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

Subject: Action Level Exceedance of November 28, 2024 – Final Written Report

Dear Ms. O'Connor,

Attached please find the final written report on the recent action level exceedance that occurred at SRB Technologies (Canada) Inc. due to events that took place on November 28, 2024.

An initial report was filed to your attention on November 29, 2024 [1].

Should you have any questions on this subject, please do not hesitate to contact me at any time.

Best Regards,

Jamie MacDonald
Manager – Health Physics and Regulatory Affairs
SRB Technologies (Canada) Inc.

cc: J. Bull, SRBT
R. Fitzpatrick, SRBT
K. Levesque, SRBT
S. Levesque, SRBT

Reference:

[1] Letter from J. MacDonald (SRBT) to A. O'Connor (CNSC), *Action Level Exceedance,* dated November 29, 2024.

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FINAL WRITTEN REPORT

Action Level Exceedance – Nov. 26 – Dec. 3, 2024

Author: _____

Jamie MacDonald
Manager of Health Physics & Regulatory Affairs

Accepted: _____

Stephane Levesque, President

Accepted: _____

Ross Fitzpatrick, Vice-President

Date Submitted: December 19, 2024

Submitted To: A. O'Connor, Project Officer - CNSC

SRBT FINAL WRITTEN REPORT

Action Level Exceedance – May 26 - June 2, 2015

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1. Introduction

During a tritium processing operation on Thursday, November 28, 2024, beginning at approximately 1026h a significant gaseous tritium release began to take place at SRB Technologies (Canada) Inc. (SRBT).

Production technicians and members of the Health Physics worked to minimize the releases of tritium to the active ventilation system over the course of the following two hours. Based on the concentrations of tritium gas measured in the active ventilation system during the event, and the length of time over which the event took place and was managed, an action level exceedance was suspected with respect to weekly gaseous releases of tritium.

SRBT communicated the suspected exceedance verbally to the Duty Officer with a call at 1152h, as well as with an email to the CNSC Project Officer at 1208h that day. Once the action level exceedance was known through quantitative analysis of effluent samples (confirmed at approximately 1500h on November 28), a formal notification letter was sent to the CNSC Project Officer within 24 hours as required by the SRBT *Regulatory Reporting Program*.

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 release event took place during processing operations on Rig 7, which is serviced by the 'Rig' stack system. Once the event was terminated and all processing systems were shutdown, the sample media on the bubbler system connected to the 'Rig' stack system was changed as per effluent monitoring procedures in order to quantify and characterize the release event.

The following data was initially obtained and included in the initial report:

Gaseous releases of tritium (0559h on Nov. 26 – 1325h on Nov. 28, Rig Stack only)

RIG STACK HTO:	*151.60 GBq*
RIG STACK HT:	*15,981.13 GBq*
TOTAL HT+HTO:	***16,132.73 GBq***

SRBT is restricted by licence condition on the quantity of tritium that may be released to atmosphere. The licenced release limit for total tritium is set at 448,000 GBq per year. The weekly release discussed above represents 3.6% of the allowed limit for the year.

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*. The action level for total tritium released to atmosphere is set at 5,000 GBq per week.

The release discussed above represented 323% of the action level for the week, with the week's releases from the 'Bulk' stack, and the remaining week's releases from the 'Rig' stack still to be quantified as part of routine sampling and analysis (sampling week ending December 3, 2024).

On December 4, 2024 the final analysis of weekly gaseous emissions from SRBT was completed.

The final quantified releases for the monitoring period between November 26 – December 3, 2024 are summarized in the following table.

Gaseous releases of tritium (0559h on Nov. 26 – 0603h on Dec. 3)

RIG STACK HTO:	*263.16 GBq*
RIG STACK HT:	*16,801.98 GBq*
BULK STACK HTO:	*49.69 GBq*
BULK STACK HT:	*22.86 GBq*
TOTAL HTO:	*312.85 GBq*
TOTAL HT:	*16,824.84 GBq*
TOTAL HT+HTO:	***17,137.69 GBq***

The final weekly release of 17,137.69 GBq of combined HTO and HT gases represents 343% of an action level for the week between Nov. 26 – Dec. 3, 2024.

3. Issuance of Preliminary Notification

SRBT communicated the suspected exceedance verbally to the Duty Officer with a call at 1152h, as well as with an email to the CNSC Project Officer at 1208h that day.

Once the action level exceedance was known through quantitative analysis of effluent samples (confirmed at approximately 1500h on November 28), a formal notification letter was sent to the CNSC Project Officer within 24 hours as required by the SRBT *Regulatory Reporting Program*.

The two communications above ensured that the applicable initial reporting requirements were met by SRBT.

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 December 19, 2024.

The investigation began with the raising of a non-conformance with the Quality Manager, as required by internal process. Non-conformance report ('NCR') #979 was generated and assigned to the Manager of HP&RA on November 29, 2024.

