Draft

MASTER INTERVIEW SUMMARY FOR THE SAVANNAH RIVER SITE CONSTRUCTION TRADES WORKERS SPECIAL EXPOSURE COHORT REVIEW

Contract No. 200-2009-28555
Revision 1

Prepared by

Kathryn Robertson-DeMers and Lynn Ayers

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

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

April 2012

S. Cohen & Associates: ***Technical Support for the Advisory Board on Radiation & Worker Health Review of NIOSH Dose Reconstruction Program***	Document No. Revised SRS Master Interview Summary
	Effective Date: Draft – April 04, 2012
	Revision No. 1 (Draft)
MASTER INTERVIEW SUMMARY FOR THE SAVANNAH RIVER SITE CONSTRUCTION TRADES WORKERS SPECIAL EXPOSURE COHORT REVIEW	Page 2 of 66
Task Manager: _________________________ Date: ___________ Arjun Makhijani	Supersedes: Rev. 0
Project Manager: _________________________ Date: ___________ John Stiver, MS, CHP	Reviewer: Arjun Makhijani

Record of Revisions

Revision Number	Effective Date	Description of Revision
0 (Draft)	01/14/2011	Initially issued as Attachment A of *Incident Records at Savannah River Site: Discussion of the Special Exposure Cohort Issue Number 12 Related to Incidents*, SC&A, January 14, 2011.
1 (Draft)	04/04/2012	Issued as a standalone document, with the addition of notes from interviews conducted in August and September 2010 and an Addendum documenting observations noted by the site in January 2012.

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

Advisory Board	Advisory Board on Radiation and Worker Health
atm	atmosphere
AVLIS	Atomic Vapor Laser Isotope Separation
BSRC	Bechtel Savannah River Company
BTC	Building Trades Council
CAM	Continuous Air Monitor
CDC	Centers for Disease Control and Prevention
cm^2	Centimeters squared
CNN	Cable News Network
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CPWR	Center for the Protection of Worker Rights
CTS	Central Transfer Station
CTW	Construction Trades Worker
D&D	Decontamination and Decommissioning
DOE	Department of Energy
DOL	Department of Labor
DWPF	Defense Waste Processing Facility
dpm	Disintegrations per minute
E&I	Electrical and Instrument
EEOICPA	Energy Employees Occupational Illness Compensation Program Act
EPD	Electronic Personal Dosimeter
ER	Evaluation Report
ES&H	Environmental Safety and Health
ETF	Effluent Treatment Facility
FOIA	Freedom of Information Act
HEPA	High Efficiency Particulate Air
HHS	Department of Health and Human Services
HP	Health Physicist or Health Physics
HPAREH	Health Physics Annual Radiation Exposure History
HSV	Hydride Storage Vessel
HT	Hydrogen-tritium

HTO	Tritiated Water
HTV	Hydride Transport Vessel
ICRP	International Commission on Radiation Protection
ITP	In-Tank Precipitation
KCP	Kansas City Plant
LaNiAl	Lanthanum-Nickel-Aluminum
LANL	Los Alamos National Laboratory
LLC	Limited Lifetime Component
LLNL	Lawrence Livermore National Laboratory
LLW	Low-level waste
LSC	Liquid Scintillation Counter
µ	micro/micron
µCi	microcurie
µCi/cc	microcurie per cubic centimeter
MOX	Mixed Oxide
mrem	millirem
MTF	Material Test Facility
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NNSA	National Nuclear Safety Administration
NRF	Naval Reactor Fuels
O&M	Operations and Maintenance
OBT	Organically Bound Tritium
OGM	Open Glovebox Maintenance
ORAUT	Oak Ridge Associated Universities Team
PAAA	Price Anderson Amendment Act
PAS	Personal Air Sampler
PCM	Personnel Contamination Monitor
PDRD	Plant Directed Research and Development
PdT	Palladium Tritide
PIC	Personal Ionization Chamber
PNNL	Pacific Northwest National Laboratory

PPE	Personal Protective Equipment
psi	Pounds per square inch
PTFE	Polytetrafluoroethylene
PuF_4	Plutonium tetrafluoride
QA	Quality Assurance
R	Roentgen
R&D	Research and Development
RadCon	Radiological Control
RBA	Radiation Buffer Area
RCO	Radiological Control Operations
RCT	Radiological Control Technician
RDZ	Radiation Danger Zone
rem	roentgen equivalent man
RMA	Radioactive Material Area
RMCU	Radiological Material Containment Unit
RSLS	Radiation Survey Log Sheet
RSO	Reservoir Surveillance Operations
RTF	Replacement Tritium Facility
RW	Radiation Worker
RWP	Radiation Work Permit
SAR	Safety Analysis Report
SC&A	S. Cohen and Associates (SC&A, Inc.)
SEC	Special Exposure Cohort
SEM	Scanning Electron Microscope
SLT	Stockpile Laboratory Test
SMT	Stable Metal Tritide
SNL	Sandia National Laboratory
SRNL	Savannah River National Laboratory
SRNS	Savannah River Nuclear Solutions, LLC
SRP	Savannah River Plant
SRS	Savannah River Site
STC	Special Tritium Compound

SWPF	Salt Waste Processing Facility
T_2	Tritium gas
T&T	Transportation and Traffic
TA	Technical Area
TAM	Tritium Air Monitor
TBD	Technical Basis Document
TCAP	Thermal Cycling Absorption Process
TCE	Trichloroethylene
TFG	Tritium Focus Group
TLD	Thermoluminescent Dosimeter
TORC	Tritium Operations Review Committee
TPBARS	Tritium-Producing Burnable Absorber Rods
TRU	Transuranic
WIPP	Waste Isolation Pilot Plant
WSMS	Westinghouse Safety Management Solutions

INTRODUCTION

As a technical support contractor supporting the Advisory Board on Radiation and Worker Health (Advisory Board), S. Cohen & Associates (SC&A) has been tasked with reviewing NIOSH's Evaluation Report on the Special Exposure Cohort (SEC) Petition for Savannah River Site (SRS) construction trades workers (CTWs). One component of SC&A's review is a series of interviews with site experts, including current and former site workers, petitioners, and worker representatives. The purpose of these interviews was to hear first-hand accounts of past radiological control and personnel monitoring practices, and to better understand how operations and safety programs were implemented at the site over time. In the case of SC&A's independent interviews, participants were identified through available site reports, public meeting transcripts, local advocates, and other interviewees. The interviews conducted in August/September 2010 were organized by the National Institute for Occupational Safety and Health (NIOSH) and the Oak Ridge Associated Universities Team (ORAUT); the participants were selected by NIOSH. This report summarizes the results of site expert-approved interviews.

SC&A personnel conducted several sets of interviews in conjunction with the CTW SEC petition evaluation report review.

- January 25, 2009 – Columbia, South Carolina [Kathryn Robertson-DeMers (SC&A)]

- January 26, 2009 – January 28, 2009, Augusta, Georgia, with one participant via phone (SC&A staff members Arjun Makhijani, Harry Pettengill, Kathryn Robertson-DeMers, and Abe Zeitoun)

- July 9, 2009 – Telephone Interview with a former worker (Kathryn Robertson-DeMers)

- August 18, 2009 – Savannah River Site (Kathryn Robertson-DeMers) – Classified

- August 31, 2010 – September 2, 2010, Savannah River Site, (Kathryn Robertson-DeMers and NIOSH staff members Brad Clawson, Phil Schofield, Tim Taulbee, and Mel Chew) – Classified

- September 9, 2010 – Telephone Interview with a former worker (SC&A staff members Kathryn Robertson-DeMers and Lynn Ayers)

Interviews conducted in January 2009 were attended by Brad Clawson. Interviews conducted in August/September 2010 were attended by Brad Clawson and Phil Schofield. A total of 42 site experts participated in these interviews.

The workers whose interviews are summarized below represent the time period from 1952 through the present (i.e., July 8, 2011). They collectively worked in the 100, 200, 300/700, and 400 Areas, TNX, and at the Savannah River National Laboratory (SRNL). Several individuals' responsibilities took them throughout the site. Interviewees participated in new construction, maintenance and repair, demolition, remodeling activities, production, and Research and Development (R&D). Some participants have assisted other workers with medical issues, claims, and/or petitions. The work categories collectively represented by the interviewees include the following:

- Administration
- Construction Engineering
- Construction Maintenance and Crafts (Electrical, Iron Work, Boilermaking, Pipefitting, Supervision, etc.)
- Crane Operations
- Decontamination and Process Operations
- Department of Energy (DOE) Oversight
- External Dosimetry
- Facility Evaluation Board
- Foreman/Supervisor
- Hydrogen Energy
- Hydrogen Processing
- Internal Dosimetry
- Laboratory Technical Support
- Materials Accountability
- Mechanical Systems
- Metal Hydride Technology
- Process Engineering
- Project Management
- Quality Control Inspection
- Quality Control Engineering
- Radiological Control Management
- Radiological Control (RadCon) Operations
- Radiological Training
- Research & Development
- Reservoir Surveillance
- Respiratory Protection
- Risk Analysis/Risk Assessment
- Rotovator Operations
- Separations Technology
- Solid Waste
- Tank Farm Operations
- Transportation
- Tritium Operations/Programs
- Tritium Processing
- Union Representation
- Weapons Technology

Workers were briefed on the background of the Energy Employee Occupational Illness and Compensation Program Act (EEOICPA) dose reconstruction and SEC programs, and the purpose of the interviews. For NIOSH/ORAUT-sponsored interviews, the introduction was presented by

NIOSH. For SC&A-led interviews, the workers were asked to supply names and contact information in case there were follow-up questions.

Onsite interviews were conducted in a secure location, with subsequent submittal of interview notes for classification review. Offsite interviewees were directed not to disclose classified information, and interviewees were reminded that all interview notes would be reviewed for classification. For classified interviews, interview summaries and interviewee-provided comments were submitted for an additional review by the SRS classification office. This interview summary does not reflect information redacted from interview notes by DOE.

Individuals interviewed were offered the opportunity to review their individual interview summaries for accuracy and completeness. This is an important safeguard against missing key issues or misinterpreting some vital piece of information. Approximately 20% of the participants did not respond to the request for review; the information obtained from non-responders has been withheld from this master summary.

The information provided by the workers and site experts is invaluable in helping SC&A to better understand the operations at SRS. This summary report is not a verbatim presentation of the material contained in the interview notes, nor is it a statement of SC&A findings or opinions—it is a consolidated summary of statements, opinions, observations, and comments that the interviewees communicated to SC&A. The sole intent of this summary is to communicate to the SRS Work Group, the Advisory Board, and other interested parties information acquired by SC&A during these interviews. ***Comments are included in brackets where SC&A has provided clarification on a statement.***

Information provided by the interviewees is based entirely on their personal experience at SRS. The site experts' recollections and statements may need to be further substantiated; however, they stand as critical operational feedback and reality reference checks. These interview summaries are provided in that context. Key issues raised by site experts are similarly reflected in our review discussions, either directly or indirectly. Interviews from all workers who reviewed and approved their individual interview summaries were consolidated into a single summary document. The information has been categorized into topical areas: Construction, Maintenance, and Construction Trades; Work Logistics; Worker Status; Site Operations; Tritium Operations at the Tritium Facilities; Tritium Research and Development; Tritium Focus Group; Radiological Control; External Monitoring; Internal Monitoring; Incidents and Accidents; Medical; Radiological and Medical Records; SEC Petition and EEOICPA Process Comments; Worker Outreach; CPWR Comments; SEC Evaluation Report Comments of Specific Passages; and Miscellaneous comments. Where conflicting observations and statements have been received, both perspectives have been retained in this summary report.

With the preceding qualifications in mind, this summary has contributed to SC&A's understanding of issues raised in the petition review report.

CONSTRUCTION, MAINTENANCE, AND CONSTRUCTION TRADES

[The interviewees involved with the construction and maintenance, collectively, provided a description of the maintenance structure at SRS, a description of job responsibilities of CTWs and DuPont Construction, areas of the site where jobs were performed, and examples of CTW tasks.]

[There were two maintenance organizations supporting SRS: in-house personnel employed by SRS and the CTWs.]

DuPont Construction hired carpenters, laborers, iron workers, and painters through the unions. Miller Dunn Electric, B.F. Shaw, J.A. Jones, M.K. Ferguson, and Norton Brothers were subcontractors to DuPont Construction. In more recent years, Bechtel Savannah River Company has brought in CTWs. When there were not enough in-house maintenance workers, they called in CTWs. SRS had in-house maintenance crews in every building who were primarily responsible for maintaining existing equipment. They did everything that could be done. CTWs filled in when they did not have enough people, or when heavy equipment was involved. If an in-house foreman could not get a maintenance crew, he would bring in CTWs to get the job done. A Construction Liaison served as a go-between. For example, say a foreman wanted to pull filters on Tank 33. The foreman would ask the Construction Liaison for resources. The Construction Liaison did the paperwork. Once he had the funds assigned, then he and the foreman worked together to get the job done, like changing the filter and taking [the old one] to the burial ground. There was a lot of overlap in job descriptions. For example, painters were available in-house and through the construction trades.

At SRS, the only union workers were the CTWs. The production workers were not part of a union at SRS and did not have a voice like a union did. DOE does not have anyone to oversee former workers' concerns.

When there was new construction, it was the responsibility of CTWs. When it came to new equipment or if bigger cranes were needed, then CTWs would be involved. Some of the big radiation jobs at SRS would be done by CTWs. New equipment does not mean clean. It could be highly radioactive work, unless they were building something new. They might be taking out a contaminated gang valve and installing a new one, or installing an automatic gang valve in place of a manual valve. CTWs were in radiological areas on a daily basis.

While those involved in production work were employed by SRS, no construction worker is hired full time. Construction workers go out with the belief that they will be there for a short period of time. Some people went to SRS and stayed out there for many years. Some went in and out like a swinging door. Some interviewees worked on specific projects for several months to a year or two. Most people have been laid off at some time. It was the luck of the draw, and if someone got into supervision, then that person would not get laid off. In lean times, supervisors might work with their hands and go back to supervision when there were more workers.

One interviewee worked at SRS for 2 years, then worked at another DOE site until the latter part of the following year. He came back and worked at SRS for 3 years. The interviewee worked on and off for a subcontractor for several years. A lot of individuals bounced between different DOE sites. Some have worked all over the place. It would be hard to give a percentage, but some move around, some do not.

There is a $2,500 floor for federal contracting rules to kick in. Under the Davis Bacon Act, the prevailing wages are set by the federal government. That is designed so that the Feds should not undercut local wages—so federal contractors should not bring in workers from low-wage areas and undercut the local workforce. It is to ensure that local contractors would pay fair wages. But contracts under $2,500 were exempt. So SRS operations would break it down into less than $2,500 jobs and give it to their maintenance crew. There are rules that make Davis Bacon applicable. If it is building up or tearing down, then it applies. If it is routine maintenance, it is not Davis Bacon.

There were about 8,000 people at SRS in 1982. There were a lot of people at SRS from 1983 to 1990, and then they started to have major layoffs and voluntary retirements. Construction trades experienced a peak employment period when they were working on DWPF [Defense Waste Processing Facility] and reworking the reactors at the same time. At that time, the electricians alone numbered over 1,000.

[CTWs interviewed described the work responsibilities of various crafts.]

- Iron Workers were part of the construction trades, working through the union. They worked with heavy metals—anything heavier than sheet metal would be handled by the Iron Workers. Iron Workers at SRS did mainly maintenance work. In the early 1990s, they would remove the lead shielding from in front of the cabinets (i.e., gloveboxes or fume hoods), modify the handles and whatever was supporting the shielding, and go back in to install the shielding, so operators could come back and use the gloveboxes. In the 100 Areas, Iron Workers were involved in installing and removing heat exchangers from the minus 20 (-20) level, butting out concrete, installing rebar and steel, welding, drilling holes, and so on. Iron Workers were also involved in constructing new buildings.

- Boilermakers were tradesmen who worked on heat exchangers and other metal components with water inside. In the 1980s, Boilermakers and Iron Workers worked together on removal, refurbishment, repair, and re-installation of reactor heat exchangers.

- Electricians did all sorts of jobs, like installing conduit, conduit supports, cables, terminations, installation of temporary lighting, instrumentation and motor change-outs, and electrical equipment. They worked in stainless steel hoods with glove ports in B-line, including dismantling and removing the gloveboxes. Supervision may be involved in going out and pre-scoping jobs, laying out work for the electricians, conducting walk downs, and safety inspections. In the early 1990s, electricians were working with the safeguards and security group at the reactors to install security alarms. They were redoing all the reactors at the time; one superintendent had about 100 electricians working the job.

- Heavy Equipment Operations operated cranes, elevators, and sometimes other equipment like forklifts. Crane operators commonly worked in radiologically controlled areas, including tank farms, separations, and tritium areas. Cranes were used in various areas, including the separations area and the S Area. They worked in the F Area, working the elevator inside the separations buildings. They ran overhead cranes in the S Area. They were responsible for running overhead cranes. Crane operators used 1400s, Grove Cranes, and Cherry Pickers. A Class A crane operator can run all sizes and types of cranes. An operator test was required to qualify for Class A. There was also equipment in the Naval Reactor Fuels (NRF) building. This was a mockup building where they did the jumpers. There was also work with stainless steel and welding.

- A Quality Control Inspector did quality assurance/quality control inspections of electrical construction and equipment. An inspector went everywhere the electricians went.

A job steward had responsibility for a particular craft's workers across the whole site. One job steward had as many as 1,100 electricians at SRS at one time. A steward covered the whole site. If a person needed to talk to the job steward, he had to go to them. A job steward was in every area, sometimes 8 or 10 times a day. He was in the Central Shops area a fair amount, because construction workers were based there. He went out from there as needed. The job steward was "a priest one day and a devil the next." Sometimes he could go and take care of a personal problem workers may have with families, and other times he was trying to prevent someone from being fired. The job steward defends the contract. Sometimes workers are at fault or the management is at fault, so someone is going to be mad at him every time.

