# Air Sample Data at Area IV SSFL in Support of SEC-00235

**White Paper**

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## BACKGROUND

In May 2017, NIOSH issued an evaluation report for petition SEC-00235 for Area IV of the Santa Susana Field Laboratory (SSFL) for the period of August 1, 1991 to June 30, 1993 (NIOSH, 2017). SEC-00235 was qualified for evaluation because of compromised bioassay samples from vendor Controls for Environmental Pollution (CEP) during this time period. NIOSH does not use the bioassay results from CEP because they were implicated in data falsification at another site (not SSFL affiliated). NIOSH found that, despite the lack of roughly two years' worth of in-vitro bioassay data, there was no dose reconstruction infeasibility for the evaluated period and did not recommend that a class be added to the SEC. During the work group discussion on Area IV SSFL pertaining to SEC-00235 on December 4, 2017, NIOSH was tasked by the work group to provide more information on the available air sample data for the period where in-vitro bioassay data cannot be used (Transcript, 2017). Below is a summary of the operational highlights and the available air sample data for the 1991-1993 period at Area IV SSFL. A period in 1993, where several elevated general air samples were observed in the Hot Lab, is analyzed in greater detail.

## RADIATION CONCERNS DURING THE REMEDIATION PERIOD (AFTER 1988)

The EEOICPA covered period for Area IV SSFL is 1955-1988, with a remediation period from 1989 through present. By the end of 1988, all nuclear reactors and their fuel had been removed from Area IV SSFL, and the facilities were undergoing decontamination and decommissioning (D&D). The main facilities that could produce a notable airborne hazard were the Rockwell International Hot Laboratory (Hot Lab), the SNAP reactor facility (T059) and the Radioactive Material Disposal Facility (RMDF) (Quarterly Reviews, 1991-1993; Documented Communication, 2017a, 2017b). The RMDF was not in D&D mode, but an active facility. The radiation hazard at any given facility could vary significantly by the specific activity that was going on at any given time—meaning that it was not necessarily consistent over the course of the 1991-1993 period. There are monthly and quarterly activity and surveillance reports available that summarize the operations at the respective facilities (see "quarterly review" and "activity report" labeled documents in the Reference section). A brief summary is provided below for each of these three facilities (Hot Lab, RMDF, SNAP facility).

Based on the evaluation by Area IV SSFL Health Physicists (Moore, 1992), the remaining radionuclides of concern at Area IV in 1992 were Cs-137, Sr-90, Co-60 and Pu-239. Only fission products Cs-137 and Sr-90 were indicated to be present in sufficient quantity to be readily dispersed for inhalation by workers and Cs-137 was considered the most important radionuclide of concern during this period in operational history. It had been observed to be present along with Sr-90. The remaining Co-60 was largely contained in activated structural steel of reactor facilities and did not readily become airborne during demolition, except during cutting operations. The remaining Pu-239 was considered low level residual surface contamination and residual in remaining liquid waste handling systems. Pu-239 presented the biggest challenge in measurement and interpretation and was a focus of personal air sampling as is Sr-90. Cs-137 and Co-60 are gamma emitters and can be detected at relatively small fractions of permissible body burdens, using whole body counting. General work area and worker breathing zone air sampling

in areas where unencapsulated radioactive materials were handled were the primary indicators of potential radionuclide intakes by workers (Moore, 1992; Documented Communication, 2017a, 2017b)

## AIR SAMPLING PRIMER

Moore (1992) and Tuttle and Kittinger (1996) are references with a good description of the air sampling program at the SSFL sites in the 1990s. Air sampling methods consisted of both general area (GA) and breathing zone samples (BZ).

The GA and BZ results were compared to the maximum permitted air activity concentration (MPC). The radionuclides of concern to the air sample program at SSFL were the beta emitter Sr-90 and the alpha emitter Pu-239. The MPC values used are 1E-09 µCi/mL for Sr-90 and 2E-12 µCi/mL for Pu-239 (Quarterly Reviews, 1991-1993). Based on the guidelines stated in the quarterly reports, any air samples above 0.25 times the MPCs were analyzed for licensed materials (as opposed to naturally occurring radon and thoron progeny). For BZ air concentrations, the site used a limit of 2000 MPC-hours per calendar year (or 40 MPC-hrs/week for 50 weeks a year). The SSFL also applied a derived limit of 520 MPC-hrs per calendar quarter (Quarterly Reviews, 1991-1993). The available filtered full face respirators provided a protection factor of 50. Air-line respirators (the type most commonly used) provide a protection factor of 2000. The respiratory program at SSFL was evaluated annually by SSFL management (Quarterly Reviews, 1991-1993, PDF p. 406). Around 1992, the terminology from 10 CFR 835 was implemented and MPC-hours became DAC-hours. The Annual Limit of Intake (ALI) and/or Derived Air Concentration (DAC) values were used to limit radiation exposure from airborne radionuclides, based on 10 CFR 835. The ALI or DAC for a single radionuclide is the maximum intake in a year or the average concentration for a working year such that a person would not exceed a committed effective dose equivalent limit of 0.05 Sv (5 Rem) or a committed dose equivalent limit to any organ or tissue of 0.5 Sv (50 Rem). The values for MPC and DAC-hours used as the limit for GA and BZ concentration remained the same as before.

During the 1988-1992 period, air sampling was the primary assessment method for worker exposure, as controlling exposure via MPC-hour assessment was the regulatory requirement. Bioassay sampling was done as a backup to the air sampling program (Documented Communication, 2017b). Moore (1992) indicated that BZ air sampling is the preferred method to control for Pu-239 intakes, because it is difficult to measure an intake at regulatory level in the body (i.e., via bioassay).

