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Ms. J. Campbell
Project Officer, Nuclear Processing Facilities Division
Canadian Nuclear Safety Commission
P.O. Box 1046, Station B
Ottawa, Ontario
Canada
K1P 5S9

Subject: Final Written Report: November 4 Action Level Exceedance

Dear Ms. Campbell,

At approximately 1400h on November 4, 2014, after performing analysis of routine weekly samples from our stack monitoring systems ('bubblers'), SRBT became aware of an exceedance of an action level. A preliminary verbal notification was made to your attention by telephone conversation at approximately 1510h, and a preliminary description of the event was furnished via formal correspondence [1].

As per condition 2.3 of operating licence NSPFOL-13.00/2015, and section 3.2 (a) of Licence Conditions Handbook LCH-SRBT-R000, attached to this letter we hereby submit a final written report of this occurrence. This notification is required to be submitted within 21 working days of our becoming aware of this condition.

This final written report is based upon our internal investigation of the matter, conducted as part of our non-conformance process. It includes corrective actions intended to prevent recurrence of the event, which have been accepted and have been (or are being) implemented.

As part of our Public Information Program, the final written report will be posted to our public website within 5 business days of issuance to CNSC staff.

Should you have any questions on this subject, please do not hesitate to contact Ross Fitzpatrick, Jamie MacDonald or myself at any time.

Best Regards,

Stephane Levesque
President
SRB Technologies (Canada) Inc.

cc: R. Buhr, CNSC
R. Fitzpatrick, SRBT
K. Levesque, SRBT
J. MacDonald, SRBT
T. Sennett, SRBT
B. St. Pierre, SRBT

Reference

[1] Letter from S. Levesque (SRBT) to M. Rinker (CNSC), *Action Level Exceedance,* dated November 5, 2014.

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FINAL WRITTEN REPORT

Action Level Exceedance – November 4, 2014

Author: _____

Jamie MacDonald
Manager of Health Physics & Regulatory Affairs

Accepted: _____

Stephane Levesque, President

Accepted: _____

Ross Fitzpatrick, Vice-President

Date Submitted: December 2, 2014

Submitted To: J. Campbell, Project Officer - CNSC

SRBT FINAL WRITTEN REPORT

Action Level Exceedance – November 4, 2014

Table of Contents

1. Introduction

SRBT measures gaseous tritium releases using two systems:

- Real-time Stack Monitoring System, and
- Tritium-in-Air Sample Collection System (TASC, or 'bubblers').

As per procedure, bubbler sampling bottles are changed weekly, typically on Tuesday mornings. The sampling media is processed and analyzed for tritium content, with results contributing to a calculated total tritium release for the sampling period. The calculated tritium releases derived from the bubblers is the formal record of tritium released via the gaseous pathway from the facility.

As per routine procedure, sample bottles were changed out on the morning of Tuesday, November 4, 2014. The sampling media was processed and analyzed via liquid scintillation counting.

Once counted, the results were input into the calculation spreadsheet, along with other critical data required to accurately derive gaseous emissions for the sampling period. At approximately 1400h, it was realized that tritium gas emissions for the sampling period of October 28 – November 4, 2014 had exceeded an action level.

2. Summary of Stack Monitoring Data

Tritium releases occur through the two active ventilation systems – the 'Rig' and 'Bulk' stack systems. Releases of tritium oxide ('HTO') and elemental tritium gas ('HT') are calculated for both systems using the results from the bubbler systems which continuously sample the air flowing through the ventilation systems prior to exiting the processing area.

The following data was obtained for the sampling period of October 28-November 4, 2014:

RIG STACK HTO:	103.26 GBq
RIG STACK HT:	16,312.47 GBq
BULK STACK HTO:	38.90 GBq
BULK STACK HT:	115.84 GBq
TOTAL HTO:	142.16 GBq
TOTAL HT:	16,428.31 GBq
TOTAL HT+HTO:	**16,570.47 GBq**

SRBT is restricted by licence condition on the quantity of tritium that may be released to atmosphere. In addition, SRBT has established action levels for tritium releases to atmosphere; these are defined in the document *Licence Limits, Action Levels and Administrative Limits*. This document forms part of the licensing basis of the facility, and is required to be accepted by the CNSC.

