A photograph of the Chernobyl nuclear power plant under a grey, overcast sky. In the foreground, a grey stone monument features a hand holding a megaphone. The background shows the industrial structures of the plant, including a tall cooling tower and various cranes and scaffolding.

CHERNOBYL

Radiation Levels in the Zone

ABOUT ME

I am a field technician specializing in the detection, sampling, and investigation of radioactive materials in the environment. I have visited and sampled at over 50 contaminated sites in the United States and have co-authored a peer-reviewed study of the radioactive wastes from the Manhattan Project.

In August 2015, I had the opportunity to visit the Chernobyl Nuclear Power Plant as part of a new vocational training program hosted by ChNPP.

During our time in the zone we had the opportunity to measure the radiation levels in various portions of the Sarcophagus and plant site, including; the control rooms of Unit 2 and Unit 4, the de-aerator building, the industrial zone, the Unit 3/4 ventilation building, the emergency operations center, interim spent fuel management facilities, multiple abandoned towns in the exclusion zone, and the city of Pripyat.

While at the plant we measured dose rates in various areas at the plant and monitored various hotspots of contamination found in the reactor buildings and sarcophagus. In the exclusion zone we monitored radiation levels and hotspots of contamination in Pripyat.



COUNTS PER MINUTE

(cpm)



When conducting field surveys looking for contamination in the environment we used a NaI scintillation detector paired with a Ludlum Model 2350 Datalogging Survey Meter and a Ludlum Model 26 Integrated Pancake Frisker. Both of these units were calibrated to measure radioactive interactions in counts per minute.

The gamma scintillation detector was used to measure gamma fields in and around the Sarcophagus and to detect contamination in the environment.

The Pancake Frisker was used to detect and measure surface contamination by alpha and beta emitting radioactive materials.



ROENTGEN

uR/hr

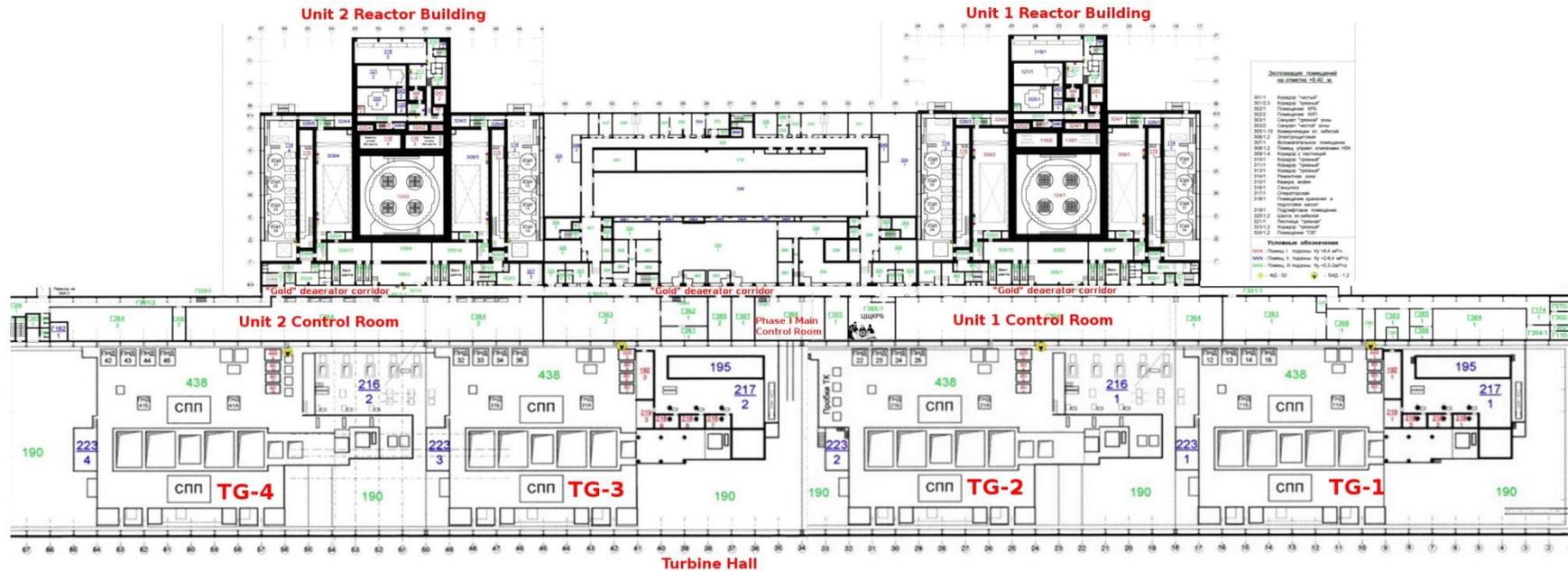


While traveling in the zone we utilized multiple methods of dose measurement. In addition to dosimetry provided by ChNPP I also took a CsI dosimeter which datalogs radiation levels and accumulates dose over time. The dosimeter tracks dose over time using the micro-Roentgen as the unit of measure. (1 uSv/hr = 100 uR/hr)

