**Draft**

# SUMMARY OF SITE EXPERT INTERVIEWS RELATING TO THE HANFORD SPECIAL EXPOSURE COHORT ISSUES

**Contract No. 211-2014-58081**
**SCA-SEC-IS2014-0058, Revision 0**

Prepared by

Lynn Ayers

S. Cohen & Associates
1608 Spring Hill Road, Suite 400
Vienna, Virginia 22182

Saliant, Inc.
5579 Catholic Church Road
Jefferson, Maryland 21755

April 2014

| **S. Cohen & Associates:** ***Technical Support for the Advisory Board on Radiation & Worker Health Review of NIOSH Dose Reconstruction Program*** | Document No.: SCA-SEC-IS2014-0058<br>Effective Date: Draft – April 1, 2014<br>Revision No.: 0 (Draft) |
|---|---|
| **SUMMARY OF SITE EXPERT INTERVIEWS RELATING TO THE HANFORD SPECIAL EXPOSURE COHORT ISSUES** | Page 2 of 13 |
| Task Manager:<br><br>_____________________________ Date: ___________<br>Arjun Makhijani, PhD | Supersedes:<br><br>N/A |
| Project Manager:<br><br>_____________________________ Date: ___________<br>John Stiver, MS, CHP | Reviewers:<br><br>Joseph Fitzgerald<br>Arjun Makhijani<br>John Stiver |

**Record of Revisions**

| Revision Number | Effective Date | Description of Revision |
|---|---|---|
| 0 (Draft) | 04/01/2014 | Initial issue |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

# ACRONYMS AND ABBREVIATIONS

| | |
| --- | --- |
| Advisory Board | Advisory Board on Radiation and Worker Health |
| Am | americium |
| CAM | Continuous Air Monitor |
| Cf | californium |
| Cs | cesium |
| D&D | decontamination and decommissioning |
| DOE | U.S. Department of Energy |
| DU | depleted uranium |
| EBR-II | Experimental Breeder Reactor II |
| EU | enriched uranium |
| FFTF | Fast Flux Test Facility |
| g/L | gram per liter |
| HP | health physicist |
| ITMA | Irradiation Test Management Activity |
| kg | kilogram |
| LANL | Los Alamos National Laboratory |
| MOX | Mixed Oxide |
| NIOSH | National Institute for Occupational Safety and Health |
| Np | neptunium |
| ORAUT | Oak Ridge Associated Universities Team |
| PFP | Plutonium Finishing Plant |
| PRTR | Plutonium Recycle Test Reactor |
| Pu | plutonium |
| PUREX | Plutonium Uranium Extraction Plant |
| R&D | research and development |
| RadCon | Radiological Control |
| RCT | Radiological Control Technician |
| SC&A | S. Cohen & Associates |
| SD | Supporting Document |
| SEC | Special Exposure Cohort |
| SNM | Special Nuclear Material |

| | |
|---|---|
| SRDB | Site Research Database |
| SRP | Savannah River Plant |
| SRS | Savannah River Site |
| U | uranium |
| $UO_3$ | uranium trioxide |

# SUMMARY OF SITE EXPERT INTERVIEWS RELATING TO THE HANFORD SPECIAL EXPOSURE COHORT ISSUES

## INTRODUCTION

As a technical support contractor to the Advisory Board on Radiation and Worker Health (Advisory Board), S. Cohen & Associates (SC&A) has been engaged in ongoing issues resolutions with the Advisory Board and the National Institute for Occupational Safety and Health (NIOSH) related to Hanford Site Special Exposure Cohort (SEC) petitions. SEC classes have previously been designated for Hanford workers from 1943 through 1983. Operations of interest for SEC issues resolution include neptunium operations, cesium-137 encapsulation, and bioassay practices from 1984 through 1989.

One component of SC&A's review is a series of interviews with current and former workers with experience related to the operations of interest. All interviews were unclassified. Most were conducted in conjunction with data capture site visits; one was conducted by telephone.

