Internal Letter

Rockwell International

Date. June 18, 1986

No. 65950-86-275

TO: (Name, Organization, Internal Address) D. W. Lindsey

FROM: (Name, Organization, Internal Address, Phone) R. T. Kimura

3-2092

Subject: Microcurie Release During Pressurizations in Double-Wall Tanks

Refs: (a) RHO-HS-SR-85-2, 4Q GAS P, February 1986, R. C. Aldrich, L. J. Stanfield, "Radioactivity in Gaseous Waste Discharged from Separations Facility During 1985"

(b) Letter, April 9, 1986, R. T. Kimura to W. H. Trott, "Characterization of Selected Double-Shell Tank Vapor Space Radionuclides - Final Report"

(c) DSI, May 13, 1986, R. E. Van der Cook to R. T. Kimura, "Tank Vapor Space"

<u>SUMMARY AND CONCLUSIONS</u>

An engineering analysis was performed to quantify a microcurie release from a double-wall tank during a pressurization. The analysis involved estimating a volume of vapor released from the tank through all major unfiltered pathways to the environment (Attachment I). The radionuclide concentrations in the primary tank vapor were determined from vapor space radionuclide characterization studies (Reference (b)). Mixing calculations were also performed to account for dilution and air displacement which occurs in release pathways during a pressurization. A statistical analysis of all data points was performed to determine the worst case concentration within 99.75 percent probability (Reference (c) and Attachment II). A review of 1985 tank pressurization data was also made for comparing actual data with worst case scenarios (Attachment III).

Conclusions made from the analysis are as follows:

1. For all statistical worst case scenarios, there is a 99.75 percent probability that the source term concentrations of vapor space radionuclides will not exceed 57 percent of 5,000 x Table II, thus providing a wide margin from immediate action levels (Reference (c)).

2. Mixing, dilution, and duration of pressurization are significant factors that reduce the final release concentration. A pressurization of over 15-minute duration is required before vapor space concentrations equal those discharged to the environment after dilution inside pits.

3. A 30-minute pressurization of tank 102-AW to 5.0 inches WG with no dilution, and at a statistical worst case concentration of 57 percent of 5,000 x Table II, would not cause the annual microcurie release from AW Farm to exceed Table II discharge limits.

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4. There was only one verified pressurization of tank 102-AW out of 97 verified tank pressurizations during 1985. The highest pressure seen was 0.5 inches WG, but its duration was only two minutes. The highest pressure seen during 1985 for all tanks was 1.0 inch WG (see Attachment III).

5. Actual releases from a pit will be much less than presented in these conservative estimates. This is due to:

   a. Actual source term concentrations for almost all of the tanks which pressurize are lower than 18 percent MIC.

   b. The practice of taping the coverblocks to help control in-leakage flow rates also serves to reduce out-leakage during a pressurization.

RESULTS AND DISCUSSION

Source Term Concentration

The beta-gamma activity present in the vapor space of tank 102-AW (Reference (b)) was higher than any other tank sampled, or 18 percent of the Maximum Instantaneous Concentration (MIC = 5,000 x Table II). Total alpha activity was measured and an Alpha Energy Analysis (AEA) is pending. Alpha activities could potentially be a limiting case. Assuming all of the alpha activity is 239 Pu, the highest alpha activity seen was 28 percent MIC in tank 102-AW.

Utilizing a standard deviation of all GEA sampling data, there is a 99.75 percent probability that the maximum beta activity will not exceed 26.9 percent MIC. Analysis of three tank 102-AW data points alone indicate that an upper limit of 57 percent MIC exists at the same 99.75 percent probability (Reference (c)). Tank 102-AW appeared to have the highest airborne activity, probably due to air lift circulator operation (Reference (b)).

Microcurie Release Estimates

Worst case microcurie release estimates were developed using the following basis: 1) eighteen (18) percent of MIC; 2) fifty-seven (57) percent of MIC; 3) flowrate estimates at 1-inch WG and 5-inches WG: 4) no dilution of vapors or displacement of air inside pits; 5) no "filtering" effects from line losses on piping and equipment; and 6) no taping of pit cover blocks.

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A correlation was developed using the two source term concentrations (Figure I). The statistical worst case was not found to be an emergency response condition (i.e., 5,000 x Table II). Hypothetically, a pressurization at this concentration and pressure may still release significant quantities of radioactivity. A 5-inch WG pressurization at 57 percent MIC (2,850 x Table II) could potentially release about 10 uCi per minute. This assumes that vapors do not mix with air inside the pits, and that vapors are discharged to the atmosphere directly from the tank vapor space.

Taping of the space between the coverblock and the pit is done for some pits in all of the double-wall tank farms. The extent of taping will vary in each farm. It will vary since taping is used as means of air in-leakage flowrate control. Seasonal weather changes also affect the amount of taping needed for vacuum/flowrate control (above that provides by flow control butterfly valves). Restricting the in-leakage also means that out-leakage during a pressurization is more restricted at a given pressure. The calculations presented in Appendix A assumed no taping, since imperfect sealing and the varying amounts of taping are difficult to quantify. However, it is estimated that over 50 percent of the coverblocks in all farms are taped. Outleakage will still occur through valve handle holes.

Actual source term concentrations are less than 18 percent MIC for eight of the nine tanks samples (Reference (b)). In addition, since only 1 out of 97 verified tank pressurizations occurred in tank 102-AW, which had 18 percent MIC. The actual activities released to the environment will be much less than 12 uCi for 99 percent of the tank pressurizations seen during 1985.

Actual releases for all tanks which pressurize may be 1/10 to 1/1000 of 12 uCi for both of these reasons.

<u>Comparison to Stack Discharges</u>

During 1985, the 241-AW tank farm had a beta activity discharge of 149 uCi per year based on monthly averages (Reference (a)). Under the worst case of 10 uCi/minute, a 30-minute pressurization would discharge 300 uCi of beta activity. If the activity due to this pressurization were added to the yearly average discharged from the stack, the resulting concentration would still be below Table II guidelines (Attachment I). Table II may be exceeded for RuRh106 only if the duration exceeds 98 minutes at worst case conditions. Isotopic distributions were assumed to be constant at the 1985 average value in this analysis.

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Actual Pressurization Data for 1985

A review was made of all verified tank pressurization events in 1985 for comparison purposes to the conservative worst case scenarios developed here. Actual data for all of 1985 revealed that only one pressurization in tank 102-AW occurred out of 97 verified tank pressurizations (see Attachment III). The 97 verified tank pressurizations were caused by 50 verified "events." An event can cause multiple tank pressurizations. A single event in AW farm, for example, could possibly cause six tank pressurizations. The magnitude of the tank 102-AW pressurization was 0.5 WG, and it lasted for two minutes. An estimated 0.7 uCi were released for this event. For all tanks, only 3 of 97 events exceeded 30-minute duration, but these were at less than 0.1 in WG pressure.

There were five tank "pressurizations" (three events) not listed which lasted 105 and 120 minutes due to planned exhauster shutdowns. Their magnitudes ranged from 0.05 to 0.15 WG. These are mentioned since it must be emphasized that it is difficult to verify that these tanks actually pressurized. The accuracy of the instruments is ± 0.05-inch WG, and the alignment of the strip chart, the width of the pen line, and the alignment of the pen, could add another 0.1 to 0.2-inch WG error to the zero position. Of the 97 tank pressurizations, 68 were less than 0.15 WG in magnitude.

Effect of Mixing and Dilution

The effect of mixing and dilution of the source term concentration with air inside the pits was significant. Using the highest actual concentration of 18 percent MIC from tank 102-AW, mixing calculations were performed on the following pathways (also see Attachment I).