General air samples were collected in fixed locations and were intended to reflect the longer term time-averaged concentrations in the workplace. At Area IV SSFL, GA samples were generally averaged over a week. Since all residual radionuclides had fairly long half-lives, radioactive decay was not a factor in evaluating time averaged general air samples. Continuous air sampling using fixed position air samplers used Gelman Type A/B glass fiber filters. The air samplers were operated continuously, with each filter collecting particulate aerosols for about 168 hours per week, or normally about 2184 hours per quarter. The available quarterly reports show averages for 13 weekly samples for each sampling location. The air flow typically is calibrated to

28.32 L/min (Quarterly Review, 1990a; Quarterly Review, 1990b, 1990c). The GA sample filters were counted in a gas flow proportional counter system for alpha and beta emitters and were allowed 72-96 hours of decay time to ensure the removal of radon daughter products before counting (Tuttle and Kittinger, 1996). However, the quarterly review reports state that the ambient air concentrations include radon and thoron daughter products (Quarterly Reviews, 1991-1993). There were 28 fixed sample locations in the Hot Lab, 7 fixed sample locations in the RMDF and no fixed sample locations in the SNAP facility (Quarterly Reviews, 1991-1993).

Breathing zone (BZ) air was measured in localized areas for very specific tasks that had a high probability of producing measurable quantities of radioactive aerosols. The sample collector was required to be placed close to the worker's nose or respirator inlet valve. This was thought to produce a better measure of worker exposure, since the BZ samplers were carried on the person. Each worker carrying a BZ sampler was equipped with a battery powered sampling pump and an air sample filter holder containing a Gelman Type A/E glass fiber particulate aerosol filter. The filter holder was mounted on the worker's outer PPE and connected to an air pump via a flexible hose. The airflow was ~ 3 L/min and is turned on and off by the worker when entering and leaving the work area. Actual worker internal exposures were controlled by the type of respiratory protection used, if any (Quarterly Review, 1990a). Breathing zone samples were reported by the worker. Some workers had multiple entries during the reporting period. Samples were averaged over the reporting period (Moore, 1992; Quarterly Reviews, 1991-1993).

## OPERATIONS SUMMARY FOR HOT LAB, SNAP FACILITY AND RMDF

The activity descriptions below were selected from quarterly reviews and weekly activity reports (Activity Reports, 1991, 1992, 1993), based on their potential impact to worker radiation exposure.

### SNAP Reactor Building (Building T059)

Quarterly reviews are available for 1991 (4 quarters) (Quarterly Reviews, 1991-1993) and weekly activity summaries are available for 1991-1993 (Activity Reports, 1991, 1992, 1993). The SNAP reactor was designed to power satellites in space. Several reactors of this type were operated at SSFL from 1956 to 1969. After the end of operations, the facilities have been gradually decontaminated and structures removed. This process was on-going during the 1991-1993 period. The facility is regulated by DOE (Quarterly Reviews, 1991-1993). The main remaining source term in Building 59 was Co-60 (Documented Communication, 2017a; Activity Reports, 1992).

During the 1991-1993 period, contaminated piping and structural material inside the SNAP reactor vessel pit were removed, which potentially resulted in high contact exposure rates of 5-8 mrem/hr. Irradiated structural steel and irradiated high density concrete were handled (such as shielding blocks). Some of this process involved the use of jackhammers. Sections from the reactor building structure were sent to the RMDF, where they were decontaminated and reduced in size before being placed into interim storage for eventual shipment off-site. A backlog of packaging material caused some interim storage of material in the high bay, which lead to

observed elevated dose rates. Deficiencies outlined in the DOE Tiger Team report were addressed (rewiring of basement). The HEPA filtration system had routine repair and maintenance. Some groundwater seepage into the test cell area was observed. Airborne radionuclide contamination was observed during operations, such as the removal of old NaK lines. Workers wore breathing zone air sample equipment and respirators during critical operations. This operation (removal of NaK lines) caused the highest assigned exposures (accounting for respiratory protection), which ranged from 0.02 to 0.22 DAC-hrs. The facility was shut down for several weeks in 1992 to acquire additional tools needed for D&D operations (a torch power supply). Test cell liners were cut and torched. A spreadsheet was developed, estimating the amount of residual radioactivity still in place at the SNAP facility, and it was ~7 Ci in 1992 (Quarterly Reviews, 1991-1993).

**Rockwell International Hot Laboratory (Hot Lab, RIHL, Building 20)**

The Hot Lab was a four-cell facility for the remote manipulation of mega-curie quantities of radioactive materials. The facility started operations in 1959. Operations with high level materials ended in 1987, when the facility was transitioned into D&D. The facility is regulated by NRC. Quarterly surveillance reports are available from first quarter of 1991 to the fourth quarter of 1993 (12 quarterly reports). The first quarter of 1990 is an incomplete report (Quarterly Review, 1990b, 1990c, 1990d, 1990e; Quarterly Reviews, 1991-1993). Annual reports detailing the Hot Lab decommissioning activities are also available (Annual Report, 1992, 1993, 1994). Annual Report (1993) has photographs showing workers wearing BZ equipment and respirators during operations (photographs are not of good quality and were therefore not reproduced here).