Background in US (2-4 uR/hr)
Background in the Exclusion Zone (4-6 uR/hr)

UNIT 2 CONTROL ROOM

Phase I, Chernobyl Nuclear Power Plant
(Approx. +10 meters elevation)



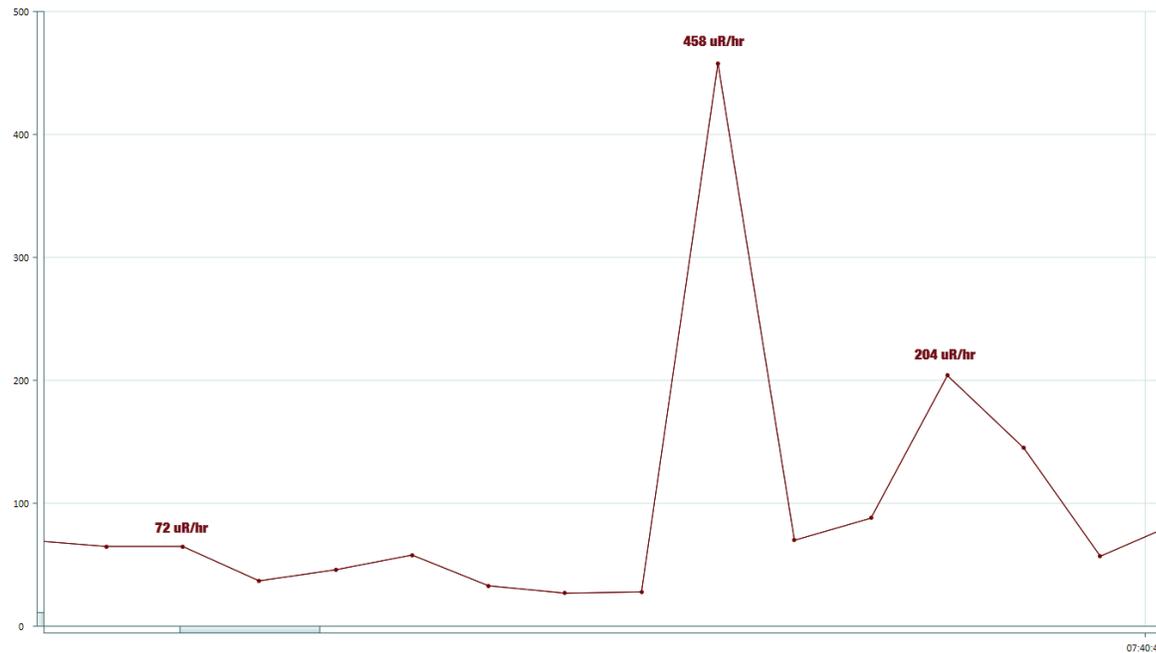
The Unit 2 reactor was shut down in 1991 after a fire damaged critical safety equipment in the turbine building. The design of the control room is very similar to the Unit 4 control room.

The dose rates in the “golden corridor” which connects the administrative buildings and provides access for workers to the reactor buildings and turbine building were between 17 uR/hr and 84 uR/hr.

UNIT 2 CONTROL ROOM

Ambient dose rates in the control room ranged between 55 uR/hr and 117 uR/hr.

