National Institute for Occupational Safety and Health (NIOSH)
SEC Outreach Meeting for Nuclear Metals, Inc.

Meeting Date: Thursday, March 15, 2012, 9:30 a.m.

Meeting with: Former Workers from Nuclear Metals, Inc., Concord, Massachusetts (Second of three meetings)

NIOSH Team:

Samuel Glover, PhD, National Institute for Occupational Safety and Health (NIOSH) Division of Compensation Analysis and Support (DCAS), Health Physicist

Joshua Kinman, NIOSH DCAS, Special Exposure Cohort Petition Counselor

Edward Scalsky, Oak Ridge Associated Universities Team (ORAU), Health Physicist

Vernon McDougall, Advanced Technologies and Laboratories International, Inc. (ATL), Outreach Project Manager

Mark Lewis, ATL, Senior Outreach Specialist

Mary Elliott, ATL, Technical Writer/Editor

Also Attending:

Bob Barton, Sanford Cohen & Associates (SC&A), Health Physicist

Proceedings

[Name and identifying information redacted] of Nuclear Metals, Inc., opened the meeting at 9:30 a.m. He welcomed the representatives of the National Institute for Occupational Safety and Health (NIOSH) and its contractors. He explained that NIOSH had asked him to organize the meeting. In response to the request, he had contacted many of his former employees and friends from Nuclear Metals, Inc. He thanked them for coming to the meeting. [Name redacted] introduced Vernon McDougall of ATL.

Mr. McDougall introduced the NIOSH team. He stated that Ms. Elliott would be taking notes and making a recording to produce minutes that will become the public record of the meeting. The recording itself would not be a public record. Mr. McDougall added that the final minutes would be published on the NIOSH Web site, but would not include the names of the attendees or any other personal information that might identify them. He asked the attendees for permission to record the meeting. They granted their consent.

Dr. Glover stated that NIOSH asked for the meeting to gather information to help evaluate a SEC petition for Nuclear Metals. He explained that classified information should not be discussed during the meeting, but that NIOSH can arrange for private, secure interviews with anyone who has that type of information.

Mr. McDougall explained the EEOICPA compensation program and that for the former workers from Nuclear Metals, the program is primarily for compensation for cancer related to radiation exposures and for respiratory disease related to beryllium exposure; the program does not cover exposures to asbestos, solvents, or other materials for Nuclear Metals workers. This meeting is only about radiation exposures.

Mr. McDougall explained that when an energy employee (or the survivors of the employee) files a cancer claim with the United States Department of Labor (DOL), DOL turns the claim over to NIOSH for dose reconstruction. NIOSH reconstructs the worker's dose using any available information about the employee's work history and radiation exposure to calculate the probability that the employee's cancer is related to the workplace radiation exposure. The claimant may be compensated if the dose reconstruction process determines that the cancer is more likely than not related to the radiation exposure.

Mr. McDougall explained that some facilities in the nuclear weapons complex do not have sufficient records for NIOSH to reconstruct the workers' radiation doses with reasonable accuracy. If NIOSH finds that it cannot accurately reconstruct the radiation doses, then they can recommend to the Advisory Board that the workers be added to the SEC.

Mr. McDougall stated that former Nuclear Metals workers had filed an SEC petition that is now being evaluated by NIOSH. NIOSH will write a report to the Advisory Board that will recommend either to add, or not to add, a class of former Nuclear Metals workers from a specific time period to the SEC. The Board will then make their recommendation to the Secretary of the Department of Health and Human Services (HHS).

Joshua Kinman stated that he had brought handouts with information regarding the SEC petitioning process and showing where the Nuclear Metals petition currently is in that process.

Mr. McDougall explained that if the Nuclear Metals SEC petition is successful, people who file claims for 22 types of radiation-related cancer will not have to go through the dose reconstruction process. He noted that NIOSH had brought a fact sheet on the SEC than includes a list of the 22 cancers. Mr. McDougall stated that the primary reason for the meeting was for NIOSH to gather information from the workers that might help NIOSH in the evaluation.

Ms. Elliott asked the attendees to identify themselves when they spoke so that they could be contacted if NIOSH needed to follow up with them for more information. She reiterated Mr. McDougall's earlier statement that they would not be identified by name in the minutes that will be posted on the NIOSH Web Site.

Mr. McDougall turned the meeting over to Mr. Scalsky.

Mr. Scalsky: We will use the handout for talking points for this discussion. The purpose of the discussion is to give NIOSH a better understanding of the operations at the Nuclear Metals facility in relation to the workers' radiation doses – the research, the production of reactor fuel rods, penetrators, powder manufacturing, and the processing of uranium greensalt (UF_4). This information will aid us in evaluating the SEC petition. It may also help to improve the dose

reconstruction input data. And, hopefully, it will give you a better understanding of the dose reconstruction process – what goes into it and what has to be done in order to determine the workers' doses.

This is the background information that NIOSH has about Nuclear Metals: The work was done at Massachusetts Institute of Technology (MIT) from 1942 to 1946. The workers during that time did research for the Manhattan Engineer District (MED), and melted and cast uranium. The MED work was moved to the Hood Building at MIT in 1946 and continued when the Atomic Energy Commission (AEC) took over the work in 1948. Nuclear Metals, Inc. was established as a private corporation in 1954 and continued the work at the Hood building until 1958. Nuclear Metals constructed a new facility in Concord for the research and development (R&D) and production of specialty metals. The new facility was occupied in March 1958. The documents that we have indicated that work with low-level radioactive materials began in October 1958. We think that the equipment may have been moved to the new facility from the Hood Building. Does anyone know when the fuel element work started at NMI?

Worker 1 The fuel element work with enriched uranium was continuous from the early 1940s until sometime in 1973. There was also some fuel work after that, but not with enriched uranium.

Worker 2: This morning, some of us became aware for the first time that the concentration of the material was considerably higher than the 1-1/2 to 3% uranium. I would like to explore that to see if anyone recalls any work that may have involved more highly enriched uranium.

Mr. Scalsky: NIOSH has documentation indicating that NMI handled uranium enriched as high as 90 to 93%. We will get to that later. When did the Department of Energy (DOE)/Department of Defense (DOD) work start on the depleted uranium penetrators?

Worker 1: Our work on the depleted uranium penetrators started in the early 1960s during the Kennedy Administration.

Mr. Scalsky: How long did that work go on?

Worker 1: Until the late 1980s, maybe early 1990s.

Worker 3: In 1998, the company made the decision to no longer manufacture the depleted uranium penetrators for the Army.

Mr. Scalsky: NIOSH knows that you did a lot of work with depleted uranium. We know that NMI produced 500,000 rounds per month on the GAU-8 line; 350,000 20-millimeter (mm) rounds per month on the phalanx line; 8,000 120-mm rounds per month; and also 110 tons of steel powder per month. You also made airplane counterweights, metal powders for medical applications, and for photocopiers. Are you aware of other jobs that were done with the depleted uranium?

Worker 3: We had commercial business applications for the fabrication of specialty uranium alloys and other products. We did toll work for the Army Research Labs for advanced materials; armored materials, also for the Army. We made commercial and medical shielding devices;

sinker bars; explosive shaped charges for oil exploration; and in addition to the kinetic energy penetrators, there were (inaudible) process penetrators. We made the aircraft counterweights from depleted uranium as well.

Worker 4: We also made containers for radiopharmaceutical applications, specifically for technetium-99. [Name redacted] mentioned the shields for industrial (inaudible) applications.

