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Calculation Note: Project W-320 Primary Ventilation Air Flow Requirements for Mitigation of Steady State Flammable Gas Concentrations in the Headspaces of Tanks 241-C-106 and 241-AY-102

S.D. Estey

Lockheed Martin Hanford Company, Richland, WA 99352
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Abstract: This Calculation Note analyzes the concentration of flammable gases in the headspaces of tanks 241-C-106 and 241-AY-102. Using measured and/or estimated hydrogen generation rates, the required minimum air flow rates and response times to a loss of ventilation condition are calculated. The conditions analyzed include: 1) tank 241-C-106 before sluicing, 2) tank 241-AY-102 before sluicing, and 3) tank 241-AY-102 after sluicing, assuming all of the waste contained in tank 241-C-106 has been transferred to it.

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Author L.D. Estey Date 6/2/97 Checked by St. Buehler Date 6-2-97

Title

Calculation Note: Project W-320 Primary Ventilation Air Flow Requirements for Mitigation of Steady State Flammable Gas Concentrations in the Headspaces of Tanks 241-C-106 and 241-AY-102

Purpose

This calculation note analyzes headspace concentrations of hydrogen dependent upon assumed ventilation flow rates provided for tanks 241-C-106 and 241-AY-102. The analyses are based on measured or estimated steady state hydrogen release rates. Tank 241-C-106 is analyzed prior to sluicing, tank 241-AY-102 is analyzed both prior to and after completion of sluicing. Specific analyses, using both best estimated and bounding hydrogen generation rates, include:

- 1) The minimum primary ventilation flow rates required in the tanks to ensure that the steady state hydrogen concentration in the respective tank headspace does not exceed 25% and 100% of the LFL.
- 2) The headspace hydrogen concentration as a function of time as well as the time required to reach 25% and 100% of LFL (i.e., the required response time) upon complete loss of active ventilation, starting from the steady state hydrogen concentration based on a 200 CFM minimum flow rate in tank 241-C-106 and a 100 CFM minimum flow rate in tank 241-AY-102.
- 3) The headspace hydrogen concentration as a function of time following partial loss of active ventilation (i.e., step changes to 160, 120, 80, and 40 CFM ventilation flow rates) in tank 241-C-106, starting from a 200 CFM flow rate and the corresponding steady state hydrogen concentration based on the 200 CFM flow rate.
- 4) The headspace hydrogen concentration as a function of time following partial loss of active ventilation (i.e., step changes to 80, 60, 40, and 20 CFM ventilation flow rates) in tank 241-AY-102, starting from a 100 CFM flow rate and the corresponding steady state hydrogen concentration based on the 100 CFM flow rate.

Methodology

The calculations utilize referenced values of steady-state hydrogen release rates in both tanks. The calculations are performed and documented using Method V8.0.

Once the total hydrogen generation rate is known for each of the tanks (gr), the required ventilation flow rate (w) to control the gas concentration in the headspace equivalent to a specified steady state hydrogen concentration is the quantity (w) such that the expression $100(gr/(gr+w))$ equals the desired headspace hydrogen concentration measured in volume percent.

The transient response of hydrogen concentration in the tank headspace to a step change in ventilation flow rate is also calculated using the determined hydrogen generation rate for each tank, an initial tank ventilation rate, the tank headspace volume, and the initial tank headspace hydrogen concentration.

Author L.D. Eddy Date 4/2/97 Checked by SA Banks Date 6-2-97

Assumptions

- The hydrogen generation rates in the tanks are 20 SCFD best estimate and 45 SCFD bounding value for tank 241-C-108 before slugging, 51 SCFD best estimate and 60 SCFD bounding value for tank 241-AV-102 before slugging, 71 SCFD best estimate and 105 SCFD bounding value for tank 241-AV-102 after slugging
- The models for the headspace hydrogen concentrations are mathematical constructs needing no assumptions other than complete, instantaneous mixing of hydrogen in the tank headspace
- The assumed minimum active ventilation flow rate is 200 CFM in tank 241-C-108, 100 CFM in tank 241-AV-102
- The headspace volume of tank 241-C-108 is assumed as 95,000 ft³ before slugging. The headspace volume of tank 241-AV-102 is assumed as 33,000 ft³ both before and after slugging. Both values are referenced
- When active ventilation is occurring in a tank, the contribution of passive ventilation to the total ventilation rate is assumed to be negligible
- The passive ventilation rate in the tanks is assumed as a referenced value of 0.45 volume percent turnover per day
- The assumed composition of gases generated in the tanks cause the LFL to occur at 2.5 volume % hydrogen, and 25% LFL to occur at 0.625 volume % hydrogen