Laborers were one of the craft unions. There are also production laborers, but there is no occupational classification for that. There are only construction laborers at SRS [as a job classification]. This is specific to SRS; it may be different at other sites.

[Examples of locations where CTWs were involved in work included:]

- Burial Grounds
- Central Shops
- Reactor buildings (C, L, K, P, R)
- F and H Canyons
- F Tank Farms
- H Tank Farms
- Tritium facilities in H Area
- Mock-up facility (~1980)
- Defense Waste Processing Facility (DWPF)
- Naval Reactor Fuels
- M-Area Waste Plant
- Maintenance shops

[Interviewees provided many examples of the specific job activities CTWs were involved in at SRS.]

- Painting every pipe in the Tank Farms.

- Electricians installed temporary lighting, including in the huts [at F Tank Farms]. They had explosion-proof lights that they put down in certain areas around the tanks. Sometimes lighting was put inside the tanks for inspection purposes.

- Electricians worked on tank tops and changed out instrumentation and motors. They had to take out conduits sometimes.

- Crews would have to work during an outage to do things before a reactor could be started up. They worked at the -20 and -40 levels in the 105 buildings, where pumps and other equipment are located.

- In the 1980s, Iron Workers and Boilermakers removed heat exchangers from the 100 Areas, refurbished and repaired them at the Central Shops, and returned to re-install them in the reactor buildings.

- CTWs worked on the huge HEPA [High Efficiency Particulate Air] filter pots (i.e., teapots) at the tank farms. They were building the structure that went out on the tank so they could start emptying the tanks.

- Crane operators ran cherry pickers up at H Area and F Area tank farms up on the Hill. During one job, they had to move lead shielding. They ran the crane, set jumpers, worked down in the cells, moved the covers off the cells, and worked with the diversion boxes. This was like a pumping station for high-level waste. Diversion boxes were in the tank farm and a crane would come in and lift the covers off. They would run a camera remotely from inside the crane.

- In March 1997 through November 1997, wiremen in the M Area were involved in building a melter for low-level waste (LLW) to put it in a glass medallion about the size of a half dollar.

- In the 200 F Area, electricians were tearing down conduit and removing asbestos. The workers would drill holes in asbestos-containing transite and put conduit through the holes. It was a demolition activity. The workers received training to remove the asbestos.

- During the Waste Remediation Program, drums from the B-line were opened in gloveboxes, the trash was sorted, and the drums were repackaged.

- CTWs did some large equipment removal in the older tritium facilities. They would also assist in the construction of containments (i.e., building huts) and the moving of large material.

Workers entered normally unoccupied areas. For example, workers would go inside tanks in the F Areas. In areas where they moved the slurry pumps, the tank top would be open. Electricians were up in the ceilings or moving around equipment where there was residue material everywhere.

CTW Involvement with Tritium Operations

There have been jobs that CTWs have been leery of. For example, they did a job down in the evaporator. There were unknowns, but there were controls. They don't always like what they have to do.

CTWs may work in areas where they were adjacent to radiological areas. There can be a barrier breach on occasion. The objective is that CTWs are treated equivalent to operations.

At the tritium facilities, in general, the construction group followed instructions from RadCon technicians better than any other set of workers. They tend to ask a lot of questions. A lot of the in-house maintenance guys have to have their hands held.

There is a dedicated maintenance crew for the tritium facility.

The CTWs handle contaminated material on occasion.

WORK LOGISTICS

[The interviewees, collectively, provided a description of how jobs at SRS were completed with SRS staff and CTWs working side by side.]

Some site experts indicated that CTWs don't work side by side with the operations personnel. CTWs have their work to do and operations personnel have their work to do. CTWs and operations may be in the same room, but not working on the same job. In the tritium facility, they worked more closely.

In contrast, other site experts said CTWs worked side by side with site operations personnel on the same jobs. Typically, there was a mix of in-house and CTW personnel. For example, sometimes they had to pull out a heat exchanger weighing a hundred tons. There was a feed pump job on Tank 13 in H Area. The pump was about 20 ft long and 3 ft in diameter, and it sent high-level waste to the evaporator. It could be a rigger crane that pulled the pump, or CTWs could do it. There was a spill. Workers had to dig up the pavement around the tanks, with CTWs and operations working side by side. At other times, riggers were handling fuel rods that would be blue under the water. Everyone was being exposed. On a shutdown in B-line, there would be 100 pipefitters (construction workers) and 15 operators building huts and doing standby (assistance) for Construction. Site operators got to know the construction workers pretty well, because they worked as a team.

Production workers in a given area stayed there. But this was not the case with maintenance workers, who went everywhere. There were mobile maintenance crews (e.g., painters) on the SRS site that would go to any area as needed. In the 100 Area, there was an operations crane crew. When any reactor went down, the crew went there to provide services. There were also CTWs working there at the same time.

Maintenance [in-house and CTWs] worked site wide out of the Central Shops in the early 1970s. Workers from the Central Maintenance Shops were assigned to various areas. They retrieved equipment from the field and brought it back to the Central Shops. They went to a lot of the areas to retrieve equipment, such as welding machines. CTWs worked in the same area while production was going on. A lot of times, the operations people did not have the skills to do their jobs. As a result, CTWs would be straightening out their mess.

DuPont Construction also employed non-construction workers (e.g., administrative and payroll staff), whose job responsibilities took the workers all over the site, including entering radiological areas. Individuals based out of the SRNL went from one area to another to do inventories of nuclear material. At least two workers were present when they went out to do these inventories.

WORKER STATUS

[The interviewees representing the CTWs, collectively, provided a description of the attitude toward CTWs at SRS.]

Interviewees indicated that the CTWs were treated as second-class citizens and that CTWs were called in particularly when they had nasty work to be done. This included some low-cost jobs normally done by in-house personnel. Even in recent years, interviewees reported not being treated the same as Bechtel workers. In fact, in places that were very hot, CTWs were often sent there because operations people did not want to go. If the in-house foreman had two jobs to be done, he would give the nastier job to the CTWs. These jobs were not just radiation work, but included working in suits, at high or low temperatures, or working at heights. They did not call the union hall just to get people to do the dirty work, but they used CTWs already on the site. They would use them for the nasty job and send them back to the same place they were before. Construction workers were eager, because they needed the work and wanted to get paid. Whatever CTWs needed to do, they did it when the supervisor asked them to. The production side was cherry-picking the work. Production workers got their share of nasty jobs, but they gave a lot away to CTWs. Production workers were also asked to help CTWs on overtime jobs.

[Interviewees gave examples of how construction workers were treated.] Production workers had their own kitchens, microwaves, luxuries of life, and cookouts. Construction workers—if they did not take their own food, they did not eat. Construction workers were not even allowed to have hot lunches. Production workers had showers and lockers. Construction workers were not allowed to use those; they had to take the muck home. They could not use bathrooms, but had to use porta-potties. They were always in the farthest parking lots. They would have to step aside for operations people to check in, and that would often make CTWs late. These details may seem irrelevant, but job stewards got pulled into many battles over such matters. An interviewee once got locked into the H Area tank farm and waited out the day (and into the night) in a shack.

In the 1980s and 1990s, there was no difference in treatment of minorities. There was a hierarchy in work assignments in the early years. This is the South. Older black gentlemen were put where they should not have been. For example, a maintenance supervisor assigned some uneducated black gentlemen (a plant painting crew) to paint a contaminated gang valve corridor in F Canyon. They wanted to decon it so the Plant Manager could walk there in his street clothes. The workers chipped, chiseled, and filed anything contaminated. They rolled the whole gang valve corridor, everywhere they thought the Plant Manager would be going.

There were no minorities in the locals until the 1970s, and then they were let in. So there was no discrimination from that point on. Prior to that, the only crafts that had minorities were the laborers and bricklayers. The CTW union made a special effort not to let discrimination happen, once minorities were in the union.

SITE OPERATIONS

[The interviewees directly employed by SRS in operations and supervision, collectively, provided a description of site activities they were involved with, and the interaction they had with, the CTWs.]

[SRS has two separations facilities.] The HB-line produced Pu-238 for the space program. The FB-line produced material for weapons. The materials looked different. Loading of fuel in the canyon was under water. They would put the fuel in the canyon and dissolve it in the dissolver. Other activities at the B-lines included pulling samples. The needle on the sample holder punctured a diaphragm, and the product would go into the "peanut." A lot of the times, the sample would not pull if there was a pig in there. Workers had to open the air valve and get it to pull enough vacuum—that was called milking it. This was an unmentioned habit. It was a "no no," because a worker's hand was exposed to the needles with the waste in them. If workers said they were milking a sample, they would be fired. It had to be done, but they did not say so.

There were a variety of jobs and skill levels within Operations; workers might get in at a low-paying position and advance from there. One low-paying job was Laundry Truck Helper; these workers went to every area of the plant, loading laundry bags on and off the truck.

Riggers were usually DuPont workers, but they were mobile. They were a part of the Transportation and Traffic (T&T) group. DuPont Riggers were treated similarly to the CTWs; they worked the whole plant. They would haul B-25 boxes (metal boxes introduced in 1983 to start cleaning up the plant) to fill with nuclear waste. These boxes were around 4 ft by 6 ft by 4 ft deep. The workers would fill the boxes, stake down the metal lids, put radiation stickers on it after HP [Health Physics] had surveyed it, and then send the box to the burial ground.

Operations workers at the tank farms included Control Room Operators and Field Operators. These were decent money jobs. Workers in the canyon loaded fuel in the canyon and dissolved it in the dissolver. In F Canyon, Decon and Process Operators could get radiation overtime or process overtime. They had to get process-qualified in order to work process overtime. When overtime lists came around, a lot of employees refused radiation overtime, like decon work in the gang valve.

[At the tank farms] in the late 1980s and early 1990s, there was probably a 50% mix of production and construction workers. Construction was cleaning out the 20-series of tanks (i.e., Tanks 25 and 29) and cleaning out Tank 17 down in the hole. Production was digging up lines and running new lines. Operations did line breaks. Construction would put up its own tents. Construction would not break a line. They would build the hut, but operations would break the line. That could lead to incidents inside the hut. Most foremen who were supervisors did the line break. Usually they had maintenance men as well. The production foremen would drill into the line, but the CTWs may be on the line.

Once a month, the supervisor received a tickler to do a required work procedure. These were work procedures that must be routinely done by a specified period. For example, the tickler would say to inspect 40-series tanks, to take delta P readings, or to take a dip sample.

Dip samples at the tank farms were taken from an 8-in opening in the riser. The proper way to do it is to build a hut around the area and lay plastic down on the floor, and the operator would manually lift the port. The operator would take a rope with a valve and pull the dip sample out of the opening. The workers pulled two dip samples from every tank, and then they would walk from one tank to another. It was very physical work, and workers were saturated with sweat in their protective clothing.

SRS did a mock-up of DWPF within a million-gallon tank. There was a new heel evaporator control room. The system was designed to process salt. The design was a tank within a tank. As it would process, the waste would go through the filters in 680-gallon tanks. Workers would fill them with light stuff. They would fill the tanks, and the rest went back to the bottom of the tank. Then they had to pull dip samples as part of the job. They pulled 1-liter samples out of this tank. Workers involved had low radiation [to date] and were good at working at the tanks. There were 12 or 20 inches of stuff at the bottom of the tanks, and the dip samples were very hot—as hot as it gets. One person held the sample and another cut the string.

The ITP (In-Tank Precipitation) facility at the Tank Farms is where all of the really hot waste from the canyons and B-lines and the processing system in the plant is pumped into the million-gallon tanks. The material includes a mixture of all radionuclides and all chemical elements that come from the site. It's the garbage disposal of the liquid waste. It is hotter than probably anywhere but DWPF. In the ITP facility, they evaporate the liquid off the sludge to concentrate it, and then they ship it over to DWPF to have glass made. Some of the tanks are very concentrated, with really high radiation and contamination levels. The tanks have slurry pumps, which are mixers to keep the material consistent throughout the tank. When they turn these off, the heaviest material settles to the bottom of the tank and is referred to as sludge. As it settles to the bottom, the liquid rises to the top, so there is a separation of levels. A measurement is taken of the sludge at the bottom of the tank using a several hundred foot measuring tape. To make the measurement, the riser plug (a concrete plug like a manhole cover) is removed. This exposes the tank. Operators take the measuring tape and bounce the tape, which has a bobbin, on the bottom until it goes slack and gives them a reading of how far down the sludge is. This allows SRS to determine how much sludge and how much liquid are in the tank. There is a negative pressure on the tanks, which is supposed to move air from the outside of the tank into the tank.

Shipment of nuclear material included natural and enriched uranium. There were a couple of plutonium shipments from the 300 Area. Tritium inventories maintained for the Manufacturing Building included the material, the quantity, and where the shipment was going. WIPP [Waste Isolation Pilot Plant] refused to accept some waste from SRS, because it had too much TRU [transuranic].

TRITIUM OPERATIONS AT THE TRITIUM FACILITIES

[The interviewees directly involved in tritium operations and research, collectively, provided a description of site activities at the tritium facilities, particularly work with metal hydrides.]

Building 232F housed the original tritium facility. The purpose of this facility was to extract tritium from reactor targets. Other tritium facilities include:

- Old Extraction Facility used for separations, extraction and purification (232H)
- Replacement Tritium Facility (RTF) or New Reservoir Facility (233H)
- Old Reservoir Facility or Reservoir Processing (234H)
- Small Hot Shop and inert work and characterization (238H)
- Helium Bottling (236H)
- Tritium Enrichment Facility (264H)

Tritium Bed Change-Out

The beds were installed in 1993, and the first beds were changed 10 years later. As the He-3 grows in, it degrades the material in the bed, requiring a change-out. There are a total of four recovery beds, two feed beds, and two product beds (each with three vessels). SRS has taken out a total of 12 canisters over time. Six were completed within the last 2 years.

The hydride material is designed so that the particulates stay in the bed and are not dispersible. The bed is made of stainless steel and is approximately 4 ft long. It is a pipe-within-a-pipe design, with a 4-in outer pipe and a 3-in inner pipe. There is a flanged connector. There are Mott filters (i.e., 5 micron sintered metal filters) incorporated into the design of the tritium beds. The beds contain seven smaller filters, rather than one large filter, to increase flow across the filter. These filters remain in place during the change, so the hydride material is always contained within the bed. There should be no potential for exposure to tritides during this job.

The presence of HTO [tritiated water] is a concern during this process. Prior to changing a bed, workers heat up the beds to bake out the tritium. They run deuterium through the bed to isotopically exchange the tritium. Regardless, there is a heel left on the bed. Workers do nitrogen flushes, backfill the line with nitrogen, and lock out the line.

To remove the beds, the entire room is turned into a hut with an airlock. A flow inside the hut is established. The Carpenters are responsible for building the hut, with assistance from the Laborers. RadCon certified the huts. Ventilation is run 24-hours before the glovebox panels are taken off.

The workers participated in a pre-job briefing and a plan of the day every day. All the individuals involved in the process are put in air supplied plastic suits because of the tritium off-gassing, regardless of the presence of STCs [Special Tritium Compounds]. Interviewees participating in hands-on operations recall wearing a personal air sampler (PAS) placed under the plastic suit for some jobs. These workers only wear a PAS if it is required by the Radiation Work Permit (RWP) and it is mentioned in the pre-job briefing.

For a bed change, the Cajon (now known by the name Swagelok VCR®) connector is loosened. Maintenance breaks the flange (i.e., line to the bed) and steps back to make sure they do not have a release of tritium. The bed connections are capped off. Capping of the vessel is done by the Plumbers and Steamfitters or the Boilermakers. Workers place the bed in a plastic bag or sleeve. These beds are usually off-gassing. The metal is completely saturated in the process, so it off-gasses once it is exposed to the air. If there is not enough room in the glovebox, the lines are taped up initially and capped after the bed is moved. All of this is performed with the glovebox under normal glovebox confinement. The line break and recapping of the system is completed within 1 hour and is also performed prior to the glass panels being removed from the glovebox.

To remove the bed, the glass panels on the glovebox are removed. This open glovebox work requires a shutdown of the processing in that particular glovebox. Under Open Glovebox Maintenance (OGM) conditions, there is a hut around the open glovebox windows, and workers are in air suits. Maintenance is performed to open a hole in the glovebox for removal of the bed. Workers cut off 2–4 gloves. The glass panels of the glovebox are removed and replaced with temporary aluminum panels to optimize the airflow velocity at the work location. There is an ion chamber in the glovebox that monitors the glovebox atmosphere until glass panels are removed, when it is taken out of service.

CTWs are responsible for handling larger items and are responsible for removal of the beds. Painters remove the glass from the gloveboxes. Ironworkers remove any metal. Electricians/Insulators are responsible for removing insulation and transducers. The Boilermaker is responsible for moving the bed, because it is considered a vessel.

Two lift and loads are located up top. There are only a few inches available to get the bed out of the glovebox. The bed weighs about 600–700 pounds. Workers use a hand crank to bring the bed out. The bed is wrapped in B-bags one time then placed in a saddle. The Boilermaker wraps the bed in a clean bag after it is removed to the air lock. The RCOs [Radiological Control Operations workers] take smears on the bag. If the bag is hot, the bed is bagged and taped again. It can take up to 10 to 12 layers of plastic to contain the tritium gas.

Installing the bed works in the reverse. The new beds are staged in the hut. Workers pick up the new bed and put it back in the bed location. They have to be careful not to bump into a line because of the sensitivity of the equipment. Pipefitters/Boilermakers bolt up the new bed. After the beds are changed out, there may be some piping work remaining.