Worker 2 to Workers 3 and 4: Here is a question that could be important for NIOSH: Do you recall the work split between the government activity with the uranium and the commercial products? Was it 80/20, 70/30?

Worker 1: It was probably 96 or 97% government-related work for the Army, the Marine Corps, and the Navy as well. [Name redacted], can you add anything about our work with the steel powders and other powders? I know we made uranium powders at times.

Worker 4: I began working in 1972 as a technician and I left the company in 2001. After college, I worked in a professional capacity. I made the uranium powder. We had a piece of equipment for specialty work in the middle of our foundry. The foundry melted and cast the uranium. We also used that piece of equipment when we made titanium powder for aerospace applications. We also made powders for cobalt alloys and titanium alloys for medical orthopedic applications. We did some work with rare earth elements for cryogenic cooling applications, nickel-based super alloys for jet engine and jet engine repair. So, the business evolved from about three or four million pounds a year specifically for one customer to a more diversified product line. I don't recall any of the applications for the depleted uranium powder in the early 1970s.

Worker 2: I was involved with the depleted uranium powder, too. We actually used some of that powder in developmental work on composite penetrators. We filled small extrusion cams with the depleted uranium powder blended with tungsten wire, and coextruded it to improve the (inaudible) elasticity of the composite for improved stiffness. Then we applied the composite of uranium powder and tungsten to advanced penetrator applications.

Worker 5: I started working at Nuclear Metals in 1976. Just to add to what [name redacted] said, I made beryllium powder using that same machine on my first day on the job.

Worker 3: For one of the larger volume products, we used the depleted uranium powder to make feed stock for DOE for the AVLIS (Advanced Vapor Laser Isotope Separation) Program. That product was cast from both depleted uranium and natural uranium, and then the cast was extruded and further processed to support new enrichment technologies. We produced tonnage quantities of that material over a period of approximately 15 years.

Mr. Scalsky: How about work with thorium?

Worker 3: My familiarization with thorium was the powder form that we used in the toll conversion process. We received the thorium powder, which we blended with other constituents. We pressed the powders into a form, put the composite material through a heated extrusion

process, and then processed the material through machining and grinding. Finally, we tested the product before shipping the feedstock to the end customer.

Worker 2: What year was that, [name redacted]?

Worker 3: I was an engineer, so this process would have been between 1980 and 1990. So we processed thorium powder into solid form, and then sent it elsewhere to be reprocessed.

Mr. Scalsky: How much powder? What was the magnitude of that?

Worker 3: We typically were working in 25-pound lots, two to three times a year in its purest form. It was not unusual for us to get feed materials that contained thorium that we processed in smaller quantities. But in most cases, when we did an order for Army Research and other areas, we didn't know the exact concentration of thorium in the material that we were processing. But even in pure form, that would be traditionally (inaudible).

Worker 6: We had constant contact with thorium and thoriated tungsten, which was used in (inaudible) process. It was 2% thoriated tungsten. I don't know if that was the same for all rep processes.

Worker 7: I did conversion work back in 1967 through 1970, converting solid material thorium from Tennessee Nuclear Services into rod stock, and then into finished bar stock.

Worker 8: I was in charge in those days, part of administration in the machine shop and storage areas and purchasing, and so forth. When we finished working with the thorium, it remained in our storage areas for the longest time. I sent letters at that time to the AEC office in New York City, trying to get them to remove it. It went on forever. Finally, they did authorize us to remove it.

Mr. Scalsky: What did you do with it?

Worker 8: We shipped it out for burial somewhere.

Dr. Glover: The original thorium came from the Hood Building to NMI, correct?

Worker 1: Yes, as I recall, the AEC did not respond to [name redacted] letters asking what to do with the thorium, even though it was their property. The material sat around for a long time and it was eventually buried on NMI property. When they surveyed the facility, the most radioactive thing they found was a granite boulder. They didn't find the thorium. I don't know how deeply it was buried. They didn't find it until six or seven years ago, maybe a little longer than that. It was news to me at the time and was removed. There were thousands of pounds in storage. How much they got out in barrels, I don't know. Someone should have records of that. Do you know, [name redacted]?

Worker 3: No.

Worker 8: The AEC didn't want anything to do with it. I kept sending letters off to them and they wouldn't reply. They were hoping somehow it would disappear, which of course it didn't.

Mr. Scalsky: The depleted uranium penetrator process began with the depleted uranium melt, which was poured into yttrium-coated molds to form ingots. The ingots were slipped into copper tubing, welded into the tubes, which were evacuated, and then crimp-sealed to form a billet. The billets were extruded into rods and the copper sheet was removed by pickling. The extruded rods were straightened and cut into blanks by sawing. Then they were outgassed, which caused some distortion in the rods. After cooling and heating, the rods were again straightened, aged, and then turned into their final configuration. Which of these processes could have caused airborne contamination?

Worker 2: You are including the ingots stage. In fact, we started with UF_4 production in this time period.

Worker 6: I think a process is not mentioned here in this list. During the (inaudible) process, (inaudible) to swage points on some of these bars.

Mr. Scalsky: This is just a general description of the process. I know there are a lot of details that are left out of the individual processes here.

Worker 6: Well during this process, the material flaked a lot. Sometimes, it even sparked.

Worker 1: I think you should add the inspections to this list for thorium. There was a lot of handling during that timeframe. They were taking off burrs while they were handling the bullets. Some of the folks talked yesterday about that step in the process. During the inspections, handling was a huge portion of the operation.

Worker 5: After I worked in the reps, I worked in the facilities. I can speak directly to most of these. All these operation could cause airborne. The question is: Was it Class Y, Class D, or Class W? In the 1970s and early 1980s and until the rule change happened, the only thing Nuclear Metals was looking for was 10 micrograms (µg) of uranium per liter of urine. Most of the air sampling was done with stationary air samplers, very few (sounds like) easy eights were pulled. The intent was to look for kidney toxicity. I did many of the operations that you just mentioned – I cut the bars, machined the bars, straightened the bars, pickled the bars, outgassed the bars, and aged the bars. All of those operations were done and documented that they were all exposed hot to open air, so the uranium went from uranium to uranium oxide on the surface, which, as mentioned earlier, is particularly tenacious. Now you're also talking on a refractory level, and refractory-level oxide is (inaudible). So chemically, it's very volatile (?).

Worker 3: I wanted to comment about the exposures. Because of the sheer volume of uranium that was being processed in the facility, the depleted uranium was throughout the building. It was not uncommon for thoroughfares and hallways to have tonnage quantities of semi-finished or finished product staged for the inspection area. The manufacturing area was in Building C and Building E, but the inspection area was actually in Building A, so the finished material waiting to be inspected was adjacent to the common areas such as the cafeteria and the office areas. Any employee walking through the facility, whether it was a secretary in the front office or a worker

in the production area, was exposed to depleted uranium. For at least 20 of the years that I was there, depleted uranium was found throughout the facility and not restricted. It wasn't until later in the production cycle that we contained it in a single area.

Worker 5: In fact, in the late 1970s and early 1980s, on the second floor of Building A, the floor was taped off so you knew where to put the penetrator baskets, because they didn't want to have the floor closed.

Worker 4: Just to add to that, the (inaudible) was the powder business. The operation that produced the steel powder was adjacent to the foundry. There were no boundaries or walls to separate the areas, so airborne material or (inaudible) could and did fall on equipment in the foundry. People who were working in the non-DU areas still had the possibility of exposure.