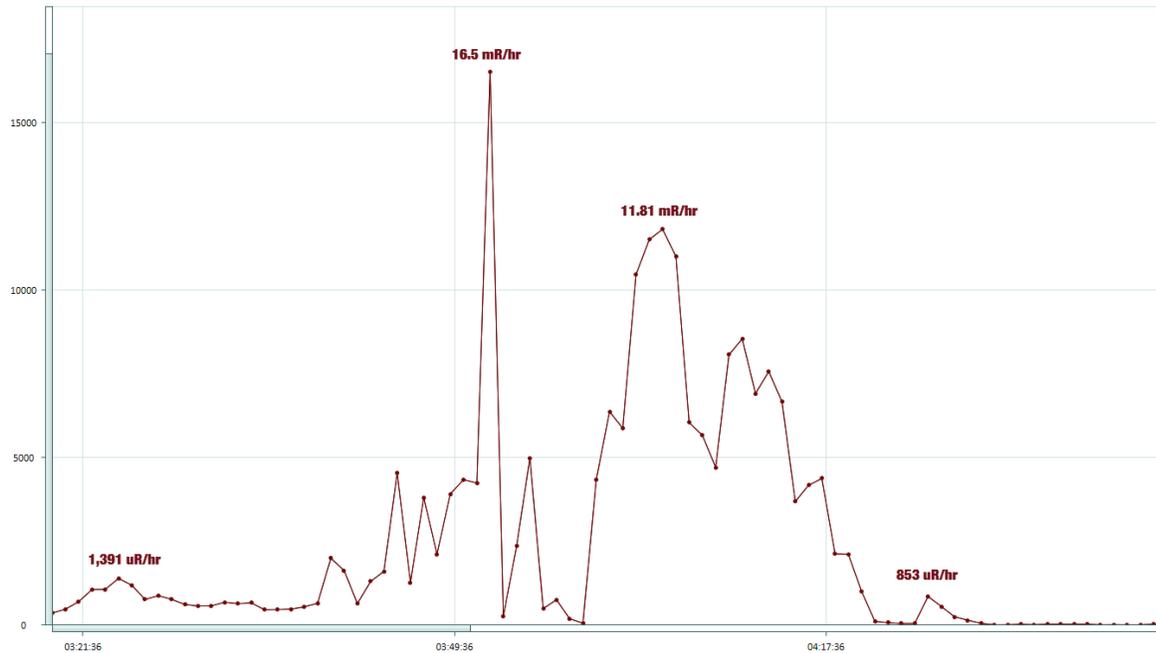
One area of the ceiling was found to have an elevated dose rate of 458 uR/hr. *This was assumed to be from feedwater lines which used to return coolant from the condensers back to the reactor building during operation.*



