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Evaluating T_2 Conversion to Tritiated Water under Ambient Conditions — Case Study

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ABSTRACT

In 2015, an incident released approximately 40 Ci of T_2 gas directly into the Tritium Exhaust System. Data from a bubbler system that monitored the stack effluent during the time period encompassing the accident, from 9 days prior through approximately 26 hours following the release, indicated that approximately 0.25% of the total accumulated tritium gas was in the form of tritiated water; however this value does not account for sources of tritium exhaust from other building operations and processes during the 9 days prior to this incident. Further analysis of the bubbler data around this time period considered the 9-day background contributions and shows that the actual fraction of the tritium that was released as tritiated water vapor (during and within 26 hours after the release) was likely lower than 0.1%.

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ACRONYMS AND DEFINITIONS

Abbreviation	Definition
Ci	Curie
LSC	Liquid Scintillation Counting
HTO or T_2O	Tritiated Water (vapor)
HT or T_2	Tritium Gas, Elemental

1. TRITIUM EXHAUST MONITORING WITH BUBBLER

1.1. Bubbler Operation

Bubbler measurements are used to quantify tritium releases up the stack. There are six vials on the bubbler system, all of which are all typically sampled and replaced every two weeks. The first three vials on the bubbler system collect tritiated water vapor content. After the air has passed through the first three vials, ~99 % of the tritiated water in the air sample has been trapped. Any tritium (primarily elemental form) that remains after passing through the first three vials then passes through a catalyst, which converts HT and T_2 into HTO. The converted HTO can then be captured by the three subsequent bubbler vials. By using LSC to measure the tritium content in all six vials and using the known volume and flow rate in the exhaust system, we deduce the relative fraction of gas that was in the air stream as tritiated water and elemental tritium (HT and T_2).

1.2. Bubbler Data around Release Event

In 2015 there was an unintended, but not of reportable quantity, release of T_2 gas of approximately 40 Ci.[1] The release event lasted from 14:30 on 01/13/2015 to 11:45 on 1/14/2015, as indicated from live monitoring of the stack effluent with Femtotech Tritium Air Monitors. Approximately 26 hours after the release concluded, the bubbler vials were removed and counted. This replacement was earlier than normal (after ten days rather than the usual two-week sampling interval) due to the unexpected release.

Historical bubbler data around the time period of interest are presented in Table 1-1, prior to subtraction of background contributions. The start column indicates the date that the bubbler vials were put into service. The end column indicates the date they were removed for measurement by LSC. Days indicates the number of days the bubbler vials were collecting the tritium in the air flow, and the HTO and HT columns indicate the amount of tritium in the air flow in each respective form. The corresponding normalized columns normalize the aforementioned values to an interval of 10.2 days. The row of data in red corresponds to the time period that includes the accidental tritium release.

Table 1-1. Bubbler Data around Time Period of T_2 Release

Start	End	Days	HTO Effluent (Ci)	HT Effluent (Ci)	HTO Stack Effluent, Normalized* (Ci)	HT Stack Effluent, Normalized* (Ci)	% HTO
10/31/14 7:44	11/14/14 8:58	14.1	0.09	0.30	0.07	0.22	24.02%
11/14/14 9:05	11/21/14 8:31	7.0	0.05	0.01	0.07	0.02	79.51%
11/21/14 14:16	12/5/14 8:17	13.8	0.10	0.03	0.07	0.02	79.40%
12/5/14 8:28	12/18/14 8:32	13.0	0.10	0.08	0.08	0.06	57.09%
12/18/14 15:29	1/5/15 9:09	17.7	0.11	4.02	0.07	2.31	2.77%
1/5/15 9:16	**1/15/15 14:09**	**10.2**	**0.10**	**39.92**	**0.10**	**39.92**	**0.25%**

2. CORRECTING CALCULATED %HTO FOR BACKGROUND CONTRIBUTIONS

The bubbler samplings taken in the weeks prior to the release (pre-accident, from 10/31/2014 to 1/5/2015) suggest that typical building activities result in releases of approximately 0.07 Ci of HTO over a typical period of 10.2 days. Typical background HT readings show more variation, so a median value of 0.06 is selected for a representative background; the HT correction does not result in a significant change in the background-adjusted % HTO value. If the these background contributions (arising from other building activities and gas evolving from long-term surface reactions in the exhaust system) are subtracted from the results for the 10.2-day period encompassing the 40 Ci release event (1/5/2015 to 1/15/2015), the amount of HTO and HT from the release event become:

Effluent released as HTO & T_2O due to accident = 0.10 Ci – 0.07 Ci = 0.03 Ci

Effluent released as HT & T_2 due to accident = 39.92 – 0.06 Ci = 39.86 Ci

The resulting fraction of HTO due to the unintentional elemental tritium gas, after correcting for other sources for building releases, reduces from 0.25% to 0.08%.

REFERENCES

[1] Dirk, S., Downs, J., Moy, A. (2015). *Tritium Causal Analysis Report* (FileNet ID NG-0000018587). Retrieved from https://eimsicn.sandia.gov