Location/Pathway	Outleakage Flowrate at (1 in. WG)	Pit Volume (ft^3)
Central Pump Pit	22 CFM	960
AW-A Valve Pit	11 CFM	1106
AW-B Valve Pit	11 CFM	1106
Service Pit	22 CFM	289
Feed Pump Pit	10.9 CFM	803
Flush Pit	22 CFM	108
Drain Pit	22 CFM	1613
Instrument/Equipment Tie-ins	10 CFM	0

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The pipe volumes and outleakage flowrates were used with a perfect mixing assumption in order to calculate the diluted concentrations (see Figures II and III). From Figure III, it can be seen that a duration of over 15 minutes is needed before the concentration of vapors exiting the pit via cover blocks, equal those entering the pit via the drain lines. Short duration pressurizations are of lesser concern that those over 15 minutes.

There will also be radionuclide losses on drain lines, pit walls and equipment, and on coverblocks prior to discharge to the atmosphere. It was assumed in this study that no line losses occurred along the release pathway in order to be conservative. Actual release concentrations will be lower due to this and dilution effects. Actual outleakage flowrates may be less due to frictional losses, which were neglected here.

In addition to the recommendations made in Reference (b), it is recommended that all coverblocks be taped and sealed to the extent allowable and still maintain the necessary air in-leakage rates.

R. T. Kimura

R. T. Kimura, Engineer
Waste Concentration Unit

RTK:jmc

Att.

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FIGURE I

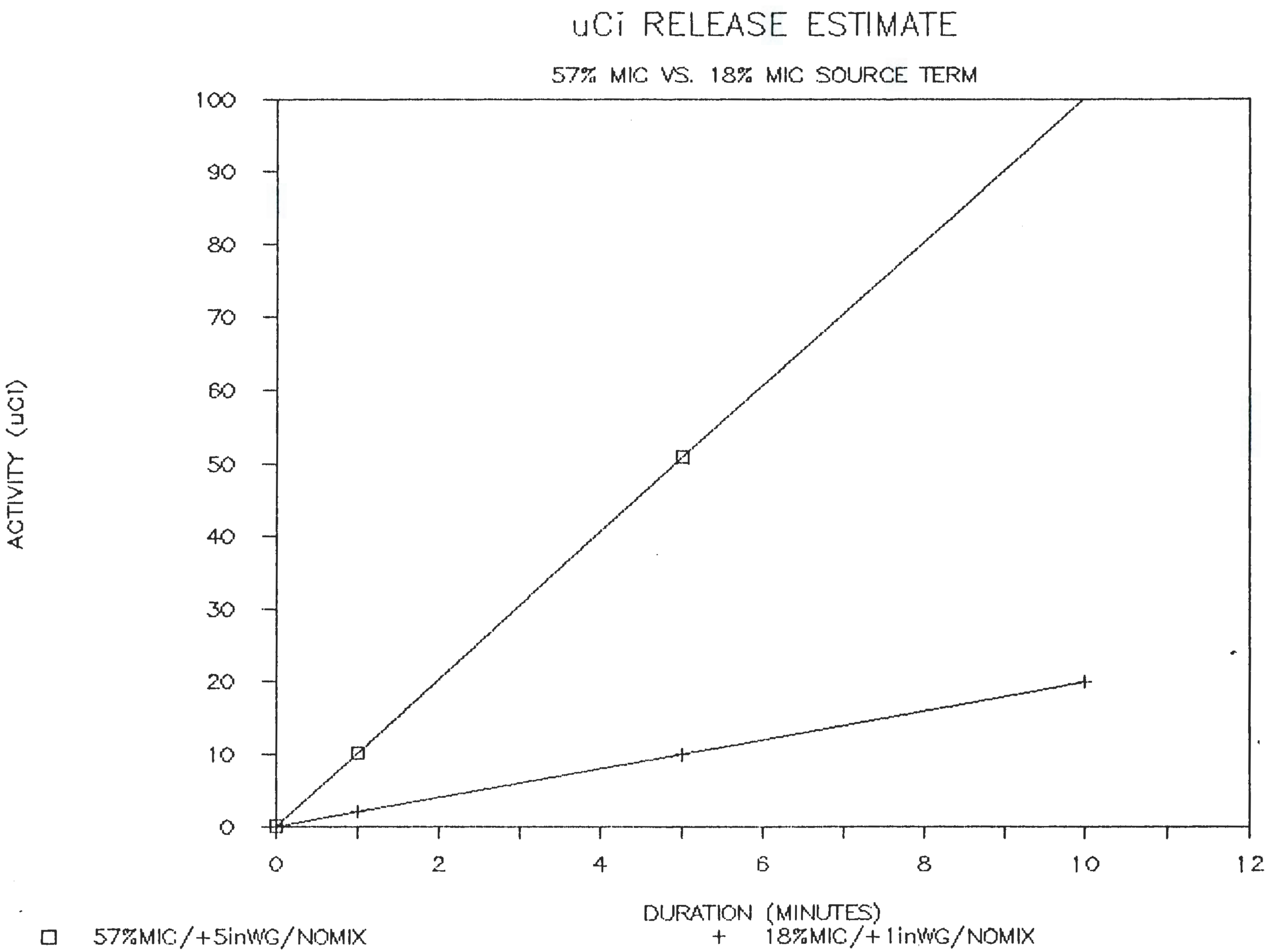
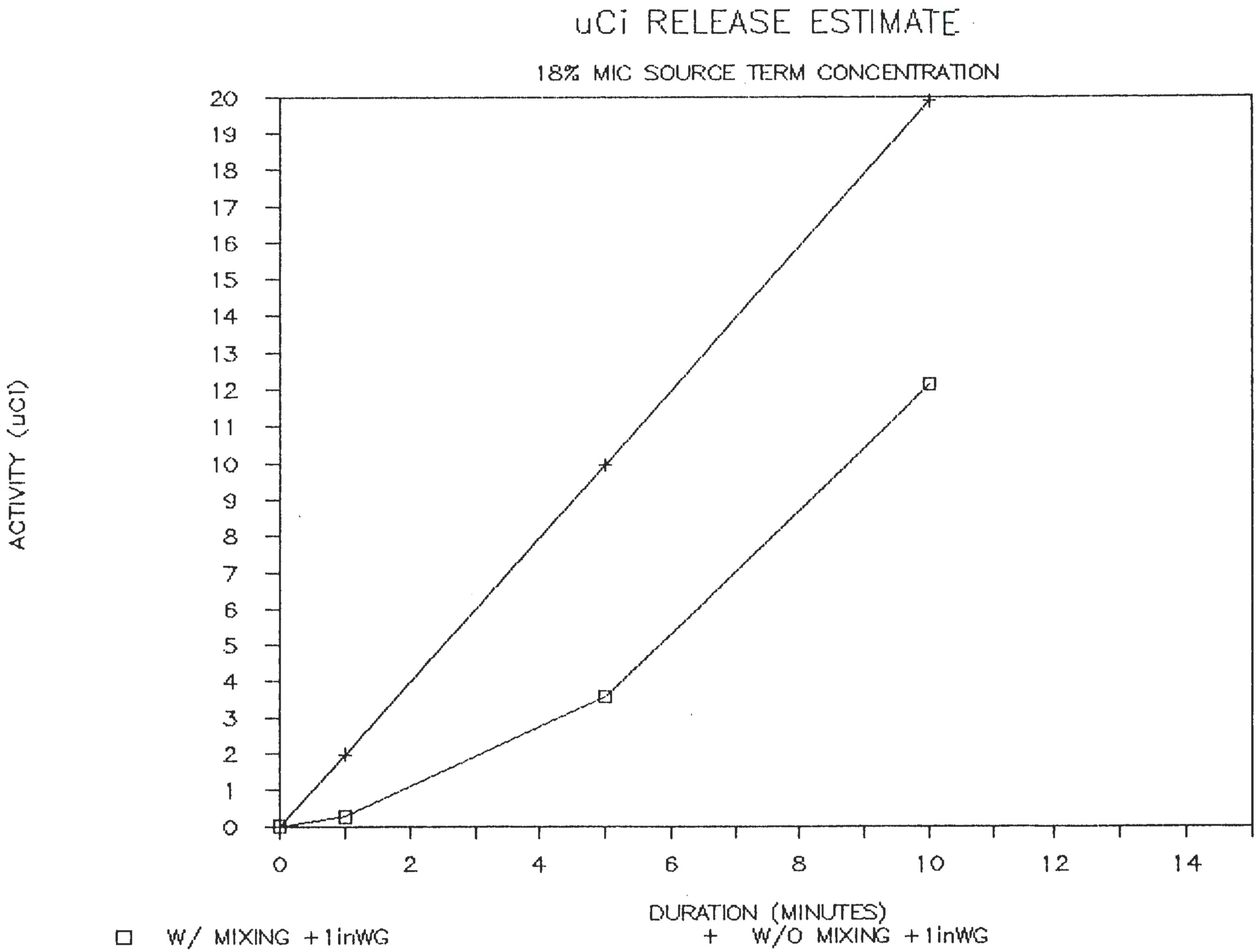
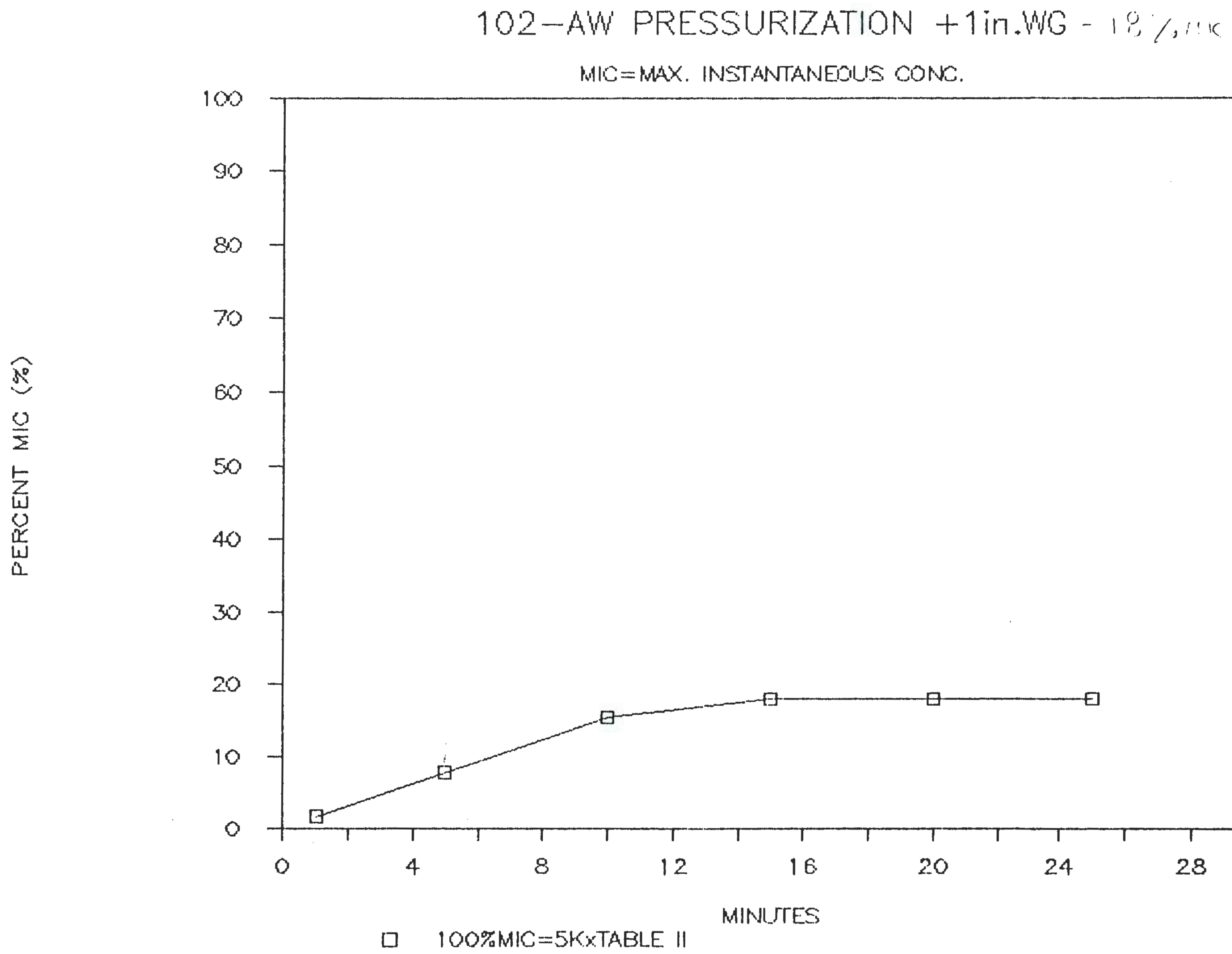