The licenced release limit for total tritium is set at 448,000 GBq per year. The weekly release discussed above represents 3.70% of the allowed limit for the year.

The accepted action level for total tritium released to atmosphere is set at 7,753 GBq per week. The release discussed above represents 214% of the action level for the week.

The real-time stack monitoring system includes tritium-in-air monitors which measure the concentration of tritium in the effluent streams of each stack. This data is trended and recorded using two components: an analog paper-based chart recorder, and a digital data recorder.

A review of the data collected by the real-time stack monitoring system showed several expected release events of small magnitude of the type that occur as part of normal processing operations.

In addition, it was clear from the review of this data that two abnormal events had occurred early in the sampling period, and that these events were the main contributing factors in the action level being exceeded for the sampling period.

3. Issuance of Preliminary Notification

At approximately 1510h, a telephone conversation was held between the President, SRBT and the CNSC Director of Nuclear Processing Facilities Division, wherein SRBT verbally informed CNSC Staff of the action level exceedance.

The following day (November 5, 2014), at 1211h, the Manager of Health Physics and Regulatory Affairs, SRBT sent a formal letter from the President, SRBT to the attention of CNSC Staff as an email attachment.

The two communications above ensured that SRBT met the reporting requirements of Licence Conditions Handbook LCH-SRBT-R000, section 3.2.

4. Investigation Process Description – NCR-426

The required investigation into the action level exceedance was assigned to the Manager of Health Physics and Regulatory Affairs (HP&RA). A final written report is required to be submitted to CNSC staff no later than 21 working days after becoming aware of the exceedance – by December 3, 2014.

The investigation began with the raising of a non-conformance with the Quality Manager, as required by internal process. Non-conformance report ('NCR') #426 was generated and assigned to the Manager of HP&RA on November 5, 2014.

The investigation was conducted as follows:

- Review of the data recorded on the analog chart recorder
- Review of the data recorded on the digital data recorder
- Review of records relating to tritium filling operations at the time of abnormal events
- Interviews with staff members working at the time of abnormal events

The results of the investigation, including the determination of root causes for the events, are discussed in the following sections. Additionally, corrective actions are proposed which, if accepted, will contribute to reducing the probability of similar events occurring.

5. Findings

Based on a review of the analog and digital data available from the real-time stack monitoring system, and on the interviews conducted with workers, it is clear that two distinct events were the primary contributors of the majority of released elemental tritium gas to the 'Rig' stack systems.

Contributing Event #1

During the late afternoon of Tuesday, October 28, 2014, as per procedure, personnel working in the Assembly work area (Zone 2) vacated the room in response to an alarm from the tritium-in-air monitor sampling the general room air. This alarm was a result of a gaseous tritium light source ('GTLS') developing a leak while being manually processed by a technician.

The sequence of events that occurred after this initial event contributed to the abnormal amount of tritium gas emitted, and thus to the action level exceedance.

Contributing event #2

During the late afternoon of Wednesday, October 29, 2014, a processing run on Rig #7 was being completed as per procedure. During the nitrogen purge steps, abnormally high concentrations of tritium were released to the Rig Stack system.

The tritium releases associated with this event contributed to the abnormal amount of tritium gas emitted, and thus to the action level exceedance.

The remaining releases for the sampling period were routine in nature, and did not significantly contribute to the action level being exceeded.

6. Contributing Event #1 – GTLS Leakage

Description of the Event

During the late afternoon of Tuesday, October 28, 2014, as per procedure, personnel working in the Assembly work area (Zone 2) vacated the room in response to an alarm from the tritium-in-air monitor sampling the general room air. This alarm was a result of a gaseous tritium light source ('GTLS') developing a leak while being manually processed by a technician.

Although the light source was isolated and transferred to the Rig Room (Zone 3) as required by procedure, the alarm condition continued to persist for an abnormally long period of time. Further assessment by a member of the Health Physics Team suggested that at least one other additional GTLS had developed a leak.