It took about a week to change out three beds. It is much slower work with all the PPE a worker has to wear. Wearing the plastic suit tires you out.

Tritium is controlled through ventilation (building and glovebox), which pulls the tritium away from the worker. The principal concern is HTO, but HT or T_2 [hydrogen-tritium or tritium gas] can be present. When the beds are removed, there are Kanne chambers running. A filter on the Kanne chamber keeps particulates out of the chamber. RadCon can monitor the room air concentration from outside the room. If there is a problem, the workers are asked to leave the room. Some interviewees reported there were a couple of times when they were asked to leave the room.

The area is decontaminated down to less than 1,000 dpm. Laborers are responsible for the decontamination, clean-up after insulation removal, and clean-up of plastic suits. Personnel stay in the prescribed PPE until the area is cleaned up.

After an STC job, smears are conducted around the hut area with Whatman smears and counted in a Liquid Scintillation Counter (LSC). Any contamination is minimal compared to the off-gassing of the tritium. The swipe data are available by building. The buildings of interest would be 234-H, 233-H, TEF, 264H and 232-H.

All of the CTW interviewees recall collecting bioassay samples during the bed change-out. Bioassays were taken 90 minutes after exit from the area and were submitted each shift. These workers recall RCO telling them the bioassays for the bed change-out were okay.

Weapons Program Operations

Reservoirs were designed at other DOE sites. Reservoirs are considered robust containers. They must verify that tritium reservoirs are empty once the tritium has been removed. This provides protection against a tritium incident.

The Metal Tritides System was controlled for temperature and pressure. The optimal temperature might be -20^{o}C to 150 ^{o}C. The pressure at the original plant was at 2 atm, and work there was exclusively at room temperature. A low pressure was needed to prevent leaking, which would lead to HTO formation. Zeolite absorbers were used to trap tritiated water.

The tritium facility is under high pressure from the military to make reservoir shipments on time. A reservoir is received at SRS for loading/reloading. In the Gas Transfer System, the gas is removed out, purified to recover the tritium, and reused. The process of handling reservoirs is protective. For example, workers are required to wear gloves when they handle a reservoir to protect the unit from the oil on the hands. In some cases, exotic tritides are used as neutron generators. The limited lifetime component (LLC) is sent to Pantex. Returns are shipped to SRS from Pantex or from the military.

After a certain number of reclamations, the container is discarded. Welding is done on reservoirs in a [fume] hood with doors. The reservoirs are transported in 5-gallon buckets.

SRS is/was involved in Reservoir or Gas Transfer Surveillance. Reservoirs are/were stored under ambient conditions established by the design authority [e.g., Los Alamos National Laboratory (LANL) or Sandia National Laboratory (SNL)]. Production line samples are taken to determine load and function. Other tests on reservoirs have been performed, such as 10-ft drop tests.

The Weapons Technology is responsible for the development of methodology for loading/ unloading and testing of new designs, and for generating surveillance reports to design agencies. The Materials Test Facility (an SRNL organization within the Tritium Facility, MTF) is involved with destructive analysis of reservoirs in 234-7H as a part of Weapons Surveillance and the reservoir Life Storage Program.

In 2002, a new Metallurgical Laboratory (part of 234-7H, Met Lab) was put in. The Met Lab consists of a series of air hoods for sample preparation and stereo-microscopes and metallographs for examining the reservoir samples. In addition, there is a scanning electron microscope for more extensive analysis.

Reservoirs to be tested are either burst tested (a stem is brazed on and then pressurized with water to failure) in another building or have a metallurgical exam to look at all of the welds, heat affected zones, and parent metal. A burst reservoir is measured at the point of failure to determine the thinnest wall section and the thin wall section removed for examination in the scanning electron microscope. Reservoirs undergoing metallurgical exam are not burst tested, but have metal samples removed for examination.

The process of sample preparation [for metallurgical examination] involves cutting up the stainless steel reservoir using saws. This is done through glove ports with the hood windows closed. A band saw may be used for initial cuts on large reservoirs for initial size reduction, then the water-cooled enclosed abrasive saws are used for the final cuts. After the final cuts are made, samples are stored in open vials (pill bottles) for identification and to allow the metal to off-gas tritium. The samples are later mounted in plastic using standard Met Lab practices (hot mount press or cold mounted in epoxy). The samples are then ground and polished on polisher/grinder equipment through open hood windows, either by hand or using machine holders. This operation is water cooled as well. Anti-contamination gloves and personal protective equipment (PPE) are worn for this evaluation. After polishing, the samples are etched using nitric or oxalic acid to reveal the grain boundaries of the sample.

After etching, the samples are checked by RadCon to verify they are not off-gassing tritium before they are removed from the hood, and then examined on the stereo-microscopes and metallographs for image capture.

Burst samples are not ground, polished or etched, but may be mounted. After imaging, the samples may have autoradiography performed. This involves manually applying a photographic emulsion on the cross-section of the sample and waiting to allow the beta-decay from diffused tritium to expose the emulsion. The emulsion is then developed like a photograph to reveal the depth of penetration of tritium permeation.

Samples are held for 6 months after the issuance of the surveillance report. When there is a can full of samples, they campaign out the can and ship it off as waste.

There are a total of 3–5 individuals working in the Metallurgical Laboratory at any one time on the destructive testing. Testing is done during the day shift. RadCon is present with a sniffer when anything is pulled from a glovebox. They also perform routine rounds in the area. Radiation exposure issues are very low. At the upper end, ~10–15 Curies could be driven off the stainless steel containers as they are cut up. This is during the cutting operations performed in an air hood through gloves. If the hood tritium monitor alarms, hands are removed from the gloves until it clears.

The Stockpile Laboratory Tests (SLTs) involve reservoirs from fielded weapons returned to the plants for testing. SRS typically tests 2 to 4 reservoir systems from each of the 8 weapons system types each year. When the Mound Plant closed, SRS picked up stockpile laboratory testing from Mound.

Prior to loading reservoirs for the military, the Life Storage area stores loaded reservoirs to look for age-related failures, identifying them before they happen in the field. Both SLT units and Life Storage units are examined as described above.

Building 238 is where the reservoirs go after examination for storage and staging for disposal in a B-12 waste container.

[Note: There was some classified discussion of reservoir design that is not included here.]

TRITIUM RESEARCH AND DEVELOPMENT

[The interviewees directly involved with tritium R&D, collectively, described research activities involving metal hydrides.]

SRNL conducted numerous studies associated with metal hydrides. These studies included the investigation of the Thermal Cycling Absorption Process (TCAP) using Palladium metal hydrides for hydrogen isotopes separation, metal hydride for storage, pumping and compressing of tritium. Research into the metal hydride process investigated hydrogen isotherms (i.e., pressure as a function of temperature) for the process. The Metal Hydride Technology group designed beds and set up test rigs. They were involved in setting up systems for testing solid storage reservoirs and defining the process testing requirements. Metals chosen for experimentation had little data.

In the development work, SRS really did not consider the metal tritides an issue, because of the containment and filters installed in the vessels. In addition, during the early R&D period, researchers did not know if it would work. At the Advanced Hydride Laboratory, the staff put all the systems together and tested it as a system. The pilot project, lasting for a couple of years, operated with protium and deuterium, not with metal tritides. SRNL had a hood to work with the palladium beds/compressor beds, mostly because of the potential for hydrogen release.

Although the R&D had to be done, the goal was to work with the material in the production setting. Operations/production needed to actually be able to use the material. A team was put together to develop a new process. There was benchtop testing followed by full-scale prototype testing. The process SNRL developed was implemented in the field by the Tritium Processing group, which was responsible for taking the tritium process from the bench scale to the process scale.

Research into the metal hydride process involved the development of hydride technology, getters (i.e., zirconium-based alloys), and the cold development testing (non-tritium).

- Titanium was evaluated for storage. They analyzed particle sizes or cycled hydride to determine the required filter size. The filters had to be designed so that the titanium would not get into the process piping. Metal hydrides can store tritium at low pressure and near ambient temperature. SRS has also worked with Lanthanum-Nickel-Aluminum (LaNiAl), titanium, and getters.

- The getter beds are part of the stripper system. The getters react with oxygen to keep the oxygen down. They are used to remove impurities and crack tritiated methane, tritiated ammonia, and tritiated water from the tritium process.

- For the tritium exchange stripping system, SRNL designed an apparatus and tested it with protium and deuterium. Then the research moved to the tritium lab at the tritium facilities when using tritium. Tests were conducted on stripper systems in a glovebox. The worked involved testing of palladium coated on a zeolite material and a zirconium-iron alloy. They circulated the tritium through the getters to collect the tritium. The Pd on zeolite was dried in an air hood before use. The material was bagged and passed out of the hood and into the glovebox. The tritium was introduced into the glovebox for the test and the bed was passed out of the glovebox after the test. In the pass chamber, the material was bagged. They had to pump down the pass chamber to reduce off-gassing from the bagged material before it was released from the glovebox. Health Physics papered the floor and provided coverage during the job. The fines were controlled by the filters installed or part of the bed design. There were two individuals involved with this work.

Storage beds were linked together and hydrogen gas was transferred between the beds by heating and cooling. Personnel cycled the temperatures 1,000 times and opened the lines to see if any metal hydride powder had gotten out of the beds. The results showed none.

Research and Development studies involving hydrogen storage or metal hydrides at SRNL were limited to protium and deuterium. Storage beds are activated using deuterium and protium. There was no exposure to metal tritides in the 773A Building. The SRNL did not have a safety basis document to handle tritium in this capacity.

The Material Technology group conducted the metal hydride work involving tritium at the tritium facilities in the MTF. There are several laboratories in one of the wings of this building for conducting tritium experiments. In this area, the beds are loaded up with tritium.

The analysis of gas samples from hydride beds is conducted in a laboratory in the tritium facilities. It requires a hot mass spectroscopy unit.

The filter of the process hydride beds prevents the powder from exiting the bed. Any particles in the filters are flushed back into the bed when the tritium is put into the bed. Researchers have to prove to users that the particles will not get out of the bed. There is/was no potential for exposure. Also, researchers have to demonstrate to the plant that the metal hydrides will not plug the filters. They limit the linear flow rate to prevent the filters from being plugged. The filters use a porous media grade 5 and a specified surface area to get the appropriate limit linear flow rate.

Whenever a new material is evaluated, researchers look at the particle size. The metals are 300 micron with some dust. Personnel handled some powders in very small amounts (i.e., gram quantities) in ventilated hoods with a dust mask. After numerous cycles of absorption and desorption reactions, the metal hydride will break down into smaller particle sizes (1 µ the smallest, 5 to 10 µ size generally). The particle size and the maximum linear flow rate of a particular system are the basis of filters designed for use in the bed system. From early on, personnel are careful to confine these powders (fines).

Researchers seldom opened the beds and take the metal hydride powder out. The materials are put into the bed and it is sealed off. The material is then hydrided. One site expert indicated the chance for exposure to hydrides was zero. Staff would remove samples for analysis after the bed was hydrided with protium or deuterium. As a part of R&D work, they pulled material out of a storage bed to do some characterization work. There was no micro-structure work. Gas transfer vessels were used to test the fracture toughness, etc.

Zirconium and Zirconium Compounds

In April or May 2010, SRNL did a job involving some zirconium samples. Personnel received zirconium tritide samples for metallographic testing on the material. They drafted a job-specific procedure. SRNL Radiological Control Operations (RCO), Safety, and Industrial Hygiene personnel did a job hazard analysis, and RCO developed a job-specific RWP. Prior to the work, a mock-up was completed, and there were pre-job briefings.

The work was going to be done in one hood. This hood was used every day for stainless steel work. The work areas (air hoods) were decontaminated down to <1,000 dpm before and after the job. The workers wore yellow laboratory coats and gloves, primarily because of the hydrofluoric acid. Workers wore laboratory coats and Radiological Material Containment Unit (RMCU) plastic shoulder-length sleeves for this job. The job lasted about 2–4 days. In addition to the PPE, the workers wore a PAS and submitted bioassay samples.

Three zirconium tritide samples (20 grams) and 13 zirconium hydride samples were received. The sample containers or test cells were first opened in a glove bag located inside a glovebox for initial visual inspection. Then they were removed from the glove bag and glovebox and transported to laboratory hoods, where the remainder of the analysis work was performed. One hydride sample was degraded, so staff had to revise the RWP to accommodate this. After the containers were opened initially, they were transferred to a laboratory hood.

The workers did the grinding to smooth out the sample for evaluation on the scanning electron microscope (SEM). The samples were sniffed to see if they were off-gassing. They looked at the samples on the SEM. Following the evaluation, the zirconium samples were discarded as waste. The hood was decontaminated to less than 1,000 dpm. The worker's personal air samples were sent to the B-area for further analysis at the Health Physics Central Counting Facility.

During the work, the hoods were wiped down on a daily basis. The individuals involved submitted daily bioassay samples upon conclusion of the work and 1 follow-up bioassay 3 weeks after the work. There were no positive bioassay samples. The smear samples taken from the evolution are available in the Visual Survey Data System.

Palladium and Palladium Compounds

Palladium tritide research was done on thermodynamics and the isotope separation process with the Palladium tritide system. It was used in isotope separation and vacuum work. To cut down on emissions, the system was put into a glovebox. Hundreds of pounds are used. Palladium/ Rhodium tritide is also used in tritide research.

The palladium on Kieselguhr was developed for the separation process. Kieselguhr is plated with palladium, and the palladium serves as the getter for tritium. This material would allow the H-3 to be trapped and let the He-3 flow through. Kieselguhr does not break down, and it keeps the palladium intact. Respirators were used when we loaded the palladium/Kieselguhr.

There was an experiment where researchers wanted to get a sample of palladium for modeling of He-3 bubbles. The material was 8–9 years old. The Palladium Tritide (PdT) sample was taken out of one vessel and put into a new vessel. In order to do this work, calculations based on the Brodsky number were completed. For inhalation considerations, a worker working for a year would be potentially exposed at 10^{-6} of the material processed through the facility. There was a known amount of tritium. Staff was working for 9 hours with 1 gram of material. For a worker, the dose would be ~1 mrem total dose. The calculation used the dose conversion factor for hafnium, which is considered the most insoluble form of tritide. The transfer of the tritide from one vessel to another was done in a glove bag in a glovebox. There was no possibility of contact between the metal tritide powder and the technician. The sample was transported to Argonne in a can.

Lanthanum Nickel Aluminum

Lanthanum-Nickel-Aluminum (LaNiAl) was developed for storage of H-3. The tritium processing group was looking at accountability issues. They developed a technique using a calorimeter to determine how much hydrogen was left behind in the bed. The initial LaNiAl was a coarse powder, but later became a fine powder after cycling. As you load hydrogen on the LaNiAl, the particle size decreases to a point where it is stabilized. The beds were not reused. All of the development work in my group was with protium and deuterium and not with tritium.

LaNiAl tritide was a workhorse in the tritium facilities at the SRS. There are various amounts of aluminum in these materials. SRS staff adjusted the aluminum content in the mixture to affect the pressure as needed. They fabricated the three different materials at different pressures. It was easier to maintain a temperature range constant. Other than titanium tritide, palladium tritide was probably the most studied tritide. Hundreds of pounds of LaNiAl tritide are used in tritium storage beds. Storage options for tritium include uranium beds for HT, and palladium hydride. LaNiAl was used as a storage material or for pressure work. SRS is trying to eliminate the use of depleted uranium tritide to eliminate mixed-waste issues. LaNiAl does not have this disadvantage.

Building 233H operations are based on a temperature range of 50^{o}C to 500^{o}C to generate all pressures. If you change the amount of aluminum in the storage material LaNiAl, you can affect the vapor pressures. You can adjust the amount of aluminum by replacing nickel with aluminum. The metal hydride storage and process beds reduced the releases of tritium to the environment. Prior to this, the tritium went out the stack. [See Addendum for comment.]

There was some testing of beds after aging (tritium exposure). Researchers used 1-kilogram size beds. At one point, the storage beds sat for 21 months. Analyses of these beds were conducted at the Tritium Facility and at Mound. There was some metal hydride material degradation. They conducted isotherm and other measurements and did some filter testing. They took the bed into an air hood and took some of the material out. The numbers are available in a report [see reference below].

The amount of He-3 that came out at Mound determined the average H-3 concentration during operation. Lanthanum-Nickel-Aluminum (LaNiAl) has a huge capacity for He-3. It is an isotope purifier. The He-3 causes the material to swell. Even with the degradation, there was a delivery of pure H-3. Palladium beds also hold on to He-3 until very late in their life. This observation was made during palladium tritide studies.

Other Tritium Compounds

Mischmetal is a mixture of rare earth materials that is not further separated and is used as is. There is a lot of lanthanum, praseodymium, etc. The exact rare earth composition depends on where the material is mined. Most of the material at SRS comes from China. SRS uses a cerium-free mischmetal because cerium reduces the efficiency. The SRS material is pretty heavy in lanthanum. One of the metal hydrides used contains mischmetal. The compressor materials, unlike the storage materials, are used to move gas and are not exposed to tritium for long periods of time. One use of mischmetal is its use in metal hydride batteries.

NiZr tritide is a new material being handled. The new MOX [Mixed Oxide Fuel Fabrication] Facility will have plutonium tritide. [See Addendum for comment.]

There was an actinide separation program involving photochemistry R&D work with actinides in about 1983 or 1984.

TRITIUM FOCUS GROUP

[The interviewees serving on or contributing to the DOE Tritium Focus Group, collectively, provided a description of the group's mission and how it impacted SRS operations and staff.]

Historically, the main concern at the tritium facilities was HTO. The STCs are really more of a recent issue. The STC issue [i.e., Stable Metal Tritides (SMTs) and Organically Bound Tritium (OBT)] first came to the attention of the complex as a result of what was happening at the Mound Plant with metal hydrides. They were raised in relation to Decontamination and Decommissioning (D&D) at the Mound Plant. A Tritium Focus Group (TFG) was established by DOE. Several individuals from SRS served as members of the focus group, with one individual responsible for the MathCad work used in the development of the [STC] standard.