uCi RELEASE ESTIMATE
57% MIC VS. 18% MIC SOURCE TERM
ACTIVITY (uCi)
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
DURATION (MINUTES)
57%MIC/+5inWG/NOMIX
18%MIC/+1inWG/NOMIX

FIGURE II



uCi RELEASE ESTIMATE
18% MIC SOURCE TERM CONCENTRATION
ACTIVITY (uCi)
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0
2
4
6
8
10
12
14
DURATION (MINUTES)
□ W/ MIXING +1inWG
+ W/O MIXING +1inWG

FIGURE III


102–AW PRESSURIZATION +1in.WG - 18%mic
MIC=MAX. INSTANTANEOUS CONC.
PERCENT MIC (%)
100
90
80
70
60
50
40
30
20
10
0
0
4
8
12
16
20
24
28
MINUTES
100%MIC=5KxTABLE II

ATTACHMENT I

ENGINEERING CALCULATIONS

1. VOLUME RELEASED ESTIMATE-1.0inWG, Cases I,II(8pgs)
2. CURIE RELEASED ESTIMATE-1.0inWG, 18%MIC(2pgs)
3. MIXING CALCULATION SPREADSHEET(1pg)
4. VOLUME RELEASED ESTIMATE-5inWG
5. CURIE RELEASED ESTIMATE-5inWG, 57%MIC-Worst Case

FOR 102-AW VOLUME RELEASE ESTIMATE
LOCATION
SUBJECT

ESTIMATE VOLUME OF VAPOR RELEASED FROM 102-AW DURING A PRESSURIZATION OF +1.0 IN WG PRESSURE

BASIS

PATHWAYS FOR UNFILTERED VAPOR RELEASE DURING PRESSURIZATIONS

A. CENTRAL PUMP PIT	3" DR-M24
B. VALVE PITS AW-A, AW-B	3" DR-369-M24/3" DR-361-M24
C INSTRUMENT/EQUIPMENT RISER TIE-INS	59 Risers
D. FEED PUMP PIT	3" DR-M24
E. FLUSH PIT	3" DR-362-M24
F SERVICE PIT	3" DR-371-M24
G. DRAIN PIT (DONT RELEASE TO ATM) SO DO NOT COUNT - 6" DOES GO TO 242-A COND RM	10" DR-334-M24 10" DR-335-M24 6" DR-343-M24
* H. DECON SHOWER - 272-AW	3" DR-374-M24
* I. 241-AW SEAL POT	3" DR-380-M24

* Protected by Seal Loops and Hepa Filters.