As a result, GTLS of the same type as the identified failed source were transferred to Zone 3 in an attempt to eliminate the source of air contamination in Zone 2.

Technicians in Zone 3 attempted to promptly identify and eliminate the leaking GTLS, but were not successful in determining which of the lights had developing the additional leakage. In order to eliminate stack emissions by closing at 1900h (as per procedure), the technicians subsequently placed lights in segregated batches into sealable plastic bags, and then sealed the entire inventory of transferred GTLS in aluminum cans.

The following morning, these cans were opened to continue to try and identify and isolate the leaking GTLS. It was discovered that seven additional sources had failed and were leaking, resulting in additional tritium releases via the Rig Stack system while segregating these from the other lights.

In total, eight additional GTLS had leaked as a result of the sequence of events described above. Each of the lights contained a maximum of approximately 370 GBq of pure tritium gas; thus, nine failed lights would have contributed approximately 3,330 GBq of tritium to the gaseous effluent stream.

Analysis

The investigation into this event has determined that the occurrence of seven of the nine failed light sources was an avoidable event.

Single light failures occur perhaps once a week when manually processing GTLS in Zone 2. A second light was clearly leaking based on measurements from the room air. It is uncommon for two lights to leak simultaneously; however, during the initial response for the first obviously leaking GTLS, a second light source may have been damaged resulting in a slow (but measurable) leakage of tritium to the room.

The occurrence of an additional seven other leaking GTLS, as discovered the next day, is the element of this event that could have been avoided.

During the investigation, it was determined that additional lights were damaged and caused to develop minor leaks during the second attempt to find the source of air contamination.

In an effort to eliminate the source of contamination, staff placed a large quantity of light sources in containers and subsequently into plastic bags. These bags were then transferred quickly into Zone 3, and then placed into aluminum cans at the end of the workday. During these activities, it is likely that the light sources were handled in a fashion that caused additional sources to begin to leak.

A final attempt to determine specific leaking lights was undertaken by Zone 3 staff at 1852h; the plastic bag containing the suspect lights was opened. Figure 1 illustrates the tritium concentration that was observed on the real-time stack monitor at the time of opening the bags.