From the dosimetry side, STCs became an issue in 2004, resulting in a change to the SRS technical basis document (TBD) and the bioassay program. SRS became aware of the different dissolution rates for different compounds and the fact that the dose was higher [from some STCs] than traditional forms of tritium. The TFG invited Dr. Yung-Sung Cheng from Lovelace[1] to do a presentation on his [solubility] studies from about 1998 to 2000. Presentations are available from the focus group.

When the STC working group was put together, it was widely acknowledged that a good bit of work was needed to fully characterize STCs and develop a proper monitoring program. The one example that is most vivid is the need for a fecal analysis method. To the knowledge of internal dosimetry staff, it still does not exist.

There was a questionnaire sent to all of the SRS site facilities to evaluate whether STCs were present. After the standard came out, SRS did a survey of the site. Historically, SRS was using uranium beds (HTV [Hydride Transport Vessel] beds, U-beds). U-beds were used for the transport vessels. The HTVs were reused without restriction and were surveyed for alpha activity each time they were unloaded. Radiological Control (RadCon) didn't see any contamination. The HSV [Hydride Storage Vessel] beds (titanium beds) were designed so that the titanium would not get out. To test for rust/dust, they pulled air samples in several areas in the older tritium facilities, including the Kanne rooms. The filter papers were counted, and no contamination was found. There were also LaNiAl and palladium Kieselguhr beds in the tritium process. The review of rust/dust did not include an assessment of this material at the reactor areas.

A few of the site experts interviewed were responsible for the tritide evaluation for the tritium facility. Additional information on tritides handled at SRS is contained in *Special Tritium Compounds in the SRS Tritium Facility*, DPD-TED-2000-00081 [SRS 2000]. A separate evaluation was conducted for the reactor area.

DOE came to the conclusion by repeatedly conducting assessments of the 13 components of the RadCon program that SRS was effectively addressing the tritide issue. DOE assessed various

[1] The Lovelace Respiratory Research Institute in Albuquerque, New Mexico, is involved in numerous studies for the federal government.

facilities to evaluate their program. There generally were few, if any, noncompliance issues with the requirements. In the tritium facilities, the occasional findings were quickly resolved by the operating contractor. If there was an issue that escaped their knowledge, they would bounce it off of Mound. They also talked to older HPs about the tritium operations and their experience over the past decades.

RADIOLOGICAL CONTROL

[The interviewees, collectively, provided their characterization of the radiation protection processes in place at various onsite facilities. General, plant-wide radiological controls are discussed first, followed by subsections focused specifically on tritium facilities.]

Production and HP had a love/hate relationship. Workers tried to do most jobs without HP. Production wanted to do whatever had to be done. Day shift did not attend to maintenance that often; much of it was done at night. Operations spent time avoiding HP, and HP tried to avoid them. Operations had work to do, and HP's attitude was not conducive to getting the job done. It could take days to get the job done if HP was involved. The production side tried to avoid HP.

Some of the HPs worked more like operators; they would work with you. If an HP trusted you, he would not go with you. For example, operations would know that there were some things to be done at the first of the month. They would get the ticklers, go get an HP, and get the job done. If a worker was an old-school person, and if they could go without HP, they would do it. In the early days, a supervisor would manipulate HP to get the work done. Workers who were more production- and work-oriented leaned on HPs, so they could get the work done.

On the shift, there was only one HP, and it is not like the HP could cover the area. Also, the HPs would take their breaks, and then there was no one there. Eventually, they did put an HP manager on shift. This was part of the change in the late 1980s—it started with the quality assurance, and it took some time.

One former RCT was assigned to various areas at SRS, including F-Area Tank Farms, H-Area Tank Farms, F & H Canyons (including the B-lines), DWPF, NRF, RTF (during construction), S Area, the Outside Facilities (i.e., outside the facility security fence), 300 Area, and the laboratories. When assistance was needed or when there was overtime, he could be assigned to any location on the site. Overtime occurred about once every 2 weeks.

A Limited Duty Inspector was limited in what jobs he could cover. He was assigned to a shift job with a more qualified inspector to give him additional experience.

HP couldn't cover everything at the tank farms, because there were not enough personnel. In the early 1980s, there were 6–7 [HP] people on the day shift covering a couple hundred workers. One HP would stay in the trailer. They were short-staffed all the time. The HP techs did not come out several times when some CTWs worked with radiation. For example, workers at the tank farms would commonly load the cars and take things from H Area to F Area without an HP.

At the tank farms, a maintenance crew worked about 50% of the time without an HP tech. You would not take an HP tech when you were going to do things your way. The DuPont procedures did not have sign-off steps in them, and workers could use the procedures the way they wanted them. Before workers needed a sign-off, the boss told the worker what was to be done and the worker could decide how they were going to do it. If, for instance, a worker was asked to decontaminate a sample box, he might go down himself and take permanganate or trichloroethylene (TCE) and do it himself. If the worker could get the contamination down, they would call HP for a survey. The workers were trying to get contamination down so they could work in lab clothes. If they could not get the contamination down, then they may not bother calling HP.

One interviewee did a job that they had a safety complaint on. Before you can put [in] a jet or sparge, you have to put in well-drilling equipment. There were complaints that it was too hard because of the physical work. Workers dropped a piece of the pipe into the tank. RadCon people were around to survey the area workers were getting into.

In 1989, Westinghouse brought in Rent-a-techs who were not experienced or trained. For a period in the early 1990s, workers did not feel protected. With DuPont, the RadCon technicians were more experienced.

Operating engineers on the construction side were considered support crafts, and they did not have procedures. When PAAA [Price Anderson Amendment Act] came out, DuPont left and Westinghouse came in. Westinghouse did things better in many ways and started Quality Assurance (QA). Only under Westinghouse did they begin to have procedures that required written sign-offs. The site did not get going on RWPs until Westinghouse was well established. A construction worker stated that they never had classes until Bechtel came on site.

In the late 1980s and early 1990s, there were people who were fired, because they were doing things the old way. They were high-performing people, but they could not change and adapt to the new ways. Westinghouse did literacy tests, and older foremen could not pass, because they were not good at taking tests, and they were humiliated and they retired. A lot of them left; it was humiliating for them not to be the shift supervisor. During the transition, [a supervisor] had to pull more prints and create more computer-generated reports. Many workers could not or would not do it. The subcontractors have changed several times since then.

Radiological Hazards and Controls

Radiation conditions in the tank farms and canyons were not always well documented. Surveys were taken near the entrance to areas, but not where the workers were. H Area was a little more lackadaisical than F Area and was worse as far as monitoring.

[At the Tank Farms, a RadCon worker] used an AS-2 for alpha surveys, a Victoreen 496 for beta/gamma surveys, and an RO-2 for dose rate surveys. Surveys were not done over the riser hole where the highest dose rate would occur.

Huts were commonly used at the tank farms. For example, they used huts when pulling dip samples, replacing an air sparge, and working on the lines. When they would take the huts down, the alpha contamination sometimes escaped. There were contaminated areas in the huts and outside the huts. The contamination areas were marked with a rope boundary.

When pulling dip samples at the tank farms, workers had to put a cap on the sample while wearing gloves. The cap had coarse threads. It was not unusual to drop a cap in the tank or drop the cap and contaminate a riser with high-level waste. Old-school people would come and clean up. This was not thought of as an incident. If workers made a mess, they cleaned it up. That was the way they worked.

If you were not working in your primary facility, you were more susceptible to higher radiation that you did not know about. The new people learned from the old timers. Going into an unfamiliar area without a buddy who knew what was going on was asking for trouble. Workers protected their own group by word of mouth. They were told to stay away from this or that area because it was hot. Some contaminated areas did not get roped off. For example, a worker was aware of a contaminated crane at the Silver Springs lay-down yard in an area that did not have a rope around it. Sometimes they would be working in an area that was not marked, and someone would inform them that the area was contaminated. For example, electricians once went out to investigate the diversion boxes to prepare for a job. An HP came along and told them to get out of the area, because they were about ready to do a tank transfer. The workers were lucky he had come along. A mobile worker with a radio could find out about work conditions in the middle of the day, but not everyone had radios on the job.

[Between 1984 and 1986, a building addition was constructed above the FB-line.] There was an extra floor added to the top of the building. The original building is concrete, but the additions were made out of blue metals. There were hundreds of construction workers, all crafts, working on that addition. It was considered new construction and the area was considered a clean area. There were no radiological postings and the workers were not monitored. Although it was considered a clean area, there was hot air coming out of the stacks of the FB-line. The chutes coming out of the FB-line (a tremendously hot area) were opened periodically to the vents. All the air in the hot canyon area came out on the ladders right next to the vents. There were all kinds of construction workers that worked out there that received doses that were not monitored. [See Addendum for comment.]

The Central Shop itself was not considered a hot shop. There were several portions that were contamination areas for a limited time. The equipment sent to the Central Shops for servicing came out of the hot buildings.

The reactor heat exchanger refurbishment project (in the 1980s) was a very hot job involving a tremendous amount of contamination. At the Central Shops, repair and refurbishment was performed in a separate building that was not being used at the time (690G). The building got so crapped up from this project that it was roped off afterwards—no one was allowed back in it for several years.

The people who worked in the HB-line would approach the 2.0 R [dose limit]. There were four operators who usually worked in the hood. Once they had received 2.0 R, newer, less-experienced operators were brought in. On the last day of the month, they could burn you up. The next day, you were right back in. They would move people from other areas of the site to receive the dose. When less-experienced operators were brought in, this is when the construction workers' uptakes would go up, because of lack of experience of the operators.

There were lead shields everywhere. There would be radiation streams that would come through areas like where pipes went through walls, so lead blankets were put around it to block the radiation. Many of the jobs RadCon covered involved piping, which was very radioactive. They would place lead blankets over them, or there would be lead from previous jobs already there. Part of RadCon's job was to find the area with the highest dose rate, so operations could put lead over it or to survey where the lead was already placed.

Personal Protective Equipment (PPE)

In F Tank Farm, workers wore protective clothing made of cotton. The site did its own cleaning and washing. Laundry Helpers, who went to all areas of the site and loaded laundry bags on and off trucks, dressed in lab coats and street clothes.

CTWs learned to check their clothing, because a lot of it was hot before they put it on. It came back from the laundry that way. So the workers learned to run a hand monitor over the clothes, especially gloves, which were often contaminated [after laundering]. The workers did not have their own monitoring instruments. The areas where they worked and dressed out had the equipment. The portable monitors were there. The workers picked one up and used it.

Sometimes workers had to dress out when they went into a Radiation Danger Zone (RDZ). CTWs had to dress out to work with heat exchangers (removal, refurbishment, repair, and installation). For work on the HEPA filter pots, workers wore one pair of protective clothing, unless they were working on the tank itself. Pipefitters would be in the hut with supplied air and they were burned out after 2 minutes for the whole month. But electricians were not in the huts so often. Sometime between the mid-1980s and early 1990s, when lifting covers off diversion boxes at the tank farm, crane operators dressed out and worked under a time limit. Some of the filter houses were very hot—workers could only stay in there 1 minute.

At the B-line, SRS was more concerned with contamination, rather than radiation. In the RDZ on B-line, workers wore a plastic suit and/or hood on a daily basis. Work in the warm canyon maintenance cell in H Canyon was all bubble (plastic) suit work. Bubble suits were also used on top of the reactor in the 100 Area. In the F Area, workers moved the slurry pumps with the tank top open while various workers were present in the general area. Direct hands-on workers were in plastic suits, but individuals outside the rope were not suited up.

Workers wore lead aprons in the 200 Area in the 235 Building. When electricians worked in gloveboxes in certain areas, they had to dress out and sometimes wear a lead apron. Sometimes jobs on the hot gang valve corridor at the canyons required the use of lead aprons. The equipment did not fully shield your entire body.

Egress

At SRNL, CTWs were up in the ceilings and around the equipment, and residue material was everywhere. These were areas that were not normally occupied. There was self-monitoring in this building, but workers had to go elsewhere to monitor, because it was hot. There was no one telling them to go monitor.

In the HP monitoring building in F Tank Farm area, it was possible to go through the radiation zone and come out unmonitored, because of the way the entrances were placed.

Alarms

There were nuclear incident monitoring [radiation] alarms and criticality alarms. Workers were involved in situations where alarms were going off. Some alarms were drills or false alarms, but others were the real thing. When there was an evacuation, workers had to gather in the parking lot. They were not told what it was all about. At the time, you just had to leave; but then they never told you anything about it. When there was a shift change and the alarm went off, workers just went home. Workers were normally not told why the alarms would go off. They would call HP as they were leaving. Sometimes [HP] would come and check; a lot of times, they said it must be radon. These alarms were not specific to any area, but the waste areas were bad. They never said where the radon was coming from.

An interviewee recalled a couple of dozen alarms over the course of his employment. One of the worst areas for alarms was H Area waste. A number of times when the interviewee was there, workers would have to seek shelter, because the alarms were going off. In the H Canyon, the alarms would go off because of air reversals about every month or two.

When CTWs removed the teapots (huge HEPA filter pots) and the alarms would go off throughout the tank farms, HP told them to just keep working. They didn't want to slow them down one bit.

In about 1994 or 1995, construction electricians were digging outside (to put in telephone lines) and the CAMs [Continuous Air Monitors] outside would go off. After further research, they found that the whole area had high readings. They found out why after they interviewed old-timers. There were 55-gallon drums stacked up on the asphalt that had gotten contaminated during the early heavy production days. The shipments out on the pad were leaking. The electricians were wearing just one pair [of protective clothing] and no respiratory equipment. The area is a CERCLA [Comprehensive Environmental Response, Compensation and Liability Act] area now and it is contaminated.

When a worker went out of a zone and a worker set off a PCM 1 [Personnel Contamination Monitor], RadCon was supposed to come out and survey you. Sometimes RadCon would not come and would say it is radon, or that the background is high. In one case, a worker insisted that they come and found that his shoes were contaminated. A CTW who set off alarms on the hand and foot counters at the FB-line had to bring in all kinds of samples. When a machine went off, workers were also told the machine was not properly calibrated.

Training

[Construction Trades Workers interviewees described the RadCon training they received.] The first training one site expert received was watching someone dress out. In 1991, there was a 4-hour training course in the H-canyon. Later, Radiation Worker (RW) II training involving several days of training was required. RW II training is completed every 2 years. Initially, this training was conducted over in Augusta. After the formal training, the dress-out procedure was more consistent. Other training includes respiratory protection, glove bag, plastic suit, and Hazardous Waste Operations training. In conjunction with respiratory protection training, respirator fit-testing using a smoke chamber test is completed.

Some areas gave/give area-specific training. For example, there was training associated with the new and old B-lines, the H-canyon, and the tritium facilities. As a result of contamination in the old B-line in the F-canyon, there was special training for dressing out in this area. Training at the tritium facilities did not include formal training on the forms of tritium, according to one interviewee. One interviewee mentioned specific training for work in 232H around 1997/1998. Part of the training involved pixie dust training. A worker had to try to get out of an area without getting pixie dust on them. The RCOs have always made workers aware of hazards, so they can take precautions. With tritium, a worker is dealing with something that was more in the air. In addition, interviewees mentioned weekly safety meetings called "Tool Box Target." To supplement training, there are pre-job briefings, including direction from the RCO.

When CTWs were asked if they had received about the right level of training, one interviewee said 30 years ago, they did not know that asbestos was bad for you. As far as radiation is concerned, you cannot be over-trained. You don't know what is going to happen down the road. Another interviewee said a lot of the training is not applicable to our job. They do not go anywhere without RCO. There are a lot of things that we do not do that are on the test (e.g., figuring out total dose from a dose rate.)

RadCon personnel indicated they make sure the training programs are adequate. Managers at the first line levels are making sure the line supervisors are having their folks implement their safety training. Training has always been equivalent for the CTWs.

Environmental/Waste Management

In environmental monitoring, the OBT is included with the tritiated water. The amount of OBTs released is minimal, compared to other forms of tritium.

SRS did not have self-boiling tanks like other locations. They always had open holes that had a high-waste transfer line. The operators would get exposed when they went by them. There were some feral cats and skunks in the area. DuPont patrols would try to catch them and shoot them. The animals would go in the huts to keep warm.

At the Burial Ground, water from the water truck was mixed with kaolin clay. Rotovator Operators drove heavy equipment over the wet kaolin to compact the clay in place as a cap (to prevent seepage of the radioactive material that was buried there).

SRS is federally controlled property. An interviewee was not aware if South Carolina and Georgia have done any sampling onsite, but [the states] have complained about it.

Tritium Facilities Radiological Controls

The tritium programs, MOX, and waste solidification are under the National Nuclear Safety Administration [NNSA]-portion of the site. There are about 35 individuals in HP, Industrial Hygiene and Industrial Safety at the tritium facility, including 4 first line managers and 26 HP Inspectors. There is a separate Quality Assurance function within tritium that is not connected to ES&H [Environmental Safety and Health].

RadCon has gotten a whole lot better over time. Everything changed at one time around 1990/1991. This included postings, Radiation Buffer Areas (RBAs), and double ropes. RadCon is more accountable than they used to be. They do have more paperwork to complete. They have learned a great deal over the years. The site got better at explaining things to workers. Prior to 1990/1991, workers had to rely on the people around them.

Tritium Facilities Radiological Hazards and Controls

Each tritium building is specific with different issues to look out for.