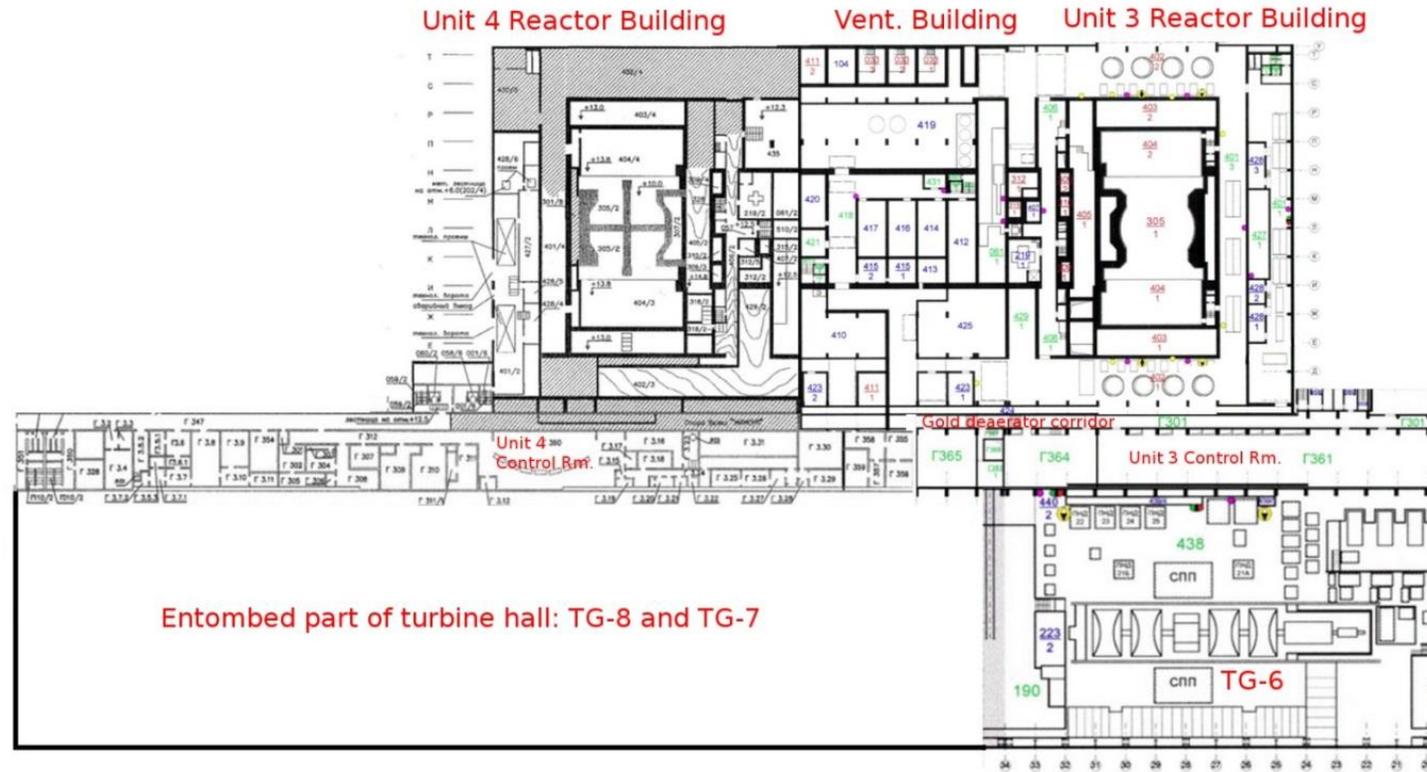
UNIT 4 CONTROL ROOM

Ambient dose rates in the Unit 4 control room ranged between 1,600 uR/hr up to 6,550 uR/hr.

The dose rates in the Unit 4 control room are greatly influenced by the gamma shine coming from the melted nuclear fuel in the reactor building. There are still hotspots of contamination which can be found in the control room, the highest of which was found behind the operators panels.



UNIT 3 REACTOR BUILDING



As we exited the Unit 2 control room and continued down the deaerator corridor, the radiation levels jumped from 69 uR/hr to 462 uR/hr until peaking at 763 uR/hr as we passed the Unit 3 control room.

The radiation levels in the Unit 3 control room were greatly affected by the destruction of the Unit 4 reactor. One of the emergency works conducted in the first few weeks after the disaster was to construct a special barrier between the Unit 3 control room and the Unit 4 reactor building in order to reduce operator exposures during operation.

UNIT 3/4 VENTILATION BUILDING



There are many drains and pipes where the gamma fields are over 3,800 $\mu\text{R}/\text{hr}$.



On top of some of the pipes and connections we were still able to detect large amounts of alpha and beta emitting radioactive materials which tended to max out the detectors capabilities.

UNIT 3/4 VENTILATION BUILDING



One of our group members brought a new detector that was being beta-tested for the manufacturer. The detector was specifically designed for better detection of beta contamination and operated better in the ventilation building than some of the other equipment in that regard. Some of the levels of contamination were so high that they caused the Geiger-Mueller tube in the device to glow red in the dimly lit rooms.

