SRB TECHNOLOGIES (CANADA) INC.
320-140 Boundary Road
Pembroke, Ontario, Canada, K8A 6W5
Tel.: (613) 732-0055
Fax: (613) 732-0056
E-Mail: sales@betalight.com
Web: www.betalight.com

FINAL WRITTEN REPORT

Action Level Exceedance – May 26 - June 2, 2015

Author: _____

Jamie MacDonald
Manager of Health Physics & Regulatory Affairs

Accepted: _____

Stephane Levesque, President

Accepted: _____

Ross Fitzpatrick, Vice-President

Date Submitted: June 30, 2015

Submitted To: J. Campbell, Project Officer - CNSC

SRBT FINAL WRITTEN REPORT

Action Level Exceedance – May 26 - June 2, 2015

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.

On Monday, June 1, 2015, during tritium processing a significant emission event was detected by the Real-time Stack Monitoring System. Corrective actions were immediately attempted by production technicians to diagnose and address the source of the emission, and management was informed of details surrounding the event.

As per routine procedure, sample bottles on the bubbler system were changed out on the morning of Tuesday, June 2, 2015. The sampling media was processed and analyzed via liquid scintillation counting. An initial count of the samples for the day concluded that an action level had more than likely been exceeded for the sampling period; the completed assay confirmed this fact once scintillation counting had terminated in the afternoon.

SRBT communicated the exceedance verbally to CNSC staff at approximately 1030h on June 2, 2015 based on the results from the quick count. Later that day, the final results were input into the calculation spreadsheet, along with other critical data required to accurately derive gaseous emissions for the sampling period. A formal letter was sent detailing the final amount of tritium released to the atmospheric pathway on June 3, 2015.

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 May 26 – June 2, 2015:

RIG STACK HTO:	362.48 GBq
RIG STACK HT:	16,275.38 GBq
BULK STACK HTO:	140.27 GBq
BULK STACK HT:	168.67 GBq
TOTAL HTO:	502.75 GBq
TOTAL HT:	16,444.05 GBq
TOTAL HT+HTO:	**16,946.80 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 3.78% 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 219% 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 clearly illustrated that the majority of these releases more than likely occurred on June 1, 2015 during routine tritium processing operations in the Rig Room.

3. Issuance of Preliminary Notification

At approximately 1030h on June 2, 2015, a telephone conversation was held between the President, SRBT and Mr. Robert Buhr, Project Officer - CNSC, wherein SRBT verbally informed CNSC Staff of the action level exceedance.

The following day (June 3, 2015) 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. A hard copy of the letter was also sent that day by post.

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

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 July 2, 2015.

The investigation began with the raising of a non-conformance with the Quality Manager, as required by internal process. Non-conformance report ('NCR') #464 was generated and assigned to the Manager of HP&RA on June 2, 2015.

The investigation included:

- Review of the data recorded on the Real-time Stack Monitoring System,
- 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, and
- Analysis of inventory of suspect tritium trap.

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, an action level was exceeded due to the passing of the packing seal on the main isolation valve on pyrophoric uranium tritium trap (PUTT) #15-107C-09 during routine tritium filling operations on Rig #8 on June 1, 2015.

A sequence of events has been established that support this finding:

TIME	DESCRIPTION
1455h	PUTT 15-107C-09 was transferred from the Bulk Splitting Rig to Rig #8 and pumped down. Maximum concentration in Rig Stack = 2,053 µCi/m^3, slightly higher than normal but not unusual.
1506h	Rig #8 purged using nitrogen gas. Maximum concentration in Rig Stack = 1,553 µCi/m^3.
1552h	First production run on Rig #8 initiated with 15-107C-09. Leak check successful prior to filling.
1604h	Production run complete; tritium gas re-adsorbed onto PUTT without incident.
1619h	Rig #8 purged using nitrogen gas. Maximum concentration in Rig Stack = 22,082 µCi/m^3, for about five seconds.
1630h	Packing tightened on 15-107C-09 in response to abnormally high tritium concentration in purge gas; PUTT pumped down. Maximum concentration in Rig Stack = 150 µCi/m^3.
1728h	Second production run on Rig #8 initiated with 15-107C-09. Leak check successful prior to filling.
1738h	Technician observed slow decrease in Rig tritium pressure after isolation of PUTT using rig tritium valve after filling cycle complete, suggesting a small internal leak in the system.
1739h	Technician attempted to isolate PUTT by using the manual valve on top of the PUTT. Decrease continued, prompting technician to reopen manual valve.
1740h	Production run aborted on Rig #8; rig tritium valve reopened to allow all tritium in system to adsorb onto PUTT.