Forms of tritium present at SRS are HTO, elemental tritium or tritium gas (i.e., HT, T_2), tritiated methane, uranium deuterium tritide, titanium tritide, lithium tritide, zirconium tritide, lanthanum nickel aluminum tritide, palladium tritide, and tritiated waste. The special tritium compounds used included LaNiAl (in the primary stage compressor, as well as the storage vessels), Ca Mischmetal nickel (in the second stage compressor), and titanium chromium manganese (in the R&D third stage compressor). Titanium tritide was used to determine when helium would be released from this material. There were no tritides in the older tritium facilities (i.e., 232H and 234H). There are no dispersible STCs in the workplace.

Palladium black was used as an absorber at the 232F facility from 1955 to 1958. For 232H, there was some testing of palladium black involving the fractional absorption of the material. A site expert does not recall any incidents associated with this material. There were also zeolite beds in the 232H Building.

There was no special program for treating powders or solids, because the hazards of tritides were not necessarily understood early on. $LaNiAl_{.75}$ was treated as though it was like any other form of tritium up until about 2007. Prior to this, staff was not aware of the tritium standard [i.e., DOE Technical Standard, DOE-HDBK-1184-2004, *Radiological Control Programs for Special Tritium Compounds* (DOE 2004)]. One of the key controls implemented for hydrides is that the tritiated compounds are treated with the same methods as HTO. The personnel at the tritium facility are most concerned about liquids. Sometimes a line is evacuated, and this may cause liquids to form. If HTO forms, operations personnel are informed and it is cleaned up. HTO is considered a bad thing at SRS. It does not take much to kill you.

There was a job involving titanium tritide. There was a concern about the degrading of the titanium powder that needed to be investigated. The job used a glove bag and a glovebox. Individuals involved wore PASs. The Reservoir Surveillance Operations (RSO) personnel were responsible for conducting the work. RSO is responsible for the functional testing of the beds. The controls seemed excessive for a 10-minute job.

Organically Bound Tritium (OBT) is frequently associated with vacuum pump oil. The Mercury pumps used in the older tritium facilities used to leak and off-gas so badly, they were kept in containment. Workers tried to avoid oils; however, there were residual oils. Workers had to be in plastic suits to work on these pumps. Organics would rapidly permeate the plastic suits. Pipefitters and maintenance were responsible for changing the pumps. Workers were trained to avoid oils or condensate in the tritium facilities' systems. They were on a daily bioassay protocol for the older facilities. There was a lot more tritium exposure in the older facilities.

As a part of the Watts Bar project, Tennessee Valley Authority irradiated TPBARS [tritium-producing burnable absorber rods]. Zirconium tritide will be handled as a part of the tritium-producing absorber rods. The TPBARS were received as waste from Pacific Northwest National Laboratory (PNNL). The TPBARS were now in the form of fines. PNNL and SRS worked together to come up with an accident scenario for this. This was the last update to the authorization basis. This project has been delayed due to leakage of targets.

There are some secret activities conducted where the Radiological Control Inspector does not have a need-to-know. At times, they smear items that are unknown to them.

In 232H and 234H, there are some air flow hoods. Things were less contained in 232H and 234H than in 233H. For jobs in 236H, they work in hoods. In Building 232H, there are 42 grams of tritium bound up in beds and pipes. The worst bed had less than 1 gram of tritium. There were LaNi beds in Building 232H, which were not in gloveboxes, but in hoods with doors on the front, prior to the 1989 time period.

In 232H and 234H, all the process areas were contamination areas (i.e., >1,000 dpm/100 cm^2). At a level of 10,000 dpm/100 cm^2, Radiological Worker II training and PPE is required.

In the old buildings, some rooms were posted as Airborne Radioactivity Areas and the workers wore plastic suits. There were Kanne monitors for the hoods, personal monitors, and room monitors. Sometimes they had a suspension guide that was exceeded because of activity in the hood. In this case, the workers were pulled out of the hood. There was usually a burp and the activity would settle out. Although this example was related to changing zeolite beds, in the old process buildings, the same conditions could happen for nearly any kind of process line break, such as replacing a valve.

The RTF, Building 233, went into operation in the mid-1990s, resulting in the shutdown of older facilities. There was a phased implementation of the RTF facility. The different sections within the building were separated both administratively and physically. At RTF, work was/is done in gloveboxes. The gloveboxes have oxygen monitors that indicate oxygen in-leakage. This may indicate that gloves need to be changed. Each glovebox is on a stripper system. Operations personnel have the capability to lock out all sources of the process system. The gloves are also routinely surveyed for tritium contamination and replaced if found to be above established limits. Titanium beds are used at RTF, but because of strong engineering controls, all the tritium is kept away from the workers.

There are areas in all tritium buildings where permeation problems are present. These areas are posted as contamination areas. Over time, SRS started to see permeation, which shows up as contamination on the glovebox gloves and is caused by high concentrations in the gloveboxes. There have been a few occurrences when the HTO permeated the gloves. This is indicative of a leak from a process system inside the glovebox.

Tritiated pump oil was an issue at the old tritium facilities. In the newer facilities, they use dry pumps. Any of the gaskets can absorb tritium-producing tritiated organics. At RTF, they implemented a metal-on-metal design to avoid issues with gaskets. The tritium facility uses one-piece neoprene gaskets for glovebox panels. There is no spalling of the gaskets, according to one site expert.

There are gaskets that tend to leak in some processes. The issue is that workers tend to add vacuum grease when there is a leak versus replacing gaskets and determining the cause of the leak. This has led to certain areas within the gloveboxes having excess vacuum grease on equipment. The workers are the cause of this problem, rather than the gaskets.

In the purification process in the older Tritium separation facility, there were Zn-65 contaminants associated with the tritium operations. Once it was separated from the tritium, the Zn-65 was not a problem.

There is concern regarding special tritium compounds in D&D activities.

The waste is left in the gloveboxes until they are ready to bag it out. There are waste campaigns, where they bag the waste out and prepare it for shipment to solid waste. None of the hydrides ended up in the tank farms. These metal tritide storage beds are put in the burial grounds.

There is some tritium handled at SRNL. There are areas where tritium has diffused into the metal, such as the stainless steel.

Tritium Diffusion/Permeation

Multiple studies on the diffusion of tritium into stainless steel are available. There have been diffusion studies conducted involving autoradiography and depth of permeation studies. The experimental measurements are made and a diffusion calculation is run. At room temperature and atmospheric pressure, the tritium mainly stays on the surface with very little penetration. To get tritium into stainless steel, you would have to heat it to 500^{o}C and [pressurize it to] 10,000 pounds per square inch (psi). At 500^{o}C and 10,000 psi, tritium saturates the stainless steel wall in 2–3 hours.

The tritium on a surface will be a hydroxide. You can clean it so it is not smearable, and two days later you can get smearable tritium. Tritium diffuses back to the surface from the bulk when the surface concentration is reduced.

The structural material of the reservoir is stainless steel. Tritium diffuses through stainless steel as an atom based on the properties of hydrogen. There are low-level contaminants. If you wait long enough, it will establish steady-state equilibrium. The form of hydrogen in the stainless steel will be atomic tritium. Tritium diffuses isotropically. The migration of tritium will not produce iron hydrides, chromium hydrides, etc.

When SRS loads a reservoir, the fill tube is pinched off with a pinch weld. The tube is under pressure, and tritium will diffuse through the metal. The tritium contamination would occur on the walls of the tube and away from the reservoirs. If you know how much H^3 you started with and correct for decay, you could tell how much is leaking out. Tritium will not produce corrosion on a weld.

All hydrogen-containing material absorbs tritium. The absorption/desorption dynamics for all types of hydrogen [i.e., protium, deuterium, tritium] is roughly the same.

Tritium diffuses through polymers as a diatomic gas based on the properties of hydrogen.

Tritium Facilities Administrative Controls

Safety analysis is conducted for processes to assure the hazards are characterized and controls are put in place. The O&M [Operations and Maintenance] contractor developed a special safety basis/hazards analysis for tritides. SRS did a lot prior to this time period to include engineering controls for tritides. For example, hydride bed designs include the presence of filters close coupled with the bed to prevent release. In the hazards analysis, SRS assumes all the tritides are Type S for the dose analysis. This prevents you from having to track each type of tritium. Assuming Type S provides a bounding analysis. Loss of confinement, fires, explosions, etc., are used for theoretical analysis. An exposure criterion of 100 rem for a worker is applied for the theoretical analysis. A safety-significant component is determined for each potential accident scenario (for example, sprinklers for fires or gloveboxes for explosions). SRS does an annual update of the authorization basis. When there is a new evolution outside the authorization basis, an update of the analysis is completed.

There is a Tritium Operations Review Committee (TORC) that reviews special evolutions. The facility treats operations with tritides in a special manner. The controls for tritide jobs are on a case-by-case basis. For example, for a particular tritide extraction job, SRNL was responsible for conducting literature research. HP did special personal air sampling monitoring for the evolution. Glove bags were used inside gloveboxes to protect the cleanliness of the piping. Filters are present, because they don't want particulates getting into the reservoirs.

A hazard analysis is completed for a procedure, and a job hazard analysis is completed for a job. Workers have input to the work packages, the pre-job briefing, and some input into safety. They do not work a whole lot with the procedures. CTWs interviewed indicated they have the right to stop work at any time, and in fact did stop work in other facilities onsite. Any work that is invasive will involve RCO coverage. For routines, workers will not always have an RCO with you.

Tritium Facility Surveillances

The RCT's responsibility is to come in, perform turnover, conduct routines (i.e., surveys, source checks, read rotometers, read stack releases every 12 hours, etc.). There are routine surveys of the step-off pads, hallways, etc. The routines are broken up between the shifts. We take dry smears. The smears are put into Ultima Gold and counted on an LSC. We are responsible for counting our own smears, with the laboratory as a back-up.

Monthly RCTs smear the rooms, hoods, the hood fronts and 10% of the glovebox gloves in Radiological Buffer Areas (RBAs). Quarterly, we smear 100% of the glovebox gloves. Glovebox gloves in 233H are maintained below contamination area limits <10,000 dpm/100 cm^2. In other buildings' RBAs, glovebox gloves are maintained at <1,000 dpm/100 cm^2.

Habitable areas (all tritium facility RBAs/RMAs [Radioactive Material Areas], including those in 233H, 234H, 236H, 238H and 264H) are maintained to <1,000 dpm/100 cm^2. There are areas of the building where you have >1,000 dpm. If RCTs find an area with >1,000 dpm/100 cm^2, the area is roped off and cleaned up. The operations personnel are responsible for decontamination. In the unloading area in 233-H, RCTs have observed some permeation of tritium.

For a period of time, RCTs only used PC-5s. The PC-5s could see down to 150 dpm/100 cm^2, which was the limit for free release or "clean" (uncontrolled) areas at that time. Historically, the routine smears were scanned with a PC-5, and then counted in the laboratory using their counters. The results less than this level were reported as "150 dpm/100 cm^2." The program at the laboratory still records "less than 150 dpm/100cm^2." In the mid-1990s, we changed from the PC-5s. The new instrument has a detection level of <1,000 dpm/100 cm^2. There is a shipment of igloos that is currently releasable to <1,000 dpm/cm^2.

Each survey was documented on an RSLS [Radiation Survey Log Sheet]. Each survey was numbered. The survey log sheet provided a survey number, a brief description of the job, and the name of the RCT(s) conducting the survey. The survey report could be pulled up by survey number or by any of the names [RCTs] listed. The actual report included the survey number, a description of the job, a diagram of the area, contamination readings, radiation readings, and air sampling results, if required for the job. All survey results were recorded on the RSLS. The diagram was marked to indicate areas with the highest readings or contamination.

The contractor filed an authorized limits request for higher release criteria. They wanted a less restrictive release limit for tritium, because the release limit was restraining their operational activities. The higher release limit was based on the premise that there was less of a dose from tritium than from equivalent rates of other contaminants. With contamination levels in the thousands of dpm, they had to put excessive controls in place.

The procedure for routines is 5Q.1.1-147. For the tritium facility, they also follow SOP-TRIT-311.

Tritium Facilities Personal Protective Equipment

Most of the RTF is an RBA and does not require PPE. In the new facilities with nitrogen-inerted gloveboxes, PPE for maintenance and other activities are based off of the glovebox activities. There are systems within systems. There can be a line break with no PPE if there is less than 0.1 µCi/cc. If the glovebox value is above 0.1 µCi/cc, there are lab coats and gloves required. There is a one-time use policy for gloves. In the older facilities that utilize flow-through hoods and plastic suits to protect workers, a worker is supposed to change his outer gloves every 15 minutes.

CTWs reported wearing bubble suits when working with tritium when there was an airborne hazard. An interviewee indicated that, historically, they were more concerned about the stay time depending on the type of suit that was worn (i.e., 6 mil or 12 mil suit).

There was concern raised by CTW site experts about the rope and how it stopped potential airborne exposure. For example, the welder welds the reservoirs. There was a rope across the room. On one side of the rope, there were individuals with plastic suits. On the other side of the rope, the individuals were not wearing any PPE.

RadCon site experts indicated there are jobs where individuals standing back from the job monitoring the work, such as Radiological Protection, are not in bubble suits, while those on the job performing the hands-on work have bubble suits. When engineered controls such as airflow are utilized, monitoring for tritium with Kanne chambers is in place and continuous Radiological Protection job coverage is provided. Work is permitted to occur in this manner as long as it is safe for those without plastic suits.

EXTERNAL MONITORING

[The interviewees, collectively, provided their characterization of how external monitoring was performed historically at SRS, as follows.]

[External monitoring reported by interviewees was variable.] Workers who were not expected to encounter radiation hazards did not have routine dosimetry. If an area was considered a clean area, workers may not be badged. In the 1950s, a worker with new construction was not assigned a dosimeter. Workers who worked outages in the 100 Areas (reactors and reactor controls) had a badge and a pencil [dosimeter]. On the B-line, workers had to wear a regular TLD [Thermoluminescent Dosimeter], a pencil [dosimeter], and a neutron button. Those required to dress-out in the Central Shops recalled having TLDs. In the mid-1970s, workers had TLDs.

Belly button [neutron] dosimeters were assigned to those who worked in the HB-line. This included those who worked in the hoods (i.e., stainless steel hoods with glove ports), dismantled or removed gloveboxes, entered the vaults where they stored fissile material, or entered rooms that were on respiratory protection. Belly button dosimeters were worn at the belt. HP used to exchange them by the month. One interviewee who operated the elevator to the B-line in mid- to late-1980s did not have a belly button badge. Workers in the HB-line had a criticality dosimeter that they kept on their lanyards. In the earlier badges, there was a “dead man’s chip;” they were read only if a criticality accident occurred.

People generally wore badges when required, but there were lots of exceptions. It is not unheard of for someone to pick up another worker’s badge, because workers would not get overtime if they had overexposure. There were several examples of situations where people did not wear TLD badges where they should have them.

- While working for DuPont Construction, a worker was not on a routine program for external dosimetry, although the individual conducted work at 100R after it was up and running and in 400 Area. The same worker was routinely monitored after transferring to DuPont Operations.

- When new CTWs went looking for materials, like in R Area, where they scavenged parts, they did not wear TLDs.

- There was a crane in the woods and workers would prop up against the crane. They went there to get out of the sun, and then one day, there were radiation signs all over there. And these guys previously did not have TLDs.

Riggers reported not being badged for a period of time.

Workers knew how to work around radiation—putting badges on the waist or on the other side of the chest [away from the source]. Workers could keep their badges out of the shine when they were working at a tank and in the canyons, also. The lead door of the sample box would shield part of the body, and a worker would put the badge there to shield the TLD if they were trying to keep their radiation down.

The workers stored their badge or TLD in a badge rack. In the F Area, the TLDs were stored inside the badge house. The H Area badge house was real small and there were no sides. It was an aluminum shed with a roof and no walls. The TLDs were exposed to the weather. [Also at tank farms], there were always trucks leaking radioactive liquids. The trucks would pass the badge racks and wipe out the TLD badges. When workers went to H Area from F Area, they picked up a temporary badge. They had a row of leftover badges. No one signed out the badges.

HP had a truck equipped for changing films and preparing film badges. The technicians assigned to this task traveled around the site in this truck to change badges (including neutron films). All films, including all neutron films, were read. TLD badges were supposed to be changed every month. Day people changed out the badges. If the month ended on the weekend, then there may be confusion, and a worker may not even pick up a badge.

Pencil dosimeters were used in some areas, in addition to the regular film or TLD badge. A single Personal Ionization Chamber (PIC) was worn at the pocket level. These dosimeters were the kind that you zeroed before you go on the job. If the pencil [dosimeter] read more than a certain amount, a worker would have to come out of the area. Workers filled in a daily form that had a place to record a date and a dose. These forms were used as far back as 1975 at F Canyon. Other areas, such as when CTWs worked reactor outages in the 100 Areas (prior to 1965), did not use forms. Some comparison studies between pencil dosimeters and TLDs may have been done during the French Fuel job. Some site experts noted there are discrepancies between the electronic dosimeters (i.e., EPDs [Electronic Personal Dosimeters]) and the dosimeter badges.

Pencil dosimeters would go off-scale. For example, when an interviewee worked on hot crane maintenance, the pencil dosimeter would peg out. When workers were changing anything out in the tank farms, they would run up the pencil [dosimeter] very quickly. Workers were told, "If you get radiation, you're going to get your foreman in trouble." An interviewee received a pencil dosimeter that was off-scale. The HP asked: "Did you drop it?" The individual said, "No, you just gave it to me." The HP told the individual to go to work and he would bring another one. He did not return.

Workers were told to wear the badge on the chest, but the source is not directly in front of the badge. For example, someone working on the crane bay would have his back towards the open canyon and his back would be exposed, in contrast to other times when his front is exposed. There were situations where hands were exposed to radiation. Finger rings and multiple dosimetry were worn for collecting hot dip samples at DWPF. The practice of "milking" samples in HB- and FB-lines exposed the hands to radiation from hot needles with waste in them. Individuals did not have ring dosimeters, because this practice was a no-no. They knew a lot of this was going on and they allowed it to go on. It was carelessness with workers' bodies and lives. Many other interviewees reported not wearing finger rings.