Author L. O. Estey Date 5/2/77 Checked by St. Barker Date 6-2-97

Input Data:

cases evaluated:

n = 1 6

n

1
2
3
4
5
6

n = 1 corresponds to tank C-108 pre-sludging best estimate
 n = 2 corresponds to tank C-108 pre-sludging bounding value
 n = 3 corresponds to tank AY-102 pre-sludging best estimate
 n = 4 corresponds to tank AY-102 pre-sludging bounding value
 n = 5 corresponds to tank AY-102 post-sludging best estimate
 n = 6 corresponds to tank AY-102 post-sludging bounding value

hydrogen generation rate:

n

1
2
3
4
5
6

$GR_n =$

20 $\text{ft}^3 \text{ day}^{-1}$
45 $\text{ft}^3 \text{ day}^{-1}$
51 $\text{ft}^3 \text{ day}^{-1}$
60 $\text{ft}^3 \text{ day}^{-1}$
71 $\text{ft}^3 \text{ day}^{-1}$
105 $\text{ft}^3 \text{ day}^{-1}$

Reference:

- 1 (Pasamehmetoglu 1997)
- 2 (Pasamehmetoglu 1997)
- 3 (LANL estimate from SHAS data)
- 4 (LANL estimate from SHAS data)
- 5 sum of 1 & 3
- 6 sum of 2 & 4

tank ventilation rates:

n

1
2
3
4
5
6

$VR_n =$

200 $\text{ft}^3 \text{ min}^{-1}$
200 $\text{ft}^3 \text{ min}^{-1}$
100 $\text{ft}^3 \text{ min}^{-1}$
100 $\text{ft}^3 \text{ min}^{-1}$
100 $\text{ft}^3 \text{ min}^{-1}$
100 $\text{ft}^3 \text{ min}^{-1}$

Reference:

- 1 (assumption)
- 2 (assumption)
- 3 (Estey 1997)
- 4 (Estey 1997)
- 5 (Estey 1997)
- 6 (Estey 1997)

Author L.D. Estey Date 4/6/97 Checked by J.S. Pinkerton Date 6-2-97

tank headspace volumes:

n	vol _n =
1	95000-ft ³
2	95000-ft ³
3	93000-ft ³
4	93000-ft ³
5	93000-ft ³
6	93000-ft ³
7	93000-ft ³

Reference:

- 1 (Pasamahmetoglu 1997)
- 2 (Pasamahmetoglu 1997)
- 3 (Estey 1997)
- 4 (Estey 1997)
- 5 (Estey 1997)
- 6 (Estey 1997)

Calculations

Derivation of ventilation equations

$$\begin{aligned}
 gr &= \text{tank H}_2 \text{ generation rate} & \text{volH}_2 &= \text{H}_2 \text{ volume} & \% \text{H}_2 &= 100 \frac{\text{volH}_2}{\text{vol}} \\
 vr &= \text{tank ventilation rate} & \text{volH}_2 &= \text{initial H}_2 \text{ volume} \\
 \text{vol} &= \text{tank headspace volume} & \text{volH}_2 &= \text{current H}_2 \text{ volume}
 \end{aligned}$$

The rate of change of hydrogen volume in a tank headspace equals the volumetric hydrogen generation rate [gr] minus the volumetric hydrogen loss rate [volumetric flow rate exiting the tank (i.e., gr + vr) times the volume percent hydrogen in exhaust air (i.e., volH2/vol)].