Mr. Scalsky: Was that in Building D?

Worker 4: That was in Building C with the foundry.

Worker 9: Building D is where all the heat treatment and etching was done. There was also was a treatment that included solutionizing, quenching, high temperature heat treatment, and aging. Part of the process was to open up the vacuum furnace, expose the red hot uranium to air so a lot of oxide was formed, and then quench it in a pit of water. During that operation, the uranium produced the most scale, certainly more than aging, which was an inert gas. That generated a lot of uranium oxide.

Worker 10: I started in 1979. I worked in the foundry. There was a lot of airborne. As [name redacted] just alluded, everything was open between the areas. We had what we commonly called "boomers." When we opened the furnace, moisture got into the magnesium underneath the head plates, and it sounded like a 12-gauge shotgun going off. The reaction produced so much smoke that the employee who was standing by the furnace would just about disappear in the smoke. This was a common occurrence, and since we had an open floor, the smoke drifted up and through the building so anyone working in any of the other departments was also exposed to that smoke. These explosions were strong enough that there were times when the percussion of the explosion would actually shatter the quartz furnace. I was never knocked unconscious, but I was knocked off my feet from that percussion on a very regular basis. When I first started working, there wasn't a lot of containment. We literally pulled a 3 x 3 piece of sheet metal off a hood, and then opened up the hood door. We had a 6-inch suction hose, but we were right in the middle of that column of smoke along with the other workers who were on the tower over the furnace. There were many times during high production when we reheated the crucibles to oxidize the uranium slag that was left on the crucible so that we could keep up with production. When the crucible cooled, we brushed the sides to clean them, handpicked the heavier pieces of slag, and washed the oxides into the bottom of the crucible so we could re-melt it. We were working over the crucibles, and the materials were "hot." There was really nothing to contain that.

Also, there was a lot of overtime. I started working on [identifying information redacted]. I worked from 8:00 a.m. to 4:00 p.m., and at three o'clock they asked me if I wanted to work

overtime. So the next morning, I started at 5:45 a.m. and worked 10-hour days. That was a normal work day.

Mr. Scalsky: We will talk about overtime in a little bit. That is the kind of information that we need to know.

Worker 5: I want to say something about RSO. In 2011, this (inaudible) was still at it, and the Concord facility wanted to release three rep machines – #5, #7, and #8. Five and seven were actually installed before a dividing wall was put up between the foundry and the rep department in the mid-1980s. Those machines had to be stripped of paint in order to meet pre-release because the paint was actually holding the contamination in place instead of providing shielding.

Worker 11: I worked in the health physics department from 1974 until 2001. When we first started to develop the GAU-8 line, the process started with the machine shop. There were a lot of problems. We continuously smelled uranium in the air. There were fires constantly starting at the lathes. There wasn't much monitoring. There was no bioassay. I worked a rep machine with [name redacted]. We worked a lot of overtime. There was a lot of airborne exposure.

Worker 7: We don't have it on the list, but the reduction of UF_4 was a big item that we discussed yesterday.

Mr. Scalsky: That's the next topic.

Worker 12: I remember when they were removing the asbestos from the far corner of Building C – away from the foundry. When the independent hygienist took the air sample for the asbestos, he couldn't take it from the building because it was too "hot."

Dr. Glover: Did the urinalysis program continue from the very beginning, or did it start in the 1970s?

Worker 5: I collected records for NIOSH and sent them off. From the late 1960s until 1981, there was a dearth of records. I didn't find bioassay records. It was really hard even finding external monitoring records. The bioassay program really started – the first time I remember giving a bioassay sample was in 1981. [Identifying information redacted] ran the bioassay laboratory in 1984. But the first time I remember giving a sample was 1981, and I worked there since 1977.

Worker 1: The bioassay program began in Cambridge. It may not have been frequent in Concord. I can't say that it was or wasn't.

Worker 2: All employees had to give urine samples, including the secretaries.

Mr. Scalsky: We will cover bioassays in a little bit.

Worker 3: One other comment on foundry operations: We learned later on that melting and casting the uranium derby produced daughter products. There was a tremendous amount of radiation that would come out as a result of the melting and casting operation. We learned later

that these daughter products had a decay time. The health physics department started enforcing a "cooling off" period before the foundry workers could handle the crucibles and other melting equipment to clean it up. I think it was about a month before they were allowed to brush out the crucibles, essentially using wire brushes to reprocess these. Before that, the cleanout was done as quickly as the day after the melt. So, many of the foundry employees were getting extremely high doses from the daughter products. The safety measure was put in place for them, but we went many years without knowing that we needed to take these precautions. All of those crucibles were stacked up adjacent to a clean area at Concord. They were just put into one area.

Worker 2: Wasn't there a transitional period? Along with the identification of (inaudible) area and the shielding… Originally, the crucibles may have been just put in an area to cool, and then they were put into 55-gallon drums. I think that was found not to be totally effective, so we built a shielded room in the 1980s. There was an evolution there, too. Many of us who didn't actually work in the foundry also spent a lot of time there. We were also getting exposed to these same things before we had the shielding in place.

Worker 7: That is a very good point. First we would set them aside in an area, and then later we learned that we had to put them into 55-gallon containers to shield them while they decayed, and later we found that we had to put all of these in another room to isolate them from the workers. All along people had free access to (inaudible).

Worker 10: There was a six-week storage time if we had enough graphite available. Then the equipment was brought back into the foundry. But then we loaded the crucibles onto racks, and we pushed them into a burnout oven. So, essentially, we heated those daughter products and started the whole process again because they were now hot. Basically, that turned the slag into oxide. They were processed immediately afterwards.

Mr. Scalsky: Initially, the UF_4 was furnished by Tennessee Nuclear Specialties. Later in the 1970s, it was acquired from the government. The drums of UF_4 were emptied in the blender…

Worker 1: It's not accurate to say that UF_4 was supplied by Tennessee Nuclear Specialties. Initially, it was supplied by the government. Tennessee Nuclear Specialties supplied us with derby metal. They were our major source of derby for a long time, although we had gotten other derby or derby-like materials from the government earlier than that. I can't remember TNS ever supplying us with UF_4.

Worker 3: I worked in the inspection department, so I was aware of the early UF_4 and where it was coming from. And that was definitely supplied by the government.

Mr. Scalsky: We will make that correction. The drums of the UF_4 were emptied into the blender, mixed with magnesium granules, transferred to the bomb, capped with graphite, and slowly heated in a pit furnace. After cooling, the bomb contents consisted of a layer of magnesium fluoride and an approximately 1,800-pound depleted uranium derby. I understand that when the drums were emptied into the blender, some of it could get on the floor and would have to be shoveled back into the blender. Is that your experience?

Attendees (consensus)**:** Yes.

Worker 11: That was haphazard. The blending area leaked profusely. The greensalt would get all over the floor. Then they put it into the torts, and they used an air hammer to compact it. There were a lot of problems in that area.

Worker 10: In the early days, it was mixed. Two 55-gallon drums were actually put together, and those were set in place during the first weeks of the process. Then we graduated to the blending equipment, which had a tendency to overflow the vessels. When that happened, you lost all the venting. I worked out there for a while. Sometimes an open vessel of greensalt hit the floor. That greensalt spread all over. The venting out there—and it wasn't all the time, but it happened enough – if you lost the belts, the vents in the roof, the vents would shut down and that whole area would fill up with greensalt. It was just in the air. Occasionally, the greensalt would react and eat through the two graphite plates and the one-inch steel cover. Then it would eat through the insulation. The steel cover would be hit first, it was in. I know of two occasions when the flame hit the ceiling, which was twenty-some feet above where they would blow out the side and hit the pit furnace next to it. That would clear the building. That would fill the building up completely.