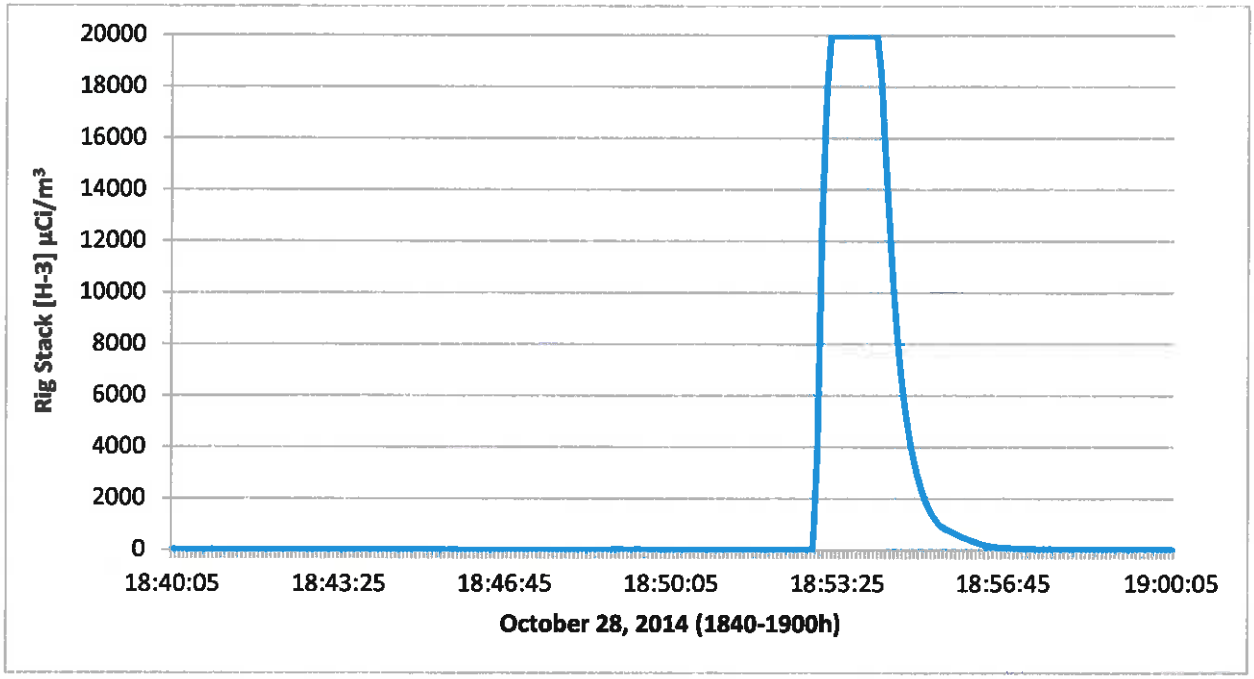

Figure 1 - Rig Stack Tritium Concentration Trend: Oct. 28, 2014 (1840-1900h)

At this time, technicians focused on eliminating leakage to the active ventilation systems before the end of the workday at 1900h; the bags of GTLS were resealed and placed into two aluminum cans to provide an additional barrier to leakage. By 1856h, stack emissions had trended back down to normal levels, as can be seen on Figure 1.

Additional tritium gas was released through the gaseous effluent pathway when the cans were opened the next morning to assess the condition of the lights. This is shown on the graph of the Rig Stack releases between 0700h and 0845h on the morning of October 29 (see Figure 2), where distinct peaks of emissions occur as each can and bag of GTLS is opened under the ventilated fume hood.

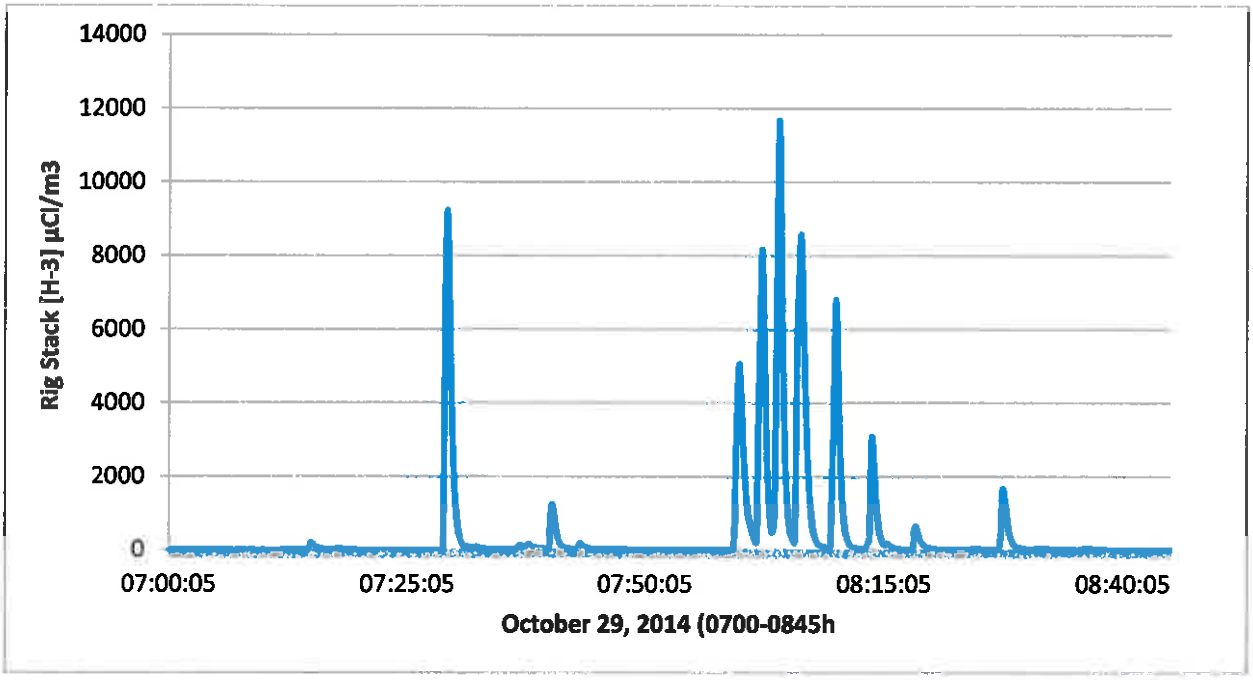

Figure 2 – Rig Stack Tritium Concentration Trend: Oct. 29, 2014 (0700-0845h)

The assessment of the condition of the GTLS on the morning of the 29th clearly showed that additional lights had developed leaks.