The investigation included interviews with staff members performing tritium processing operations at the time of abnormal events, and a training needs analysis (TNA) of the materials and methods used to train production technicians to perform such work, in accordance with the systematic approach to training (SAT) described in the SRBT Training Program Manual.

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 digital data captured from the real-time stack monitoring system, and on the interviews conducted with workers, the following sequence of events took place on November 28, 2024:

TIME	DESCRIPTION
1010h	A run of 100 light sources had been loaded earlier onto Rig 7 for tritium filling, and the vacuum pump system was active and being applied to the system to 'pump down' the light sources in preparation for the filling operation to be performed.
1015h	A discussion was being held between two production technicians (Technician A, recently qualified for filling non-pressurized light sources; and Technician B, several years qualified in a supervisory role) regarding another work-related matter.
1020h	While still involved in the discussion, Technician A went to Rig 7 and began the tritium processing operation by applying heat to the tritium trap connected to Rig 7; however, the vacuum pump was still active and the vacuum valve was still open. **The required procedural steps to isolate the vacuum by closing the vacuum valve, conducting a system leak rate check, and then de-energizing the vacuum pump before applying heat to the tritium trap had not been performed.**
1023h	Technician A observed that the system pressure was not rising at the expected rate, and believed this to be due to the depletion of propane from the hand-held torch used to apply heat to the trap. Technician A then went to obtain a new torch and then resumed the heating operation.
1026h	The concentration of tritium in the Rig stack effluent stream began to rise, as recorded on the electronic data recorder, and as displayed to operations staff in the Rig Room on the remote display unit (RDU). Both of these devices are connected to the real-time gaseous effluent monitoring system for the Rig stack.

1027h	Technician A initially diagnosed that the system is configured incorrectly and ceases heating the tritium trap. Technician A simultaneously notified Technician B of the problem verbally. Technician B then approached Rig 7, immediately identified the open vacuum valve and operating vacuum pump. Technician B immediately closed the valve and de-energized the pump.
1028h	A call was made by Technician B to the Assistant Manager – Health Physics (AM-HP) for assistance in the Rig Room. The AM-HP is a qualified SAT-based trainer and subject matter expert in tritium light source filling operations. The concentration of tritium in the Rig stack system was approximately 6,000 $\mu Ci/m^3$ and rising. The rate of rise begins to reduce with the pump de-energized; however, the concentration continues to rise in absolute terms.
1030h	The AM-HP advised Technician B to open the vacuum valve and attempt to recover the tritium released to the pump inlet line by introducing the gases back onto the now-cooling tritium trap. The concentration of tritium in the Rig stack system was approximately 8,000 $\mu Ci/m^3$ and continuing to rise at a steady rate.
1031h	The President and the Manager – Health Physics and Regulatory Affairs (HP&RA) are verbally notified of the occurrence of a release event in the Rig Room. Both attend to the Rig Room ante room to observe the release profile on the electronic data recorder in real time, and to provide technical support as efforts are made to recover released tritium from the vacuum pump and inlet line.
1032h	The concentration of tritium in the Rig stack system reached 10,000 $\mu Ci/m^3$ triggering the low-level alarm on the RDU. The concentration continued to rise at a steady rate.

1037h	The concentration of tritium in the Rig stack system reached 20,000 µCi/m^3 triggering the high-level alarm on the RDU and surpassing the upper level of the display range of the tritium-in-air monitor (TAM) sampling the effluent. *Technical note – at a value just over 22,000 µCi/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 approximate value represents the highest output the monitor can quantify and display. Concentrations above 22,000 µCi/m^3 are thus off-scale of the instrument.*
1040h	The concentration of tritium in the Rig stack system as recorded on the electronic data recorder exceeded 24,000 µCi/m^3, representing the signal limit of the TAM ion chamber through the 4-20 mA digital output. At this off-scale level, the rate of change in tritium concentration in the effluent can no longer be monitored electronically. *Note: throughout all operations, the bubbler systems continue to sample the effluent and capture a representative sample of tritium gases released for the ultimate emission of record.*
1050h	Based on the system pressures on Rig 7, the Manager – HP&RA assesses that the tritium in the vacuum inlet line is irrecoverable, and instructs the AM-HP to turn on the vacuum pump and begin to pump out and release the residual gases in a controlled fashion.
1054	The Manager – HP&RA enters the Assembly room where the TAMs for the real-time gaseous effluent monitoring systems are located. The inlet line for the Rig stack sample line is removed from the associated TAM in order to assess the functionality of the instrument. Within seconds, the concentration of tritium measured drops quickly, indicating that the instrument is still responsive and functional within design specifications. The sample line is connected immediately and the measured concentration rises quickly going above the upper limit of the scale of the instrument again.
1057h	The concentration of tritium in the effluent being measured by the real-time monitoring system fell to the scale of the instrument (i.e. below the signal limit of approximately 24,000 µCi/m^3). The concentration continued to decrease at a relatively steady rate over the next fifteen minutes at the tritium was cleared through the vacuum pump.

