175	173	172	172	171
F1 FIRST STAGE RECYCLE	40	40	40	40	40
F2 VC FEED RATE	3½	3½	3½	3½	→
F3 VC BLOWDOWN	1.6	1.6	1.6	1.6	1.6
F4 VC RECYCLE	3½	3½	3½	3½	—
H1 VC BRINE WEIR	1"	1"	1"	1"	—
H2 3RD STAGE WEIR	3"	3"	3"	3"	3"
H3 4TH STAGE WEIR	3"	3"	3"	3"	3"
FEED TANK LEVEL 283	208	132			
M1 VC DISTILLATE 21622	(38) 21660	(50) 21710	(47) 21757	21797	21810
M2 MEMS DISTILLATE 17971	(40) 18011	(26) 18037	(41) 18078	18098	18140
M3 COMBINED DIST.	75	76	86		
V VOLTAGE	475	475		475	475
A AMPS	58.7	41.5		45.2	11.7
KW KILOWATTS					

PF POWER FACTOR

Rocky Flats, Col. POND BN Batch #2 9/26/90 Richard W. Boothe

TIME	9:30	10:00	10:30	11:00	11:30	12:00	12:30	1:00	1:30	2:00	2:30
VC FEED PH		8.6	8.3	8.4	8.5	8.6	8.7	8.7	8.7	8.7	8.8
FLASH DIST/COND.		0.28	0.16	0.11	0.08	0.04	0.03	0.03	0.02	0.01	0.01
FLASH DIST/PH		6.2	5.7	5.4	5.4	5.3	5.3	5.2	5.2	5.2	5.0
VC DIST /COND.		0.05	0.07	0.07	0.06	0.07	0.06	0.07	0.06	0.07	0.06
VC DIST/PH		5.3	5.4	5.5	5.4	5.5	5.4	5.5	5.4	5.4	5.4
DIST/COMBINED COND.		0.26	0.21	0.24	0.18	0.17	0.14	0.13	0.15*	0.04	0.04
DIST/COMBINED PH		5.9	5.8	5.7	5.5	5.5	5.7	5.6	5.6	5.4	5.5
FLASH CONC. PH		8.5	8.3	8.3	8.4	8.4	8.4	8.4	8.4	8.4	8.4
VC CONC. PH		8.7	8.7	8.8	8.7	8.8	8.8	8.8	8.8	8.8	8.8
TANK FEED (COND)		13.59	13.55	13.57	13.59	13.58	13.59	13.61	13.62	13.61	13.63
FLASH CONCENTRATE (COND)		off scale	off scale	62.5	off scale	off scale	88.7	off scale	off scale	off scale	135.7
VC DISTILLATE SAMPLE POT (COND)		0.03	0.04	0.05	0.03	0.04	0.06	0.03	0.03	0.03	0.03
VC DISTILLATE SAMPLE POT (PH)		7.6	7.6	7.4	7.9	7.7	7.7	7.7	7.9	7.8	7.8
FLASH DISTILLATE SAMPLE POT (COND)		0.06	0.04	0.02	0.01	0.01	0.01	0.008	0.01	0.009	0.01
FLASH DISTILLATE SAMPLE POT (PH)		9.1	7.8	6.5	6.2	6.3	6.8	6.3	5.7	5.6	6.2
VC CONCENTRATE TANK (COND)	27.5	off scale	off scale	36.75	off scale	off scale	off scale	off scale	25.0	off scale	35.0
ED TANK (PH)	7.7	8.3	8.3	8.5	8.5	8.6	8.7	8.8	8.8	8.8	8.8
FEED TANK (COND)	13.58	13.58	13.54	13.55	13.57	13.55	13.57	13.56	13.59	13.61	13.62