Case I ISOTHERMAL FRICTIONAL FLOW (SEE DIAGRAM - CASE I)
$N_{Ma} < 0.3$, $f = 1$, $\rho_a/\rho_b = P_a/P_b$, Low ΔT
6 pipes are 6' LONG WITH 1 elbow, 1 EXPANSION (10' eff.)
3 pipes are 50' long WITH 5 elbows, 1 EXPANSION (100' eff.)
Pressure in tank = P_a = +1.0 IN. WG
Pressure in Atm = P_b = 0 IN. WG = atmospheric
Ref. P.135, McCabe/SMITH UNIT OPERATIONS OF CHEM. ENGR.

The compressible flow through a conduit is:

$$\frac{M}{RT}\left(P_a^2 - P_b^2\right) - \frac{G^2}{g_c}\ln\frac{\rho_a}{\rho_b} = \frac{G^2 f \Delta L}{2 g_c r_H} \qquad (1)$$

where M = Molecular weight of gas = 29 lb/lbmol
R = Ideal Gas Constant = 1,545 $\frac{lbf\text{-}ft}{lbmol\,°R}$
T = Temperature = 550°R

P_a = Tank Pressure 1.0 IN. WG = 2122 lb/ft² abs.
P_b = Atmospheric Pressure 0 IN WG. = 2117 lb/ft² abs
G = Mass Velocity lb/ft²s
ρ_a = Density of Tank gas
ρ_b = Density of gas at atmospheric
f = friction factor = 1 no friction
g_c = Newtons Law Proportionality Factor = 32.174 $\frac{ft-lb}{lb_f-s^2}$
r_H = Hydraulic Radius of CONDUIT (ft) = $\frac{D}{4}$ = 0.0625 ft
ΔL = pipe Length

from (1)

$$G = \sqrt{\frac{\frac{M}{RT}(P_a^2 - P_b^2)}{\frac{1}{g_c}\ln\frac{P_a}{P_b} + \frac{f\Delta L}{2g_c r_H}}}$$

$$G = \sqrt{\frac{\frac{29.9\ lb/lbmol\,(2122^2 - 2117^2)\ lb^2/ft^4}{\left(1545\ \frac{lb_f-ft}{lbmol\,°R}\right)(550\,°R)}}{\frac{1}{\left(32.174\ \frac{ft-lb}{lb_f-s^2}\right)}\ln\frac{2122}{2117} + \frac{(1)(10\,ft)}{2\left(32.174\ \frac{ft-lb}{lb_f-s^2}\right)(0.0625\,ft)}}}$$

$$G = \sqrt{\frac{0.7234\ lb^2/ft^4 s^2}{0.0000733 + 2.49}}$$

$$\boxed{G = 0.54\ lb/ft^2\text{-}s}$$

mass velocity through 10 ft, 3 in ∅ pipe ←

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$\bar{U}$ = Velocity = G/ρ ρ = 0.0722 lb/ft³ air @ 90°F)
[ρ = PM/RT = $\frac{14.7 \times 144 \times 29}{1545 \times 550}$]

$\bar{U}_{10 ft} = \frac{0.54 \text{ lb/ft}^2\text{-s}}{0.0722 \text{ lb/ft}^3}$ = **7.5 ft/s**

$\dot{V}_{10 ft} = \bar{u}A = (7.5 \text{ ft/s})(\pi \frac{(0.25 ft^2)}{4})(60 \text{ sec/min})$ = **22 CFM**

USING Case II, V_f = 100 CFM For Instrumentation/Eqpt lines

$\bar{U}_{100 ft}$ = 7.6 ft/s

$\dot{V}_{100 ft} = \bar{u}A = (7.6 \text{ ft/s})(0.022 \text{ ft}^2)(60 \text{ s/m})$ = 10.0 CFM

∴ AT 5 minute duration (6 pipes @ 10', 3 pipes @ 100')
and 2.0 IN. WG pressure

V_T = [22 CFM (6) + 10 CFM] 5 MIN

V_T = [142] 5 = **710 ft³** ←

CASE II Assume leak occurs across coverblock/pit wall interface. Assume isothermal frictional flow. Also assume that cover block perimetric distance could be circular geometry.

$$r_H = \frac{D_o - D_i}{4} = \frac{1/16}{4} = 0.01563 \text{ ft}$$

A. Central Pump Pit Perimeter = 42' Depth = 6'

$42' = 2\pi r_i \Rightarrow r_i = 6.69' \Rightarrow A_A = 0.133 \text{ ft}^2$ (cross-sectional area of leak path)

B Valve Pits Perimeters (AWA or AWB) = 56' but tie into single 3" DR

$56' = 2\pi r_i \Rightarrow r_i = 8.91' \Rightarrow A_B = 0.188 \text{ ft}^2$ Depth = 6'7"

C. Feed Pump Perimeter = 36' Depth = 9'-11"

$36' = 2\pi r_i \Rightarrow r_i = 5.73' \Rightarrow A_C = 0.024 \text{ ft}^2$

D Flush Pit Perimeter = 15'7" Depth = 5'6"

$15'7' = 2\pi r_i \Rightarrow r_i = 2.5' \Rightarrow A_D = 0.08 \text{ ft}^2$

E. Service Pit Perimeter = 22' $A_E = 0.057 \text{ ft}^2$

$r_i = 3.5'$ Depth = 7'

F Inst lines @ 1/2" ⌀ perimeter = 0.13'

$r_i = 0.0208$ $A_F = 3.61^{-4} \text{ ft}^2 \times 1 \times 59 = 0.022 \text{ ft}^2$

G. Drain Pit Back flows through 3 Cover blocks. Case I will be limiting

(H. SEAL LOOP PROTECTED I. HEPA FILTERED + SEAL POT NOT A PROBLEM) from (1)

$$G = \sqrt{\frac{\frac{M}{RT}(P_A^2 - P_b^2)}{\frac{1}{g_c}\ln\frac{P_a}{P_b} + \frac{f\Delta L}{2g_c r_H}}}$$

$$G = \sqrt{\frac{\frac{29}{1545(500)}(2122^2 - 2117^2)}{\frac{1}{32.174}\ln\left(\frac{2122}{2117}\right) + \frac{1(2.4')}{2(32.174)(0.01563)}}}$$

$$G = \boxed{0.55 \ lb/ft^2 s}$$

$$\bar{u} = G/\rho = (0.55\ lb/ft^2 s)/(0.0722\ lb/ft^3) = \boxed{7.6\ ft/s}$$

		5 min
$\dot{V}_A = (7.6\ ft/s)(0.133\ ft^2)(60\ sec/min) =$	60.6 CFM	303
$\dot{V}_B = (7.6\ ft/s)(0.188\ ft^2)(60\ sec/min) =$	85.7 CFM	428.5
$\dot{V}_c = (7.6\ ft/s)(0.024\ ft^2)(60\ sec/min) =$	10.9 CFM	54.5
$\dot{V}_d = (7.6\ ft/s)(0.08\ ft^2)(60\ sec/min) =$	36.0 CFM	180.0
$V_e = (7.6\ ft/s)(0.057\ ft^2)(60\ sec/min) =$	26.0 CFM	130.0
$V_f = (7.6\ ft/s)(0.022\ ft^2)(60\ sec/min) =$	10.0 CFM	296.0