- March 19, 2013 – unclassified interview conducted by Joe Fitzgerald (SC&A)
- April 10, 2013 – conference call attended by Arjun Makhijani (SC&A), Sam Glover (NIOSH), and Brad Clawson (Advisory Board)
- July 30, 2013 – an unclassified group interview attended by Joe Fitzgerald and Arjun Makhijani (SC&A); Sam Glover and Bob Burns [NIOSH/ORAUT (Oak Ridge Associated Universities Team)]
- July 30, 2013 – an unclassified group interview attended by Joe Fitzgerald, Joe Porrovecchio, and Arjun Makhijani (SC&A); Sam Glover and Bob Burns (NIOSH/ORAUT); and Brad Clawson (Advisory Board)
- August 15, 2013 – an unclassified group interview attended by Joe Fitzgerald and Arjun Makhijani (SC&A), and Sam Glover (NIOSH)
- August 21, 2013 – an unclassified interview attended by Joe Fitzgerald (SC&A), Sam Glover (NIOSH), and Brad Clawson (Advisory Board)

A total of 15 individuals were interviewed in 2013; their employment dates range from the late 1960s to the present. Their experience includes research and development (R&D), operations, engineering, testing, radiological control, decontamination and decommissioning (D&D), supervision, and management. The interviewees worked in the 308 Building Fuel Fabrication and Testing group, the Fast Flux Test Facility (FFTF), the 200 Area PUREX [Plutonium Uranium Extraction Plant] and B Plant operations, and the Plutonium Finishing Plant (PFP).

A classification officer was present for all onsite and telephone interviews. Participants were advised that the interviews were unclassified and that they should not disclose any classified information. All interview notes were submitted for classification review and were released to SC&A. A written summary of each interview was prepared, submitted for classification review, and provided to the interviewee for review. All changes initiated by interviewees to correct or clarify information in the draft interview summaries were also submitted for classification review and were released to SC&A as unclassified. Responses have been received from 14 of the 15 interviewees (93%). This summary only includes materials from interviewees who provided responses.

Information provided by the interviewees is based on their personal experience and recollections; individuals' statement may need to be further substantiated. The interview summaries are provided in that context.

## FUEL FABRICATION AND TESTING

*[The interviewees, collectively, provided characterization of fuel fabrication and testing activities, as follows:]*

[Workers at Building 308 were involved in fuel fabrication from the late 1970s through 1989. Some interviewees returned to 308 for deactivation and stabilization activities, beginning about 1992.] Engineers at 308 Building were responsible for fabricating test assemblies for breeder reactor fuel experimental programs. They fabricated fuel assemblies, fuel rods, etc. The test assembly group built instrumented assemblies for various test reactors within DOE [Department of Energy].

An interviewee supported development of offsite vendors to supply "fuel" to Hanford and Idaho, such as fuel pins (rods) for FFTF. The worker was located in Building 324 and had office space in Building 309 PRTR [Plutonium Recycle Test Reactor]. One interviewee indicated that FFTF pins were bundled and stored in Building 306. Another participant's written response stated the pins were bundled in Building 308, and non-radiological materials were stored in Building 306. From the 1970s through the late 1980s, workers at 308 fabricated pins for FFTF and EBR-II [Experimental Breeder Reactor II]. The actual fuel was made by vendors, with Hanford fabricating and assembling pellets for using FFTF for research and testing.

An engineer had responsibility for inspections and acceptance testing of fuel supplied by vendors, including destructive testing and sampling of pins to see if they met specifications. There were a lot of glovebox operations for doing the receiving inspections. [Workers in 308] also fabricated test fuel for EBR II. Assembly operations were involved in making fuel pins into assemblies. One activity that had potential dose was a fissile assay machine. Driver fuel came in from vendors; each and every pin would be run under a Cf source to check whether it had the correct fissile content. That operation would create quite a bit of dose to the operator of the machine.

During 1982–1983, an interviewee recalled making special Np pellets for a limited number of pins (3?), which was an unusual campaign. The worker believes that once fabricated, [the Np pellets] were sent to EBR-II. The worker recalled mostly routine runs, although some "oddball" runs were done in FFTF (U-233 and thorium were the only ones the worker recalled).

It is possible that [neptunium] pins [may have been received] from LANL [Los Alamos National Laboratory] and fabricated into assemblies at Hanford. The ceramic engineers may help resolve that question. If [the neptunium pins] were made at 308 from powders, they would know. The ceramic engineers were at 308 Building during the time frame [of interest: 1988–1989].