Mr. Scalsky: Was there an alarm to indicate that you should evacuate the building?

Worker 10: No, it was more common sense. You left. You couldn't stop what was happening when you had a burn through. That wasn't going to happen, so you just left the building. You left the area.

Worker 3: We had a system to call the security department if it was a very severe release, and they would pull the alarms. Then the guard called for everyone to stabilize their jobs, leave the building immediately, and then go to a central point. But if it was just a process-related anomaly, it may not have been enough to evacuate. There was an explosion on record – and I know that the NRC became involved – where, in the middle of the night, one of the vessels blew and covered the inside of Building D from the reduction process. In fact, it was publicized in the paper. We had to get a cleanup crew in because it covered the machine shop area adjacent to the reduction facility. They had to clean off the roof and everything because the white residue from the hypothermic reduction of this derby production spewed beyond the area where they were making derby, and then went into the main part of the building.

Mr. Scalsky: That happened on the third shift?

Worker 3: It was a third shift incident. There were a few people in the building when we arrived. The fire department was notified. We got everything stabilized, but it was a recordable event.

Mr. Scalsky: What was the time period for the UF_4 work? How long did it last?

Worker 1: The reduction in Concord?

Mr. Scalsky: Yes, before it was moved to Carolina Metals.

Dr. Glover Yesterday, we said that maybe it started in the mid-1970s. Is that about right?

Worker 5: Building D was actually built in 1976 and opened in 1977. My recollection is that it started in 1978 and it ended in 1983 or 1984 when Carolina Metals was opened for reduction.

Mr. Scalsky: What happened to the UF_4 processing area when the work was shifted to Carolina Metals? Was it decontaminated or was it just reused?

Worker 5: It was reused actually. That's where aging and solutionizing was.

Mr. Scalsky: But there was decontamination of the area?

Worker 5: No. It was just vacuumed. It was being used for more depleted uranium work, so why would you decontaminate?

Mr. Scalsky: The next topic is thorium. We have a lot of documents that we haven't gotten to yet and a lot of records that we have to look at. There were three thorium jobs that we know about: the billets from Tennessee Nuclear Specialties for rod stock, the billets that became the thorium powder, and the R&D on thoriated tungsten welding rods, which somebody said just a while ago. Can you provide any details on thorium processes or other jobs that used thorium?

Worker 3: We did toll fabrication of thorium powder and blended thorium powders. We were supplied the ingot thorium. We processed that through blending, screening, compacting, putting it into canisters for extrusion, and then extruding the thorium. Following the extrusion, we removed the canned material either chemically or mechanically, and processed it through machining and testing, to the end product of consolidated thorium bar stock. In addition, we also processed thorium alloys from supplied powder blends or ingots of materials containing thorium. We never knew how much thorium would be in there. We did solvent processes and processed these things into solid bars.

Worker 2: When?

Worker 3: I was an engineer then, so it was from 1980 until at least 1990 when we did the toll work with specialty products.

Worker 2: Who was your customer?

Worker 3: We did some research projects for AMRAC, the Army Materials Research lab in Watertown. We did some work for Alpha Ventron, which was a fabricator and vendor of specialty metals to the nuclear industry.

Mr. Scalsky: Do you know the quantities of thorium that might have passed through the facility?

Worker 3: Not specifically, but in general terms, we processed lots of 10 to 15 kilograms of input material. This work was not considered to be large batches like our other products.

Mr. Scalsky: The 1981 license indicates that you were authorized for about 25,000 kilograms.

Worker 3: I was never aware of having that level of material. We called that toll conversion work. We received the material and processed it and returned it to our customer. We held on to the scrap metal. When that accumulated, we disposed of it through our low-level disposal process.

Worker 1: We extruded so many different materials. We extruded marble. I don't know about the marble. I know that granite contains a lot of natural uranium, but we extruded marble. It worked, too.

Mr. Scalsky: The next page shows a diagram of the facility. The diagram will aid us in understanding the movement of materials and the traffic patterns that took place. Buildings A, B, and C were built in 1958; Building D was built in 1978; and Building E was built in 1984. Building A was the labs base: chemistry, metallurgy, applied physics, and other labs. Building B had the boiler room, electrical switch room, locker rooms, clinic, cafeteria, and perhaps other areas that what we would consider to be non-controlled. Building C was the foundry that had all the processes that we have been discussing. Building D also had some of the processes: the pickling, rod straightening, aging, and machining. The reduction area was also in Building D.

Worker 3: It was located in the spot marked 'large cab, heat treat, and machinery.'

Mr. Scalsky: Building E was added in1984 to provide additional space for finishing, QC, materials storage, liquid waste treatment, processing the waste materials for shipping, and general waste area activity. Is there anything else?

Worker 5: First of all, the present location of Butler B3 is located as shown, but before Building E was constructed, it was actually outside where the waste packaging area is shown. So the uranium waste was trucked outside to be processed. The charge prep area was in B3 at one point, and it was also in B1. So the uranium charges were made and trucked through (inaudible) before. Does anybody know if that actually changed when Building E was built?

Worker 3: The inspection area was in Building A on the second floor. A tremendous amount of depleted uranium was migrated into hallways and common areas as a staging area for the inspection department.

Unidentified attendee: And close to the cafeteria.

Worker 3: The metallography department was on the first floor across from the President's office. That's where all the grinding, polishing, and inspection of the sampled materials, as well as chemical etching. The metallography area was also an open area.

Mr. Scalsky: Let's talk about the work schedules. Work schedules are taken into account during dose reconstruction. Over a period of time, there were three shifts, but this wasn't true for the entire period of time from 1958 through 1983.

Worker 1: I'm trying to remember exactly when we started having three shifts. It was probably 1973 or early 1974. But it started in the powder room for Xerox Corporation. And then it was later in the 1970s that it came into play with the depleted uranium work.

Worker 3: In 1976, I was hired as a third-shift employee in the uranium operation. It likely started before then.

Worker 4: I was hired to work in the powder operation in 1972 when I was in still in high school. At that time, the powder operation was running two shifts. I was working the night shift. We went to three shifts about two years later. In 1977, we were not only running three shifts, we were also running 16 hours on Saturday and Sunday. It ramped up pretty quickly in the powder operation. That probably continued up through 1983.

Worker 10: In the foundry, a typical day was 10 hours with 6 to 8 hours on Saturday and 4 to 6 hours on Sunday. We had two shifts. The first shift started just before six o'clock in the morning. A second group came in at 8:00 a.m. since there were two furnaces and one generator to power them, so the shift was staggered throughout the day. It was the same thing on second shift. Because we would work overtime, that meant that second shift worked with very hot furnaces. Second shift worked so late into the night that when we came in at 6:00 a.m., we worked on hot furnaces.

Mr. Scalsky: Ok. You said typically it would be a 10-hour day?

Worker 10: There weren't many people who worked 8-hour shifts.

Mr. Scalsky: Would that be everybody?

Worker 10: That was pretty much everybody. We had a plant manager who was very persuasive. On Fridays, he would come through and say, 'Are you working this weekend?' And you know, people would just say, 'yes we are.' He came to one particular gentleman who said, 'I'm not working this weekend.' The question was resubmitted to him again, as if it had never been asked the first time. So the third time the plant manager asked the question, the employee finally said, 'Yes, I will be in here this weekend.'