— All Conductivity measured mS/cm —

8:50 9# EDTA Added to feed tank

Before EDTA PH 9.7 COND. 13.12

After EDTA PH 8.1 COND. 13.58

* Note - Prior to 2:00 reading, Found Leaky valve to Dist Line from Conc. Tank

2:55 VC shut down

4:00 VC Back on Line

Rocky Flats, Col Pond BN Batch #2 9/26/90 Richard W. Boothe

TIME	4:30	5:00	5:30	6:00	6:30	7:00	7:30	8:00	8:30	9:00	
VC FEED PH	8.9	8.8	8.9	8.9	9.0	9.0	9.0	9.0	9.0		
FLASH DIST/COND.	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01		
FLASH DIST/PH	5.0	5.0	5.2	5.0	5.1	5.2	5.2	5.1	5.2		
VC DIST /COND.	0.07	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07		
VC DIST/PH	5.5	5.4	5.3	5.5	5.6	5.5	5.5	5.4	5.4		
DIST/COMBINED COND.	0.06	0.07	0.06	0.06	0.06	0.07	0.07	0.07	0.07		
DIST/COMBINED PH	5.7	5.6	5.6	5.4	5.5	5.4	5.3	5.4	5.4		
FLASH CONC. PH	8.4	8.2	8.3	8.3	8.3	8.3	8.3	8.3	8.3		
VC CONC. PH	8.8	8.8	8.6	8.3	8.7	8.8	8.8	8.9	8.9		
TANK FEED (COND)	13.63	13.66	13.67	13.69	13.71	13.68	13.67	13.68	13.80		
FLASH CONCENTRATE (COND)	*153	off scale	off scale	off scale	168	off scale	off scale	off scale	off scale		
VC DISTILLATE SAMPLE POT (COND)	0.05	0.04	0.03	0.03	0.04	0.04	0.05	0.03	0.03		
VC DISTILLATE SAMPLE POT (PH)	7.8	7.6	8.0	8.0	8.0	8.0	8.0	8.0	7.6		
FLASH DISTILLATE SAMPLE POT (COND)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01		
FLASH DISTILLATE SAMPLE POT (PH)	7.3	6.6	6.6	6.8	6.8	6.5	6.5	6.7	6.1		
VC CONCENTRATE TANK (COND)	off scale 153	off scale	off scale	off scale	off scale	off scale	off scale	off scale	off scale		
FEED TANK (PH)	8.9	8.8	8.9	8.9	8.9	9.0	9.0	9.0	9.0		
FEED TANK (COND)	13.61	13.63	13.63	13.64	13.64	13.64	13.66	13.66	13.72		

- All conductivity measured mS/cm

*@ 1630 3rd Stage Tank 156.25 mS at end of test 118.4 mS

*@ 1815 4th Stage TANK 167.520 mS " 222.8 mS

8:45 pm VC shut down pumping to Flash.

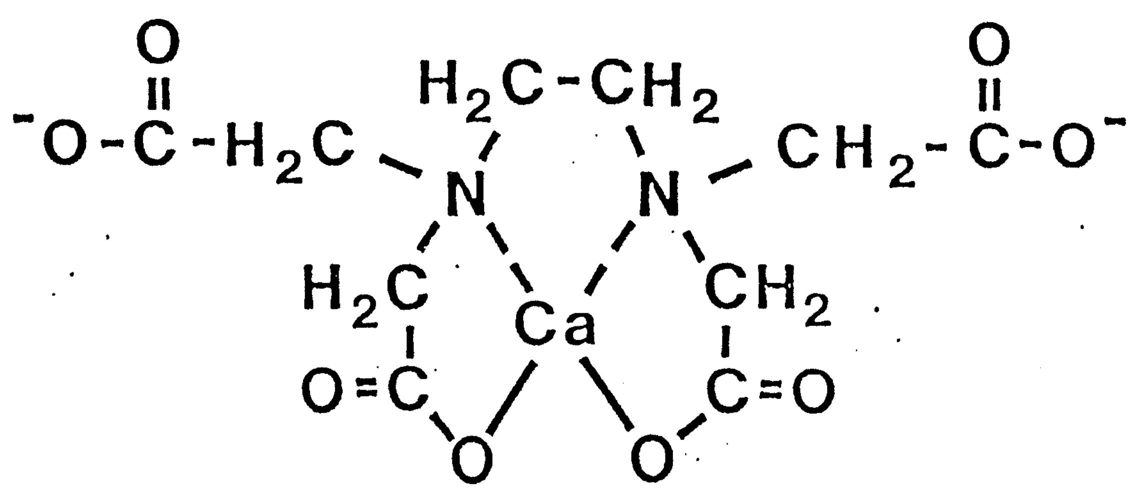

Figure 3b. Calcium chelate of ethylenediaminetetraacetate.