INTERNAL MONITORING

[The interviewees, collectively, provided their characterization of how internal monitoring was performed historically at SRS, as follows.]

The internal dosimetry program director developed the basis for the internal dosimetry program and was responsible for setting up the program based on current standards at that time.

Several interviewees were concerned about "clean" areas that were suddenly posted as radiological areas. A lot of times, they were supposed to be working in clean areas and all of a sudden the area was hot.

Over the period of coverage by the interviewees, they reported routine, special, and job-specific bioassay participation. If there was a special job, samples were collected for the day of the job. Workers reported giving routine bioassay samples during their work in the tritium and reactor areas. Routine bioassay samples were collected in the tritium area. The frequency was weekly, but daily if they went into the facility. If the result was greater than 1 μCi/ml, the worker was told to drink liquid. Samples were submitted monthly or every 3 months for reactor area workers in the late 1980s/early 1990s for about 3 to 4 years. In the 100 Areas, individuals submitted tritium samples when they worked at the minus 40 (-40) level or when they suited up. Individuals in the 100 Areas who were not in a tritium-specific area would leave weekly bioassay samples. There were also samples collected from personnel who worked at ETF [Effluent Treatment Facility]. Some individuals reported routine monitoring in the 200 Areas, while others did not remember giving samples while at the tank farms, the canyons, and even the

B-line. If an individual was on a routine program, they left a sample approximately monthly. When air reversals occurred in the canyon, bioassay samples were left. There were also areas in 772F where samples were left daily, and workers had to take a shower when they left. Although a worker entered radiological areas, they were not on a routine bioassay program when working for DuPont Construction.

An interviewee was working in the D-Area on the pumping station and came up positive for Cs-137. The technician attributed it to eating deer meat. The worker was sent home as a result.

The whole-body counts started up later [with variable frequencies reported by interviewees.] One individual reported having a baseline chest count and another count after he quit and returned to SRS. Today, if an individual has worked under an RWP, there is a quick scan. Workers reported having initial chest counts in the late 1970s and 1980s. Some interviewees reported receiving annual counts, while others reported only a few counts done. Whole-body counts started up later. In one case, one interviewee did not have a whole-body count until 1990. Extra counts were sometimes performed when workers were assigned to hot areas. CTWs were supposed to have a count when they quit, but that did not always happen. Whole-body counts were reported after medical treatment in one case.

Several interviewees reported that they did not wear personal air samplers.

Tritium Internal Dosimetry

The routine radiobioassay program at SRS is triggered by respiratory protection use. The determination of which radionuclides to sample for is based on process knowledge and waste characterization data. This is true for all parts of SRS, including the tank farms.

The tritium in the tank waste is all treated as oxides. There isn’t much monitoring for tritium in the tank farms. One site expert does not recall seeing any positive samples. Most of the tritium dose at SRS since the shutdown of the reactors comes from the tritium facilities.

There is no external monitoring of personnel in the tritium facilities; a worker is only required to leave a bioassay sample.

Site experts involved with metal hydride research reported leaving a bioassay sample when working with tritium. The results were provided to them.

There is no routine monitoring for tritides. When this type of monitoring is needed, there is an interaction between the field and internal dosimetry. This special type of monitoring began in 2004 or 2005 when the tritides issue became hot.

There are Kanne chambers throughout every room where tritium is processed, handled, or stored. The alarm set point inside the glovebox is 0.2 microcuries per cubic centimeter (µCi/cc). Historically, this set point was 0.1 µCi/cc. The alarm set point for the room in which personnel are working is 4E-5 µCi/cc. The Tritium Air Monitor (TAM) is a flow-through ionization chamber.

SRS has come up with a way to detect tritides on a PAS. Monitoring for tritides is treated like other particulates. When there is work with tritides, the field uses PASs with PTFE [polytetrafluoroethylene] filters, which hold the tritide but not the tritium gas. The battery-powered unit is worn on the belt inside the plastic suit. The PAS remains on the worker through the doffing process. The RCT collects the sample and sends the filter up to the lab for analysis on the Protean detector (a windowless proportional counter). The personal data are put on an air sampling form that accompanies the PAS filter to the lab for analysis. The filters are held for 24 hours to allow the radon to decay. The Protean is calibrated for tritium using a National Institute of Standards and Technology (NIST) traceable source. The laboratory does not account for absorption by the metals. The air sampling form is not put into the personal radiation exposure file.

You cannot discriminate OBT, tritiated water, and metal tritides in urine. It would be helpful to have solubility study information and a fecal method developed that is specific for STCs.

Solubility

The Plant Directed Research and Development (PDRD) program is designed to take the science that is known and apply the technology to operations. SRS does not know the solubility for all tritides handled. As a result, the project responded to a PDRD request. The tritium facilities wanted to look into solubilities for various compounds. The site started working with Lovelace. A study is proposed to look at the solubility of the following tritides:

(1) Titanium tritide
(2) Lanthanum/Nickel tritide
(3) Magnesium tritide
(4) Zirconium/magnesium tritide.

The first tritide to be studied is lanthanum/nickel tritide. Dr. Eduardo Farfan[2] will be developing the dose factor. The funding is in place for fiscal year 2011. It takes about 3 months to conduct a study for each tritide. The study requires microgram quantities of the tritium compound. Obtaining the samples of tritium for this research will be conducted at the tritium facility. SRNL is considering developing a capability to conduct these and other tritium studies in A-Area, but this would require meeting National Emission Standards for Hazardous Air Pollutants and Environmental Protection Agency requirements.

The steps required for the study include (1) creating the lung equivalent tissue material, (2) attaching the tritium to the lung tissue (implantation), and (3) monitoring the release of tritium over time.

While not all tritides have been studied, SRS does not/did not handle hafnium tritide. After the evaluation [of tritides at SRS], it looks like the more insoluble forms (e.g., hafnium) of SMTs are/were not at SRS. Part of the findings regarding tritides was that SRS had Type M tritides. Preliminary results from a solubility study indicate LaNiAl tritide appears to be more like uranium in solubility.

[2] Dr. Farfan is an Associate Professor at Idaho State University.

One interviewee recommended that dissolution studies be conducted with deuterium and confirmed with a metal tritide. He is not aware of any metal deuteride solubility studies.

Often times, internal dosimetry does not have particle size or solubility information. The technical standard [on STCs] says to be conservative when accessing exposure potential from STCs without solubility studies. If SRS does not know the solubility of the tritide, they treat it as Type S. For unknown particle size, a default International Commission on Radiation Protection (ICRP) value is used, unless there is information that contradicts this. With internal dosimetry, staff is trying to fit data points to models.

Dose

An interviewee who received dose at the K Area storage area commented that they did not receive the same exposure as individuals do at a nuclear plant. The laborers work more with decontamination, so their doses could be higher. The pipefitters do their own access ways and drilling through holes.

As a result of work in Room 17, Building 233, one interviewee was put on work restriction for 2 days. It only took a small assimilation to get out. If you receive 100 mrem, they want to pull you out of the 100K Area.

When asked if they believe the information in the annual dose reports provided to them, one interviewee said it seems his dose rates go up each year slightly, but he does the same thing every year. Other interviewees indicated their doses correspond with where they were on site, and the jobs they were working. The CTWs interviewed indicated there are some nay-sayers who believe there are paper whippers to make the dose appear like they are going down. One interviewee doesn't believe CTWs receive less than natural background.

Tritium Dose

Over the last 5 years, the collective dose at the tritium facility has been less than 100 mrem. Most individuals have received around 1 mrem or less. There has been a decrease in tritium exposure over time. From 1998–2005, there was more tritium exposure, because 232H was in operation. At the time, the collective dose was about 300–400 mrem for 400 radiological workers in the facility. The last individual dose above 100 mrem from tritium occurred about 20 years ago.

INCIDENTS AND ACCIDENTS

[The interviewees, collectively, provided their recollection and understanding of what incidents occurred at SRS, and how they were handled and documented, as follows.]

An interviewee was not aware of a procedure for documenting incidents [prior to the mid-1980s]. There was a big paper trail when there was a recorded incident. If supervisors did not have to report it to upper management, then there was no paper trail. In the mid to late 1980s, they started the emergency operations center. In the late 1980s, they started [defining] reportable items; any contamination greater than a certain level had to be logged in. Before that, workers did not report anything that did not have to be reported. If you look at incident reports, the incidents are mostly during the daytime. Operations would just clean up other spills at night, and a lot of stuff never got reported. There were a lot of times when workers got crapped up when there was no HP. In some cases, workers deconned themselves.

Workers might know about the incidents and they might not. Sometimes they found out after the fact. For example, in approximately 1979, [an interviewee's] wife was at home watching CNN. All day, CNN had been running the news that SRS had just had the largest tritium release in the history of the site from the Manufacturing Facility. The interviewee was working in the building at the time, and the site did not notify him of this release; he had to learn the details from TV and the newspaper. There was no bioassay sample requested as a result of this occurrence. In about 1989, another interviewee was working in the 100F Area Tank Farm. He came home and his wife asked if he had heard about a release at SRS. There was a sand filter release in the F Area. They did some sort of investigation.

[Interviewees provided several examples of incidents and unusual occurrences at SRS.]

- There were radiation conditions in the tank farms and canyons that were not documented. One interviewee requested his personnel file to see if there were incidents included. Once there was an increase in the tank level when they were not transferring anything. The stuff from the canyon, still in the acidic state, was sent by mistake to the tank farm. The interviewee stopped it and diverted it into his pump tank, which was made of stainless steel. This was just after the releases of tritium that affected the place all the way down to [the city of] Savannah. When he stopped the plutonium product from getting into the tank, the interviewee got awards and dinners, and even that incident was not in his personnel file. When asked if he had told NIOSH about this incident during his interview, the interviewee could not remember. He did not know what they were looking for in the interview. A worker representative has requested records, including incidents, on behalf of workers. He has noted that in hundreds of cases, he has not gotten them.

- Air reversals occurred in some areas, most commonly in the B-lines. In the H Canyon, the alarms would go off because of air reversals. This occurred about every month or two and should be documented in the Operations Shift Log. The B-lines had more of a tendency to produce air reversals. This was because there was more air turnover in this area. They were trying to keep one room under positive pressure and the next under a vacuum. An air reversal would bring radioactive material into the room, causing it to get blown around, so there was more of a potential for contamination. When an air reversal occurred, workers had to exit the buildings. [RadCon] sent a decon crew into the area. The length of the evacuation was different at different times. Once, the workers could not go back in until the next day, because their clothing got contaminated.

- There was an incident in 1979 or 1980, where there was an air reversal on the fourth level of H Canyon B-line. The interviewee was working in Room 410 Cell bagging out the plutonium. There were some newer operators who opened the doors before they had reached a certain point in the process. The inexperienced people did not call the B-line before opening the crane door. There was an air reversal when they opened up the door.

The people packaging were in respiratory protection. HP came in with a respirator on and told them to get the hell out of there, so the interviewee and his coworker evacuated the building. They learned that there had been an air reversal when the door was opened, resulting in plutonium being drawn from the gloveboxes and spreading to Room 410. The interviewee and coworker did not have respirators. [An HP] called them in a few hours later and did nasal smears. One of the men had contamination in his nostril. The interviewee was not asked to submit a bioassay sample. The HP who warned them earlier started logging the incident in the log. The HP Supervisor said he did not want him to write the incident up, because it would look bad, but the individual logged it anyway. The HP logging the incident had to go to the Army Reserves. During this time, his desk was broken into and the logbook was removed.

- In the older tanks in the F Area Tank Farm, there is one tank that has a hole 40 inches down, and liquid cannot be put in the tanks above that level. There was an extraordinary rain. The storm waste-water drains were blocked with materials. Water did not run into drains; water ran off the parking lot into the F Area Tank Farm. Some of the storm drains were covered with pallets, and it was actually going into the tanks. Operations foremen got every pump they could find in the tank farm to move that water. Operators were in the water while they were pumping.

- Workers changed out a jet or sparge on a high-heat waste tank. A supervisor went on overtime to change out the air sparge with the new Health Protection and Production foremen. The air sparge was put in to cool the tank temperature-wise. They built a hut and had a crane lined up. Workers built a pipe sleeve on top of the riser, and the man inside would pull the plug and pull the pipe sleeve close to the riser, pulling the air sparge through the sleeve. In the procedure, it said to swipe the bottom of the air sparge and let it drip for 5 minutes. Workers were required to get rid of all liquid in equipment before sending it to the burial ground. In this tank, the temperature was much greater than outside, especially on a cool night. The supervisor bagged it up without letting it drip for 5 minutes. The production foreman and the HP came in and insisted that it needed to drip for 5 minutes according to the procedure. They opened the riser back up and let it drip. This crapped up the sleeve, the HP foreman, the production foreman, the tank, the hut, and the area outside the hut.

- In L Area around 1990 or 1991, two electricians were core drilling. Workers cut a hole through concrete wall. They had to keep the bit cool with liquid. A laborer was asked to get some water and returned with a bucket, and it was heavy water. It became a major incident and everyone on the plant heard about it.

- At DWPF, there were some line breaks and some bad incidents; sometimes they could not re-enter the facility for a week.

- On the HB-line, there was a leak in an expansion joint. They had to paint it every couple of years to keep the dose down.

- An incident occurred with a new crane operator on shift. He tried to lift a jumper in the canyon without undoing the jumper and it caused a leak. The crane operator ripped the pipe in the riser loose.

- In the P Area, they discovered a neutron beam. Operations had an E&I [Electrical and Instrumentation] shop on the other side of the hall.

- One interviewee heard that Little Hector (a test reactor) went critical. It had a crack in the core, and they had to shut it down.

- There was a meltdown in 105 K that is not mentioned in the evaluation report. A fuel rod melted down. An interviewee who was present said the reactor shut down. The incident was during scramming of the reactor. Workers never received any more information about the 105 K incident.

- R Area was contaminated and shut down due to a major incident in the 1960s. People said it was a reactor meltdown, but the interviewee cannot verify the story. Even 10 years ago, they still had radiation contamination signs posted there.

- An interviewee had worked with an old gentleman who got blinded out there. He was hurt by a crane and could only see out of the sides of his eyes. They said they had not seen eye damage like that except for Japanese bomb blasts and long-term welders. There were no records of the incident. [See Addendum for comment.]

Interviewees provided some examples of incidents that are not being considered in dose reconstruction. There are incidents that are not reported in the radiation exposure files, incidents where critiques were held. Any time there was a trigger limit exceeded, there should have been a critique. The lack of incident records seems to be an SEC issue, because a claimant representative runs into the same problem with every case he has dealt with. If they had the incident records, [the claimants] could show exposures far exceeding the estimates NIOSH is using in the dose reconstruction. Even when they do get something on an incident, it is usually just an acknowledgement that the incident occurred and a statement that they have accounted for it in the dose reconstruction. The records do not include any safety meeting minutes, log sheets, or investigation reports. As far as the interviewee can determine, NIOSH does not make the specific request for these records and DOE does not produce them in response to the general request from NIOSH.

There were quite a few incidents that occurred at the site when limits were exceeded, either for contamination or radiation or a combination of the two or the scope of the job just got out of control. An RCT was involved in several incidents where monitors would go off scale and he would be called in to assist. These would all be documented with DOE critiques, because DOE was over the entire process. Any time there was a trigger limit, where something was exceeded a certain amount, they would have to do a critique, so that they could find causation for whatever the problem was. There are quite a few of these that are not included in the file [NIOSH claim file].

- There was an incident during a job to put blanks into the chromate cooling lines. The chromate lines, a contained system that ran through the radioactive waste tanks to cool off the superheated sludge in the bottom of the tanks, obviously had leaked. These chromate lines corrode, have gaskets that leak or disintegrate, or blow out. The contamination actually got into the chromate cooling line and through the leak. When they unbolted the pipe, the chromate line was contaminated, so they had to exit the area. The entry requirements for the job were one pair of Anti-contamination clothing and no respiratory protection. The initial survey of the area exceeded the limits on the RWP and the respiratory protection limits. At that point, the RCTs were already in the area (without respiratory protection) and the survey was done, so they just had to exit the area and get the workers out. The operations workers would not have been in there before RCTs had done the initial survey, but the RCTs got out and got the workers away from the area. The incident was reported to supervision and subsequently reported to bioassay and dosimetry. The workers were required to collect a bioassay sample and probably nasal and saliva smears. There was quite a bit of paperwork to go along with this job/incident; they spent many days in meetings to try to find the cause.

- There was another incident that occurred at the ITP facility at the Tank Farms. An RCT was covering an operator who was doing sludge founding. The RCT was in Anti-Cs and no respiratory protection. Surveys were conducted. A masslin wipe was taken and the results saturated the portable contamination instrument. They had to use a dose rate instrument to get the reading on the wipe. The supervisor did not readily accept the survey levels, so they had to go back in and survey the same thing when they knew the limits were already exceeded. After the initial entry, they had to enter the area dressed out in respirators because of the radiation contamination/radiation levels. There were no chemical surveys done during this period.

- There was an incident in the H-Tank Farm involving the CTS [Central Transfer Station]. This is a concrete building with various pipes and valves. They rotate the valves to ship the waste through a diversion box, where it goes to a central area and then gets diverted into different pipes going in different directions. Workers were conducting a job in respiratory protection when an operator in the control room inadvertently transferred sludge directly through the building where they were. The sludge went the wrong direction and came out of a pipe that was not joined to the correct place. The area should have been locked down so this could not occur. The sludge was inadvertently dumped outside the building where they were working. The radiation monitors and the contamination monitors immediately went off. When any of the alarms go off, you have to exit the area immediately. [The workers inside the building] were unaware of the spill outside because they could not see it, and they had no radio communication because of the concrete building. They proceeded to the step-off pad where they took off their outer layer of clothing and respirator. Protective clothing was removed per the normal procedure, because they did not know they were actually moving into a higher level than they were leaving. The material had spilled all over the ground, and workers were coming out with no respirators and not enough protective clothing. They exited into a more contaminated area with airborne contamination. The instruments were off scale because of the radiation levels, so they could not survey. There were weeks of critiques associated with this incident. There were bioassay samples, nasal smears, and saliva smears collected. It was a major incident that caused untold millions of dollars worth of damage.