7. Contributing Event #2 – Manifold Gauge Leakage

During the late afternoon of Wednesday, October 29, 2014, a processing run on Rig #7 was being completed as per procedure.

As per operating procedure, once all GTLS are sealed off, the remaining tritium in the rig is allowed to re-adsorb back onto the tritium trap (PUTT). Generally, the internal pressure of the rig header will be gradually reduced to near-baseline vacuum levels. Once the operator is satisfied that no further tritium can be re-adsorbed, the system is 'pumped-out' using a dry scroll-type vacuum pump.

Any gases removed are exhausted to internal piping on the exhaust port of the pump. Since there is very little actual gas volume being moved, rigs are subsequently 'purged' using nitrogen gas, in order to completely eject any residual gases into the active ventilation system.

During the processing run, it was noted that the pressure gauge connected to the header had increased. This can indicate one of two conditions - a leak of tritium across the pneumatically operated isolation valve has occurred internally, or a leak of air has occurred into the system between the isolation valve and the gauge itself.

Upon completion of the processing run, the residual tritium in each bank of stubs and the rig header was re-adsorbed onto the PUTT. Once header pressure was at baseline (as read on the Digitech pressure display), the manifold gauge isolation valve was opened, and gauge pressure decreased as the gas was distributed through the header and onto the PUTT. The system was left to re-adsorb any remaining tritium that potentially remained.

Soon after, the system was ready to undergo purging. The vacuum pump was activated, and the vacuum isolation valve was opened. Nitrogen was admitted in a controlled manner in order to purge the system. At this point, abnormally high concentrations of tritium were measured by the real-time stack monitoring system. Purging was initially stopped, which paused the emission event; however, the transfer of tritium from the rig to the exhaust stream had already been completed. Purging continued in order to complete the processing operation as the tritium was no longer recoverable.

This sequence of events is corroborated by the data collected by the stack monitoring chart recorders. A graph of data from the digital recorder is included (see Figure 3):

If we look closely at the real-time stack monitoring data, a gradual rise can be observed prior to the purge cycle being started (see Figure 4). This would suggest that there was tritium being liberated from the system due to the air ingress; the purge then rapidly ejected this tritium through the pump exhaust.

The most likely cause of the tritium excursion is that the manifold gauge isolation valve leaked to atmosphere, causing air to enter into the line between the valve and the gauge. When the isolation valve was opened, this air then entered into the rig and interacted with the PUTT, liberating tritium that was subsequently rejected via the purging operation.