$$\frac{d(\text{volH}_2)}{dt} = (\text{H}_2 \text{ generation rate} - \text{H}_2 \text{ loss rate}) = \left[gr - (gr + vr) \cdot \frac{\% \text{H}_2}{100} \right] = \left[gr - (gr + vr) \cdot \frac{\text{volH}_2}{\text{vol}} \right]$$

$$\frac{d(\text{volH}_2)}{dt} = \left[gr - (gr + vr) \cdot \frac{\text{volH}_2}{\text{vol}} \right]$$

Separating the variables,

$$dt = \frac{d(\text{volH}_2)}{\left[gr - (gr + vr) \cdot \frac{\text{volH}_2}{\text{vol}} \right]} = \frac{d(\text{volH}_2)}{\left[gr - \left(\frac{gr + vr}{\text{vol}} \right) \cdot \text{volH}_2 \right]}$$

Factoring the equation by the differential of the volH2 term,

$$- \left(\frac{gr + vr}{\text{vol}} \right) \cdot dt = \frac{- \left(\frac{gr + vr}{\text{vol}} \right) \cdot d(\text{volH}_2)}{\left[gr - \left(\frac{gr + vr}{\text{vol}} \right) \cdot \text{volH}_2 \right]}$$

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Integrating the equation and evaluating between the limits of time = 0 to time = t, and volH2 = volH2i to volH2 = volH2t,

$$\int_0^t - \left(\frac{gr + vr}{vol} \right) dt = \int_{volH2_i}^{volH2_t} \frac{- \left(\frac{gr + vr}{vol} \right)}{\left[gr - \left(\frac{gr + vr}{vol} \right) volH2 \right]} d(volH2)$$

$$- \left(\frac{gr + vr}{vol} \right) t = \ln \left[gr - \left(\frac{gr + vr}{vol} \right) volH2_t \right] - \ln \left[gr - \left(\frac{gr + vr}{vol} \right) volH2_i \right]$$

Solving for time (t) as a function of the current volume of hydrogen contained in the tank headspace, (volH2t),

$$t = \left(\frac{vol}{gr + vr} \right) \left[\ln \left[gr - \left(\frac{gr + vr}{vol} \right) volH2_t \right] - \ln \left[gr - \left(\frac{gr + vr}{vol} \right) volH2_i \right] \right]$$

$$t = \left(\frac{vol}{gr + vr} \right) \left[\ln \left[\frac{gr - \left(\frac{gr + vr}{vol} \right) volH2_t}{gr - \left(\frac{gr + vr}{vol} \right) volH2_i} \right] \right]$$

Solving for the current concentration of hydrogen contained in the tank headspace, (volH2t/vol), as a function of time t,

$$\ln \left[gr - \left(\frac{gr + vr}{vol} \right) volH2_t \right] = \ln \left[gr - \left(\frac{gr + vr}{vol} \right) volH2_i \right] - \left(\frac{gr + vr}{vol} \right) t$$

$$\left[gr - \left(\frac{gr + vr}{vol} \right) volH2_t \right] = \left[gr - \left(\frac{gr + vr}{vol} \right) volH2_i \right] \exp \left[- \left(\frac{gr + vr}{vol} \right) t \right]$$

$$\left(\frac{gr + vr}{vol} \right) volH2_t = gr - \left[gr - \left(\frac{gr + vr}{vol} \right) volH2_i \right] \exp \left[- \left(\frac{gr + vr}{vol} \right) t \right]$$

$$(gr + vr) \frac{volH2_t}{vol} = gr - \left[gr - \left(\frac{gr + vr}{vol} \right) volH2_i \right] \exp \left[- \left(\frac{gr + vr}{vol} \right) t \right]$$

$$\frac{volH2_t}{vol} = \frac{volH2_i}{100} - \frac{gr - \left[gr - \left(\frac{gr + vr}{vol} \right) volH2_i \right] \exp \left[- \left(\frac{gr + vr}{vol} \right) t \right]}{(gr + vr)}$$