UNIT 3/4 VENTILATION BUILDING



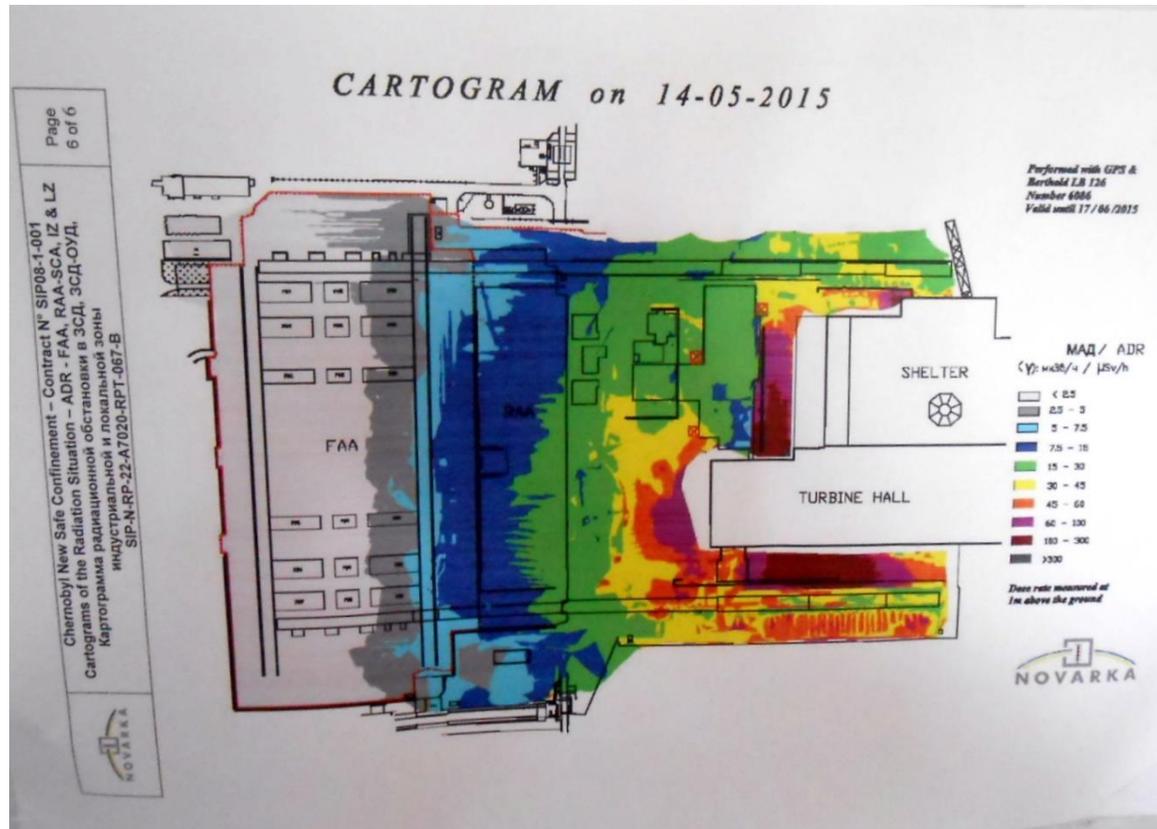
One of the most contaminated areas that we found in the maintenance corridors was a dimly lit stairwell with hotspots of contamination on the floor that contained gamma exposure rates over 48,260 uR/hr (48.26 mR/hr).

UNIT 3/4 VENTILATION BUILDING



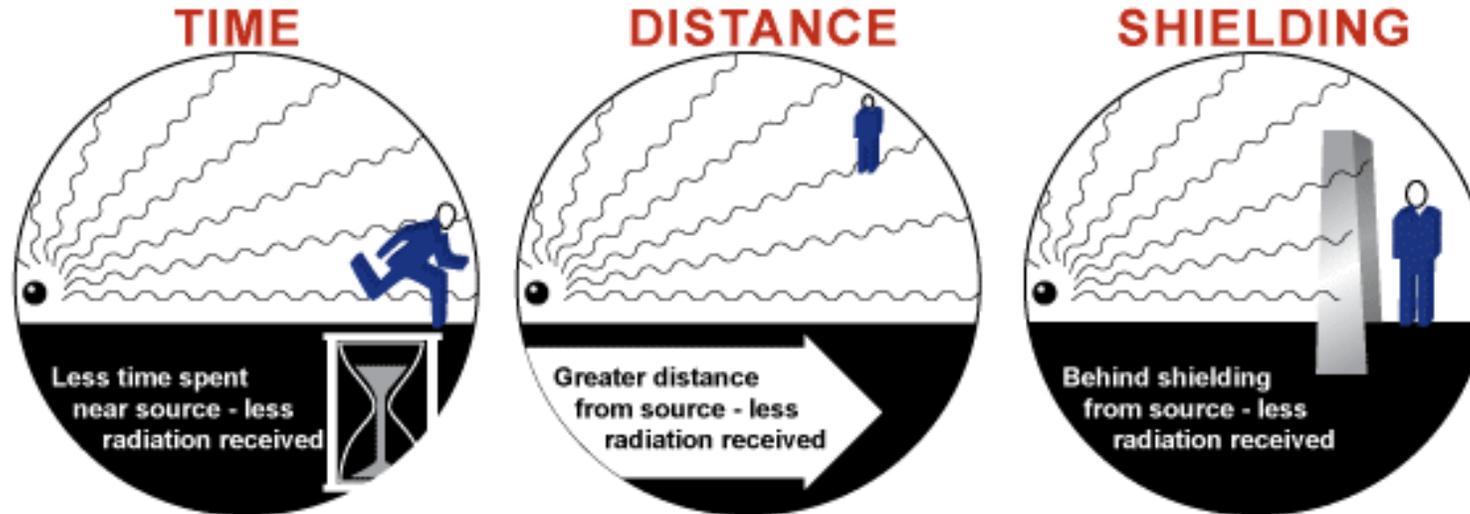
There is a continuing problem of contamination spreading and getting trapped in the dusts in the buildings. We continuously monitored the accumulating dust piles on top of pipes and rafters in the reactor buildings and main circulating pump rooms. We were able to identify areas with large piles of dust which maxed out the pancake detector with alpha and beta particles but where the gamma levels were no where near as high.