Worker1: We also had 16-hour shifts on the weekends. We had some employees who worked two 16-hour shifts on Saturday and Sunday, and that was their work week.

Mr. Scalsky: That was a full work week for them?

Worker 1: Yes, two 16-hour shifts were a full work week for some employees.

Mr. Scalsky If the typical was 10-hours a day, how many days a week did you work?

Worker 10: I worked 10-hour days Monday through Friday, and then worked a 6- to 8-hour shift Saturday and maybe 4 to 6 hours on Sunday. I worked every day for months.

Mr. Scalsky Then we had the 16-hour days, two 16-hour days…

Worker 8: We had certain employees who only wanted to work two 16-hour days on the weekend. They didn't work overtime.

Worker 3: Because we had production contracts to satisfy, there were opportunities for many people to work extended shifts. The company started incentive programs that would pay you for 12 hours if you worked 11 hours and 15 minutes, so they paid your lunch. Many of the employees, especially in the machining area, liked participating in that. We also had an incentive program that tracked all the employees who had over 400 hours of paid overtime at the end of the fiscal year, because we were trying to keep up with DOD demands.

Mr. Scalsky Are those records available?

Worker 3: They would have to be in the HR department. The program tracked all of the employees with an excess of 400 hours of overtime. Most of the hourly employees were in that category because they wanted to be part of that incentive program.

Worker 5: It is my understanding that all of the personnel records were destroyed in September or October 2000. You can ask [name redacted].

Mr. Scalsky: Didn't the State of Massachusetts pick up the records?

Worker 5: Not to my knowledge.

Worker 3: I asked for the radiological records so I could get them to DPH. I never got them.

Worker 1: There are probably a lot of records still in the building if those handling the cleanup haven't thrown them out. I understand there are 150 filing boxes of records.

Worker 3: The contract lapsed with the offsite storage company, so they turned the records back over to the company. The records are on the mezzanine area of Building C. I can't imagine anyone going through them. There were tens of thousands of records that were placed on the mezzanine.

Worker 2: I was up in that area around 2006. It's a disaster. There were several gray, two-door file cabinets that were opened and boxes of cards had spilled out all over the floor. The whole floor was littered with jumbled paper, so I don't know how useful that's going to be when you get there.

Worker 5: I left the facility on [identifying information redacted] 2011. As far as I know at that time, all the files in the personnel department were destroyed. Again, ask [name redacted]. The files that were on the mezzanine in Building C, I don't know if they have gotten to those. As far as I know, they still exist. Whether there are personnel files in there? Probably not… There are lots of time cards.

Worker 1: (Inaudible) a little history of the corporate changeover that occurred at which time the records no longer belonged to Nuclear Metals. They belonged to somebody else. I'm sure that [name redacted] can add to it.

Mr. Scalsky: Did the secretaries work overtime?

Worker 3: Yes.

Mr. Scalsky: So everybody put in basically the same amount of time during peak times.

Worker 1: Certain areas had opportunities to work overtime, including secretaries. The secretaries were so efficient that (inaudible).

At this point, Mr. Scalsky recessed the meeting for a short break.

Mr. Scalsky: [Name redacted] is going to give us a little history on the records.

Worker 1: My retirement officially began in [identifying information redacted]. So I can be more accurate from that time backwards, but two or three years after my retirement, Nuclear Metals became Starmet. Approximately six years later, the company was in bankruptcy. Out of the bankruptcy came, I think, two companies. I think [name redacted] could be more accurate than I can be on that, but I didn't follow it very closely. Two companies got the right to work with the facility. They got ownership of the equipment that was inside it. Through the course, they were somehow able to benefit a lot of the employees who continued there and to function for several years. I don't know the names of those two companies. More recently, the powder operation and some of the facility that purified (inaudible) were being reconstructed in Morgantown, Pennsylvania. Prior to that, the IBC Corporation procured the rights to the berylcast work, which was a tremendous Nuclear Metals development for casting beryllium alloys – a technique that eluded the finest metallurgical minds of the 1940s, 1950s, and 1960s.

As far as the records go, I know from my personal time at the company, and even for a couple of years after my retirement, I could go into the company and my records would be there or they would get them out of storage at Iron Mountain in Walden. One time when I tried to get the records, I was told, 'We can't get them for you.' And I asked, 'Why is that?' They said, 'We're not paying the bills.' So for several years, I tried to get my personal files and a lot of things that were in there in several great big boxes. Eventually, I heard that the records came back to Nuclear Metals and were put up in the mezzanine. I continued to try to get my personal files, unsuccessfully. Well, I understand those records are still there and up in the mezzanine. Yes, I would like to get my three boxes. If the government wants them for a year or two, hopefully I'll still be alive and I can see them afterward. But there are records up there. As [name redacted] pointed out, I understand they're in quite a bit of disarray. [Name redacted], do you want to add to that?

Worker 3: I joined the company in 1976 and worked my way up. When the Starmet Corporation was formed, I was appointed as [identifying information redacted] of two of the companies, predominantly the beryllium business, both commercial and aerospace applications. Shortly thereafter, in 1998, I was a member of [identifying information redacted] for the parent

company, which was Starmet Corporation. I left in 2001 and resigned from [identifying information redacted] as well. And at the time, the business was being managed as Starmet Corporation with [name redacted] successor, a gentleman by the name of [name redacted]. Following up with the business periodically, the gentleman who operated it until recently, [name redacted], purchased the assets and the intellectual property of the company out of bankruptcy and operated in that site. As I understand it, Iron Mountain turned the records back over for failure to pay the bill, and would no longer store the records. It's been suggested that there were various parts of the building where all of these items were placed, personnel records comingled with operational records. It is unlikely that everything got destroyed because the gentleman wouldn't spend the money. Rather than paying money to get rid of the records, he just left them in the building because he knew the building was going to be turned over at some point. That's my understanding.

Up until the point when we turned over our NRC license, we continued to manufacture and process radioactive materials. And then following that, the predominant materials were the powder metals – non-radioactive as well as beryllium-containing materials and alloys.

Worker 5: In 2002, the Commonwealth of Massachusetts actually got the courts to stop Starmet from destroying the records they had. That's when the records were transferred. I don't know if any money was exchanged for those. If it was, it came out of a trust fund that was actually put up by Nuclear Metals for (inaudible). Those records, as far as I know, the ones that were stored, still exist up in Building C mezzanine and the super-secret area in Building D. Personnel records that were stored in the old personnel offices were destroyed. But the records that were retained by Iron Mountain that came back to Starmet by order of the Radiation Control Department of DPHMCP, because they were concerned about the radiological records that were among those records.

Mr. Scalsky: Let's go to the radiation protection page. This is a list of issues that we need to understand for dose reconstruction: the film badges, the bioassay urine samples, the air monitoring, the breathing zone sampling, the radiation and smear surveys, the respiratory protection, the protective clothing, the ventilation, the x-ray examinations, and the limited whole body counting and lung counting. On the next page, we have the film badges. I understand the film badges were worn from 1958 on. They were worn even before then, but for our purposes, it was 1958 until 1983. Is that your understanding?

Worker 4: The people who worked in the powder area, I don't believe that we wore thumb badges with any type of consistency or even at all.

Worker 8: We had a film badge program all the way through. I'd be very surprised if people weren't wearing film badges.

Worker 5: I don't remember wearing them in 1976 or 1977 in the rep department. I think in 1979 I remember wearing something.