Author LD Eddy Date 5/2/97 Checked by St. Baker Date 6-2-97

At steady state (equivalent to $t = \infty$), the exponential term drops out and,

$$\frac{volH2_t}{vol} = \frac{\%H2_t}{100} = \left(\frac{gr}{gr + vr} \right)$$

Required tank ventilation rate to maintain steady state hydrogen concentration:

$$vr = 100 \left(\frac{gr}{\%H2_t} \right) - gr$$

Required ventilation rate (m^3 per second, CFM) to keep tank headspace concentration below 100% LFL (equivalent to 2.5% hydrogen):

$$vr_{100} = 100 \left(\frac{gr}{2.5} \right) - gr$$

n	$wH2_n$ $\left(\frac{m^3}{sec} \right)$	vr_{100}_n $\left(\frac{ft^3}{min} \right)$
1	$2.556 \cdot 10^{-4}$	0.542
2	$5.752 \cdot 10^{-4}$	1.219
3	$6.519 \cdot 10^{-4}$	1.381
4	$7.669 \cdot 10^{-4}$	1.625
5	$9.075 \cdot 10^{-4}$	1.923
6	$1.342 \cdot 10^{-3}$	2.844

Required ventilation rate (m^3 per second, CFM) to keep tank headspace concentration below 25% LFL (equivalent to 0.625% hydrogen):

$$vr_{25}_n = 100 \left(\frac{gr_n}{0.625} \right) - gr_n$$

n	vr_{25}_n $\left(\frac{m^3}{sec} \right)$	vr_{25}_n $\left(\frac{ft^3}{min} \right)$
1	$1.642 \cdot 10^{-3}$	2.208
2	$2.345 \cdot 10^{-3}$	4.969
3	$2.658 \cdot 10^{-3}$	5.631
4	$3.127 \cdot 10^{-3}$	6.625
5	$3.7 \cdot 10^{-3}$	7.84
6	$5.472 \cdot 10^{-3}$	11.594

Author L D Lattig Date 6/97 Checked by SA Bush Date 6-2-97

Determine the steady state hydrogen concentration (% hydrogen) in the tank headspace at the minimum per tank W-030 ventilation flow rate of 200 CFM for tank 241-C-106 and 100 CFM for tank 241-AY-102

$$\%H_{2h} = 100 \left(\frac{g'_{H_2}}{g'_{H_2} + v'_{H_2}} \right)$$

n	%H _{2h}
1	0.0069
2	0.0156
3	0.0354
4	0.0416
5	0.0493
6	0.0729

Natural ventilation flow rate in tanks 241-C-106 and 241-AY-102 (m³ per second, CFM)

$$v'_{\text{passive}_h} = 0.0045 \frac{\text{vol}_h}{\text{day}}$$

Reference (Crappen 1993)

n	$\frac{v'_{\text{passive}_h}}{\left(\frac{\text{m}^3}{\text{sec}} \right)}$	$\frac{v'_{\text{passive}_h}}{\left(\frac{\text{ft}^3}{\text{min}} \right)}$
1	1.401 10 ⁻⁴	0.297
2	1.401 10 ⁻⁴	0.297
3	4.867 10 ⁻³	0.103
4	4.867 10 ⁻³	0.103
5	4.867 10 ⁻³	0.103
6	4.867 10 ⁻³	0.103

Author S. D. Eddy Date 5/2/97 Checked by M. Parker Date 6-2-97

Determine the time to exceed 25% LFL (equivalent to 0.625% hydrogen) upon complete loss of active ventilation (seconds; days):

$$t_{25} = - \left(\frac{\text{vol}_a}{Q'_a + V \text{ passive}_a} \right) \ln \left[\frac{Q'_a - \left(\frac{Q'_a + V \text{ passive}_a}{\text{vol}_a} \right) \frac{0.625 \text{ vol}_a}{100}}{Q'_a - \left(\frac{Q'_a + V \text{ passive}_a}{\text{vol}_a} \right) \frac{\%L_{25} \text{ vol}_a}{100}} \right]$$

n	t_{25} (sec)	t_{25} (day)
1	$2.735 \cdot 10^4$	31.65
2	$1.151 \cdot 10^5$	13.317
3	$3.339 \cdot 10^5$	3.865
4	$2.805 \cdot 10^5$	3.246
5	$2.336 \cdot 10^5$	2.704
6	$1.512 \cdot 10^5$	1.75