During the 1990-1993 period, areas of contamination in the hot cells and the decontamination room were cleaned by sandblasting and components were reduced in size and removed. The removal of the hot cell liner was a time-consuming and tedious task that involved cutting the liner with oxy-acetylene torches to smaller pieces to remove them from the substructure (Annual Report, 1992). Other power tools, such as jackhammers, were used for size reduction of structural elements. The main objective was the removal of the contaminated fixtures from non-contaminated substructures. The HEPA filtration system was routinely maintained (filter replacement, duct maintenance) and repaired where needed. Structural components were removed and sent to the RMDF for size reduction, packaging and interim storage and eventually off-site disposal. Some areas required contamination tents to be installed around the area being dismantled. The removal of drain lines was an operation that had the potential to produce significant external dose rates. Alternate ventilation methods were implemented as the regular ventilation system had to be dismantled to get access to the drain lines. The removal of in-floor storage tubes began in 1993. An earthquake struck in January 1994, but no significant damage to SSFL structures was observed. Personnel radiation exposures for the fourth quarter of 1993 were significantly higher than previous quarters. This was due to the removal of contaminated drain lines which contained high levels of activation products. Some operations took place outside the building, such as removal of contaminated asphalt in the holdup yard and surveying of metal stock that was stored outside. With the removal of the glove box in room 139, all former

plutonium processing equipment had been removed from the Hot Lab, except for trace amounts in ventilation and liquid waste processing systems.

Incidents reported consisted of skin contamination and a case of a cut from flying debris during metal cutting operations. Incidents were followed up by health physics if there was a radiological concern. Concerns voiced by Health physics was related to a shortage of respirators, which caused scheduling delays. All workers requiring BZ samples also were reported wearing respirators.

Breathing zone sampling was reported for 7 to 22 workers, based on their work assignments. Some workers had multiple entries; some workers had more than 50 entries during the reporting period. The reported MPC-hours account for the use of respirators by the workers. The highest MPC or DAC-hours assigned was 7.295 MPC hours in 1993 (of 520 allowed per quarter).

The Hot Lab reported between 31 (in 1990) and 28 (1991-1993) locations for general air sampling. The data is summarized in Table 1. During the first three quarters of 1993, there were four reported GA averages that were above the MPC levels, all for the gross beta monitor (Sr-90). These elevated results are discussed below.

**Radioactive Materials Disposal Facility (RMDF)**

The Radioactive Materials Disposal Facility (RMDF) consisted of several buildings dedicated to storage, packaging and shipment of radioactive materials, and was in active use during the 1991-1993 period. Quarterly surveillance reports are available for the years 1990 and 1991, with the exception of the third quarter of 1990 (Quarterly Reviews, 1991-1993; Quarterly Review, 1990a). Activity Reports for Radiation Protection and Health Physics Services are available for January-December, 1991-1993 respectively (Activity Reports, 1991, 1992, 1993).

In this period, shipments of radioactive waste materials were made to various recipients, such as Hanford and University of Missouri. Liquid and solid waste materials were treated and stored or removed from the site. The RMDF received radioactive wastes from the Hot Lab, T059 and T886, as well as other smaller facilities. The boxes from T059 consisted mainly of contaminated concrete, and the material was shipped to Hanford for burial. The material from the Hot Lab of most concern was the contaminated drain lines. In addition, material from the remediation of the Sodium Burn Pit facility (T886) was received in the form of lightly contaminated soil. A quantity of depleted uranium (DU) (240 kg) was shipped from the RMDF to Los Alamos National Laboratory (LANL). Materials from the TRUMP-S program (DU and Np-237) were shipped to University of Missouri in May of 1990. The RMDF retention pond was drained, sampled and resurfaced. In 1991, the facility had increased shipment activity, which resulted in a reduction of perimeter dose rates as radioactive items were removed. In 1991, the Hot Lab Cell doors were placed in temporary storage. In 1993, a total of 149 boxes and 349 bags of laundry were shipped without incident. Other routine operations at the RMDF consisted of cleanup of localized areas of radioactive contamination. Routine maintenance and repairs were done on the HEPA filter system. Work was suspended in the decontamination room in 1991 because of vent blower failure. Also in 1991, operations were briefly suspended until better air sampling procedures

were implemented as a result of the Tiger Team report. Laundry was routinely sorted and prepared for shipping to the laundry vendor.

Seven locations at the RMDF typically reported GA air samples. The highest sample was collected next to the fume hood in the decontamination room when handling material from the Hot Lab (first half of 1990).

BZ data for up to ten workers are available from various operations, such as size reduction of Building 059 concrete, laundry sorting and HEPA filter handling.

## AIR DATA REPORTING AND DATA AVAILABILITY

Air data are reported in the quarterly safety review reports for the Hot Lab and for the RMDF and the SNAP reactor Building (T059). Not all quarterly reports are available to NIOSH for all three facilities. It is not clear if these reports exist and where they are located. A recent request for additional quarterly reports to the DOE-EM Consolidated Business Center (EMCBC) in Cincinnati, Ohio, where DOE records from SSFL operations were sent, has not yielded additional quarterly review reports. It is not known at this time if additional reports or potentially raw data could be located, but attempting to do so would likely require significant time and effort.