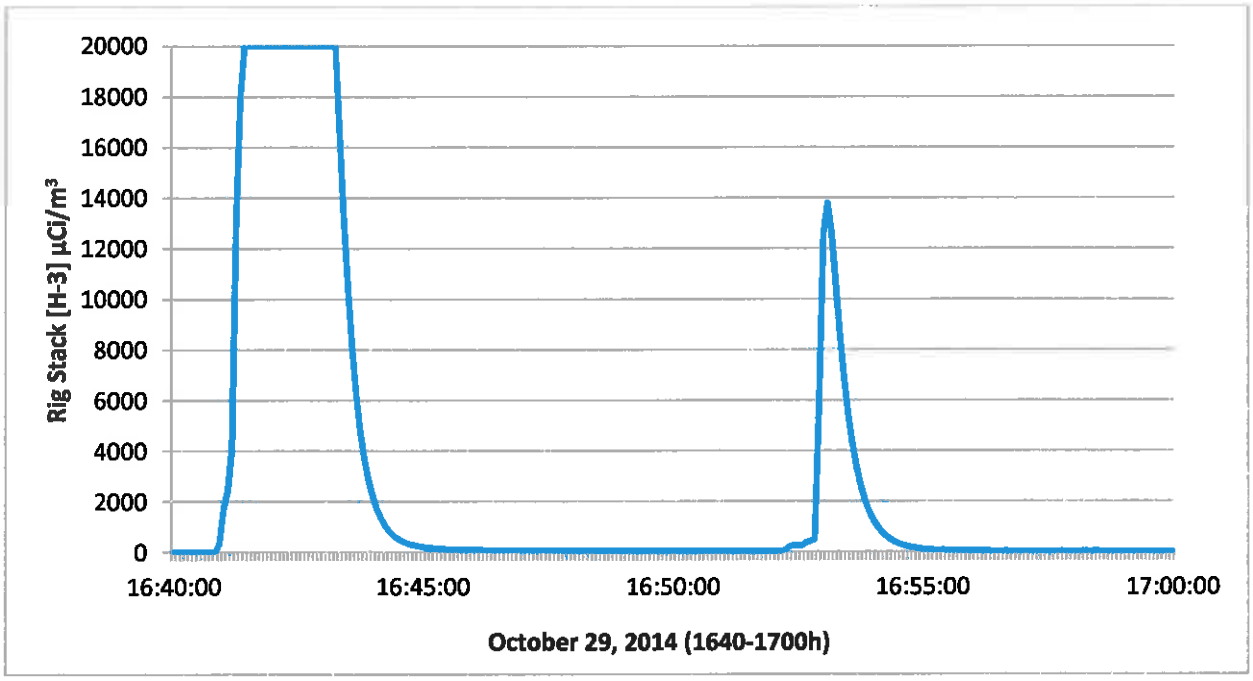

Figure 3 – Rig Stack Tritium Concentration Trend: Oct. 29, 2014 (1640-1700h)