Determine the time to exceed 100% LFL (equivalent to 2.5% hydrogen) upon complete loss of active ventilation (seconds; days):

$$t_{100} = - \left(\frac{\text{vol}_a}{Q'_a + V \text{ passive}_a} \right) \ln \left[\frac{Q'_a - \left(\frac{Q'_a + V \text{ passive}_a}{\text{vol}_a} \right) \frac{2.5 \text{ vol}_a}{100}}{Q'_a - \left(\frac{Q'_a + V \text{ passive}_a}{\text{vol}_a} \right) \frac{\%L_{100} \text{ vol}_a}{100}} \right]$$

n	t_{100} (sec)	t_{100} (day)
1	$1.5 \cdot 10^7$	173.655
2	$5.261 \cdot 10^6$	60.89
3	$1.451 \cdot 10^6$	16.794
4	$1.223 \cdot 10^6$	14.155
5	$1.025 \cdot 10^6$	11.864
6	$6.804 \cdot 10^5$	7.875

Author L.P. Entry Date 4/6/97 Checked by M. Barlow Date 6-2-97

Resulting hydrogen concentration (volume percent) in tank headspace upon total loss of active ventilation as a function of time (days)

tnarrow = 0.20

$$\%H_{2_{n, \text{narrow}}} = 100 \frac{G_n - \left[G_n - \left(\frac{G_n + V_{\text{passive}_n}}{\text{vol}_n} \right) \frac{\%H_{2_n} \text{vol}_n}{100} \right] \exp \left[\left(\frac{G_n + V_{\text{passive}_n}}{\text{vol}_n} \right) \text{tnarrow day} \right]}{(G_n + V_{\text{passive}_n})}$$

trwide = 0.20 1000

$$\%H_{2_{n, \text{trwide}}} = 100 \frac{G_n - \left[G_n - \left(\frac{G_n + V_{\text{passive}_n}}{\text{vol}_n} \right) \frac{\%H_{2_n} \text{vol}_n}{100} \right] \exp \left[\left(\frac{G_n + V_{\text{passive}_n}}{\text{vol}_n} \right) \text{trwide day} \right]}{(G_n + V_{\text{passive}_n})}$$

Determine the response of hydrogen concentration (volume percent) in tank headspace upon partial loss of active ventilation as a function of time (hours) and the reduced ventilation flow rate

thours = 0.6 240

p = 1.5

$V_{r_p} = p \cdot 20 \text{ ft}^3 \text{ min}^{-1}$

$$C106\text{pre}\%H_{2_{p, \text{thours}}} = 100 \frac{G_2 - \left[G_2 - \left(\frac{G_2 + 2 V_{r_p}}{\text{vol}_2} \right) \frac{\%H_{2_2} \text{vol}_2}{100} \right] \exp \left[\left(\frac{G_2 + 2 V_{r_p}}{\text{vol}_2} \right) \text{thours hr} \right]}{(G_2 + 2 V_{r_p})}$$

$$A Y102\text{pre}\%H_{2_{p, \text{thours}}} = 100 \frac{G_4 - \left[G_4 - \left(\frac{G_4 + V_{r_p}}{\text{vol}_4} \right) \frac{\%H_{2_4} \text{vol}_4}{100} \right] \exp \left[\left(\frac{G_4 + V_{r_p}}{\text{vol}_4} \right) \text{thours hr} \right]}{(G_4 + V_{r_p})}$$

$$A Y102\text{post}\%H_{2_{p, \text{thours}}} = 100 \frac{G_6 - \left[G_6 - \left(\frac{G_6 + V_{r_p}}{\text{vol}_6} \right) \frac{\%H_{2_6} \text{vol}_6}{100} \right] \exp \left[\left(\frac{G_6 + V_{r_p}}{\text{vol}_6} \right) \text{thours hr} \right]}{(G_6 + V_{r_p})}$$