TOT = $\boxed{1802.0\ ft^3}$ ← at 5 MIN and 1" WG

∴ LIMITING CASE ON THEORET. FLOW IS CASE I FOR A, B, D, E

CASE II SHOWS THAT C, F ARE LIMITING CASES

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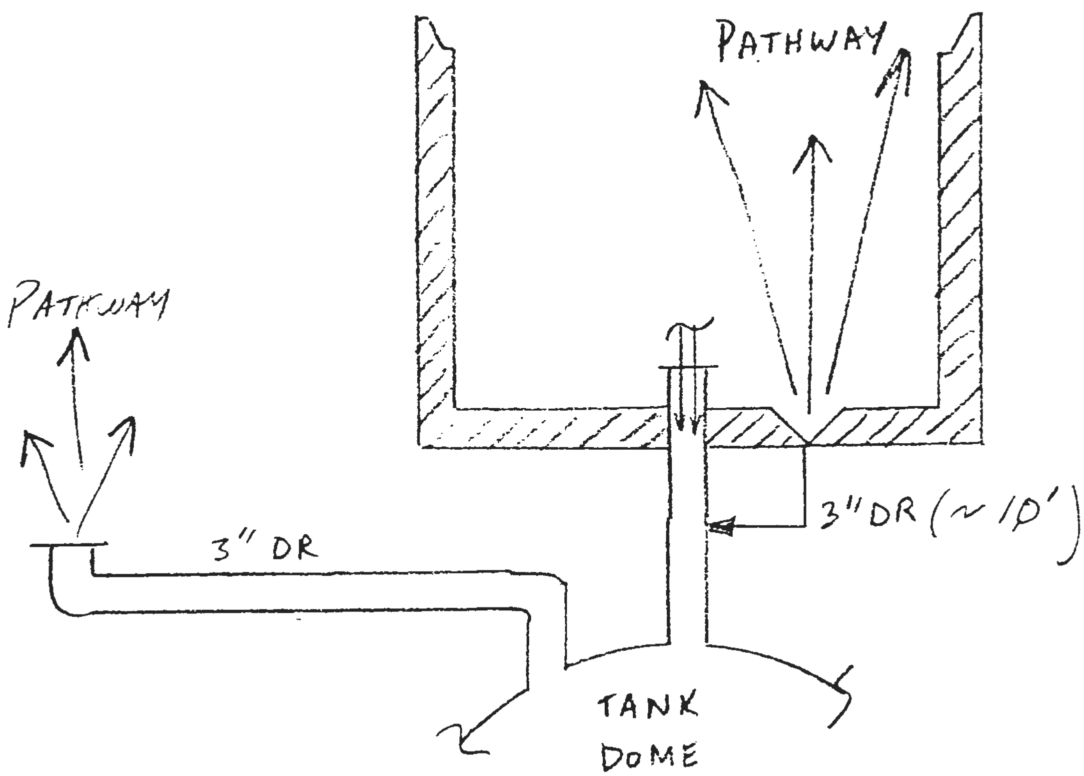
DIAGRAM - CASE I
NO COVER BLOCK
POSSIBLE PATHWAYS



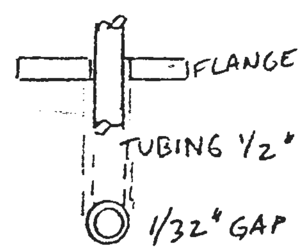
(NOT SHOWN - INSTRUMENT TIE-INS TO RISERS)

DIAGRAM CASE II LEAK THROUGH COVER BLOCKS

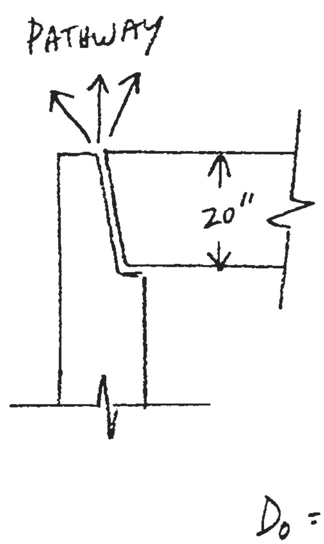
Pit Dimensions (GAP'S ALL ARE 1/32")

	Dimensions	Perimeter
Central Pump Pit	16' × 10'	(26')2
Valve Pits AWA-AWB	14' × 12'	(28')2
Drain Pit 02-D	14'8" × 10'	(24'8")2 +20
Feed Pump Pit	9' × 9'	(18')2
Flush Pit	5' ϕ	15.7'
Service Pit	7' ϕ	22'

Instrument/Eqpt Lines in Risers

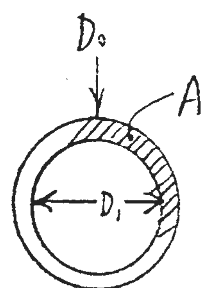


Cover Blocks



Path length estimate
$L = 20"(1.2) + 5" = 29"$
$L = 2.42 ft$

GAP = 1/32"



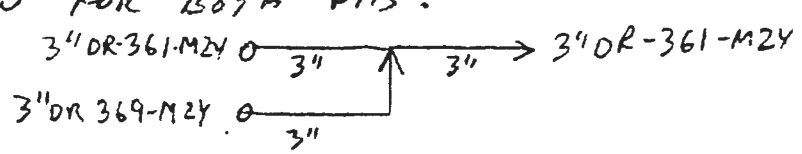
$D_o = 2r_o$
$D_i = 2r_i$
$A = \pi(r_o^2 - r_i)^2$
ASSUME CIRC. GEOM.

Calculate Duration Times NEEDED for displacement of Pit Air with tank vapors.

Pit	Dimensions L×W×D	Volume (ft³)	Flowrate[1] At 1" WG (CFM)	Displacement Time (min)	Case
Central Pump	16'×10'×6'	960	22	43.6	I
Valve[2] AWA	14'×12'×6'7"	1106	22 ÷ 2	100.5	I
Valve[2] AWB	14×12×6'7"	1106	22 ÷ 2	100.5	I
Service	$\pi(3.5^2)7'$	269	22	12.2	I
Feed Pump	9'×9'×9'11"	803	10.9	36.5	II
Flush	$\pi(2.5')^2 5.5'$	108	22	4.9	I
Drain	14'8"×10×11	1613	22	73.3	I
Inst Lines	–		10.0		II

NOTE 1: FROM CASES I & II; RATE LIMITING FLOWRATE USED - SINCE THIS WOULD BE THE THEORETICAL FLOWRATE POSSIBLE.

NOTE 2: AW-A, AW-B DRAIN LINES JOIN AT A COMMON HEADER SO FLOW THROUGH 3" LINE IS TOTAL FLOW FOR BOTH PITS:



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DESIGN ANALYSIS

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FOR
LOCATION
SUBJECT CURIE RELEASE ESTIMATE
102-AW - REALISTIC CASE
1" WG, ~18% MIC

BASIS

Pit	Pit Volume (ft³)	Outleakage Flow (CFM) [1]	Pit Volume (ml)
Central Pump	960	22	2.72^{7}
AW-A VP	1106	11	3.13^{7}
AW-B VP	1106	11	3.13^{7}
Service	269	22	7.61^{6}
Feed Pump	803	10.9	2.27^{7}
Flush	108	22	3.06^{6}
Equipment lines	-	10.0	-
Drain	1613	22	4.56^{7}

$\Sigma = 130.9$ CFM

Source Term Concentration [2]

Average of (3) Samples taken ($1 \times 10^{-4} = 1^{-4}$), in μCi/ml

	10/24/85	10/25/85	1/27/86	AVG
Cs 137	1.2^{-7}	2.3^{-7}	4.4^{-7}	2.63^{-7}
Cs 134	2.4^{-7}	5.4^{-9}	1.6^{-10}	2.46^{-7}
Ru Rh 106	1.6^{-8}	4.0^{-8}	-	2.8^{-8}
ml	1.3^{7}	1.7^{6}	1.9^{6}	5.53^{6}

Other Assumptions:

1 +1.0 in WG Pressurization - Limiting Flow - Case I & II
2 Corrected for filter efficiency + line loss per Letter 65950-86-174-CI and all the other assumptions made there.