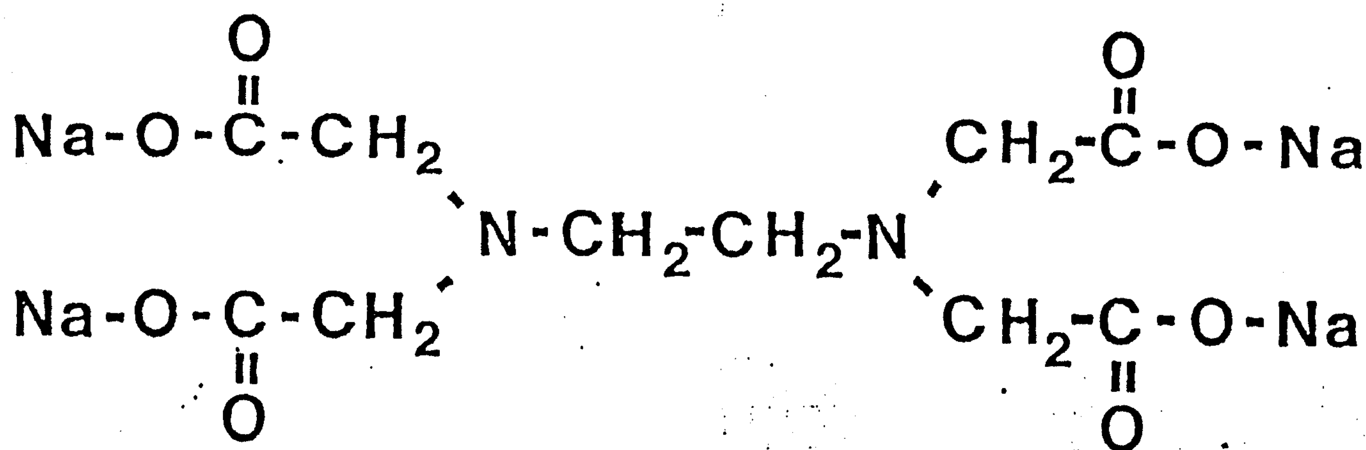

Figure 3a. Tetrasodium salt of ethylenediaminetetraacetic acid.

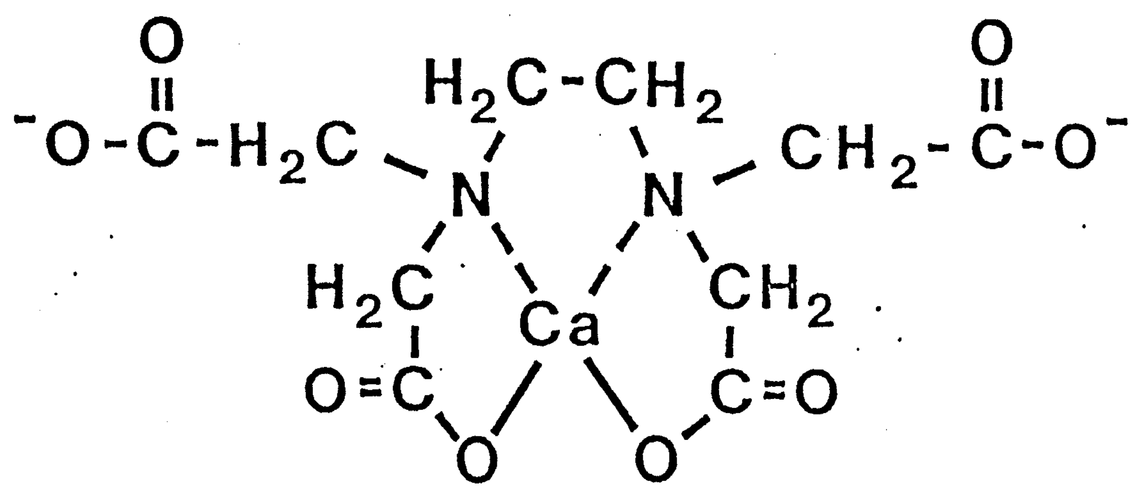

Figure 3b. Calcium chelate of ethylenediaminetetraacetate.

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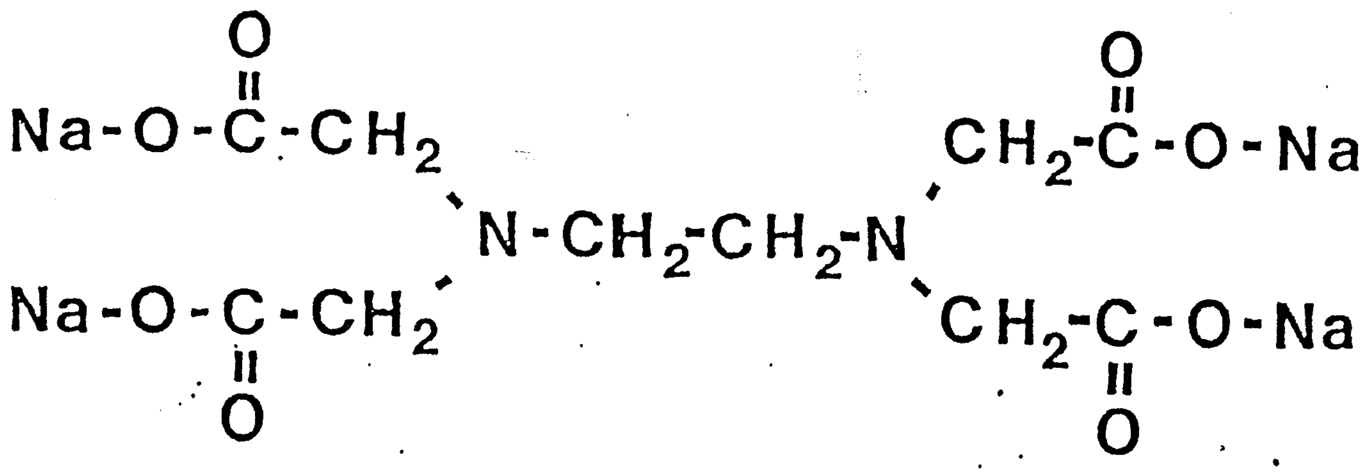

Figure 3a. Tetrasodium salt of ethylenediaminetetraacetic acid.

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