Mr. Scalsky: I'm getting mixed signals here. Apparently not all the people wore badges all the time. Is that what I'm hearing?

Worker 5: Yes, that's what you're hearing. That some people wore badges, some people didn't; and it wasn't consistent until 1978.

Worker 11: When the company started the process of developing safety procedures in 1979, we went to a company-wide film badge program. Basically, everyone wore a film badge on the left breast pocket area. Everyone in Concord from 1979 on was issued film badges.

Worker 1: The film badge program began in Cambridge and it was continued when we came up to Concord. There may have been a gap of years, I'm just not clear. The use of film badges for all employees did not begin in 1979. It may have been re-instituted in 1979, but it began in Cambridge.

Worker 8: I wore a film badge in 1955.

Worker 5: Looking at the records that I assembled for NIOSH, it appeared that in the late 1960s, the amount of records that were available dropped off until 1979 to 1980. So there's a period of about a decade, plus or minus, that the records literally did not exist. I don't know what happened to the programs. I could not get my hands on the records for those programs.

Worker 1: When I went back to the company in 1972, I wore a film badge. I was away for some period of time between 1969 and 1972, so I had nothing to do with health safety at the time. That coincides with what [name redacted] was saying regarding the late 1960s, maybe they weren't used in 1969 to 1972. I can't say everyone wore them from 1972 to 1979. I'm just not sure. I would rely on records, except I think the records are still in that building. [Names redacted] have very sharp memories. They are the best ones to answer these questions until we find out where some records are.

Worker 3: As an employee in 1976, I was issued a radiation badge. And I think that the policy was that every employee had one. I can't say whether every employee adhered to the policy of wearing it on their left pocket. It wasn't until the process was tightened up, beginning around 1979, that they began auditing employees to make sure they were wearing their badges. When I joined the company, all employees had film badges – even visitors. The health and safety department issued a monthly report with our radiation doses, but the doses were usually negligible. It didn't matter where you worked, you had a film badge.

Worker 10: I worked in the foundry. I started in 1979. We were issued badges that we wore on our chests. During the changeover period at the beginning of the month, sometimes we had to catch up to them. There were a lot of employees, so at the very beginning of the month sometimes you didn't have a badge, but that would be for a very, very short time. You were taken out of the department when you got to your limit. We lost a lot of people out of the foundry department.

Worker 11: The foundry personnel were moved to a program where they got new film badges weekly. For a brief time, some employees had chips in their safety glasses. Also, for a brief time, we even issued badges for their shoes. Foundry, machining, and QC personnel all had rings.

Mr. Scalsky: Were there any other change periods, or was it mostly monthly?

Worker 11: It was mostly monthly for all employees except for the foundry.

Worker 2: I provided the photo album. When I looked through the photo album, I didn't see the ring badges, particularly in all the inspection photos.

Mr. Scalsky: That's the next question. Were ring badges or other hand dosimetry worn in any of the processes? As someone said yesterday in QC, they wore them sometimes but not all the time.

Worker 5: That depends on what period you're talking about. There really wasn't a health physicist on the staff until [name redacted] was hired in 1979. When they started doing the safety audits in 1981 or1982, they discovered that the daughter products from foundry operations were causing significant daily exposures. Then the health physics department started issuing special badges to look for that – rings for the skin doses to the hands, and the badges for the safety glasses for eye exposures. So it wasn't until 1982 or 1983 that rings and other special badges were even considered. Before then, we really didn't know what to look for.

Mr. Scalsky: When you say 'health physicist,' do you mean some people were assigned to it?

Worker 5: It was somebody who actually knew something about radiation safety. [Name redacted] was a health physicist. After him, [name redacted] was a health physicist.

Worker 7: Until that time, [name redacted] was the Safety Director.

Mr. Scalsky: Were you ever given the results of the badge readings?

Dr. Glover There was an annual report.

Worker 5: Yes, annual reports were issued.

Mr. Scalsky: Did you get a monthly report or quarterly because of the limits?

Worker 3: The reports were issued monthly for a time, and then they changed to quarterly reports based on the monitoring for the office workers. The safety department issued a quarterly report as well as the annual report as part of the physical.

Worker 5: In addition to that, the foundry workers were monitored much more frequently. They were monitored weekly. I don't think reports were issued, but they were certainly kept up to date because they were in danger of being pulled off their jobs because of high skin doses. By the end of the quarter, they probably lost one-third to one-half of the employees in the foundry due to high skin doses.

Mr. Scalsky: Let's go to the next subject: the bioassays. Our documents show that urine sampling at NMI started in 1958. From 1958 to 1983, approximately 14,500 urine samples were analyzed for uranium. In 1983, 484 samples were analyzed for depleted uranium. Between 1958 and 1960, and in 1962 and 1970, 484 urine samples were analyzed for enriched uranium. Six

samples were analyzed for thorium in 1964. No samples were identified for 1968, 1972, or 1975. What workers provided the samples? Was it foundry workers?

Worker 5: Again, it depends very much on what period you're talking about. From 1979 or1980 onward, every employee was required to give one sample monthly, except for the office workers, who were required to give a sample yearly. It depended on where you worked, but everybody should have been hit at least once a year. That would have started in 1979 or 1980. Anybody working with uranium on the floor was sampled at least monthly.

Worker 3: My recollection from 1976 is that all employees were required to give a urine sample as part of the annual physical. That would have been in addition to any factory workers who had special testing.

We also submitted urine samples if an event occurred – such as an unusual process, an anomaly, a foundry fire, a trash fire, or things like that. The safety department would then sample all the individuals who may have been exposed. Those were special cases as well.

Mr. Scalsky: Did you see the results of your bioassay samples?

Worker 5: Yes. From 1980 on, they were a part of the annual report.

Mr. Scalsky: How about before that?

Worker 3: I know that when I started in 1976, we got our annual report on our health as well as any of the radiation, including urinalysis, from the health department.

Worker 2: I was there in 1977, and I recall getting quarterly memos on TLD badges, probably from 1978 or 1979 onward, but I don't recall about urinalysis results. If there was an annual basis for engineers, I don't recall seeing that data.

Worker 7: When I was hired in 1967, we had annual urinalysis. I assumed everybody at that time did. Employment at that time was probably in numbers of 50 or 60 employees.

Dr. Glover: What company did the bioassay measurements? Did that change over time?

Worker 11: Fulton Atlantic at MIT used to do the bioassays for us. And then NMI started their own bioassay lab and was doing subsequent sampling for QC purposes starting in 1984. But before that (inaudible)…

Worker 2: When did they start doing them?

Worker 5: No idea. Landauer might have records for the film badges.

Worker 11: Right. Fulton Atlantic was the company to go to for urinalysis. [Name redacted] did the samples for NMI for a long time. He wanted to retire and actually came to NMI to get the urinalysis lab up and running. That was in 1983.

Dr. Glover: We didn't ask this earlier, but a lot of places have extensive databases where a lot of that data was input.

Worker 5: There was a section of Nuclear Metals' computer system which was a digital thing that the data eventually got put into, but that was probably after the 1983 time frame. I think all the stuff earlier than that was just kept in paper files.

Mr. Scalsky: The next topic is air monitoring. Our documents show that there were 12 monitors located throughout the plant, and the filter papers were changed every two weeks. We have not identified the locations or the proximity of these monitors to the processes.