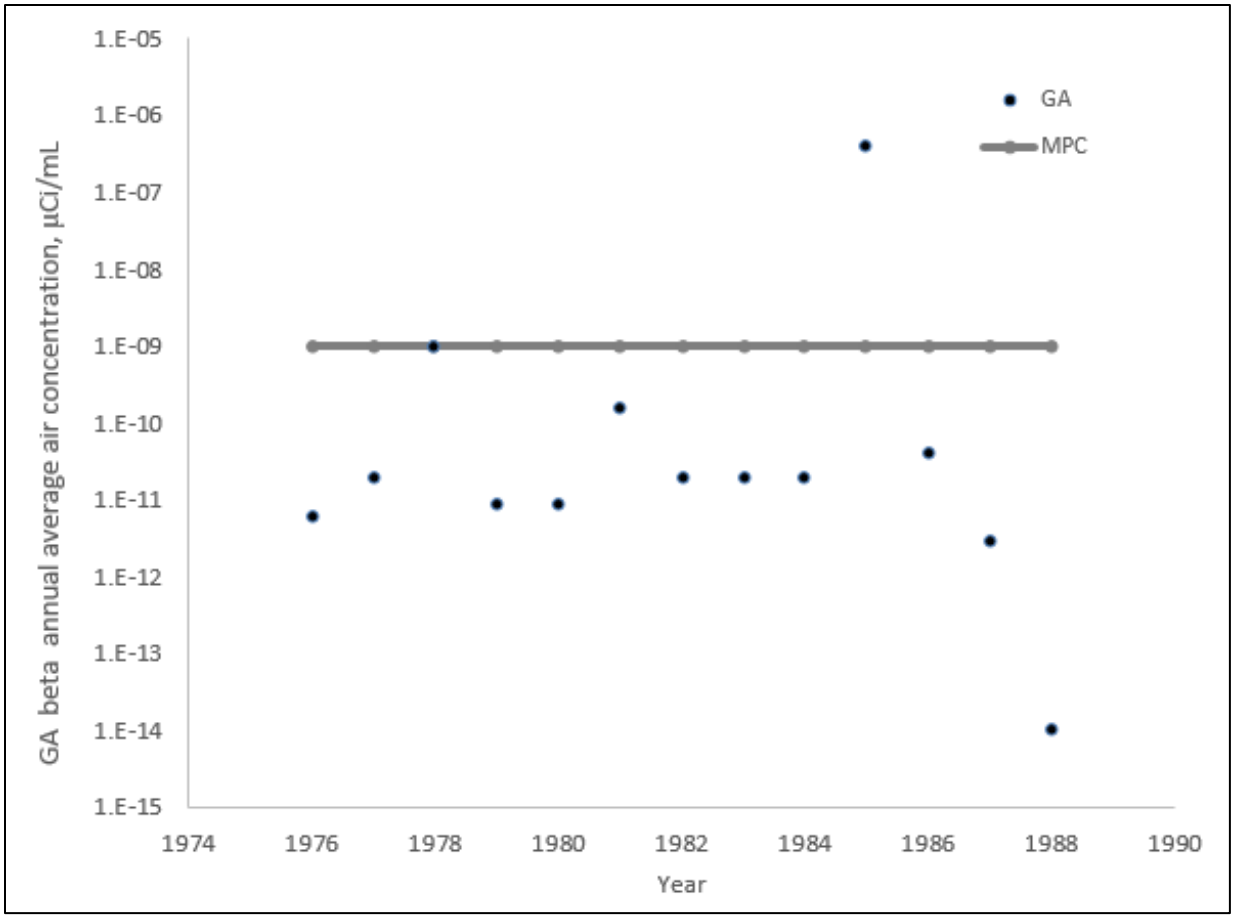


**Figure 1. Annual Maximum Averages for GA Beta Sampler at the Hot Lab Reported in Annual Reports for 1975-1988**

Annual Review of Radiological Control reports are available for the operational period from 1975-1988 (Annual Review, 1975-1988). These reports have annual interior air sample summary data for the Hot Lab available. The annual maximum average air results over time are shown in Figure 1 for beta analysis. Even the maximum reported annual averages are below the MPC of 1E-09 µCi/mL, except for 1985. The 1985 review does not discuss the above MPC average value in any detail. Generally the reported average values are in the same range as the values reported during the 1990-1992 period. The GA average values for 1993 have locations with elevated GA results for some locations. This is discussed in more detail below.

Table 1 below lists the general air data available in quarterly reports from Area IV SSFL during the CEP period as well as adjacent quarters. There are gaps in the completeness of the records during this time. However, the available summary reports are complete for the Hot Lab for 1990-1993.

The maximum reported values are the highest values reported in that quarter between the three facilities, where available. The maximum value GA in Table 1 represents a 13 week average of a given air sample location. The maximum BZ value represents the highest number of DAC-hrs

assigned to a worker as a result of wearing a BZ sampler over a quarter. This accounts for respirator protection factors assigned.

It is a reasonable assumption that the Hot Lab would represent a bounding dose regarding potential airborne particulate intakes, because of its operating history and its residual levels of Pu-239 and elevated results observed in 1993. It also has the largest number of GA samplers and the largest group of workers with BZ data available. This is supported by the activity reports for 1992, which mentioned that worker bioassay was triggered, as some BZ results from Hot Lab operations in the second and third quarter 1992 were detected above the MDA (Activity Reports, 1992, PDF pp. 32, 84). This report also indicates that the site maintained the BZ data results in spreadsheet and data base form (dbase) (a database management system) (Activity Reports, 1992, PDF p. 94). NIOSH does not have this data at this time.