- Another incident occurred in 1992/1993; the job involved pulling a slurry pump. [Slurry pumps] continually circulate the sludge and help with the cooling and keeping the tank contents consistent. The slurry pump was going to come out of the tank covered with contamination and sludge, which made it a very hot job to cover. The levels that were encountered during the job were far beyond what the limited duty inspectors were allowed to do, and beyond the scope of what the job had originally started at. All of the workers received doses. The instruments would not read the radiation levels. They had to bring in Teletectors from other areas that have probes that extend 12 feet from your body to get an estimate of the levels. There were no bioassay results for this job [in the claimant's file], but bioassay samples were collected.

These incidents are not reflected in NIOSH dose reconstruction. [A claimant] gave NIOSH names of coworkers, hoping they could locate incident records through them. There has been no response from NIOSH; they have not followed up. NIOSH has two incident reports from 1997 in [a claimant's] file, and they assume that information is enough for the dose reconstruction. The CTF incident is not reported. These incidents [in the file] are not at all equivalent to the CTF incident; it's like comparing apples and oranges. There would have been follow-up documentation and critiques for the above described incidents. Incident information can be obtained from the radiation survey log sheets, also. After an incident, someone would enter to check levels and record it; they were all dressed out in the highest level of protection. There are records that would back up everything that happened, because they had to document everything, but [claimants] cannot get those records.

Tritium Incidents

Several site experts stated they were not aware of any incident or job in which there have been unexpected exposures associated with tritides. This is based on the PAS and the bioassay program since 2004. Some site experts reported asking about incidents, because they wanted to know about any legacy problems so they were aware of them.

There was an instance in 233H where the tritium level became very high in the glovebox, because there was a line breakage and the piping came loose. They screwed it back together, but it was too late. The material permeated through the gloves and into the room. After line breaks, there are surveys of gloves for permeation.

Databanks and Database

In about 1975, an individual with a background in deterministic risk assessments for the [SRS] reactors was asked to head up a group of five people to do risk assessment for the other facilities at Savannah River Plant (SRP, later called Savannah River Site). The group needed to compile failure and accident data, which is necessary for viable risk assessment studies. [This work led to the development of fault tree databanks.] The 200 Area Fault Tree Databank was originally put together as a research project under SRNL. Safety analysis was later moved under the

Engineering Department, and eventually to WSMS [Westinghouse Safety Management Solutions], along with the databanks.

The WSMS database [along with its predecessor/component databanks] was used for many purposes, primarily [to evaluate the] frequency and consequences of events for use in safety analyses. You could do a lot of statistics with the databank. There was a thesaurus of similar words that it would recognize (i.e., plug, plugged, clogged, etc.). Based on the data, you could determine the frequency, consequences, and recovery time based on a proper sort and analysis of the data. The database also generated error factors. The risk assessors looked at the minimum, maximum, and average numbers associated with consequences of the events. [The data were used for other purposes as well.] It was used in verifying claims that individuals were involved in specific incidents. The database could be used to look up the incident, if they knew when and where [it occurred]. The database developer worked very closely with the lawyers on individual cases claiming incident involvement. The interviewee never found a case where [the database verified the individual's claim]. Another use of the databank was to try to prevent accidents from occurring. For example, operations would call up and say that steam was coming out from around a cell cover. The databank could be used to indicate the probable causes (e.g., plugged equipment) and the situation could be remedied before it became a major failure. [The data were also used for] trend analysis and to aid designers in improving equipment stability. The developers shared the databank with anyone who wanted to have the data, including individuals at other DOE facilities and even anti-nuclear interveners.

When the group started the 200 Area Fault Tree Databank, they searched primarily published information (i.e., daily teletypes, incident reports, fire records, monthly reports, Works Technical reports, Health Protection reports, etc.). They found that the detail in the published report was frequently too general to use for analysis; the reports talked about single major failures, and most events are caused by a series of minor failures. At this point, the group started to review the shift turnover logbooks, which were handwritten logbooks prepared by shift supervisors. They read through the logbooks, filled out a datasheet, and initially put the information on punch cards. There were about a million of these punch cards. Later, they started to enter the data into a mainframe computer via personal computers.

The incidents in the databank ranged from minor leaks, which could lead to safety failures, to major incidents. Each incident was assigned codes, which included a source of data code, the date of the incident, the area, the facility (e.g., canyon, tank farms, burial ground, etc.), the unit operations, and keywords (e.g., leaks, explosions, fires, etc.). They assigned these codes to make the data more easily retrievable. When they entered an event, they tried to combine all input (e.g., operations, engineering, health protection) into a single entry to gain everyone's perspective and to eliminate duplication.

[Several databanks were developed for various areas and facilities at SRS.] Each of the databanks is structured the same way. The 200 Area Fault Tree Databank includes data for the separations facilities, tank farms, outside facilities, A-line, burial grounds, and support facilities. It does not include data for the tritium facilities in 200 H area. There are separate databanks for Fuel Fabrication (300 Area Fault Tree Databank), Tritium, and SRL. Waste Management events were entered as the facility "W" in the fault tree databanks for both F and H areas. Major incident reports should all be in there. There was no fault tree databank for the reactors, but there was a collection of incidents for the reactor areas. This [reactor incident collection] would include only major incidents.

The information in the 200 Area databank goes back to the startup of the facilities. [The number of incidents per year increased in the mid-1970s. For example, there were 590 entries in the database for 1960, whereas there were 18,708 entries for 1980. The increase in the number of incidents was related to changes in information sources.] Data from 1954–1973 were based primarily on published reports [generally limited to major incidents, as described above]. Data from 1973 to 1995 were based on all sorts of data types, but primarily came from logbooks. The use of logbooks increased the number of minor events put into the database. They tried to go back and get a couple of years of old logbooks, but many of them were already transferred to archives. When the interviewee left in 1995, data continued to be added to the databank for at least 2 years. The last entries after 1995 may not be well edited.

Some superintendents were more prone to issue formal incident reports than others, but information was available from other sources. There are several incident reports generated on an incident (i.e., operations, health protection, fire protection, etc.). Generally, the shift supervisors were extremely honest and did not cover up anything. The logbooks in general were fairly consistent. Some areas had more facilities in the area. F Area had the A-line and the burial grounds. Tritium facility in H Area was a separate database. This could explain why F Area has more entries than H Area.

Routine external radiation exposures will not be listed in the databank, but they did try to account for all the internal uptakes. The database included Health Protection department data, although individuals' names were not used. The entry always contained a reference to the incident report from which individuals could be identified. By doing this, and by not putting the blame on anyone, they got an extreme amount of cooperation from operations. The interviewee's best recommendation for locating radiation-related incidents is to run searches for keywords, such as ingestion, inhalation, uptake, etc.

With respect to incidents in the tritium facilities, the Special Hazards Investigations are not the best source. For a more detailed list of incidents, you need to look at the Separations Incidents prior to 1983–1984 and Tritium Facilities Incidents from 1984 through the mid-1990s. The tritium fault tree databank has been converted to a Filemaker Pro database to make it more usable. It is available through the tritium facilities on the classified network with a Q-clearance and demonstrated need-to-know.

The group issued annual reports on the databanks for the benefit of the production people. The Safety Analysis Reports (SARs) and the Systems Analysis Reports would be a source of information. The Systems Analysis Reports were non-legal documents that contained a lot of detail. The SARs contained only what information DOE requested. The SAR for the canyon facility started out as one volume, but with comments from DOE, ended up being 15 volumes. The 15-volume version was rejected, because it cost too much to generate, even though it contained the information DOE requested.

MEDICAL

[The interviewees, collectively, provided their characterization of how medical monitoring was performed historically at SRS, as follows.]

Up to 1985, subcontractors had to go through Medical. After this, the subcontractor was responsible for the physical. Direct hires still used the onsite Medical Facility. Since then, there were no onsite physicals, just referrals to a public hospital to get a certificate that you are physically able to do work. Even at offsite medical clinics, the doctor does not give you a physical. Parsons requires a fitness-for-duty check if you work at Salt Waste Processing Facility (SWPF).

There was a lax process [for documenting incidents] on the part of the Medical department. An interviewee explained that the safety record was a big deal at SRS. "You didn't want to hurt yourself on the job." A CTW was injured on the job and required surgery. The worker was fired during the hospital stay and hired a lawyer to force the issue and get his job back. After returning, the individual sat in an office for weeks. So long as you reported to work, they did not record the injury.

RADIOLOGICAL AND MEDICAL RECORDS

[The interviewees, collectively, provided knowledge of their understanding of the completeness and adequacy of radiological and medical records, as follows.]

Workers had to fill out all security clearance forms to obtain security clearance. Every contractor, no matter how small, had to go through Medical and Security. Workers all got assigned a number when they came on site. Each craft had a specific prefix (25 – Electrician, 21 – Sheetmetal Worker, etc.). They also had a user ID when Bechtel came on site, which was used to check training records. An interviewee had one payroll number for a while. When he went back out after a break in employment, they assigned him a different payroll number. The worker told them this was not the right payroll number. They said they could not find the original payroll number, so he had to use this new one. This was not an isolated case.

A worker representative has sent hundreds of records requests to SRS on behalf of workers. When they would get the records, they would see there were gaps in the records. They would get a summary, but would not see the details. There would be an indication that a sample was given, but nothing in the records as to the result. NIOSH has requested records, and they have more records than are made available to the claimants, but they are still not complete. Even now, people who worked for the contractors have no records of employment out there. They want to know how they can verify that they worked there. Some of them have income tax records, or they can get signed affidavits from someone who knew that they worked out there. In one case, an individual was at SRS off and on from the early 1980s to about 2002. When he returned to SRS, they did not seem to have records of where he had worked. They said they could not find when he was there.

[SC&A observed that one interviewee's DOE records (collected by NIOSH) did not include any data for several years scattered over a 15-year period when the worker was employed at SRS (late 1950s through mid-1970s).] The worker reported no significant changes in work activities that would explain these gaps. The interviewee was still entering radiological areas during these years, and does not know why there are no data. Worker representatives are concerned that NIOSH does not have all the records. If they do have all the records, then the monitoring information is incomplete.

Westinghouse at one time had retrieved logbooks and they were stored at the cotton warehouse. As a result of an incident requiring medical treatment, an individual requested logbooks from the site to prove an incident had occurred. These logbooks were from the F Area canyon and the tank farms for certain years. There are inconsistencies between records. If you were to take a canyon control operations logbook, the HP office logbook, a lab area logbook, and the DOE morning report, that would tell you everything that happened in the area. If you were to try to match them, there would be discrepancies; for instance, in the number of the samples. To say that HP was on every job is not right.

There were all kinds of records destroyed from the offices of subcontractors after they left the plant. In 1989, the subcontractors started leaving the job as their contracts expired. The personnel were transferred to BSRC [Bechtel Savannah River Company]. The crafts were transferred at various times starting in September 1989. In 1989, the electricians changed from Miller Dunn to BSRC. In the early 1990s, the fitters changed to Bechtel. Sometime in the early 1990s, crews of 6–8 laborers went around to the office buildings that the general contractors had left. It was the records in their offices that were destroyed. Laborers went in and shredded the records; they loaded the stuff on pickup trucks and left. The interviewee is not sure whose laborers were doing the shredding; they were either DuPont construction laborers or Bechtel construction laborers. They shredded all kinds of records (e.g., monitoring records, time cards) after the subcontractors left the plant. The interviewee observed this when he had a maintenance crew out there to fix the electricity for the building. He went out to see why the electricity was out. There were laborers in there cleaning out file drawers to be shredded. If the interviewee is not mistaken, it was the heavy equipment office [where he observed this occurring], but he is not positive. The interviewee asked the laborers what they were doing, and they said they were shredding records.

[In the 1980s,] every day they would print out radiation reports, so they could prevent people from getting overexposed. That would be the monthly reports. The supervisor would assign a job based on the radiation levels. Supervision would come up and talk to workers about their dose.

Annual radiation reports were provided to some interviewees, particularly in the last few years. Others recalled getting a report when they left the site. Annual exposure reports were not reviewed with, or explained to, the workers. Although they received annual reports, some workers do not believe the numbers reported on them.

One worker stated that a lot of things are missing from the Medical file. He once had an incident where he was nauseous while working in the F Area canyon. They thought he was having heat stroke. This was last-minute overtime, and they were working on the hot gang valve corridor all night. They were doing a transfer. The worker called the foreman and said he was going to Medical, including the route he was taking. He called the foreman when he reached Medical. The nurse treated him for heat exposure. The worker went to a private doctor, because he developed and had a [redacted] for 2 years. This incident was not in the medical records. This was a unique exposure that required a visit to the infirmary. There was no triage in the file. The safety record was a big deal at SRS. A worker did not want to hurt himself on the job.

Another worker indicated there are gaps in the exposure data. There were dosimeters on our extremities, ankles and wrists. Electronic dosimeters were also used. These are not available in the records. All of this information is linked to a particular job. NIOSH has used coworker data in the dose reconstruction, but they have not looked at specific jobs.

SEC PETITION AND EEOICPA PROCESS COMMENTS

The petition went in for construction workers and all other workers, but NIOSH narrowed it to construction workers. The petitioners defined the class to include all workers who worked at SRS from 1951–2007. Two of the three petitioners were from operations, not construction. NIOSH's initial letter to the petitioner indicated that supporting documentation was available for qualifying SRS construction workers; however, no supporting documentation was provided or identified by NIOSH to qualify SRS non-construction workers. The letter stated, "We have completed the evaluation process," and that the class definition was narrowed to all construction workers. This decision was provided in March 2008.

Petitioners claim that there is inadequate monitoring. There were numerous occasions when people were not properly monitored. A lot of times, a worker was supposed to work in clean areas and all of the sudden, the area was hot. There were tons of times when records were inaccurate or not kept properly. SRS would give workers a 6-month or quarterly report on how many rems they received. It was never right. People would get more in one session than they were told they got in the quarterly report. For example, a CTW working on the B-line got more rems in one day than the report says he got in the quarter. He knew this, because he read his self-reading pencil [dosimeter]. NIOSH just took the dose records as is.

NIOSH said that the production workers were in a set area. There were monitors in the area. They did not move around. This was absolutely false. There were affidavits signed by production personnel where the men worked all over the plant on the weekends. There were not any monitors to go around. There was no supervision around. Another said they were not monitored on the weekends.

One non-construction petitioner and his representative requested an administrative review. Before issuing a proposed finding that non-construction workers failed to meet the specific requirements needed to qualify for evaluation, it was the responsibility of NIOSH according to its Petition Evaluation Plan (Plan) to provide a fair, science-based determination of whether it is feasible to estimate with sufficient accuracy the radiation doses of the class of employees through NIOSH dose reconstructions. NIOSH was obligated to review available data, including documents and information, which supported the basis of the petition, and in fact, NIOSH solicited additional information at outreach meetings in May 2008.

If a review has been requested, three Department of Health and Human Services (HHS) personnel who were not involved in developing the proposed finding are appointed by the Director of NIOSH to complete the reviews and report to the Director. The Director of NIOSH considers the results of the review and then makes a final decision as to whether the submission satisfies the requirements for evaluation.

The petitioner received a letter from Dr. Howard [John Howard, M.D., Director of NIOSH] stating that a panel of three had presented findings and said the non-construction petitioner did not provide sufficient information to extend the class definition. The petitioner requested another review, because it was obvious that NIOSH had not complied with the requirements of its own Plan and the requirements set out in the regulations for the first review. For example, the 29 pages of minutes of the May 2008 meetings were not available to the panel, as far as the petitioner was able to ascertain. Also, there is no credible evidence in the FOIA [Freedom of Information Act] material [provided to the petitioner] that NIOSH found a way to make an independent determination about which hazards employees were most likely to be exposed to during their employment at SRS, because of the uncertainty and gaps in the monitoring data, as mentioned in the assessment.

In order to view what materials were reviewed by the panel, the non-construction petitioner requested that he be given the material relating to the decision of the panel, including a copy of the panel's report to Dr. Howard. There were no panel findings, reports, or recommendations contained in the material. There are also no records of the workers who gave information at the May 22, 2008, meeting. Because the Director withheld four pages of information that were presented to him from the panel, the petitioner has been prevented from determining whether or not the panel complied with regulations.

WORKER OUTREACH

[The interviewees, collectively, provided comments on their experiences with worker outreach meetings, as follows.]

At the November 2003 meeting, NIOSH was soliciting information to write the site profile. An interviewee never did understand what NIOSH's purpose was. Workers thought they were here to help, but they were disappointed. The Building Trades Council (BTC) had been screening and found out that the guys were exposed to beryllium. SRS said that there was no beryllium onsite. The BTC wanted to protect its workers. When [the meeting was over], this was the last the participants heard from NIOSH. The BTC never got any minutes of the meeting.

A NIOSH representative indicated to the CTW petitioner they had been able to obtain all the records they needed to prove electricians were monitored adequately. During a worker outreach workshop in Cincinnati, Ohio, one individual said DOE had agreed to furnish the records. DOE said the records would not be complete. If the records are incomplete, why doesn't NIOSH approve the petition? One of NIOSH's people said they had to go through the records. The petitioner was also told that NIOSH does not determine the SEC status. At the time, it sounded like NIOSH was going to approve the petition. It was an about-face when the petitioner got the letter.