Worker 5: I was a health physics technician from 1982 through 1985. The air monitoring was a lot more involved. There were 12 areas that were monitored. Each of those areas might have had 10 sample locations. Some might have had as many as 24 sample locations. There should be a log book. They were changed every two weeks, at least, as far as that goes. Breathing zone samples generally weren't used in the early1980s. They really weren't pushed, except for special operations, until after the rule change happened, when people actually started getting concerned about internal dose.

Mr. Scalsky: So you had dozens of monitors.

Worker 5: Yes. They were at all different locations—the machine shop, the foundry, the foundry extension, solutionizing, aging, finish machining, blank machining. There were monitors, little filter holders, everywhere.

Mr. Scalsky: Did you make any changes in the program based on the results of these air samples?

Worker 5 and Worker 11: The foundry went from 6-inch ducts to 18-inch ducts. And we installed a lot more filter units. Facilities engineering and the health physics department used to work together (in the 1980s and beyond) to make sure that the ventilation that was being proposed was adequate. That was also part of the air permit system that Massachusetts installed, probably in that time period.

Worker 10: I'm not sure what the time table was when all those stationary air samplers were put in.

Worker 5: Probably in 1980.

Worker 10: Was that prior to the new ventilation systems?

Worker 5: I don't know.

Worker 11: There were samples being taken before 1980, but I (inaudible). There were selected areas.

Worker 10: I remember they put new ventilation in with the sliding hoods. They actually attached monitors to it. Those monitors weren't there prior to that. They were hooked up to the house vacuum system so you had a hose that always had suction on it, and they had filter papers there. Those were put in after the majority of the improvements were made.

Worker 8: We came out here in 1958. For approximately 10 years, or maybe it was 8 years, we used MIT for all our health and safety. We had (inaudible) who was an expert in ventilation. We used [names redacted] on badges. They covered the entire thing for us, supplemented by our people. That went on through our work at MIT and the Hood Building. We just brought them along with us in 1958.

Worker 2 to Worker 10: I was hoping you could tell us something about the reduction area, where there was a station where the workers brought the derbies in and chiseled off the magnesium fluoride. That area had an air monitor, but it was awkward to work in there. You told me that the workers used to move out of there onto the floor so there was enough room to work.

Worker 10: In the reduction area, we worked with vessels. There was a pit, and we flipped over the vessel, lifted it up, and dropped it several feet to shock everything out of it. When the residue came out of the vessel and dropped down into the pit, there was a cloud. That was also weekend work. We went down into that pit and hand-shoveled all the scrap products into drums. If the derbies we produced had a lot of extra slag, we chipped that off with a hammer and chisel.

Worker 1: When I came back in 1972, we decided that we were going to get out of the enriched uranium work. We petitioned the AEC to end our license, which they would not formally do. Sometime afterward, we found some enriched uranium in the company, in the form of chips in a hacksaw and a large quantity in water. We immediately contacted the AEC. An inspector came out and threatened to send me to jail. I wasn't concerned, I was sure that the simple argument that new ownership was cleaning up the company would prevail. I went down to Valley Forge with [name redacted] and we met with people from the Washington headquarters. The people at Valley Forge were unrelenting and the arguments were listened to, and the people in Washington overruled that we were there cleaning up the company. But one thing to conclude from that is there was a significant quantity of highly enriched uranium that hadn't been properly accounted for and it was still in the company in 1972 and into 1973 or so. Fortunately, people acted concerned that there could be some criticality questions.

Mr. Scalsky: An AEC inspection report dated 1959 indicated that air samples were intended to be obtained during every operation involving high enriched uranium. Did that happen? Were sample taken?

Worker 5: We have no idea.

Mr. Scalsky: Was it done for new operations?

Worker 5: Certainly after 1980, but not before 1980.

Mr. Scalsky: Were breathing zone samplers used? Who used them and during what periods?

Worker 11: It's a complicated question to answer. If you had to have a radiation work permit (RWP) to do a job, the AEC said that the employees had to use PAMs. A lot of employees wore them as directed by [name redacted]. He gave them out on a random basis to the general worker population. It was more specific for foundry work.

Mr. Scalsky: The RWPs didn't come in until the early 1980s.

Worker 11: Mid-1980s to early 1980s.

Mr. Scalsky: Mid-1980s?

Worker 5: I gave out PAMs for certain jobs in 1982. I worked in fabrication in 1978, 1979, and 1980. I think the first time I was ever actually handed an air sampling pump and was told to wear it was 1979. I don't know if anybody else can speak to that.

Worker 10: I can't remember years. They gave us personal air monitors when we did specific jobs in the foundry. There were other times when we would get them more randomly. On a routine basis, that was fine. But if you weren't assigned a PAM and one of the furnaces decided it was going to blow and sent smoke all over, and then all of that activity would not be captured. Or there might have been a person with a PAM on a tower working with three other people, but six more were on the other tower without a PAM; or if you were just randomly in the area when some of these things went on, you were not monitored.

Worker 11: There was some resistance to wearing the personal air monitoring systems.

Mr. Scalsky: They didn't want to wear those? Were they cumbersome?

Worker 11: We would also hear, 'Why do I have to where this when I didn't have to before?' That was probably 1981 or 1982. As health physics technician, I remember getting that a lot.

Mr. Scalsky: What did you tell them?

Worker 5: 'You have to wear it.'

Mr. Scalsky: Let's go on to radiation and smear surveys. Did you have radiation safety people on site before the 1980s?

Worker 11: I started in the health physics department back in 1977 or 1978.

Worker 1: Define 'radiation safety person.'

Mr. Scalsky: A person who is qualified in radiation safety, a health physicist or technician who has had sufficient training in radiation safety and can make decisions about personal exposures and when to use various protective clothing. When I speak of a health physicist, I speak of someone who had sufficient training and had college courses that permitted them to be classified as health physicists.

Mr. Scalsky: Were radiation surveys performed for specific jobs?

Worker 10: Health physics came into the foundry to take samples, wipes that you could take off the floors in different areas. I don't remember exactly when, though.

Worker 11: That was part of our daily jobs. We were all assigned to do wipes.

Mr. Scalsky: How about the radiation surveys – to check the levels of radiation?

Worker 11: We did surveys in the production area weekly and monthly in the offices.

Worker 5: The rules actually haven't changed since the early 1980s. Office areas were allowed to be up to 1,000 dpm for alpha The rest of the areas were 10,000 dpm alpha and 25,000 dpm beta, except for the foundry, which was 25,000 dpm alpha and 50,000 beta. That was 1982. I'm not sure what those limits were on the 1986 license.

Mr. Scalsky: Were the people informed? In the early 1980 time frame, there was health physics work going on, you had the RWPs, and you made surveys, and then the people were informed. I assume that they had to read the RWPs.

Worker 2: Yes.

Worker 5: People were only informed if a survey was higher than normal.

Mr. Scalsky: And those routines were at what frequency?

Worker 5: That depended on the area – monthly for some areas, weekly for others.

Worker 10: There was also a lot of production work going on back then. That meant that if there was a problem, you fixed the problem. Production schedules were involved. You had to get things back up and running. If you lost a vacuum pump, you changed the vacuum pump. Sometimes it took a lot of time to get an RWP to get all this in place. We were a high-production facility and we had a schedule to keep. Sometimes we didn't wait for an RWP.

Worker 2 to Worker 5: There was a contrast in the 1970s and the 1980s in the level of formal training for staff members. There was also, apparently, an evolution of 'codified requirements' for the license. Basically, there was contrast between the types of surveys for different programs.