**Table 1. Air Sampling Data Summary for Area IV SSFL Before, During and After the CEP Period.**

| Quarter | SNAP (T059) Bz | SNAP (T059) GA | Hot Lab BZ | Hot Lab GA | RMDF BZ | RMDF GA | Maximum Reported Value BZ (DAC-hrs) | Maximum Reported Value GA (µCi/mL) |
|---|---|---|---|---|---|---|---|---|
| 01/1990 | Not Applicable | Not Applicable | Not Applicable (pages missing) | Not Applicable | Not Applicable | 7 | Not Applicable | Beta: 1.7E-12 (RMDF)<br>Alpha: 1.7E-14 (RMDF) |
| 02/1990 | Not Applicable | Not Applicable | 22 workers | 31 | 4 workers (6 entries) | 7 | 1.78 (RIHL) | Beta: 1.1E-11 (RMDF)<br>Alpha: 5.8E-14 (RMDF) |
| 03/1990 | Not Applicable | Not Applicable | 16 workers | 31 | Not Applicable | Not Applicable | 1.14 (RIHL) | Beta: 3.8E-12 (RIHL)<br>Alpha: 5.0E-14 (RIHL) |
| 04/1990 | Not Applicable | Not Applicable | 11 workers | 28 | 3 workers | 7 | 1.1 (RMDF) | Beta: 5.1E-12 (RMDF)<br>Alpha: 4.1 E-14 (RMDF) |
| 01/1991 | Not Applicable | 0 | Not Applicable | 28 | Not Applicable | 7 | Not Applicable | Beta: 1.0E-11 (RIHL)<br>Alpha: 1.0E-14 (RIHL) |
| 02/1991 | 3 workers | 0 | 13 workers (275 entries) | 28 | 10 workers (23 entries) | 7 | 0.89 (RIHL) | Beta: 3.4 E-11 (RMDF)<br>Alpha: 4.0E-14 (RIHL) |
| 03/1991[a] | 7 workers (32 entries) | 0 | 12 workers (285 entries) | 28 | 8 workers (32 entries) | 7 | 0 .396 (RIHL) | Beta: 3.4E-12 (RIHL)<br>Alpha: 5.0E-14 (RIHL) |
| 04/1991 | 6 workers (12 entries) | 0 | 10 workers (245 entries) | 28 | 6 workers (20 entries) | 7 | 0.6 (RIHL) | Beta: 1.2 E-12 (RIHL)[b]<br>Alpha: 2.2 E-14 (RMDF)[b] |
| 01/1992 | Not Applicable | Not Applicable | 10 workers (314 entries) | 28 | Not Applicable | Not Applicable | 0.4 (RIHL) | Beta: 1.5E-13 (RIHL)[b]<br>Alpha: 2.0E-14 (RIHL)[b] |
| 02/1992 | Not Applicable | Not Applicable | 11 workers (373 entries) | 28 | Not Applicable | Not Applicable | 0.594 (RIHL) | Beta: 3.04E-12 (RIHL)<br>Alpha: 1.56E-13 (RIHL) |
| 03/1992 | Not Applicable | Not Applicable | 9 workers (208 entries) | 28 | Not Applicable | Not Applicable | 0.057 (RIHL) | Beta: 1.4E-12 (RIHL)<br>Alpha: 6.38E-14 (RIHL) |

| Quarter | SNAP (T059) Bz | SNAP (T059) GA | Hot Lab BZ | Hot Lab GA | RMDF BZ | RMDF GA | Maximum Reported Value BZ (DAC-hrs) | Maximum Reported Value GA (µCi/mL) |
|---|---|---|---|---|---|---|---|---|
| 04/1992 | Not Applicable | Not Applicable | 15 workers (261 entries) | 28 | Not Applicable | Not Applicable | 1.791 (RIHL) | Beta: 1.97E-13 (RIHL) Alpha: 8.58E-15 (RIHL) |
| 01/1993 | Not Applicable | Not Applicable | 16 workers (414 entries) | 28 | Not Applicable | Not Applicable | 1.069 (RIHL) | Beta: 9.90E+1 (RIHL) Alpha: 2.41E-14 (RIHL) |
| 02/1993 | Not Applicable | Not Applicable | 13 workers (262 entries) | 28 | Not Applicable | Not Applicable | 0.466 (RIHL) | Beta: 4.82E+1 (RIHL) Alpha: 3.7E-14 (RIHL) |
| 03/1993 | Not Applicable | Not Applicable | 14 workers (315 entries) | 28 | Not Applicable | Not Applicable | 7.295 (RIHL) | Beta: 8.49E+4 (RIHL) Alpha: 5.04E-14 (RIHL) |
| 04/1993 | Not Applicable | Not Applicable | 7 workers (131 entries) | 28 | Not Applicable | Not Applicable | 2.234 (RIHL) | Beta: 2.27E-12 (RIHL) Alpha: 1.52E-14 (RIHL) |

a. The CEP period, 03/1991-02/1993, is shaded grey.
b. These quarters reported only averages for quarter.

Even though the highest reported samples for several quarters were for the RMDF, please note that none of these samples were above the MPC, and that the results for the hot lab were in the same overall range – with the exception of the 1993 results.

During the first three quarters of 1993, the Hot Lab reported four significantly elevated general air samples in a three locations for Sr-90, as shown in Table 1. Table 2 below shows more detail on these elevated air samples (Quarterly Reviews, 1991-1993, PDF pp. 371, 436, 532, 538).