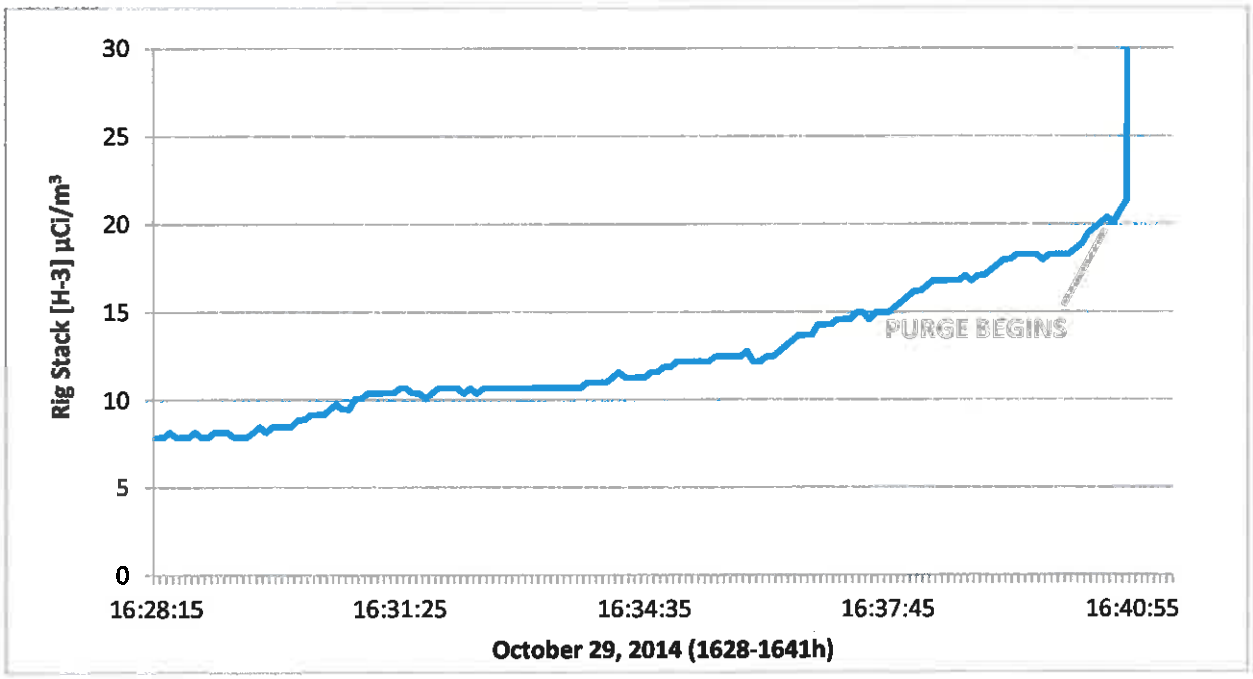

Figure 4 – Rig Stack Tritium Concentration Trend: Oct. 29, 2014 (1628-1640h)

Once empty, calibration activities showed that the PUTT associated with this event exhibited evidence of a loss of tritium that correlates with the magnitude of the estimated release from this event (~8,000 - 10,000 GBq).

The technician performing the filling run noted that the manifold pressure gauge had exceeded 100 mbar; usually if the valve had simply admitted tritium past it, the gauge would not have risen to the degree described in this event.

8. Root Causes of Each Contributing Event

Event #1

Technicians are trained to ensure that any leaking light sources are isolated as soon as possible. Occasionally this can be a difficult task to perform quickly, especially when leaks are small and lights have not yet visibly dimmed. Time is required to isolate lights and check them with portable tritium monitors. The act of searching for a leaking GTLS in a larger batch can present significant challenges if the leak is small.

As well, if a container of lights is not gently and carefully handled while segregating potential leaking GTLS, additional leaks can develop.

Root Cause: Mishandling of a container of GTLS while attempting to isolate a single leaking unit, during the bagging and transfer of the container to Zone 3, and during the further attempts to isolate leakers in Zone 3, caused additional GTLS to develop leaks.

Event #2

Leakage across the manifold gauge isolation valve has been observed during processing runs in the past. Typically this indicates that a small quantity of tritium has passed through the valve into the gauge line, and therefore can be re-adsorbed onto the PUTT after all other tritium has been re-adsorbed after sealing of GTLS.

In this case, there was evidence that air had leaked into the line between the gauge and the isolation valve (the gauge exceeded 100 mbar vs. a smaller magnitude rise).

Root Cause: Mechanical failure of a system component.

9. Summary of Recommended Actions

Recommended Corrective Actions for Event #1

CA-1: All staff working in Zone 2 and 3 should be coached to ensure:

- That GTLS must be handled with care and caution at all times, including when attempting to isolate potential leaking sources.
- That when leaking lights occur and the source of the leakage cannot easily be determined in a batch of lights, careful heat-sealing in plastic is the preferred method to reduce or eliminate leakage outside of the 0700-1900h operating hours.

Recommended Corrective Actions for Event #2

CA-2: The manifold gauge isolation valve on the Rig 7 purging system should be replaced, including the valve body.

CA-3: Operators should be coached to ensure that if it is noticed that the manifold gauge pressure indicator exceeds 100 mbar (as opposed to slowly rising during a filling run), this may be indicative of potential air ingress into the system. Supervision should be contacted for further instruction prior to opening the affected line onto the PUTT.

Recommended Corrective Actions for Both Events

CA-4: Procedures and training should be reviewed and revised to ensure that the corrective measures taken with respect to these events are formally incorporated where applicable.

10. Conclusions

The action level for gaseous tritium emissions has not been exceeded by SRBT in several years. The circumstances of the events that contributed to the exceedance have been thoroughly investigated, and recommended corrective actions have been documented.

Completion of these actions will reduce the potential for recurrence of these events.

Jamie MacDonald
Manager – Health Physics and Regulatory Affairs — DEC 2/2014 — December 2, 2014

This report was reviewed by the following SRBT staff:

Donna Buder
Rig Room Supervisor — Dec 2/2014 — December 2, 2014

Laura Macartney
Rig Room Technician — Dec 2/2014 — December 2, 2014

Brenda St. Pierre
Manager – Health Physics and Regulatory Affairs — Dec 2 2014 — December 2, 2014