[A ceramic engineer] recalls doing some small tests that had neptunium. The interviewee had trouble remembering the nature of the design of the test pins and the materials in the test. The engineer assumes they got the Np from one of the R&D groups. There were folks in both of those companies (B&W Hanford and Fluor Hanford) that did R&D. There is a possibility that the material was already in usable form that could have been incorporated into a fuel pin. When materials were made into ceramic fuel form, they would be mixed in a glovebox. But the interviewee does not recall that for Np. It may have already been in usable form.

Usable form [would not necessarily mean] ceramic pellets; perhaps the neptunium was in capsules. But the interviewee does not remember the Np material form or composition. The interviewee was hoping there would be documents to refresh his memory. He would normally remember more, but maybe he doesn't remember much because he wasn't told much. They received material in oxide form; they made it in 308. But the interviewee does not remember details [for neptunium]. There was only one neptunium experiment that they ever put in FFTF. [The interviewee suggested other individuals who may remember details.]

[A ceramics engineer] does not remember batching Np-containing materials. Was the Np already encapsulated in some way? In that case, [the fuel fabrication group] would place it in the part of the fuel pin according to the design requirement. This is something like a medicine capsule that you could slide in. The interviewee doesn't remember dealing with raw Np material in the gloveboxes. The only "weird" material they handled in the gloveboxes was U-237. If they had handled neptunium oxide, they would have done things like mixing that he would remember. But there is no specific memory about that, and it is frustrating.

There is just an off chance that the Np oxide came from LANL, because LANL was doing the feasibility calculations of Np tests. [LANL] actually created Np targets using surrogate materials. So, this was an Np oxide surrogate pressed into a foil target. [Specific individuals] at LANL might know.

An interviewee's feeling is that the material was in usable form when it came to 308. If it came to 308 and required batching, [he would have] had to figure that out [and would remember]. [It may have come] to 308 in capsule form that they would place into fuel pins. He does not remember any type of batching. All he remembers is the Np-237 was part of a test and they would have assembled the test pins. The chance that neptunium powder was handled at 308 seems low to [the interviewees].

[Assembly of test pins] would be done in a pin loading box. Normal test pins were 8-foot-long stainless steel rods. They would assemble pellets, springs, and spacers into the hollow rods, seal the ends, and then weld them. The whole thing could be handled physically without worrying about components sliding around. What they call pellets were in ceramic form and were not encapsulated. It was like lining up pencil erasers and sliding them in. They did have a tiny amount of [loose] material on the outside, so you could get contamination if you wiped it with a rag. The interviewee does not have a specific recollection of Np being in that form. If it was already encapsulated, it would be put in a test pin as one component. There was a cover gas in the test pin that would be used to detect a leak.

The target issue would possibly be in 326 Building. It is possible that the Np was handled in 326 and then sent encapsulated to 308. Some of the individuals [named by the interviewees] would be able to help.

Every assembly had a data package that described everything about it. They are SD documents and they should be available for every test assembly that was produced in 308 Building. "SD documents" refers to a general document designation – SD (for Supporting Document) – within Westinghouse document ID numbers [e.g., WHC-SD- XX-YY-123].

Every job had a fabrication data package with certifications on the chemistry. The design document was the specification for the test – technical basis document, Volume 1 or 2. That would describe where you would put this material in the test pin. What you want is the ITMA [Irradiation Test Management Activity] document. That would be the document that would be approved for FFTF tests.

A manager of core physics testing at FFTF was familiar with the Np testing, but did not recall any real quantities of Np at Hanford. He thought that came from SRP [Savannah River Plant]. The interviewee suggested talking with [another individual], who fabricated "mini-pellets" for FFTF and would be more familiar with what was handled at the pellet fabrication stage. There should be a full report of the Np testing on file (an ITMA was prepared for every test). The interviewee seriously doubts that Np mini-pellets would have been fabricated in Building 308.

Destructive analysis would have been done in 325. It would have been done onsite, because there was urgency for the results from the political standpoint. In Building 325, the post-irradiated pin assembly would have been taken apart in a hot cell. The tiny Np "dosimeters" within each pin would have been pulled out and gamma analyzed, with the measured emissions indicating the conversion rate of Np to U-238. The Pu-236 content was also measured to ascertain whether the buildup of that impurity would present undue interference; that would have been the biggest reason to run test.