**Table 2. Reported Elevated GA Sample Reading for Hot Lab in 1993 for Sr-90.**

| Quarter | Location | Minimum Reading (µCi/mL) | Maximum Reading (µCi/mL) | Average Reading (µCi/mL) |
|---|---|---|---|---|
| 01/1993 | Service Gallery Beta Monitor | 4.00E-01 | 9.90E+01 | 3.01E+01 |
| 02/1993 | Service Gallery Beta Monitor | Non-detect | 4.82E+01 | 1.25E+01 |
| 03/1993 | Basement North East | 3.20E-14 | 4.99E+04 | 3.84E+03 |
| 03/1993 | Service Gallery North | 3.79E-14 | 8.49E+04 | 6.50E+03 |

Table 2 indicates that elevated general air results occurred during three quarters of 1993. Of the 28 monitored GA locations, one showed elevated beta counts for the first two quarters, and two locations had elevated results during the third quarter. There were no elevated results reported during the fourth quarter. The remaining locations of the 28 had averages below the MPC for these quarters. The location for the elevated averages is "Service Gallery Beta Monitor" for 01/93 and 02/93 and "Basement North East" and "Service Gallery North" for 03/93. The average values reported in the quarterly report represent a 13 week average, so it is not clear for how long this elevated airborne contamination was recorded (Quarterly Reviews, 1991-1993).

Activity reports were reviewed to determine the activities that could have resulted in these elevated GA samples. During those quarters, generally some elevated personnel exposures were observed (Quarterly Reviews, 1991-1993, PDF p. 517). One quarterly report mentioned a CAM alarm on July 20, 1993 in an area in the basement where a plasma torch was used to cut ventilation ducting. The worker's BZ sampling indicated the airborne ambient concentration was 0.21 DAC (< 0.1 DAC after accounting for a respirator factor of 50). As a consequence of this incident, the worker was instructed to change his procedure and the sample point was moved to a more appropriate location. It is likely that this incident is related to the reported elevated GA result for the Hot Lab basement area. A review of area TLD data for 1993 indicated some TLD slightly elevated results (< 2 mrem) in the hot lab basement area and the liquid waste tank area during the second and third quarter in 1993 (Quarterly Reviews, 1991-1993; Tuttle, 1994, PDF p. 33). One of the major tasks completed in this timeframe was the removal of contaminated drain lines from the hot cells. This required accessing the drain lines from the basement through concrete walls (Quarterly Reviews, 1991-1993; Activity Reports, 1993). It also required the removal of ventilation ducting and installation of alternate ventilation in the affected area. The drain line removal resulted in very high external dose rates from contaminated debris contained in the drain lines. Therefore, the source of localized high general air samples in the basement

area likely was a result of this operation, especially since there were changes in the area ventilation setup.

No information was found in the available records on the elevated sample in the Service Gallery North. The service gallery was an area running the length behind the decontamination cells (which were behind the hot cells) on the hot side of the facility. There were four GA samplers in this area, labeled "Service Gallery Alpha Monitor", "Service Gallery Beta Monitor", "Service Gallery North" and "Service Gallery South." Two of those locations had elevated GA results but the other GA sampler (Service Gallery South) did not, indicating that the elevated air concentration was somewhat localized. The operations in that area consisted of the removal of drain lines in cells 3 and 4, the core drilling of through tubes and slave ports in the service gallery and in the decontamination rooms, and the removal of ventilation ducts in cell 4 (Activity Reports, 1993). Available incident reports point to work activities in the hot lab that resulted in an off-scale dosimeter reading (Incidents, 1990) for work in cell 3 area in September of 1993, and personal contamination as a result of a "contamination event" at the Hot Lab (Incident, 1993) in August of 1993.

During this period, workers in the Hot Lab also had BZ data available and whole body counts on workers were done in October 1992, April 1993, September/October 1993 and June 1994. Those results are available and were also included in quarterly reports. The names of the workers involved in the Hot Lab operations requiring BZ monitoring are available and detailed worker records can be accessed in the workers' dosimetry files, which are available to NIOSH, even if the worker is not a claimant. Looking at the WBC results, three hot lab workers had reported values for Cs-137 of 2 nCi (+/- 1 nCi) during 1993. Those workers' individual worker dosimetry files were reviewed (Worker dosimetry files can be found in the ABRWH review folder under Santa Susana).

To further investigate the exposure potential of the Hot Lab workers in light of elevated beta readings, NIOSH selected five workers who were working in the Hot Lab during those quarters and who had indications of non-zero breathing zone MPC-hours assigned (none were close to the limit, though), and who also had whole body counts and urine bioassay to assess if there were any indication of unmonitored intakes from the Hot Lab (third and fourth quarter 1993 bioassay are useable due to a new bioassay vendor). The data are provided below in Tables 3 and 4. Table 3 indicates that the highest worker was assigned less than 0.1% of the occupational intake limit based on their BZ data assessment.