Worker 5: When I first started working for Nuclear Metals in 1976, I was a rad technician, which meant I wasn't a radiation worker. I was only [identifying information redacted]. I had no clue. I know there was stuff that, as a health physics technician, I should have written myself up for. I had no idea what I was doing. We loaded billets, we helped in the foundry. If people needed to have stuff done, they had to come. It wasn't until [name redacted] came and really said 'No, you have to make a separation.' That was in 1979, that things started changing and radiation workers, at least on the (inaudible) shifts, became a little bit more formalized. I have no idea what happened on A Shift, but on B Shift, if somebody said 'Hey, they need you over at the 1400

press,' you would go over to that press, load the 18 billets of depleted uranium, turn on the mixer, and walk away. So we were walking around the radiation areas. In 1979, that was not allowed to happen by edict. The work had to be done whether it happened or not. In the early 1980s and mid-1980s, there was a huge conflict between the health physics and health safety functions and the production department. It was very intense because they were using health physics technicians and health safety technicians as police.

Mr. Scalsky: So it was an evolutionary process. Let's go to respiratory protection and protective clothing. Did you wear dust masks, or did you wear respirators with canisters?

Worker 5: That would depend on when you're talking about.

Mr. Scalsky: Let's separate it between the early days and the later days.

Worker 10: In the early days, we didn't wear respirators. We had a little face shield that we shared when we opened the furnace. We started out using a cloth-type respirator. In this picture, these two people are in the foundry with beards. When I first started in the production area, we wore a lesser dust mask, per se. It just pinched your nose. You were literally chest-level with that vessel and you were compacting the grease off of the vessels with a 3-lb. sledge hammer and a 4- or 5- inch piece of grab bar with a steel pad. And you would literally pound on that and move around the vessel. You were required to do a vessel in the morning and a vessel in the afternoon. Every time you struck it with a hammer, you got a plume that came up around you.

Mr. Scalsky: That would have been a good job for the personal air monitors, but they weren't used at that time.

Worker 10: No, not in the early days.

Worker 5: As far as respirators and respiratory protection, does anybody remember when the beard controversy happened?

Worker 3: It started when we were in the beryllium business. We established the clean-shaven policy.

Worker 5: That was fairly late.

Worker 3: That would have been in the (inaudible) contracts. That's when we established it. In order to work on that project, you had to be clean shaven.

Mr. Scalsky: What year was that?

Worker 5: I would say it was probably late 1980s.

Mr. Scalsky: Did you wear protective clothing? Coveralls, shoe covers, gloves, lab coats, head covers?

Worker 5: Nuclear Metals had a uniform policy, so Nuclear Metals had uniforms. You came in at the beginning of the day, went to your locker, and changed into your uniform if you were a floor employee. Office workers wore regular clothes.

Mr. Scalsky: That was the grays?

Worker 5: The grays or the blues, depending on what time period.

Worker 3: We had a problem with employees going out their cars to eat lunch in their work uniforms and shoes. So there was a tidying process. We also found that some employees, especially foundry workers, would take their street belt off, put it on their work pants, and then take it home. There was an incident where we surveyed an employee's car and home, and he had brought some materials home on his shoes.

Mr. Scalsky: I think the NRC got involved in one of those.

Worker 3: They did. So that was tidied up. Shoes were specially marked. In the radiation areas, they had to use specially marked shoes. Foundry workers would walk around the office area in their work clothes.

Worker 2: There was also a brief period in the 1970's – I started in 1977 – when [name and identifying information redacted], was barred from entering the facility because his truck was "hot." The reason was because, during break time and lunch time, the employees would leave their work areas without going through a change area, and go right out back to get their sandwiches, coffee, and donuts off the truck. They apparently contaminated the crap out of his truck. This truck was found "hot," so it was barred from the lot. He can tell us when he was barred. He'll be here at about one o'clock.

Mr. Scalsky: We will get his input then. Let's go on to the ventilation. Was there local ventilation for certain jobs?

Worker 5: The short answer is yes.

Mr. Scalsky: And that was the later period?

Worker 5: As [name redacted] alluded, and in 1979 certainly, the foundry ventilation was not adequate. In the early to mid-1980s, things started improving. Most of the HEPA units that were installed at Nuclear Metals were installed in the 1980s.

Mr. Scalsky: Apparently they had some vent tubes that were over the cutting and machining areas.

Worker 5: The ventilation became more sophisticated over time.

Mr. Scalsky: Were the tubes that were over the cutting and machining very effective?

Worker 10: It all depended on the state of the filters. If the filters were changed, there was decent ventilation. To go back just for a second to the protective clothing, we wore coveralls. We called them 'potato sacks.' They were heavy cotton duck with a drawstring neck. They were washed, but even after washing and using these over a period of time, they were as contaminated as anything they were protecting us from. So, they were discontinued. So there was a lot of that. We had fire aprons. Those were used so long that again, those became as contaminated.

Mr. Scalsky: What year did you wear coveralls?

Worker 10: That was very early on when I started. So that would have been about 1979. I remember the big yellow 'potato sacks.'

Mr. Scalsky: What about x-ray examinations? Did you have a pre-employment x-ray examination and physical?

Worker 5: Depending where you worked, it was either yearly or every three years.

Mr. Scalsky: No, the pre-employment.

Worker 5: Pre-employment, you had a chest scan. Or if you were big, you had two.

Mr. Scalsky: Then you had an annual X-ray.

Worker 5: Either annually or every three years. It depended on where you worked and your job title.

Dr. Glover: And those were all done at Emerson Hospital.

Worker 5: Or Concord Radiology.

Dr. Glover: Off-site.

Worker 5: Yes.

Mr. Scalsky: Did you have a post-employment X-ray when you terminated for whatever reason?

Worker 5: We had a post-employment physical, but I don't know if it included an X-ray.

Mr. Scalsky: The last slide is a listing of some of the facilities that received or shipped materials to Nuclear Metals. This is only a partial list. [Name redacted] indicated that he's going to put something together on some of the other facilities and how much thorium and when that was.

Worker 1: As we discussed in the prior meeting, I think I can add some things on the depleted uranium. It's difficult to do more on thorium.

Worker 3: There should be a record of transfer because we were required to fill out an NRC transfer form.

Worker 1: Where is that record?

Worker 3: It was filed with the NRC. There was a monthly document that we used to disclose all shipments transferred in and out of our facility.

Worker 1: There should be a document on thorium that the government gave us that said they would no longer tell us what to do. There were some files in the 1980s going back to the 1950s.

Worker 3 Any transfer in our facility required documentation and we filed those documents with the NRC. It was there to verify that people who transferred had licenses (inaudible).

Worker 2: Certainly, two government facilities that are missing on that list include Los Alamos National Lab and the U.S. Army Ballistics Research Lab at Aberdeen Proving Ground.

Worker 3: Honeywell Corporation.

Mr. Scalsky: That concludes our session. If there are other things anybody wants to discuss, some of us can certainly stay around.

Worker 2 to Mr. Scalsky: There is one thing that we are hoping to find out while everyone is here. We didn't just handle 1½ to 3% enriched uranium. We had jobs where we were handling much higher assays of enriched uranium. Do you have that information?

Mr. Scalsky: We are aware that some of the highly enriched uranium may have been as high as 90 to 93%.

Worker 7: We didn't realize how "hot" the material was. Stuff came in and we just processed it. Mr. Scalsky thanked the attendees for coming to the meeting and sharing their information with NIOSH. He adjourned the meeting at 12:15 p.m.