MAX. CURIE RELEASED

Σ Ci = 2.63^{-7} + 2.46^{-7} + 2.8^{-8} = 5.37^{-7}

Total Flow Rate = 22 + 11 + 11 + 22 + 10.9 + 22 + 10 + 22
= 130.9 CFM

@ 1 min: Ci = 130.9 ft^3 × 1 min × 3.785 L/gal × 7.481 gal/ft^3 × 1000 ml/L × 5.37^{-7}

Ci = 1.98 µCi

@ 5 min: Ci = 654.5 ft^3 × 5 min × 3.785 × 7.481 × 1000 × 5.37^{-7}

Ci = 9.95 µCi

@ 10 min Ci = 1309 ft^3 × 10 × 3.785 × 7.481 × 1000 × 5.37^{-7}

Ci = 19.9 µCi

Graphs were generated with + without dilution

CALCULATION OF CURIE RELEASED WITH AIR-VAPOR MIXING
ASSUME PERFECT MIXING INSIDE PIT
FOR +1.0 IN WG PRESSURIZATION

PIT	PIT VOL(CF)	FLOW(CFM)	PIT VOL(ML)
CENTRAL PUMP	960	22	27182961.6
AW-A	1106	11	31317037.01
AW-B	1106	11	31317037.01
SERVICE	269	22	7616892.365
FEED PUMP	803	10.9	22737414.755
FLUSH	108	22	3058083.18
DRAIN	1613	22	45673038.605
'INST LINES		10	

MIC GRAPH

Time(min)	FRACTION OF MIC CS137	CS134	RURH106	(SUM)X100
1	0.0064840536	0.0073962589	0.0017257937	1.5606106231
5	0.0324202681	0.0369812944	0.0086289687	7.8030531154
10	0.0642409539	0.0732786547	0.0170983528	15.461796133
15				18
20				18
25				18

NOTE: 18=ASYMPTOTIC LIMIT ON TANK CONCENTRATION FROM SAMPLING DATA

CURIE RELEASED GRAPH

TIME	uCi-MIXING	SUM OF ALL uCi-NO MIXING uCi@1in/18%	uCi@5in/57%
0	0	0	0
1	0.2640410623	1.98	10.18
5	3.5610265584	9.95	50.9
10	12.137854906	19.9	100.18

AVG CS137 IS 2.63E-07
AVG CS 134 IS 2.4E-07
AVG RURH106 IS 2.8E-08

	AIR DISPLACED (ml)	CS137(uCi/ml) AVG	CS 137 uCi RELEASE	CS134(uCi/ml) AVG	CS 134 uCi RELEASE	RU106(uCi/ml) AVG	RU 106 uCi RELEASE
1MIN	622942.87	0.000000006	0.0037545286	0,0000000055	0.0034261858	0.000000006	0.0003997217
1MIN	311471.435	0.0000000026	0.0008147259	0.0000000024	0.0007434761	0.0000000003	0.0000867389
1MIN	311471.435	0.0000000026	0.0008147259	0.0000000024	0.0007434761	0.0000000003	0.0000867389
1MIN	622942.87	0.0000000215	0.0133990611	0.0000000196	0.0122272801	0.0000000023	0.001426516
1MIN	308639.8765	0.0000000036	0.0011018405	0.0000000033	0.0010054818	0.0000000004	0.0001173062
1MIN	622942.87	0.0000000536	0.0333735875	0.0000000489	0.0304549848	0.0000000057	0.0035530816
1MIN	622942.87	0.0000000036	0.0022345613	0.0000000033	0.0020391434	0.0000000004	0.0002379001
1MIN							
1MIN	TOT AIR DISP	WT AVG CONC	SUM OF uCI	WT AVG CONC	SUM OF uCi	WT AVG CONC	SUM OF uCi
1MIN	3423354.2265	0.0000000162	0.0554930309	0.0000000148	0.0506400282	0.0000000017	0.0059080033

5 MIN	3114714.35	0.0000000301	0.0938632147	0.0000000275	0.0856546446	0.0000000032	0.0099930419
5 MIN	1557357.175	0.0000000131	0.0203681479	0.0000000119	0.018586903	0.0000000014	0.002168472
5 MIN	1557357.175	0.0000000131	0.0203681479	0.0000000119	0.018586903	0.0000000014	0.002168472
5 MIN	3114714.35	0.0000001075	0.3349765284	0.0000000981	0.3056820031	0.0000000114	0.0356629004
5 MIN	1543199.3825	0.0000000178	0.0275460129	0.0000000163	0.025137046	0.0000000019	0.0029326554
5 MIN	3114714.35	0.0000002679	0.8343396865	0.0000002444	0.7613746189	0.0000000285	0.0888270389
5 MIN	3114714.35	0.0000000179	0.0558640336	0.0000000164	0.0509785858	0.0000000019	0.0059475017
5 MIN							
5 MIN	TOT AIR DISP	WT AVG CONC	SUM OF uCI	WT AVG CONC	SUM OF uCI	WT AVG CONC	SUM OF UCI
5 MIN	17116771.133	0.0000000811	1.3873257719	0.000000074	1.2660007044	0.0000000086	0.1477000822

10 MIN	6171825	0.0000000597	0.368541317	0.0000000545	0.336311468	0.0000000064	0.0392363379
10 MIN	3085912.5	0.0000000259	0.0799727993	0.0000000236	0.0729789804	0.0000000028	0.0085142144
10 MIN	3085912.5	0.0000000259	0.0799727993	0.0000000236	0.0729789804	0.0000000028	0.0085142144
10 MIN	6171825	0.0000002131	1.3152403877	0.0000001945	1.2002193652	0.0000000227	0.1400255926
10 MIN	3057858.75	0.0000000354	0.1081557232	0.0000000323	0.0986972379	0.0000000038	0.0115146778
10 MIN	6171825	0.0000005308	3.2759228176	0.0000004844	2.9894352708	0.0000000565	0.3487674483
10 MIN	6171825	0.0000000355	0.2193426313	0.0000000324	0.2001605761	0.0000000038	0.0233520672
10 MIN							
10 MIN	TOT AIR DISP	WT AVG CONC	SUM OF uCi	WT AVG CONC	SUM OF uCi	WT AVG CONC	SUM OF uCi
10 MIN	33916983.75	0.0000001606	5.4471484755	0.0000001466	4.9707818787	0.0000000171	0.5799245525