Author L.D. EntleyDate 5/2/97Checked by AtkinsonDate 6-2-97Tank [H₂] Upon Active Ventilation Loss

- C-106 pre-shutdown best estimate
- - -○- C-106 pre-shutdown bounding value
- △— AY-102 pre-shutdown best estimate
- - -△- AY-102 pre-shutdown bounding value
- AY-102 post-shutdown best estimate
- - -□- AY-102 post-shutdown bounding value

Author

L.D. Easty

Date

4/1/97

Checked by

J.A. Becker

Date

6-2-97Tank [H₂] Upon Active Ventilation Loss

- x- C-106 pre-shuicing best estimate
- o- C-106 pre-shuicing maximum value
- x- AY-102 pre-shuicing best estimate
- o- AY-102 pre-shuicing maximum value
- x- AY-102 post-shuicing best estimate
- o- AY-102 post-shuicing maximum value

Author L.D. Estey Date 5/2/87 Checked by M. Barker Date 6-2-87

Author L. D. Catey Date 6/2/97 Checked by [Signature] Date 6-2-97

Author L. D. EattyDate 6/2/97Checked by St. BakerDate 6-2-97

Author: S. D. Estay Date: 4/4/97 Checked by: St. Paul Date: 6-2-97

Results

- 1) The minimum primary ventilation flow rates required to ensure that the tank headspace do not reach 25% and 100% of the LFL are shown on page 6
- 2) Following complete loss of forced ventilation, the headspace hydrogen concentration as a function of time, and the times to reach 25% and 100% of the LFL, are shown on pages 10 & 11, and page 8, respectively
- 3 & 4) Headspace hydrogen concentrations following various partial losses of forced ventilation are shown as a function of time, using the bounding hydrogen generation rates, on pages 12 and 13 for tank 241-C-106, and on page 14 for tank 241-AI-102

The results show that the hydrogen generation rates in the tanks utilized by Project W-320 are low enough that only a very small ventilation rate is needed to ensure that a steady state release of gas with the assumed composition will not result in a uniform tank headspace fuel loading exceed 25% of the LFL. A ventilation flow rate of 100 CFM is calculated to be roughly an order of magnitude greater than the flow rate required to satisfy the <25% LFL criteria for these tanks at any of the analyzed conditions. The flammable limits would become a concern in the tank headspaces following complete loss of forced ventilation. In all cases, the requirement to remain < 25% LFL cannot be met by passive ventilation alone. As a rough order of magnitude estimate, using bounding hydrogen generation rates, the < 25% LFL limit would be reached at 1.75 days for tank 241-AI-102 in its limiting waste condition, and at 13.3 days for tank 241-C-106 in its initial condition. If an extended loss of forced ventilation were long enough, the tank headspaces would eventually exceed the LFL in all the analyzed conditions.

Conclusions

A 100 CFM primary ventilation flow rate is sufficient to prevent the formation of a uniformly flammable tank headspace composition in the tanks utilized by Project W-320, even if all the waste resides in tank 241-AI-102. However, using bounding hydrogen generation rates, if forced ventilation were completely lost on these tanks, the 0.825 percent hydrogen control limit is predicted to occur at 1.75 days for tank 241-AI-102 in its limiting condition (i.e., following complete retrieval of tank 241-C-106 wastes), and at 13.3 days for tank 241-C-106 in its initial condition.

References

Estay, S. D., 1997, "Calculation Note: AIAZ Waste Tank Primary Ventilation Requirements for Mitigation of Steady State Flammable Gas Concentrations in the Tank Headspace," HNF-SD-WM-CN-108, Rev. 0, Lockheed Martin Hanford Company, Richland, Washington

Pasamehetoglou, K. O., W. L. Kubicek, Jr., P. Badarwan, 1997, "DISCUSSION OF FLAMMABLE GAS ISSUES FOR PROJECT W-320," LA-UR-97-1330, Rev. 0, Los Alamos National Laboratory, Los Alamos, New Mexico

Crippen, M. D., 1993, "Barometric Pressure Variations," WHC-EP-0051, Westinghouse Hanford Company, Richland, Washington

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Scope of Review:

Yes No NA

☐	☐	☐	☒	* Previous reviews complete and cover analysis, up to scope of this review, with no gaps.
☒	☐	☐	☐	Problem completely defined.
☒	☐	☐	☒	Accident scenarios developed in a clear and logical manner.
☒	☐	☐	☐	Necessary assumptions explicitly stated and supported.
☒	☐	☐	☐	Computer codes and data files documented.
☒	☐	☐	☐	Data used in calculations explicitly stated in document.
☒	☐	☐	☐	Data checked for consistency with original source information as applicable.
☒	☐	☐	☐	Mathematical derivations checked including dimensional consistency of results.
☒	☐	☐	☐	Models appropriate and used within range of validity or use outside range of established validity justified.
☒	☐	☐	☐	Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
☒	☐	☐	☐	Software input correct and consistent with document reviewed.
☒	☐	☐	☐	Software output consistent with input and with results reported in document reviewed.
☒	☐	☐	☐	Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.
☒	☐	☐	☐	Safety margins consistent with good engineering practices.
☒	☐	☐	☐	Conclusions consistent with analytical results and applicable limits.
☒	☐	☐	☐	Results and conclusions address all points required in the problem statement.
☐	☐	☐	☒	Format consistent with appropriate NRC Regulatory Guide or other standards
☒	☐	☐	☐	Review calculations, comments, and/or notes are attached.
☒	☐	☐	☐	Document approved.

S. A. Barker
 Reviewer (Printed Name and Signature)

6-2-97
 Date

* Any calculations, comments, or notes generated as part of this review should be signed, dated and attached to this checklist. Such material should be labeled and recorded in such a manner as to be intelligible to a technically qualified third party.

[illegible]

HN-50-20M-EN-114, Ru. O

	B	C	D	E	F	G	H	I	J	K	L
	Check of Calc Note: HW-SD-WP-FCM-134 Rev 8.										
	Task	1 C-105 Dist Est	2 C-105 Boulding	3 AY102 Before Dist Est	4 AY102 Before Boulding	5 AY102-After Dist Est	6 AY102-After Boulding	7 Forum	Variable Name	Range Name	
29	Time = 240 hours	%	0.01963		0.00260		0.00960	$100 * (0.012 + 0.003 - 0.012 + 0.004 * 0.012) / (0.012 + 0.003 + 0.012 + 0.004 * 0.012)$	%H2		
30	Unit rate =	19.2/min	200		100		100	$100 * (0.012 + 0.003 - 0.012 + 0.012 * 0.012) / (0.012 + 0.003 + 0.012 + 0.012 * 0.012)$	%H2		
31	Time = 360hrs	%	0.01502		0.04105		0.01200	$100 * (0.012 + 0.003 - 0.012 + 0.012 * 0.012) / (0.012 + 0.003 + 0.012 + 0.012 * 0.012)$	%H2		
32	Time = 30 hours	%	0.01502		0.04105		0.01200	$100 * (0.012 + 0.003 - 0.012 + 0.012 * 0.012) / (0.012 + 0.003 + 0.012 + 0.012 * 0.012)$	%H2		
33	Time = 90 hours	%	0.01502		0.04105		0.01200	$100 * (0.012 + 0.003 - 0.012 + 0.012 * 0.012) / (0.012 + 0.003 + 0.012 + 0.012 * 0.012)$	%H2		
34	Time = 90 hours	%	0.01502		0.04105		0.01200	$100 * (0.012 + 0.003 - 0.012 + 0.012 * 0.012) / (0.012 + 0.003 + 0.012 + 0.012 * 0.012)$	%H2		
35	Time = 120 hours	%	0.01502		0.04105		0.01200	$100 * (0.012 + 0.003 - 0.012 + 0.012 * 0.012) / (0.012 + 0.003 + 0.012 + 0.012 * 0.012)$	%H2		
36	Time = 240 hours	%	0.01502		0.04105		0.01200	$100 * (0.012 + 0.003 - 0.012 + 0.012 * 0.012) / (0.012 + 0.003 + 0.012 + 0.012 * 0.012)$	%H2		

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