1113h	The concentration of tritium in the Rig stack system fell to below 10,000 $\mu Ci/m^3$. The first of several low-pressure 'pulse' purges of argon gas are introduced to the Rig. Argon gas purge is a routine procedural step that accelerates the clearing of tritium gas from the system and pump. The concentration of tritium begins to rise again quickly with the first purge.
1115h	The concentration of tritium in the Rig stack system as recorded on the electronic data recorder exceeded 24,000 $\mu Ci/m^3$, and remained off-scale for approximately 90 seconds before falling at a relatively steady rate.
1121h	Four more pulse purges are introduced to the system at incrementally increased argon pressures (1121h, 1128h, 1133h, 1138h). Each purge results in the concentration of tritium in the effluent exceeding the scale of the system for shorter amounts of time, and the rate of decrease in the concentration associated with each purge is higher.
1143h	A 'flow-through' purge is established in the Rig for approximately one minute. This type of purge is continuous and at a steady argon pressure. The concentration of tritium in the effluent goes off-scale for just over one minute before dropping relatively quickly.
1146h	A series of one-minute flow through purges are completed over the next 20 minutes.
1150h	The concentration of tritium in the Rig stack effluent falls below 100 $\mu Ci/m^3$ for the first time since the onset of the release event.
1222h	The filling rig 'heads' are pumped out and purged, resulting in a final release that very briefly peaked at approximately 24,000 $\mu Ci/m^3$.
1230h	The release event is complete. All processing operations are restricted for the remainder of the day pending an operational safety 'stand-down' with all qualified workers, which took place around 1500h that day.

6. Review of Similar Historical Events

A review of historical records on gaseous emissions-related events, and discussions with workers of long tenure at SRBT did not find evidence that this type of event had happened before at the facility.

The most recent action level exceedance at SRBT relating to weekly gaseous emissions of tritium was for the monitoring period of May 26 – June 2, 2015. A total of 16,946.80 GBq of tritium was released via the active ventilation systems, representing 218.6% of the action level of 7,753 GBq.

7. Cause Analysis

Based upon the information at hand, the established primary cause of this event is a human performance error, where there was an instance of distraction / inattention when a worker was performing a routine but safety-significant work activity. A contributing factor is the relative inexperience of the qualified production technician involved in the event.

Tritium light source filling operations are performed several times a day by qualified operators, which through repetition can present challenges in keeping a dedicated focus. This is especially true when there are distractions taking place, such as discussions on trying to solve an unrelated problem to the task at hand with other technicians, as occurred here.

During qualification processes for trainees in this area, the importance of staying focused on the task at hand is emphasized during the designed on-the-job training. The safety performance level achieved in this area of nuclear substance processing operations in recent history has shown that the systematic approach to training applied to these work activities has been highly effective. This is supported by the fact that this was the first exceedance of an action level in nearly ten years.

Despite this, this event provides a good opportunity to review and improve these training processes, as well as the procedures for processing, in an effort to reduce the likelihood of a similar event occurring in the future. There also may be opportunities to adjust other facets of these processes to reduce the relative impact of such events, such as the amount of tritium that may be released.

8. Summary of Recommended Actions

Action 1: To prevent recurrence, conduct a training needs analysis (TNA) in response to this human-performance related safety event, in line with the processes described in SRBT Training Program Manual, and in line with the requirements of the Regulatory Reporting Program.

Action 2: To prevent recurrence, review the SAT-based training materials associated with tritium processing operations, and incorporate a greater level of emphasis on conducting tritium processing operations without distraction.

Action 3: To prevent recurrence, include a health and safety video on avoiding distractions in the workplace as part of future all-staff training.

Action 4: To reduce the potential impact of similar events, the 'low alarm' set point on the remote display unit (RDU) servicing the Rig Stack real-time monitors will be reduced to a level that will reasonably provide an earlier alert of a problem, without significantly increasing the number of 'nuisance' alarms that would occur during routine processing operations.

These actions will be tracked to completion and reviewed for effectiveness at an appropriate date in the future via NCR-979, as per MSP-012, *Corrective Action*.

9. Conclusions

The circumstances of the events that contributed to the action level exceedance for gaseous emissions of tritium for the monitoring week of November 26 – December 3, 2024 have been thoroughly investigated, and recommended corrective actions have been documented.

Completion of these actions will reduce the potential for recurrence of these events, and reduce their impact should they occur.

DEC 18/2024.

Jamie MacDonald
Manager – Health Physics and Regulatory Affairs
Investigation and Reporting Lead

December 18, 2024