GAMMA FIELDS AT CHERNOBYL



This is a map of the gamma shine levels around the Sarcophagus and “The Industrial Area” where the new confinement structure is being constructed.

GAMMA FIELDS AT CHERNOBYL



One of the radiation exposures of concern at Chernobyl is the gamma shine coming from the melted nuclear fuels in the Sarcophagus. The closer you get to the structure the higher the levels become, the more shielding between you and the structure – the lower the dose received.

GAMMA FIELDS AT CHERNOBYL

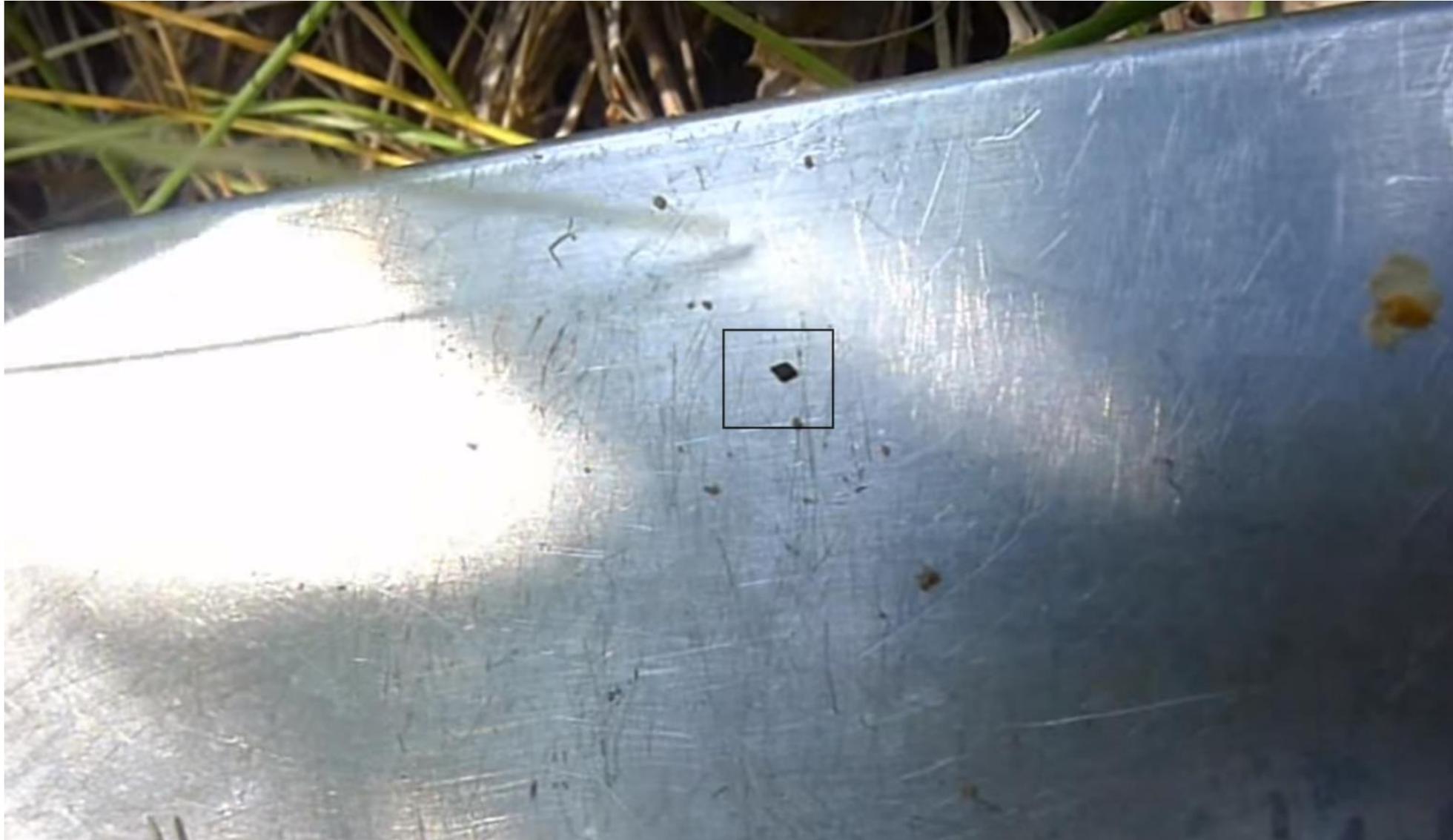


While taking this picture, directly behind me is a large viewing window that is pointed directly at the Unit 4 Sarcophagus. When facing the Sarcophagus with the dosimeter pointing at the structure, the dose rate was 731 $\mu\text{R/hr}$. When my back was turned to the window, the radiation exposure dropped to 61 $\mu\text{R/hr}$. If I walked to the opposite side of the room near the poster the rates dropped to 37 $\mu\text{R/hr}$.

