APPENDIX B

Thermo Eberline LLC Radon Evaluation

Fomer Eberline Instrument Corporation Facility

5981 Airport Road

Santa Fe, New Mexico

CN ASSOCIATES

YOUR PARTNER IN RADIATION SAFETY

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LIST OF ATTACHMENTS

EXECUTIVE SUMMARY

During characterization of the building at the Thermo Eberline LLC (Company) facility located at 5981 Airport Road, Santa Fe, New Mexico (site) elevated alpha and beta background readings were observed during the collection of measurements of radioactivity on building surfaces. The levels of alpha emitters in particular were elevated such that they impacted the ability to assess for the presence or absence of detect total surface alpha contamination at the lower limits of New Mexico Environment Department (NMED) Radiation Control Bureau (RCB) Release Criteria by direct measurement with handheld monitoring instruments. Several lines of evidence were brought to bear on this phenomenon that resulted in the conclusion that the elevated alpha and beta activity were the result of emissions from the deposition of radon progeny. These lines of evidence included:

- An extensive series of direct surface measurements in reference background areas showed similar variations in alpha and beta readings occurring in a cyclical manner that changed with the time of day, day of week, and with changing weather patterns.
- Particulate air samples had elevated alpha and beta count rates that decayed over time to minimum detectable activity (MDA) levels indicative of radon progeny.
- Volumetric sampling of building surface substrates and analysis by alpha spectroscopy at an off-site laboratory confirmed an absence of elevated activity associated with licensed alpha emitting radioisotopes that could account for the elevated surface alpha count rates.

Additional measurements were collected by both CN Associates, Inc. (CN) and an independent contractor DC Environmental, Inc. (DCE) to supplement previous site building survey data. The combination of the past and more recent results confirm the conclusion that the observed alpha levels on building surfaces are the result of radon progeny deposition.

1 OBJECTIVE

Additional evaluation of the radiological survey data collected in support of site building characterization, the collection of additional supplemental data by CN and additional monitoring by an independent third-party DCE was completed to demonstrate that the evaluated alpha readings recorded on building surfaces were associated the deposition of radon progeny on those surfaces and not associated with contamination form licensed radioactive materials.

2 *METHODOLOGY*

In 2020 an initial study was done that consisted primarily of direct measurements taken in reference background areas along with volumetric samples taken from various substrate materials located in 10 locations as Potential Areas of Concern (PAOCs) within the building where the potential for residual impact from licensed radioactive materials was greatest.

For this evaluation air samples were obtained inside the facility within three PAOC areas and external to the facility on the Loading Dock. Large Area Wipes (LAWs) were collected from building surfaces in each of the three PAOCs where the air samples were taken. The interior samples underwent radioisotope identification by gamma spectroscopy and were also counted with alpha and beta/gamma handheld monitoring instruments. Measurements were collected as counts per minute (cpm) repeated over time to assess the half-life of the activity on the sample (air samples taken previously were counted for decay only and did not undergo gamma spectroscopy). The exterior air sample was analyzed by gamma spectroscopy only. Additionally, a third-party vendor (DCE) was contracted to measure radon concentrations using electret monitors.

Instrumentation used consisted of:

- A Ludlum Model 3030 alpha, beta/gamma sample counter for air sample decay evaluation.
- A Ludlum Model 43-93 alpha, beta/gamma detector for LAW decay evaluation and for direct measurements at the locations of LAWs.
- An In Situ Object Counting System (ISOCS) was used for gamma spectroscopy analyses of LAWs and air samples.
- Vendor supplied electret monitors.

Data Sources

The data sources used to inform this updated evaluation consisted of the following:

- Historical air sample decay data from 2020.
- 2022 air samples decay and gamma spectroscopy data.
- 2022 LAWs decay and gamma spectroscopy data.
- 2022 Radon Electret monitoring results
- Independent Radon Investigation by DC Environmental.

3 EVALUATION

Attachment 1 provides the DCE supplied radon monitoring report. Attachments 2 and 3 provide pictorials depicting the Thorium 232 (Th-232) and Uranium 238 (U-238) decay chains that produce radon isotopes and their concomitant progeny. Supporting air sample decay data and gamma spectroscopy reports are available from CN.

As previously stated, particulate air samples were obtained inside the site buildings in 2020. Additional air samples along with fixed point measurements and LAWs were obtained in 2022. All air samples were counted using a Ludlum 3030 alpha beta sample counter. Counts were repeated over a period of hours and days until each sample reached MDA levels.

In all cases the observed decay was indicative of radon progeny (i.e., decaying to mda levels in 72-96 hours). The 2022 air samples were additionally analyzed by gamma spectroscopy. The gamma spectroscopy detected only radon progeny (i.e., isotopes of Lead, Bismuth, and Thallium). Details are provided below. The LAWs taken in 2022 were counted with a Ludlum 43-93 alpha, beta/gamma detector. These counts were repeated over a period of hours and days until the response reached background levels. The LAWs were analyzed by gamma spectroscopy which detected only radon progeny (i.e., isotopes of Lead and Bismuth). Facility radon concentrations were obtained using vendor supplied electret monitors.

3.1 2020 AIR SAMPLES

Eight (8) particulate air samples were selected for this evaluation. The samples were taken at three (3) different locations inside the facility. The samples were collected in the June/July 2020 time frame.