**Table 3. Breathing Zone Air Sample Data for 1993 Hot Lab Operations for 5 Selected Workers.**

| Worker Number | Quarter | Number of Entries | Maximum BZ for Sr-90 (µCi/mL) | DAC-hrs Assigned[a] |
|---|---|---|---|---|
| 1 [redacted] | 3/93 | 64 | 1.2E-08 | 1.08 |
| 2 [redacted] | 1/93 | 43 | 2.60E-09 | 0.165 |
| 3 [redacted] | 1/93 | 35 | 4.6E-09 | 0.032 |
| 4 [redacted] | 1/93 | 33 | 1.9E-9 | 0.036 |
| 5 [redacted] | 1/93 | 14 | 2.6E-9 | 0.162 |

a. DAC-hrs assigned for Sr-90 from this entire quarter of BZ sampling accounting for respiratory protection (the limit is 520 DAC-hrs)

**Table 4. Urine and Whole Body Count Data for 5 Selected Hot Lab Workers.**

| Worker Number | WBC Date | WBC Result (nCi) | Urine Sample Date after CEP | Urine Bioassay Analytes | Urine Result |
|---|---|---|---|---|---|
| 1 [redacted] | [redacted]1993<br>[redacted]1993 | 0<br>0 | [redacted]1993<br>[redacted]1994 | GA, U, MFP, GB | "less than" |
| 2 [redacted] | [redacted]1993<br>[redacted]1993<br>[redacted]1994 | 2 (± 1) Cs-137<br>2 (± 1) Cs-137<br>2 (± 1) Cs-137 | [redacted]1993<br>[redacted]1993<br>[redacted]1993 | GA, GB, U, | "less than" |
| 3 [redacted] | [redacted]1993<br>[redacted]1993<br>[redacted]1994 | 2 (± 1) Cs-137<br>0<br>0 | [redacted]1993<br>[redacted]1994 | GA, GB, U, GB | "less than" |
| 4 [redacted] | [redacted]1993<br>[redacted]1993<br>[redacted]1994 | 2 (± 1) Cs-137<br>0<br>0 | [redacted]1994 | GA, GB | GB: 7.60 (± 4.3) pCi/L |
| 5 [redacted] | [redacted]1993<br>[redacted]1993 | 0<br>0 | [redacted]1993<br>[redacted]1994 | GA, GB, H-3 | "less than" |

From examination of Table 4, it can be seen that there is no seemingly clear correlation between the GA data, the BZ data and the WBC and the bioassay results from August 1993 and later. The positive whole body count results are for Cs-137, which is a fission product and is often present along with Sr-90. Since work was done in an area of elevated airborne contamination, it is possible that some workers received some intakes. There is no indication that the radiation dose could not be bounded for these workers (or their coworkers) using the available data, be it available air, WBC or urine bioassay data. Whereas it seems that all workers who were involved in the D&D operations were monitored by BZ and WBC, it is also possible to assign potentially missed dose using the available coworker models for SSFL. The period in 1993 is a period of occasional higher airborne contamination in the Hot Lab as a result of the D&D operations, and

may be the bounding exposure scenario for the CEP period. Since the new bioassay vendor started analyzing samples in August 1993, any intakes from the previous quarters would likely be detected.

## CONCLUSION

There are BZ and GA air data available for Area IV of the SSFL during the CEP period, but they are not complete for some quarters. Data for the Hot Lab is available and can be considered a bounding scenario, based on available operations descriptions and workers being monitored. There is no clear evidence that the general air and breathing zone data are in any way unusual, given the operational status of the facilities at the time. Elevated air samples and whole body count results are in line with the work that was being completed then. There were a few localized elevated samples observed during the 1993 period, when bioassay are not useable for the first half of the year, but there is no indication that between the WBC and the bioassay sampling taking place in August would have led to significant missed exposures. Whole body counts and BZ samples wer e collected for workers in locations likely to receive an intake. Not all air and BZ data is available for all quarters and facilities, but it is believed this is because it has not been captured, not because it does not exist. There is no evidence that additional data capture for remaining quarters and facilities will lead to a different conclusion on the status of the air data or the feasibility to assess internal doses for Area IV SSFL using available data or the coworker model.

## REFERENCES

Activity Reports, 1991, *Compilation of Weekly Activity Reports for Radiation Protection and Health Physics Services, throughout 1991*, correspondence, P. Rutherford, Rockwell International, various dates throughout 1991. [SRDB Ref ID: 166437]

Activity Reports, 1992, *Compilation of Weekly Activity Reports for Radiation Protection and Health Physics Services, throughout 1992*, correspondence, P. Rutherford, Rockwell International, various dates throughout 1992. [SRDB Ref ID: 166447]

Activity Reports, 1993, *Compilation of Weekly Activity Reports for Radiation Protection and Health Physics Services, throughout 1993*, correspondence, P. Rutherford, Rockwell International, various dates throughout 1993. [SRDB Ref ID: 166450]

Annual Report, 1992, *Annual Report Rockwell International Hot Laboratory Decommissioning, GFY 1992*, E. M. Larson, Rockwell International, July 02, 1993. [SRDB Ref ID: 072050]

Annual Report, 1993, *Annual Report Rockwell International Hot Laboratory Decommissioning, GFY 1993*, L. D. Felton, Rockwell International, April 26, 1995. [SRDB Ref ID: 072025]

Annual Report, 1994, *Annual Report Rockwell International Hot Laboratory Decommissioning, GFY 1994*, L. D. Felton, Rockwell International, April 26, 1995. [SRDB Ref ID: 072026]

Annual Review, 1975, *Annual Review of Radiological Controls—1975*, R. S. Hart, Rockwell International, July 29, 1979. [SRDB Ref ID: 019137]

Annual Review, 1976, *Annual Review of Radiological Controls —1976*, R. S. Hart, Rockwell International, March 21, 1980. [SRDB Ref ID: 019136]

Annual Review, 1977, *Annual Review of Radiological Controls —1977*, R. S. Hart, Rockwell International, May 27, 1980. [SRDB Ref ID: 019135]

Annual Review 1978, *Annual Review of Radiological Controls —1978*, R. S. Hart, Rockwell International, August 06, 1980. [SRDB Ref ID: 019134]