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DESIGN ANALYSIS

PAGE 1/4
JOB NO.
DATE 5-12-86
BY R T KIMURA
CHECKED BY

FOR
LOCATION
SUBJECT WORST CASE CURIE RELEASE
VOL. DISCH. EST. - 102-AW
5 in WG, 57% MIC

Case III 5.0 in WG Pressurization - 3" pipe $r_H = .0625$

from (1) 5 in WG = .417 ft WG

$$P_A = \frac{33.91 + .417}{} \left| \frac{14.7 \frac{lb}{in^2}}{33.91 ft H_2O} \right| \frac{144 in^2}{ft^2} = 2143 \; lb/ft^2 abs$$

from (1)
$$G = \sqrt{\frac{\frac{29.9(2143^2 - 2117^2)}{1545(550)}}{\frac{1}{32.174}\ln\frac{2143}{2117} + \frac{10}{2(32.174)(.0625)}}}$$

$$G = \sqrt{\frac{3.90}{3.79^{-4} + 2.49}} = 1.25 \; lb/ft^2 s$$

$$\frac{G_{5 in WG}}{G_{1 in WG}} = \frac{1.25}{0.54} = 2.31$$

check answer

$$G \propto \dot{V} \propto \sqrt{\Delta P}$$

$$\dot{V}_1 = K\sqrt{\Delta P} = K\sqrt{1} = K$$

$$\dot{V}_5 = K\sqrt{\Delta P} = K\sqrt{5} = K(2.24)$$

close

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SUBJECT

Case III (Cont'd) 5.0 in WG - Cover Blocks

$r_H = 0.01563$

$$G = \sqrt{\frac{\frac{29}{1545(500)}(2143^2 - 2117^2)}{\frac{1}{32.174}\ln\frac{2143}{2117} + \frac{2.4}{2(32.174)(.01563)}}} = \sqrt{\frac{3.90}{3.79^{-4} + 2.38}}$$

$G = 1.28 \ lb/ft^2 s$

$$\frac{G_{5in}}{G_{1in}} = \frac{1.28}{0.55} = 2.33$$

Case III Disch @ 5 in WG

Cent. Pump	22 CFM	×	2.31	=	50.8
AW-A VP	11	×	2.31	=	25.4
AW B VP	11	×	2.31	=	25.4
Service	22	×	2.31	=	50.8
Feed Pump	10.9	×	2.33	=	25.4
Flush	22	×	2.31	=	50.8
Drain	22	×	2.31	=	50.8
Eqpt/inst lines	10.0	×	2.33	=	23.3

$\Sigma \dot{V}_T = 302.7$ CFM

Factor up Vol. Discharge During 5 in. vs 1 in pressurization by $\frac{302.7}{130.9} = \boxed{2.3125}$

∴ Factor up Curie Release figures by Same Figure

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PAGE 4/4
JOB NO.
DATE 5-12-86
BY R T KIMURA
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FOR
LOCATION
SUBJECT WORST CASE CURIE RELEASE

WORST CASE BASIS

1. No Pit Mixing or Dilution
2. 5.0 in WG Pressurization
3. 30 min Duration

Flow Rate at 5 in WG = 302.7 CFM

	18% MIC	57% MIC	
Cs137	1.2^{-7}	3.8^{-7}	
Cs134	2.4^{-7}	7.6^{-7}	$\Sigma = 1.19^{-6}$ µCi/ml
RuRh106	1.6^{-8}	5.08^{-8}	@ 57%

$$302\ CFM \left| \frac{7.481\ gal}{ft^3} \right| \frac{3.785\ L}{gal} \left| \frac{1000\ ml}{L} \right| \frac{1.19^{-6}\ \mu Ci}{ml} = \boxed{10.18\ \frac{\mu Ci}{min}}$$

∴ at 1 min ⇒ 10.18 µCi   5 min ⇒ 50.9 µCi   10 min ⇒ 101.8 µCi

Effect of 30 min Pressurization on Yearly Discharge - AW Farm

- 1985 Avg release from AW Farm Stack 296-A-27 = 149 µCi [1]
- Assume 1985 Avg Radionuclide distribution on worst case activity
  1) RuRh 106 = 3^{-11} µCi/ml = 15% Table II
  2) Cs134,137 < 10% Table II

$$\frac{30\ min}{} \left| \frac{10.18\ \mu Ci}{min} \right. (305.4) + 149\ \mu Ci\ (\text{all of } 1985) = 454.4 \text{ total } \mu Ci \text{ released}$$

RuRh 106: $15\% \left| \frac{454.4}{149} \right. = 45.7\%$ of Table II

Cs 134,137 $<10\% \left| \frac{454.4}{149} \right. = 30.5\%$ of Table II

To Exceed Table II in RuRh106

$$15\% \frac{(X)\ \mu Ci}{149} = 100\% \text{ Table II} \quad X = 993\ \mu Ci \Rightarrow 98\ min$$

1 R.C. Aldrich / L. J. Stanfield - RHO-HS-SR-85-2-4Q GAS

BD-6400-060 (R-2-79)

ATTACHMENT II

STATISTICAL ANALYSIS

DON'T SAY IT-- WRITE IT

DATE: May 13,1986

TO:R.T. KIMURA

FROM: R.E.VAN DER COOK

SUBJECT: TANK VAPOR SPACE

The worst case vapor space content for both beta-gamma and alpha content was calculated from the data listed in your letter to Trott of April 9, 1986. The worst case was estimated by adding the product of the sample standard deviation and the "student t factor" to the sample mean. The resulting value is such that only 0.25 percent of the possible values should exceed this worst case value. Note that for beta-gamma values three values were calculated. In the first value tank 102 AW was excluded due to the air lift circulators increasing the vapor space concentration. In the second, 102-AW was included and in the third only 102-AW was used. In all cases the release is estimated to be less than 5000 times Table 11 values.

type	% MIC	
beta gamma	4.5	Excludes 102-AW
beta-gamma	27	Includes 102-AW
beta-gamma	57	Only 102-AW
alpha	37	All tanks

From this analysis the air lift circulators in 102-AW appears to be the limiting case and still provides a wide margin from the immediate action levels.

Details are provided in the attached table.

TANK	MIC % B-G	
AW-104	.13	.0169
AW-105	.008	.000064
AW-105	.0154	.0002372
AW-105	2.4	5.76
AW-106	.1	.01
AW-101	1.2	1.44
AN-105	.002	.000004
AN-106	1.3	1.69
AN-107	.94	.8836
SY-101	2.9	8.41
SY-101	.32	.1024
================================		
	9.3154	18.3132052
	10.4244163	
	1.0424416	
STD.DEV	1.0210003	
AVG	.8468545	
t,10,.005	3.5814	
upper val	4.5034651	

TANK	MIC % ALPHA	
AW-102	28.4	806.56
AW-102	22.5	506.25
AW-102	14.8	219.04
SY-101	14.3	204.49
SY-101	9.4	88.36
AW-102	8.8	77.44
AN-106	5.1	26.01
AW-105	3.7	13.69
AW-105	3.8	14.44
AW-106	2.6	6.76
AN-105	.7	.49
AW-105	3.3	10.89
AN-107	1.4	1.96
AW-104	.35	.1225
================================		
	119.15	1976.5025
	962.4508929	
	74.0346841	
STD.DEV	8.604341	
AVG	8.5107143	
t,13,005	3.3725	
upper val	37.5288543	

TANK	MIC % B-G	
AW-102	18	324
AW-102	13	169
AW-102	18	324
AW-104	.13	.0169
AW-105	.008	.000064
AW-105	.0154	.0002372
AW-105	2.4	5.76
AW-106	.1	.01
AW-101	1.2	1.44
AN-105	.002	.000004
AN-106	1.3	1.69
AN-107	.94	.8836
SY-101	2.9	8.41
SY-101	.32	.1024
================================		
	58.3154	835.3132052
	592.4070711	
	45.5697747	
STD.DEV	6.7505388	
AVG	4.1653857	
t,13,.005	3.3725	
upper val	26.931578	

TANK	MIC % B-G	
AW-102	18	324
AW-102	13	169
AW-102	18	324
================================		
	49	817
	16.6666667	
	8.3333333	
STD.DEV	2.8867513	
AVG	16.3333333	
t,2,005	14.089	
upper val	57.004773	