In 1991 or 1992, fuel and fuel pins were being shipped to PFP in 200 West. An interviewee did not recall fuel fabrication in that time period [1989]. At that time, it was, "How do you package a glovebox and ship it out?" As far as production of irradiated fuel, the interviewee does not recall. [The worker suggested] contacting the operating group at FFTF. A lead individual had responsibility for documentation of all fabricated test fuel pins and assemblies. [The interviewee believes this individual] was still at Building 308 in 1989 and was involved in de-inventory and shipment of SNM [Special Nuclear Material] to PFP.

## NEPTUNIUM SEPARATIONS ACTIVITIES (PUREX)

*[The interviewees, collectively, provided characterization of PUREX activities involving neptunium, as follows:]*

A nuclear chemical operator at PUREX [in the early 1980s] performed job functions ranging from lead worker in the control room, where they operated the reprocessing process, to every task and job associated with PUREX. These tasks included sampling, making up chemical tanks, transferring solutions, decontamination, maintenance, and repairing canyon equipment. Seven years into the operation, PUREX got a shutdown notice.

PUREX staff was also responsible for the $UO_3$ [Uranium Trioxide] plant. [There were] similar activities, but different nuclides. In the 1989 to early 1990s period, there was deactivation of the $UO_3$ plant. The interviewee went back to PUREX for deactivation. Deactivation is a transition to D&D – removal of chemical hazards, plus utility isolation to put the plant in a safe mode. PUREX is still in that mode. An interviewee [participated in] all phases of the $UO_3$ plant—operation, deactivation, and D&D.

From the 1960s to 1972, PUREX purified Np and shipped liquid solutions of Np to SRS [Savannah River Site]. During the restart process in 1982, an interviewee was responsible for reactivating the neptunium process – both the Q cell (contact maintained) and the J cell (package located in a canyon cell). They spent about a year getting all of the gloveboxes ready [for reactivation].

PUREX restarted in 1983 without reactivating the Np recovery equipment. The canyon J cell package and some of the Q cell equipment were reactivated and modified in 1984–1985 to enable storage of impure Np solution. The purification part of the Q cell was not reactivated, because they could no longer ship liquid Np solution to SRS. An Np oxide conversion process was designed, but it was not installed by the time PUREX shut down in 1989. The impure Np solution was eventually sent to a waste tank in the early 1990s.

The J cell was a subset of the PUREX process. The J cell package in the canyon took a side stream off the back cycle waste system in the canyon and provided a gross cleanup that removed most all of the contaminants. Up to 1972, there were minor problems with fission product contamination, occasional problems with Pu, and frequent contamination with thorium. After restart in the 1980s, the waste was so old there was little fission product contamination, and most of the thorium had been flushed from the process as well. Since they were only storing the impure solution until ready for the final purification, contaminants were not a major concern except to ensure low levels of Pu for criticality concerns. The interviewee does not recall any Pu problems in the 1980s.

The problem with Np is the ingrowth of Pa-233 daughter. When they had gallon jugs of purified Np solution, before 1972, they had a time limit to ship them to SRS. In the 1980s, the impure liquid was stored in Tank J-2 in the canyon, so daughter ingrowth was not of concern. The interviewee does not recall having dose rate problems with any of the periodic J-2 samples they took.

The only dose from Np that people got in the 1980s at PUREX came from two sources:

(1) Exposure to low levels from Np-contaminated equipment during reactivation work in the Q cell holds and when repairing equipment removed from the J cell package and placed in the canyon hot shop for repair. Most of the dose rate was from residual fission products, not from Np or Pa-233.

(2) Exposure to low levels from samples taken during processing and storage.

An interviewee set the schedules to get the crews and equipment together to do repair jobs. They worked with the equipment. There were rigid jumpers; they were pieces of equipment. J cell would have been remote handling; Q cell hood was contact handled. But sometimes entry into the canyon hot shop was necessary to fix the jumpers. When working on J cell package jumpers in the hot shop, workers probably replaced 50 to 60 jumpers. There were both electrical jumpers and process jumpers. Most repairs involved changing out leaking gaskets or jumper fingers. An interviewee estimates that 80% of the jumper maintenance work was performed by three individuals. That was the only contact work they did with Np-related equipment.