- Sample Locations (please refer to figures in the main report):
  - PAOC-4
  - PAOC-6
  - Reference Background Area (non-PAOC office area)

- Total Air Volume ranged from 86,400 liters to 190,800 liters per sample.

- Alpha Beta Sample Counter Results:
    - All samples were initially counted shortly after collection (approx. 1 to 1 ½ hours after sample collection) and again at intervals of hours and days.
    - All samples exhibited alpha, and beta/gamma counts significantly above the MDA at the time of the initial count.
    - Both alpha, and beta/gamma values dropped significantly at the one-hour and 4-hour counts and decayed to MDA levels after 72 to 96 hours.
    - Air sample decay plots for 2020 air samples are included in Attachment 1.

3.2 2022 AIR SAMPLES

Three (3) particulate samples were obtained inside the building over the period of 2-1-2022 through 2-4-2022 with a 4th particulate sample collected on the exterior loading dock on 2-28-2022.

- Sample Locations (please refer to figure in the main report)
    - North Building PAOC-3
    - Middle Building PAOC-7
    - South Building PAOC-6
    - Exterior Loading Dock

- Total Air volume was approximately 250,000 liters for each sample.

- Alpha Beta Sample Counter Results:
    - All building interior samples were initially counted shortly after collection (approx. 1 to 1 ½ hours after sample collection) and again at intervals of approximately one-hour, 4 hours, and 72 hours after the first count.
    - All samples exhibited alpha and beta counts significantly above the MDA at the time of the initial count.
    - Both alpha and beta/gamma values dropped significantly at the one-hour and 4-hour counts, and after 72 to 96 hours were MDA.
    - Air sample decay plots for 2022 air samples are included in Attachment 2.

- Gamma spectroscopy Results:
    - Only radon progeny isotopes were detected.
    - Air sample gamma spectroscopy results are provided in Attachment 4.
    - All 4 air samples identified the following isotopes:
        - From the Thorium 232 Decay Chain that produces Radon 220 (thoron gas)
            - Pb-212
            - Bi-212
            - Tl-208
        - From the U-238 Decay Chain that produces Radon 222 (radon gas)
            - Pb-214
            - Bi-21

3.3 2022 LARGE AREA WIPES (LAWS)

LAWs were collected in the same PAOCs as the 2022 air samples to assess for deposition of removal radon progeny on concrete floor surfaces.

The following measurements and analyses were obtained for each location:

- A 2-minute fixed-point measurement was taken on contact with the floor surface using a Ludlum Model 43-93 alpha-beta detector:
    - Alpha counts ranged from 9 to 14 total counts (5.5 cpm to 7 cpm).
    - Beta counts ranged from 632 to 700 total counts (316 to 350 cpm).
- A LAW was obtained from the same area as the fixed-point measurement and monitored for:
    - Alpha and beta emissions using the Ludlum 43-93 alpha-beta detector.
    - Gamma emitting isotopes via gamma spectroscopy (ISOCS).
- Alpha Beta Detector Results:
    - All LAWs exhibited alpha and beta counts significantly above the background at the time of the initial count.
    - Both alpha and beta values dropped significantly at the one-hour and 4-hour counts, and after 72 to 96 hours were background.
    - LAW decay plots are included in Attachment 3.

- Gamma Ray Spectroscopy Results
    - Only radon progeny isotopes were detected:
        - Th-232 Decay Chain
            - Pb-212
        - U-238 Decay Chain
            - Pb-210
            - Pb-214
            - Bi-214

3.4 2022 RADON MEASUREMENTS USING ELECTRET MONITORS

DC Environmental (DCE) conducted an independent evaluation of radon gas within the site buildings. DCE's report is included as Attachment 5. DCE placed 17 monitors throughout the facility including all PAOCs, some non-PAOCs, and one exterior (open loading dock).

- Monitors were deployed on 3 March 2022 and collected on 8 March 2022 for a monitoring duration of five days.
- Deployment of 16 standard E-Perm Electret cannisters:
    - These monitors collected radon data the entire time and the output was integrated and calculated as a per day average.
    - Average Radon levels ranged from 0.7 to 3.4 picocuries per liter (pCi/liter).
    - The overall average concentration within the building was 1.8 pCi/liter.
    - The exterior radon monitor had an average of 1 pCi/liter.
- 1 Electret continuous rad monitor was deployed in PAOC 6:
    - The continuous monitor was instrumented such that incremental values were recorded throughout the exposure period.
    - Radon levels ranged from 1 to 5 pCi/liter (5 pCi/liter was a one-day spike that occurred on 4 March 2022).
    - Other single day transients included 1 – 2 pCi/liter spikes and a 1 – 3 pCi/liter spike.
    - DCE opined that high sustained external winds on 4 March 2022 may have contributed to the spike (20-30 mph steady).

- Radon was detected in every location actively monitored (a blank was also installed that was recorded as a "PASS" by DCE).
- Each PAOC was isolated from the other PAOCs using doors or plastic sheeting such that the presence of radon would not be attributed to cross-contamination between different areas of the building.

4 CONCLUSIONS:

The 2022 radiological data from multiple sources confirmed CN's previous conclusion that elevated alpha activity levels measured with handheld monitoring instruments on building surfaces are the result of radon progeny. The radon progeny were observed in all of the locations sampled at similar concentrations indicating the source is from radon gases migrating into the building at multiple locations from below ground with possible contributions from building materials (i.e., concrete aggregate constituents). The radon monitoring conducted by DCE provided independent identification and quantification to verify the presence of elevated radon within the building.