1755h	Rig #8 pump down initiated after tritium re-adsorbed. Shortly after, a significant spike was noted on the chart recorder. Maximum concentration in Rig Stack = 22,277 $\mu Ci/m^3$, sustained over about 1.5 minutes.
1758h	Rig #8 pump shut down. Elevated tritium levels continue to persist in Rig Stack exhaust, trending downward slowly.
1825h	Vacuum pump restarted on Rig #8 after low concentration of 1,970 $\mu Ci/m^3$ in Rig Stack exhaust achieved. Maximum concentration in Rig Stack = 9,410 $\mu Ci/m^3$.
1825h	Rig #8 purged using nitrogen gas. Maximum concentration in Rig Stack = 22,257 $\mu Ci/m^3$, sustained over about 1.5 minutes.
1841h	Rig Stack falls below 100 $\mu Ci/m^3$. Event terminated.

Technical note – at a value somewhere just over 22,000 $\mu Ci/m^3$, the ion chamber in the tritium-in-air monitor associated with the Real-time Stack Monitoring system reaches its saturation point. As a result, this value represents the highest output the monitor can achieve. Concentrations above 22,000 $\mu Ci/m^3$ are thus off-scale of the instrument.

6. Analysis

Based upon the data and the description of the event by the technicians involved, it is concluded that the packing on PUTT 15-107C-09 was compromised during the first processing run, and then further when the technician closed and then re-opened the valve while performing the second processing run.

Problems with the packing on this valve were evident when the purge of the first run (at 1619h) resulted in a high peak concentration in the Rig Stack exhaust. This is typical of a slight packing leak.

During the second run beginning at 1728h, the technician manually closed and reopened the PUTT using the valve in question while tritium was being processed in response to slight loss of tritium pressure, suggesting tritium was passing the tritium isolation valve and re-adsorbing onto the PUTT.

The packing is believed to have retained tritium within the valve body of the PUTT during the run, and when it was manipulated closed and then opened during the second filling run. The valve packing was likely compromised physically at the interface between the packing and the rig system.

Tritium likely entered the packing of the valve body when the valve was being opened in the presence of tritium in the process piping. Subsequently, under the high vacuum conditions associated with pumping out a rig, tritium was released in enough quantity to exceed the action level when the final pump out of the run began just before 6 PM. Upon closing the valve in preparation for the final rig purge, additional tritium was likely released into the system and carried away with the purge gas.

Based upon the data, it is estimated that the described events on Rig #8 contributed the majority of elemental tritium to the gaseous emissions pathway on June 1, 2015. The PUTT in question was further adjusted and removed from service in a safe fashion. It was determined that the unit was sufficiently leak tight to allow the remaining tritium to be removed and measured on the Bulk Splitter.

The valves used on the PUTTs are restricted to use with three PUTT bases, in order to limit these types of failures. Historically, these valves have been used for up to six cycles, with the service reduction being implemented over time in order to limit leakage as valve operation increased. The valve in question was on its third PUTT base, and this PUTT was being used for the ninth filling cycle out of a maximum of thirteen. The valve was four PUTT fill cycles away from being removed from service.

As of the day of the event, valves were authorized for use with three separate PUTT bodies (coded A, B and C), for a total of 39 filling cycles (13 cycles / PUTT x 3 PUTTs) on the Bulk Splitter rig. These valves are being operated more frequently since operations switched to shutting down rig pumps and isolating the PUTTs during non-operating hours, as well as required closing when purging is performed.

7. Root Causes

The failure of the packing on the PUTT manual valve is due to the following two factors:

1. The valve that failed was the in-service unit with the longest service term, and by extension, the most actuation cycles.

Root Cause #1: *Service-related degradation of the packing.*

2. The valve was manipulated in the midst of a filling cycle, which is a highly infrequent occurrence.

Root Cause #2: *Manual valve operated during processing at an inappropriate point in the process.*

8. Summary of Recommended Actions

CA-1: Increased restriction on manual valve reuse

- Valve re-use will be restricted to two PUTT cycles from three, in order to mitigate any service-related degradation.

CA-2: Coaching to ensure technicians understand when the PUTT manual valve may be operated

- Technicians will be coached to ensure that the valve is only operated when there is no tritium in-process, except in an event where it is certain that operation of the valve is required to limit releases.

CA-3: Incorporation of lessons learned from this event into SAT-based training on Tritium Processing

- The responsible manager for the SAT program being implemented at SRBT will ensure that lessons learned are incorporated into the design and development of SAT-OP-03, *Handling PUTTs.*

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

- Rig Room supervision will ensure that any alterations required to procedures are incorporated as soon as practicable.

CA-5: Engage with valve manufacturer to explore potential options for valve improvements in tritium processing equipment

- A meeting of the Mitigation Committee was held on June 26, 2015, including technical representatives of current valve manufacturer.

  Exploratory options for changing processing equipment valve types were discussed to see if there are alternative technologies or designs that may be more appropriate for our purposes.

  Further discussions are to be held; change control processes have been initiated as part of the research into this initiative.

9. Conclusions

The circumstances of the events that contributed to the action level exceedance for May 26 – June 2, 2015 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 — June 29, 2015

This report was reviewed by the following SRBT staff:

Donna Buder
Rig Room Supervisor — June 29, 2015

Laura Macartney
Rig Room Technician — June 29, 2015

Brenda St. Pierre
Human Protection Coordinator — June 29, 2015