J cell package jumpers were removed remotely by the crane operator. They were usually flushed before removal, where practical. Any liquids in the jumper drained to the canyon cell sumps [and were] then transferred to the tank F-18. Any liquid remaining in the jumper when it went to the hot shop for repair was incidental (i.e., just a wet internal surface with occasional drips). The Np concentration was very low, 0.001 g/L up to maybe 0.5 g/L for a very few jumpers.

As the jumpers would be taken off, they would be decontaminated in M cell, washed, hosed, and rinsed before the maintenance guy would get to the end and the connector to replace the gasket or whatever. Workers wore respirators.

Q cell was all contact maintenance. Since the purification equipment was not reactivated [in the 1980s], they concentrated the impure solution and stored it in a tank in the canyon. [When asked if the total Np amount was 10–12 kg, an interviewee agreed that is consistent with his recollection.]

Before 1972, the impurities were minor amounts of fission products and thorium. In the 1980s, there were very little fission products, and [the interviewee recalls] the thorium was lower. There would be some contaminants. They had almost no Pu-238. This was not like SRS. They did not have that at Hanford. There was almost no Pu-238 in it. There were various grades of Pu-239. Tank J-2 was an accountability tank, so there would be tank sample analyses. There is probably someone at the laboratory (222 S Laboratory) who would know where to find the analyses.

A PUREX worker does not recall any significant incidents or problems. This was from the back-cycle waste stream, and the solution wasn't that hot. Most of the impure liquid from the J cell package would be a gram (g) per liter or less of Np. It could build up to 3 or 4 g, and you would then dilute it. The Np in the fuel elements was about 10 to 30 g per ton of U. PUREX restarted in 1983, and impure Np was recovered from the fall of 1985 until at least 1988. The plant shut down in 1989. An interviewee recalls a total of 12–14 kg [of Np] were recovered and stored in Tank J-2.

.

[When asked about the quantity and location of thorium from the U-233 campaign, an interviewee said] it was residual from 1966 and (mostly) 1970 thorium rinse. There wasn't much, but it followed Np through the process. The interviewee does not know how much was there, but it was always there with the Np in 1972 and before. It was a real problem with the Np. They ended up having to recycle a lot of Np because it was very difficult to get rid of the thorium. Thorium was not recalled as a concern in the 1980s.

## CS-137 ENCAPSULATION AT B-PLANT (221-B)

*[The interviewees, collectively, provided characterization of Cs-137 encapsulation activities, as follows:]*

Interviewees reaffirmed that Cs-137 encapsulation had taken place past October 1983. They provided documentation to that effect, including a 1984 B Plant report and a 1985 presentation.[1] Interviewees explained that Cs-137 capsules were sent offsite for use in irradiation facilities in the United States and other countries. These capsules were returned to Hanford; if they were damaged, the cesium-137 was re-encapsulated.

## RADIOLOGICAL CONTROLS

*[The interviewees, collectively, provided characterization of radiological controls, as follows:]*

Radiological Control Technicians (RCTs) [in the 300 Area (late 1980s)] moved around a lot. They would do a month at 308 and then a month at another building and rotated as help was needed, but all in the 300 Area.

Protective clothing [for Building 308 fuel fabrication activities] generally consisted of coveralls with latex gloves taped at the wrist. [In the early 1970s, workers] did not routinely use respiratory protection for bag outs. Respirators were used for large diameter ports. There was no respiratory protection requirement for routine glovebox operations, although they were available for emergencies. There were daily contamination sweeps, checking of the CAMs [Continuous Air Monitors] and running tests on them every day. Skin contamination was documented on survey reports, which are in the Seattle Repository. For air sampling, there were fixed neutron dosimeter and stack samplers. You can check the 308 stacks (308 and 308A).

[At PUREX in the 1980s], workers always wore a full-face respirator and two pairs of coveralls, gloves, boots, etc., for work in the hot shop on jumpers. When working in Q cell, they always had coveralls, boots, gloves, etc., but they only wore a respirator when bagging equipment in or out of the hood, or when doing any activity where there was a potential for airborne particles. Most of the glovebox work did not require a respirator.

[1] Refer to SRDB 126387, "B-Plant/WESF FY 1984/1985 Operating Plan Update," and SRDB 126388, "Recovery and Encapsulation of Cesium and Strontium at Hanford 1967–1985."