In May 2008, NIOSH held a meeting to get information about construction and other workers, and to get information about missing monitoring data. Information was read into the transcript of testimony from a responder. They provided statements concerning surveyors. A participant at the meeting also talked about going out on the site without a badge. All of this information was there. They said, "…present information to get these people [operations workers] back." The non-construction petitioner and others did provide the information. NIOSH did not consider any of the other evidence that was presented, and they did not do any follow-up on what workers and representatives said.

At the meeting, the attendees cited the TBD and individuals working at SRS when badges were not worn on weekends. When participants gave the information at the May 2008 meeting, they showed names redacted, but they gave NIOSH tracking numbers for each one of these people, in order to get the records. The cases included someone who had been sent home in booties and raincoat without his clothes, and those records are not in his dose reconstruction. The interviewee expected that NIOSH would ask for the records of the people who spoke. In December 2008, NIOSH said that they had not requested the records, because they had other records that they said were sufficient.

NIOSH did not contact the CTW petitioner about the evaluation report. NIOSH has not paid attention to what workers say in the meetings. They never gave participants responses to their individual comments. The interviewees never saw anything that NIOSH incorporated into the site profile.

CPWR COMMENTS

[Interviewees working with the Medical Surveillance Program, collectively, provided information on their involvement in EEOICPA, information they have gained on SRS, their understanding of the NIOSH analysis of CTW dose, and the difficulties associated with determining CTW dose, as follows.]

The Center for the Protection of Worker Rights (CPWR) has a contract with the DOL [Department of Labor] to verify employment for construction workers when a DOE site does not have any records. It is not unusual that the DOE not only has no information on the worker, but also no information on the contractor. It is not unusual for the DOL to not be able to identify the company. Presumably, the central records database can be found from Atlanta. CPWR has established a database of contractors and subcontractors for the DOL. They can verify the name of the contractor, the contractor's presence at the specific site, and the time period when that contractor was at the site. They have various ways to verify employment, like dispatch records, health records, and so on. CPWR can usually get verification for 80% of the requests. For SRS, they have 399 specific verifications.

CPWR conducts interviews as the first part of a health-screening program to see if a worker is eligible for a medical examination, and to tailor the examination to the needs of that worker. This is a screening calculation to identify if they have a significant risk, and to try to help them medically. All interviewers are workers who know these sites in and out. This is done at every site. It is important for retired workers to do these interviews. It is proving to be a very good approach.

CPWR's computer program can calculate the exposures that workers were getting from their workplace, say to asbestos, or as a bystander near others working nearby. They have modules for beryllium, mercury, lead, asbestos, and silica exposure. Nearly everyone has asbestos exposure, so essentially everyone gets to go for a medical screening. They pick the chemicals up with blood tests and other tests. They do not have a radiation module, because there is nothing they can do for a radiation cancer that makes it unique. This is not a research project, so CPWR does not go into details about radiation. They go into details about trade, employer, period, areas, tasks, materials, and exposure incidents. They have identified 50-odd high-risk work tasks. For most of these things, they consider how much is the worker's own work and how much from people working around them. They have a five-point scale for exposure.

When asked if self-reported exposure information is reliable, a CPWR representative stated that they have done a lot of work on this. Workers do report low exposures to hazards. Electricians, for instance, will say "one" for silica or "zero" for beryllium. Ten years ago, 99% did not know what beryllium was. An interviewer can tell when a worker is not telling the truth. They have been provided with training. If an electrician says he was doing sandblasting, then the interviewer knows it is not right. But if he says he was near someone who did and says a "two" for silica exposure, then the interviewer's judgment is that it is right. Ninety percent (90%) of the people give you accurate information. CPWR interviewers do not question what the workers say in terms of writing it down. CPWR works with a doctor who looks at the statistical reliability of the data. Two epidemiologists are a part of the CPWR team serving as epi[demiological] advisors.

CPWR has supplied 83 significant site history documents to NIOSH, as was communicated in Attachment A of the petition. They have a repository of site history at the University of Cincinnati, which was developed so that interviewers would have an understanding of the sites for their interviews. CPWR has done 3,300 worker interviews at SRS. From the interviews, they have learned a lot about the site. They identified a list of additional radionuclides for NIOSH in 2003. They have given NIOSH everything they asked for. Cooperation with NIOSH is very tense, because CPWR keeps pushing the differences that construction workers have with operations workers.

A CPWR representative does not think anything they have given to NIOSH was incorporated into the SRS site profile with regards to the construction workers. This is part of CPWR's problem. CPWR raises an issue and NIOSH says, "We are working on it" or "We are developing a model." So CPWR is fighting a moving target, and it is impossible for them to keep track of all the changes. The interviewee has no idea as to whether NIOSH applies those changes to the cases and goes back to rework them. One group from NIOSH is going around telling workers to file SECs, while another part of NIOSH is saying they can do dose reconstruction.

NIOSH says if persons were not wearing monitoring in radiologically controlled areas, they were in violation of the procedures. This issue does not place a barrier on NIOSH to bound dose (page 69 of the ER). NIOSH says they are evaluating a coworker model on page 70 of the evaluation report. [Several questions and concerns were raised about this coworker model.] How do you define a coworker? NIOSH is very vague about how they define a coworker for dose reconstruction. There have been more construction workers than production workers. One of the critical failures of NIOSH's approach is not to classify people by occupation. When they have to identify workers as construction workers, they do a text search to determine that. It is hard to understand how they can exclude production workers from the SEC petition, because they themselves decided not to go through and identify by production and construction. At one point, they agreed that their general model for dose reconstruction was not valid for construction workers, and they agreed to re-do the SRS dose reconstruction procedure. They went and defined where the trades workers were. They use [text search] terms, and anyone they have a hit on is called a construction worker. Everyone else is a production worker.

At SRS, NIOSH says they can take an all-worker average, make an adjustment, apply it to construction workers, and everything should work out just fine. They can come up with a dose, but whether it is valid or not is anyone's guess. The coworker model says SRS had monitoring data in Health Physics Annual Radiation Exposure History [HPAREH] and those data are also similar to other workers. Construction workers are much more episodic than production workers. In one sense or another, all construction work is improvised. It is not routine in any way. Construction workers discuss work on the spot and work by experience and skill. NIOSH has not understood that or was not willing to accept that there was something special about construction workers. NIOSH says that unmonitored construction workers must also be similar to monitored workers. But just because monitored construction workers were similar to monitored operations workers, it doesn't mean that unmonitored construction workers are like monitored construction workers.

It is unreasonable to expect that claimants should define something that NIOSH itself has not defined. There is a gray area in main, renovation, or repair work. That can be in-house or construction workers. DuPont had full-time construction workers on site. DuPont said they would operate this site if they can do production with non-union and construction with union workers. See the 1946 and 1947 hearings; DuPont won that argument. DuPont directly hired people from union halls. There were also specialized subcontractors, like Miller Dunn, who did electrical work.

OTIB-52 [Construction Worker Procedure ORAUT-OTIB-0052] does not adequately cover the differences with construction workers. And so far as the SC&A review is concerned, the summary is favorable to the procedure, but this is different than the content of the review.

The 1999 hearings referenced [in the petition] by CPWR were the hearings that David Michaels[3] held as part of the law being passed.

[3] David Michaels, PhD, MPH, was the DOE Assistant Secretary of Energy for Environment, Safety, and Health from 1998 to 2011.

SEC EVALUATION REPORT COMMENTS ON SPECIFIC PASSAGES

[An interviewee provided specific comments on statements in the NIOSH SEC evaluation report.]

Page 20, paragraph 2: The independent ventilation system that they talk about failed at one time. Reversed air came into the room and people (office workers and such in the K Area) had to stay out for 3 weeks before they could go back in there. The ER missed that.

Page 20, bottom of page: The bubble tower crew was 9 to 12 people, and they were told to cut it and get out. There were all kinds of contamination in those bubble towers—radiation, asbestos, and all kinds of contamination. There was no monitoring equipment and no dress up—nothing. Electric Motor Service, the company they worked for, is not in business, and there is no record of it. Four of the people have claims; some others are dead.

Page 21, Tritium facilities (5.1.5): Buildings 236 and 238 are not mentioned. These are tritium buildings, as well.

Page 22, next to last paragraph: The list does not mention Building 321, where the final stages of the fuel rods were put together. It is now torn down. It was contaminated, and there was a tremendous amount of beryllium contamination there. Some people were checked and they took blood samples at 15 to 30 minutes and said there was none. So far as [the interviewee] knows, it takes 2 or 3 weeks to do a blood culture to check for beryllium.

Page 26, last paragraph: The Naval Reactor Fuels facility was crapped up at first start-up and never restarted. It has been torn down for some time; it is now a parking lot. The decontamination was done by production, and construction workers did the work.

MISCELLANEOUS

[The interviewees, collectively, provided additional comments they wished to include in the summary for consideration, as follows.]

- Until Hazel O'Leary [Secretary of Energy, 1993–1996], workers did not even know how much product was being produced.

- The Naval Reactor Fuel facility was started in 1985 or 1986 and is decommissioned now. The facility backed up to the F Canyon. A lot of people who worked in Naval Reactor Fuels have a nasty cancer, and a lot of those workers have large non-cancerous tumors in their organs.

- Each subcontractor's main goal is to get their bonus money and get contracts renewed, not help previous workers with problems that did not happen on their watch.

- All of the reactors used to drain out into those outfalls. There were mutated frogs and fish and all kinds of things.

- In 1981, one interviewee was sent out to LANL to work on the Molecular Laser Isotope Separation project with the Laser Isotope Separation Group in Technical Area (TA)-55. LANL and LLNL were developing an AVLIS [Atomic Vapor Laser Isotope Separation] technique for separation of plutonium metal. This involved vaporizing the plutonium into a gas phase, ionization, and subsequent separation. The interviewee was conducting cross section, spectroscopy, and physical experiments with plutonium tetrafluoride (PuF_4). The interviewee spent about one-fourth of the time handling PuF_4. LANL was responsible for his personnel radiation monitoring. He received an exit whole-body count, which was negative. The program ended in 1983 or 1984.

- A release of beryllium was documented during the meltdown in 105K. There is some beryllium locked up in a vault.

- One interviewee indicated he came back positive for beryllium sensitivity. In 2002, they flew him to Colorado for a test of his lung fluid. The doctor indicated the beryllium was not in the lungs. He did not think he would pick up beryllium with all the precautions taken.

Recommended References

Special Tritium Compounds in the Savannah River Technology Center, WRC-RP-2000-00705, August 3, 2000.

Metal Hydrides for Pumping and Storing: Studies of LaNi4 After Twenty-one Months of Tritium Exposure (U), DPST-89-366

Drawing of the Bed (Provided to NIOSH)

Tritium Focus Group presentations (available through Bob Rabun)

Personal tritium files of Bob Rabun

Tritium Facilities Incident No. 88-1-7, DPSP-88-1085

Tritium Training

REFERENCES

DOE 1993. *Radiation Protection of the Public and the Environment*, DOE 5400.5, U.S. Department of Energy, Washington, DC. January 7, 1993.

DOE 1994. *Radiological Control Manual*, DOE/EH-0256T, U.S. Department of Energy, Washington, DC. April 1994.

DOE 2004. *Radiological Control Programs for Special Tritium Compounds*, DOE-HDBK-1184-2004, U.S. Department of Energy, Washington, DC. September 2004.

ORAUT 2007, Parameters *to Consider When Processing Claims for Construction Trade Workers*, ORAUT-OTIB-0052, Rev. 00 PC-1, Oak Ridge Associated Universities Team, Oak Ridge, Tennessee. January 16, 2007.

SRS 2000. *Special Tritium Compounds in the SRS Tritium Facility*, DPD-TED-2000-00081, Savannah River Site, Aiken, South Carolina. August 25, 2000.

ADDENDUM

SC&A submitted a draft of this interview summary to Savannah River Nuclear Solutions, L.L.C. (SRNS) for classification review in December 2011. When the document was returned to SC&A, a letter from Karen Brown, Worker Health Studies Program Manager for SRNS to Lynn Ayers of Saliant, Inc. (subcontractor to SC&A) was enclosed. Ms. Brown's letter states, "During the course of the review, personnel in the Classification Office familiar with the history and operations of the Tritium Facilities identified concerns about the accuracy of certain information presented in the summary." The concerns are listed in an attachment to the letter (Brown 2012).

With CDC approval, SC&A forwarded the letter and a draft version of this Addendum to the three interviewees involved to inform them of the concerns and questions raised, as well as SC&A action taken. One of the interviewees provided a response.

Where conflicting observations and statements about a site are received from site experts, SC&A's typical practice is to retain both perspectives in the summary report. This Addendum presents the concerns and questions verbatim from Ms. Brown's correspondence and describes the actions SC&A has taken in regard to each issue, as well as contextual material and the interviewee's response. We are finalizing this interview summary, since it contains a great deal of material that is under discussion in the SEC petition relating to the site that is under review. We will issue a revision of this interview summary if any further interviewee responses are forthcoming.

For each comment sent by SRNS, SC&A created a set of entries in the following table (Table 1):

- "Reference:" The referenced item, page, and paragraph.
- "Quote from Draft Summary:" This reproduces the passage from the draft interview summary to which SRNS made reference.
- "Accuracy Concern:" This reproduces verbatim the concern expressed by SRNS.
- "SC&A Action:" This states the action that SC&A took in response to the concern.
- "Response from Site Expert:" This presents an interviewee's response concerning one of the issues.

Table 1: Context, SRNS Concern, SC&A Action, and Interviewee Response (if applicable)

Reference	Page 18, first paragraph under "Weapons Program Operations"
Quote from Draft Summary	"Reservoirs are designed by Lawrence Livermore National Laboratory (LLNL) and Los Alamos National Laboratory (LANL). The Rocky Flats Plant design (reservoir design on the early bottles) was built at the Kansas City Plant (KCP)."
Accuracy Concern	The Rocky Flats Plant and Lawrence Livermore National Laboratory (LLNL) did not design reservoirs. Reservoirs were designed at Sandia and Los Alamos.
SC&A Action	Because the reservoir design site information does not make any particular point about radiological hazards or controls at Savannah River, SC&A revised the text to read: "Reservoirs were designed at other DOE sites."
Reference	Page 24, third paragraph
Quote from Draft Summary	"Building 233H operations are based on a temperature range of 50°C to 500°C to generate all pressures. If you change the amount of aluminum in the storage material LaNiAl, you can affect the vapor pressures. You can adjust the amount of aluminum by replacing nickel with aluminum. The metal hydride storage and process beds reduced the releases of tritium to the environment. Prior to this, the tritium went up the stack."
Accuracy Concern	Concerning Building 233-H, the reason stack releases are almost non-existent is due to the use of a closed glovebox system with a stripper system. The use of hydride beds will greatly decrease the tritium that escapes the atmosphere <u>in the event of a catastrophic failure</u> (e.g., earthquake) during which the piping is opened up to the atmosphere.
SC&A Action	SC&A inserted a note in square brackets at the end of the sentence to direct the reader to this Addendum.
Reference	Page 25, first sentence
Quote from Draft Summary	"NiZr tritide is a new material being handled. The new MOX [Mixed Oxide Fuel Fabrication] Facility will have plutonium tritide."
Accuracy Concern	MOX will not have plutonium tritide.
SC&A Action	SC&A inserted a note in square brackets at the end of the sentence to direct the reader to this Addendum.
Reference	Page 26, top of second paragraph
Accuracy Concern	Should STS be SRS instead?
SC&A Action	SC&A corrected the typographical error.

Table 1: Context, SRNS Concern, SC&A Action, and Interviewee Response (if applicable)	
Reference	Page 28, next to last paragraph
Quote from Draft Summary	"[Between 1984 and 1986, a building addition was constructed above the FB-line.] There was an extra floor added to the top of the building. The original building is concrete, but the additions were made out of blue metals. There were hundreds of construction workers, all crafts, working on that addition. It was considered new construction and the area was considered a clean area. There were no radiological postings and the workers were not monitored. Although it was considered a clean area, there was hot air coming out of the stacks of the FB-line. The chutes coming out of the FB-line (a tremendously hot area) were opened periodically to the vents. All the air in the hot canyon area came out on the ladders right next to the vents. There were all kinds of construction workers that worked out there that received doses that were not monitored."
Accuracy Concern	Air from the hot canyon did not exhaust to the roof. It went out the stack via 292-H fan house and through the sand filter.
SC&A Action	SC&A inserted a note in square brackets at the end of the paragraph to direct the reader to this Addendum.
Response from Site Expert	The site expert responded by telephone to provide clarification about the situation described in the interview summary. SC&A recorded the response as follows: The site expert agreed with the SRNS observation regarding the stack location. The air exchange described in the interview summary was from roof vents that could open and close, not from a stack. When the vents opened, workers felt air coming up from below, so people working close to the vents were exposed to the same air as the workers below. The workers below were dressed out to work in a hot area. The workers on the roof were uneasy about this. They had no way to know if they were exposed or not, because they were not monitored.
Reference	Page 45, last bullet
Quote from Draft Summary	"An interviewee had worked with an old gentleman who got blinded out there. He was hurt by a crane and could only see out of the sides of his eyes. They said they had not seen eye damage like that except for Japanese bomb blasts and long-term welders. There were no records of the incident."
Accuracy Concern	It is unclear what is being described here. There is a reference to an "old gentleman" being hit by a crane. His eye damage was compared to a Japanese bomb blast. Was the eye damage described a result of radiation exposure or some other trauma?
SC&A Action	SC&A inserted a note in square brackets to direct the reader to this Addendum. The inquiry was directed to the interviewee.

Reference:

Brown, K. 2012. Letter from Karen Brown, Savannah River Nuclear Solutions, L.L.C., to Lynn Ayers (Saliant/SC&A), ESH-WHS-2012-0016, January 24, 2012.