FUEL FLEAS (HOT PARTICLES)



FUEL FLEAS (HOT PARTICLES)



FUEL FLEAS (HOT PARTICLES)



Gamma exposure rate on contact with the closed probe is about 60 mR/hr (35-40 kcpm).

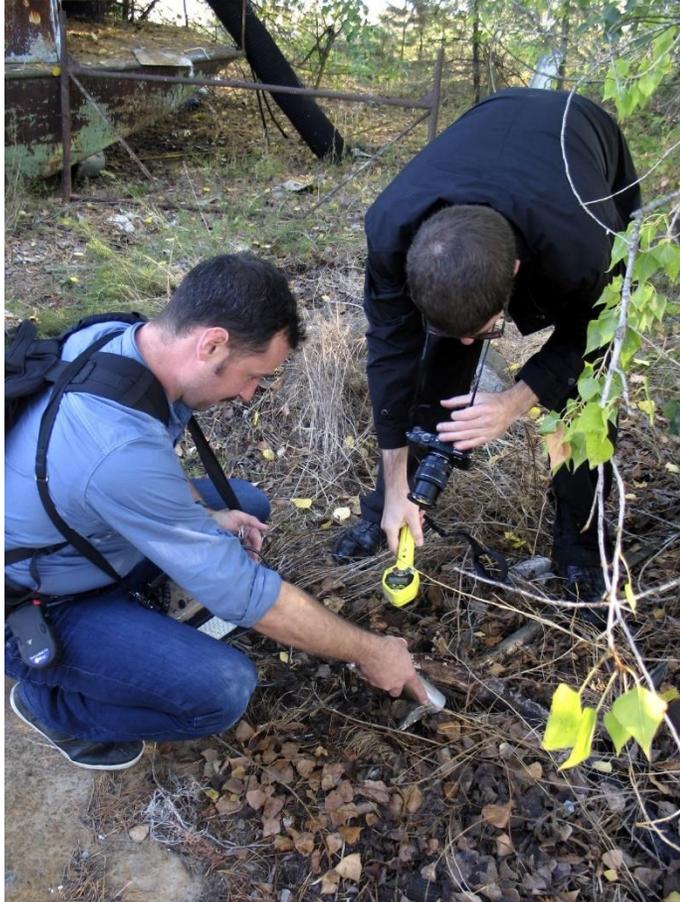
CONTAMINATION IN THE ENVIRONMENT



The Chernobyl Nuclear Power Plant drew coolant from a large man-made lake that was connected to the Pripjat River.

At the site of the water-intake stations, which once drew water into the cooling ponds, we found a hotspot of contamination while looking for fuel fleas in the local environment.

CONTAMINATION IN THE ENVIRONMENT



The gamma levels in the area of investigation were over 1,000,000 cpm at surface and peaked at over 3,460,000 cpm once the surface materials were removed and the dirt exposed.

CONTAMINATION IN THE ENVIRONMENT



CONTAMINATION IN THE ENVIRONMENT

Isotope	Activity
Am-241	3,782 pCi/g
Ba-133	42 pCi/g
Cs-137	78,274 pCi/g
Eu-154	48 pCi/g
Gd-153	21 pCi/g
Ra-226	384 pCi/g