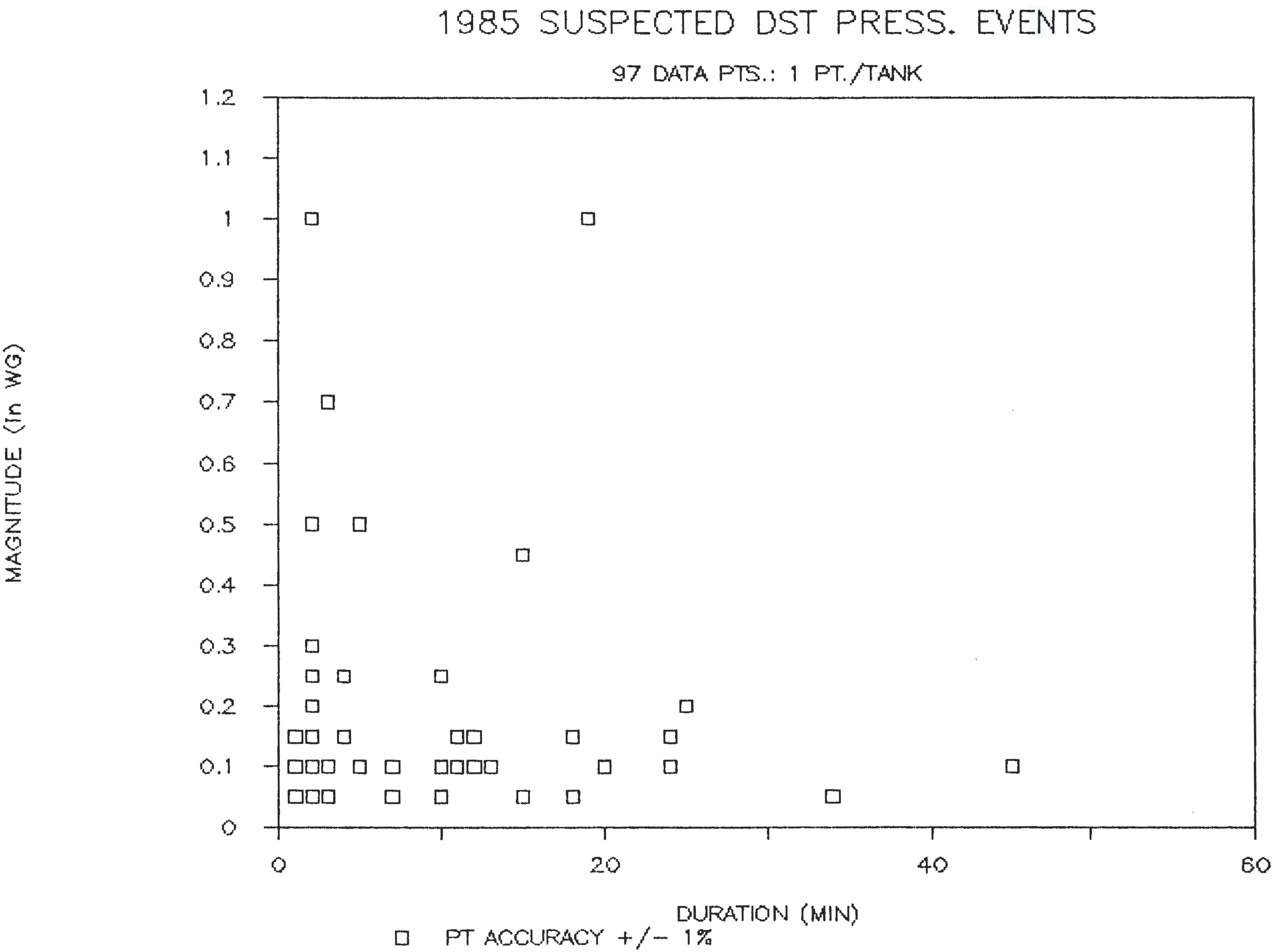
ATTACHMENT III

1985

ACTUAL PRESSURIZATION DATA

FOR ALL VERIFIED PRESSURIZATION EVENTS

(per tank basis)


1985 SUSPECTED DST PRESS. EVENTS
97 DATA PTS.: 1 PT./TANK
MAGNITUDE (In WG)
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
DURATION (MIN)
PT ACCURACY +/- 1%

SUSPECTED PRESSURIZATION EVENTS IN
AN,AW,AY,AZ,SY FARMS

NOTE: "PRESSURIZATIONS" UNDER 0.1 in WG
ARE WITHIN ACCURACY OF ZERO AND ARE
TYPICALLY DUE TO MAINT. SHUTDOWNS, ETC

DATE 1985	TANK	DURATION (MIN)	MAGNITUDE (in WG)
JAN1	1AN	15	0.45
	2AN	10	0.1
	3AN	10	0.25
JAN4	1AZ	2	0.05
	2AZ	2	0.05
	1AY	2	0.05
	2AY	2	0.05
JAN8	3AW	4	0.15
JAN14	3AW	1	0.1
JAN30	3AW	3	0.7
JAN31	1SY	13	0.1
FEB1	3AW	2	1
FEB5	1AZ	2	0.05
	2AZ	2	0.05
	1AY	2	0.05
FEB9	2AW	2	0.5
	4AW	2	0.15
FEB14	1SY	3	0.05
	2SY	3	0.05
	3SY	3	0.05
FEB15	3AW	3	0.05
MAR11	3AW	15	0.05
MAR22	6AW	2	0.3
MAR26	3AN	1	0.05
MAR27	1AN	2	0.2
APR4	1SY	7	0.05
	2SY	7	0.05
	3SY	7	0.05
APR18	5AW	7	0.05
	6AW	7	0.05
APR26	1SY	7	0.05
	3SY	7	0.05
	3SY	3	0.05
JUN7	2AW	45	0.1
JUN20	1SY	105	0.1 } Exhauster Shutdown
	2SY	105	0.1
	3SY	105	0.05
JUN26	1SY	18	0.15
	2SY	18	0.05
JUL16	1AW	2	0.3
JUL 23	1AW	5	0.5
	3AW	3	0.1
	3AW	2	0.2
JUL28	1AN	19	1
	2AN	11	0.1

	3AN	12	0.1
	4AN	12	0.1
	5AN	12	0.15
	6AN	11	0.15
	7AN	11	0.15
AUG1	2AZ	2	0.1
AUG23	1AZ	1	0.05
		1	0.05
	2AZ	1	0.05
		1	0.05
	1AY	1	0.05
	2AY	1	0.05
AUG27	1AZ	1	0.05
	2AZ	1	0.1
	1AY	1	0.05
	2AY	1	0.05
SEPT3	1SY	34	0.05
SEPT12	1SY	20	0.1
	3SY	20	0.1
	3SY	2	0.1
	1SY	2	0.1
	2AZ	7	0.1
SEPT13	1AZ	48	0.1
SEPT17	1SY	5	0.1
	3SY	4	0.25
	3SY	2	0.25
	1SY	2	0.1
SEPT18	2AZ	3	0.05
SEPT19	2AZ	2	0.1
	3SY	2	0.25
	3SY	2	0.25
SEPT22	1AZ	2	0.1
	2AZ	2	0.1
SEPT30	3SY	1	0.15
OCT 2	1SY	24	0.15
	2SY	24	0.1
	3SY	25	0.2
NOV20	1AN	10	0.05
	3AN	10	0.1
	4AN	10	0.05
	5AN	10	0.05
	6AN	10	0.05
NOV28	2SY	2	0.15
DEC10	3AW	3	0.1
DEC11	3SY	15	0.05
DEC14	3SY	120	0.15