Annual Review, 1979, *Annual Review of Radiological Controls —1979*, R. S. Hart, Rockwell International, September 15, 1980. [SRDB Ref ID: 019133]

Annual Review, 1980, *Annual Review of Radiological Controls —1980*, R. R. Eggleston, Rockwell International, October 12, 1983. [SRDB Ref ID: 019132]

Annual Review, 1981, *Annual Review of Radiological Controls —1981*, R. R. Eggleston, Rockwell International, May 29, 1984. [SRDB Ref ID: 019131]

Annual Review, 1982, *Annual Review of Radiological Controls —1982*, R. J. Tuttle, Rockwell International, January 29, 1985. [SRDB Ref ID: 019130]

Annual Review, 1983, *Annual Review of Radiological Controls —1983*, R. J. Tuttle, Rockwell International, January 25, 1986. [SRDB Ref ID: 019129]

Annual Review, 1984, *Annual Review of Radiological Controls —1984*, R. J. Tuttle, Rockwell International, March 18, 1986. [SRDB Ref ID: 019128]

Annual Review, 1985, *Annual Review of Radiological Controls —1985*, R. J. Tuttle, Rockwell International, July 11, 1986. [SRDB Ref ID: 019142]

Annual Review, 1986, *Annual Review of Radiological Controls —1986*, R. J. Tuttle, Rockwell International, July 05, 1988. [SRDB Ref ID: 019141]

Annual Review, 1987, *Annual Review of Radiological Controls —1987*, R. J. Tuttle, Rockwell International, July 28, 1988, [SRDB Ref ID: 019140]

Annual Review, 1988, *Annual Review of Radiological Controls —1988*, R. J. Tuttle, Rockwell International, May 12, 1989. [SRDB Ref ID: 019139]

Documented Communication, 2017a, *Documented Communication with Former Area IV of the SSFL Employee*, Email communication by ORAU Team and NIOSH, May 10, 2017. [SRDB Ref ID: 166848]

Documented Communication, 2017b, *Personal Communication with Former Area IV of the SSFL Employee*, Interview by ORAU Team and NIOSH, April 18, 2017. [SRDB Ref ID: 166847]

Incident, 1993, *Radiological Safety Report ─Personnel Contamination of Co-60 and Cs-137 on T-shirt*, Rockwell International internal letter, August 10, 1993. [SRDB Ref ID: 166190]

Incidents, 1990, *Historical Radiological Incidents ETEC-SSFL*, compilation of incident files received from DOL in December 2017. [SRDB Ref ID: 169476]

Moore, 1992, *Internal Dose Assessment Program Procedures, Operating Procedure*, J. D. Moore, Rockwell International; December 16, 1992. [SRDB Ref ID: 073474]

NIOSH, 2017, *SEC Petition Evaluation Report for Petition SEC-00235, Area IV of the Santa Susana Field Laboratory*, National Institute for Occupational Safety and Health (NIOSH); May 11, 2017. [SRDB Ref ID: 174360]

Quarterly Review, 1990a, *Quarterly Reviews of the Radioactive Materials Disposal Facility for 1990*, correspondence to P.D. Rutherford, J. D. Moore, Rockwell International, May 20, 1991. [SRDB Ref ID 166470]

Quarterly Review, 1990b, *Quarterly Review of the Rockwell International Hot Laboratory (RIHL), Building 020 SSFL, for Radiation Safety, First Calendar Quarter of 1990*, incomplete document, correspondence P.D. Rutherford, J. D. Moore, Rockwell International, September 04, 1990. [SRDB Ref ID: 174328]

Quarterly Review, 1990c, *Quarterly Review of the Rockwell International Hot Laboratory (RIHL), Building 020 SSFL, for Radiation Safety, Fourth Calendar Quarter of 1990*, correspondence to P. D. Rutherford, J. D. Moore, Rockwell International, April 2, 1991. [SRDB Ref ID: 74775]

Quarterly Review, 1990d, *Quarterly Review of the Rockwell International Hot Laboratory (RIHL), Building 020 SSFL, for Radiation Safety, Second Calendar Quarter of 1990*, correspondence P.D. Rutherford, J. D. Moore, Rockwell International, October 22, 1990. [SRDB Ref ID: 174329]

Quarterly Review, 1990e, *Quarterly Review of the Rockwell International Hot Laboratory (RIHL), Building 020 SSFL, for Radiation Safety, Third Calendar Quarter of 1990*, correspondence P.D. Rutherford, J. D. Moore, Rockwell International, November 26, 1990. [SRDB Ref ID: 174330]

Quarterly Reviews, 1991-1993, *Compilation of Quarterly ALARA and Surveillance Reports (1991-1993)*, correspondence, various authors, Rockwell International, various dates through 1991-1993. [SRDB Ref ID: 166444]

Transcript, 2017, U.S. Department of Health and Human Services Centers for Disease Control National Institute for Occupational Safety and Health, Advisory Board on Radiation and Worker Health, Area IV of the Santa Susana Field Laboratory Work Group, Transcript, Monday, December 4, 2017. [SRDB Ref ID: 174359]

Tuttle, 1994, *Radiological Health Branch TLD Results for 1993*, Letter to R. Tuttle by State of California Department of Health Services, April 13, 1994. [SRDB Ref ID: 170405]

Tuttle and Kittinger, 1996, *Methods and Procedures for Radiological Monitoring*, R. J. Tuttle, W. D. Kittinger, Rockwell International, Supporting Document, May 14, 1996. [SRDB Ref ID: 166409]