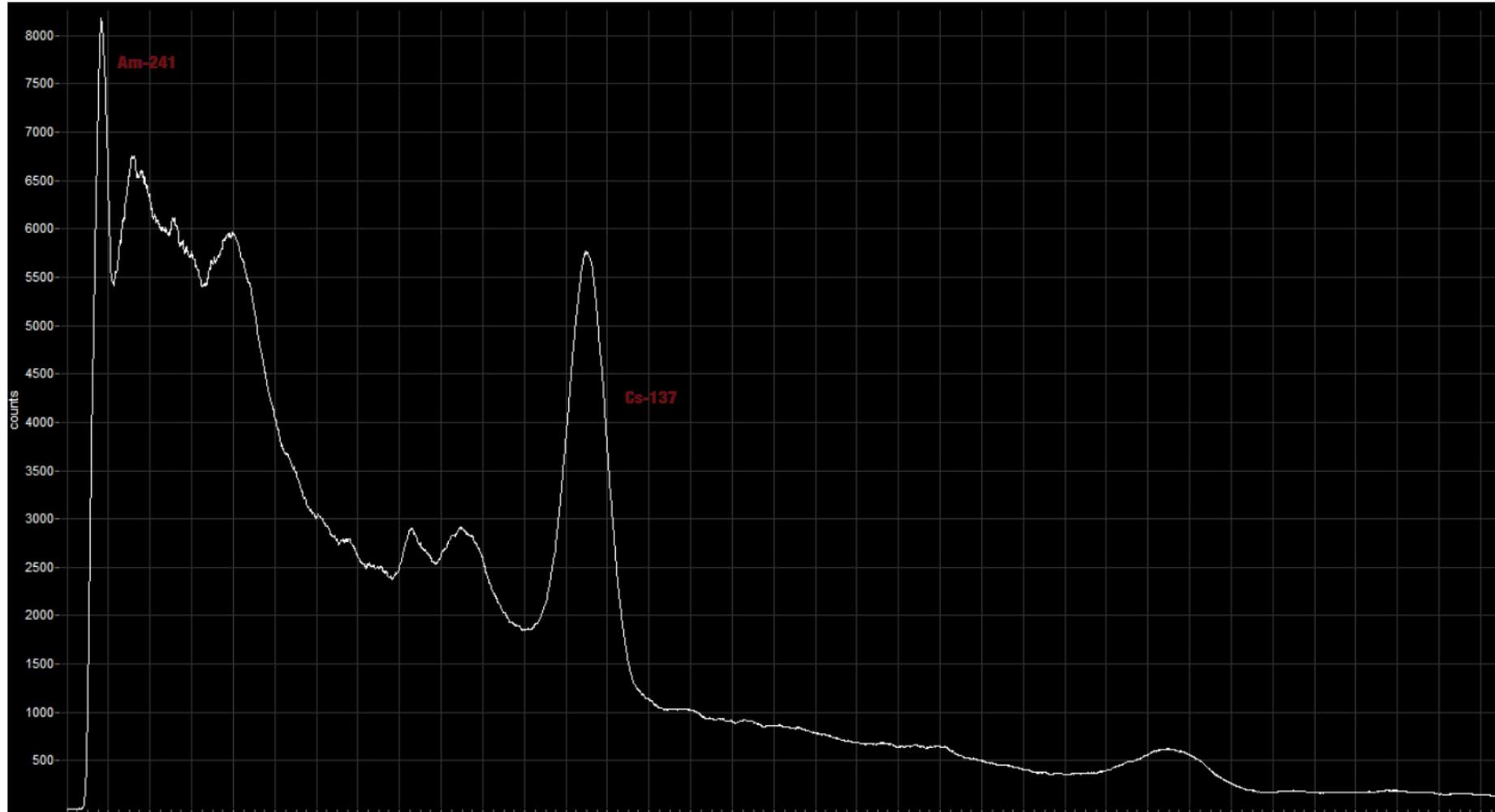


CONTAMINATION IN THE ENVIRONMENT



Chernobyl City is about 10 miles away from the Chernobyl nuclear power plant. Near the docks at the Pripyat River we analyzed a small soil sample where the dose rates were below background (4-6 $\mu\text{R/hr}$ at waist-level).

CONTAMINATION IN THE ENVIRONMENT





CLOSING THOUGHTS

THANK YOU FOR LISTENING

Radiation levels in and around the Sarcophagus and the contamination in the exclusion zone remains a difficult problem at the Chernobyl Nuclear Power Plant. Over 3,500 workers travel everyday to the site to conduct various activities. These workers are an inspiration for me and I'm grateful that they accepted us so much during our time at the nuclear power plant.

I would like to thank: the Goethe-Institut, Beyond Nuclear, Heinrich Böll Foundation, the Chernobyl Nuclear Power Plant, Carl Willis, Dr. Sonja Schmid, Heidi Baumgartner

We will be returning to the power plant and the exclusion zone in September 2016.