They did have hot [contaminated] areas [at PUREX]; that is why they wore masks. When you have contamination, you know it and deal with it. Workers always had whites (coveralls) on. RadCon [Radiological Control] personnel always did routine smear surveys in Q cell, plus they had CAMs in Q cell and all routinely occupied areas.

RadCon personnel did routine dose rate surveys in M cell and the hot shop. M cell is stainless steel lined. There was a controlled access door into the hot shop and an opening from there to M cell. M cell is where stuff was decontaminated. In the real world, it took too long to decontaminate, and so sometimes they would just go in and change the gasket or whatever, if the dose rate was low. They always measured the dose rate before repairing anything. Workers would wear two pairs of coveralls and a mask. No exposed skin anywhere.

## INTERNAL AND EXTERNAL DOSIMETRY

*[The interviewees, collectively, provided characterization of internal and external dosimetry practices, as follows:]*

[Interviewees involved in fuel fabrication indicated] personnel whose external exposures went above a certain level went to monthly urinalyses. The higher dose people had monthly dosimeters. They had body and lung counts annually, along with standard urinalysis. If some people were exposed due to a glovebox failure or an incident, those people would go to weekly sampling and then afterwards go back to the usual routine.

Technical personnel and managers [in fuel fabrication] had monthly or quarterly urine samples. That was prompted by the fact that they worked with Pu oxide material. Managers were at a lower frequency. In the event there was a need for it, they could increase the frequency of sampling.

[Work on J cell package jumpers] was supposed to be done with radiological HPs [Health Physicists], but that took too long. To be honest, they just did the work anyway if an HP was not available. Workers performed their own monitoring. If you want to look at Np-related exposure, look at dose rates of [three specific individuals] for the 1984–1985 period.

An interviewee [involved in J cell jumper maintenance] did not have internal exposure and would know it if anyone else had. Internal exposure was a big deal. Everyone had to give a bioassay sample every 6 to 12 months. Whole body counts [were done] every year. And if you worked with certain radionuclides, there would be a lung count, too. Workers had lung counts if they worked with Pu. The interviewee thinks they had [lung counts] for the few people working with Np, but he can’t remember for sure. The bioassay was separate from the annual physical. The urine bioassay was already being done [at PUREX] in 1970. [An interviewee does not recall any] positive results from 1984 onwards.

[An interviewee involved in maintaining bioassay procedures at PFP was asked to discuss historic bioassay practices during the D&D time period at PFP.] Plutonium and americium are included in all monthly, annual, and termination bioassays; voluntary compliance rates are very high for termination bioassays at about 80%. One change in practice was to add Am-241 [americium-121] bioassays and to increase the sensitivity threshold for fecal sampling.

[When asked about whole body counter activities for personnel involved in Cs-137 encapsulation, an interviewee who was working at B Plant in 1983] did not recall a change in the method of counting from sitting to standing position. The interviewee stated that they would receive a letter from Pacific Northwest Laboratories when it was time for personnel to be counted, and they would send workers (and go themselves) to be counted. It was a routine thing.

## INCIDENTS

*[The interviewees, collectively, provided characterization of incidents and occurrences, as follows:]*

Glovebox failures occurred periodically [in fuel fabrication and assembly operations]. As an example, if the seal on a bag-out failed, there would be spread of contamination. Things happen; there were incidents more extreme than that. The workers handled plutonium, EU [enriched uranium], DU [depleted uranium] and MOX [Mixed Oxide]; mostly MOX.

There were instances of tiny glove breaches – usually the technician would know if he accidently poked something in the glove – and then someone helped him to remove his hands from the gloves. The tendency of the Pu powder was to go straight down. The normal method of cleanup was damp white cotton towels. The interviewee does not think the Np was in the same powdery form as the Pu they normally handled.

A log was made of unusual occurrence reports. They were provided to DOE. In the 1980s, this process of occurrence reports was very formal. [An interviewee estimated that] the transition to formal incident reports occurred around the early to mid-1970s. If they had a glovebox failure or bag-out seal failure that resulted in a contamination incident, all of that had to be documented. Exit interviews in 1995 or 1996 were conducted to try to figure out early incidents [that occurred] before the formal period. Clearly, there were incidents in the 1960s that were not very well documented.