Summary Descriptions of the Accident

Dr. Richard S. Denning's Description:

During Run 14 of the Sodium Reactor Experiment, severe fuel damage occurred resulting in the release of radioactive material. Although there are a number of interesting questions that could be raised about the accident, I have focused my review on assessing the amount of radioactive material, in particular radioactive iodine and cesium, that was released to the environment. I think that this is the question of highest interest to the public. In my presentation, I attempt to describe the processes leading to the release of radioactive materials from metallic fuels in non-technical terms.

An aspect of the accident that has been highly disputed is the amounts of radioactive iodine and cesium that were released to the cover gas region above the sodium and subsequently released to the environment. Although the reports prepared by Atomics International following the accident strongly state that no iodine or cesium was released to the cover gas, in the material that I reviewed I found very little in the way of direct measurements to support or refute that conclusion. Nevertheless, based on the reported quantity of radioactive material released to the stack, it is possible to establish an upper bound to the release of iodine and cesium of a small fraction of the core inventory. This finding is completely consistent with my own assessment of source term behavior for this type of fuel under the conditions experienced. However, in their assessments, Mr. D. Lochbaum and Dr. J. Beyea concluded that substantial quantities of radioactive iodine and cesium could have actually been released to the environment. Those conclusions are largely based on estimates of radionuclide releases from molten uranium oxide fuel in light water reactors or on releases experienced from other nuclear facilities such as the Windscale accident, in which the temperatures and chemical conditions were substantially different. Not only does a technical assessment indicate that the release of cesium and iodine from molten uranium fuel would be very small, only a very small fraction of the iodine and cesium released to the sodium pool would subsequently be released from the pool to the cover gas region and be potentially available for release to the environment.

Another controversial aspect of Dr. Beyea's report is the use of the linear, no-threshold model to estimate potential latent cancer fatalities within very large populations that receive very small doses. As indicated by J. Frazier in his review, the Health Physics Society recommends against this practice. However, the real question of interest to the people living in the vicinity of the plant is whether their health could have been affected by the accident. Based on a very conservative analysis of the maximum offsite dose assuming a release of radioactive iodine and cesium equal to Mr. Lochbaum's highest estimates, I conclude that the impact of the SRE accident on increasing the personal risk of people living near the site, the risk to members of their family, or the risk to their neighbors of incurring cancer is negligible. This conclusion is independent of whether Mr. Lochbaum's numbers are correct or Dr. Beyea's approach to the calculation of population dose.

Dr. Paul S. Pickard's Description:

The fuel damage accident that occurred at the SRE reactor in 1959 was caused by blockages in fuel coolant channels that formed when the organic pump coolant (Tetralin) leaked into the primary sodium system. The organic fluid decomposed in the hot sodium resulting in the formation of a porous carbon material which coated the reactor fuel and other components and collected in the fuel inlet channels to form partial blockages in the SRE fuel bundles. The carbon blockages restricted coolant flow to the reactor fuel during operation resulting in elevated and erratic fuel temperatures.

During Run 14, fuel temperatures of over 1400 F were observed which caused partial melting and clad failure in 13 of the 43 SRE fuel bundles. The fuel damage and clad failure occurred at temperatures well below the 2069 F melting point of the Uranium metal fuel. At temperatures of 1400 F, a lower melting point alloy formed between the Uranium metal fuel and the stainless steel cladding, resulting in partial melting of the fuel and failure of the fuel cladding. The liquefied metal fuel allowed radioactive fission products that are normally trapped in the fuel matrix to be released and enter into the surrounding primary sodium coolant. The fraction of the fuel that was liquefied in this process is uncertain but the amount is limited by the relatively small amount of stainless cladding available to alloy with the Uranium fuel. Pictures of the damaged fuel bundles show partial melt and cladding failures, but also show that sections of the fuel bundle did not reach high enough temperatures to alloy with the clad. The only measurement made of the fraction of fuel that melted was done on fuel bundle 24. About 1% of the Uranium fuel in bundle #24 was estimated to have been liquefied. Based on the limited mass of cladding available to alloy with the fuel, and the observation that many sections of damaged fuel bundles did not show evidence of melting, a reasonable estimate for the amount of melted fuel is in the range of 1 to 3 %. The liquefied fuel was retained in the fuel channels and did not result in a threat to the primary system vessel.

The amount of liquefied fuel is the primary factor in estimating the release of radioactive fission products to the sodium. Noble gases are readily released under these conditions and the 1959 estimate of about 1% release of noble gas fission products is reasonably consistent with this melt fraction. Volatile species, such as Iodine and Cesium are mobile at high temperatures but are less likely to be released than the noble gases. These species react with sodium to form a less volatile iodide – resulting in significant retention of these fission products in the sodium. In addition, Iodine reacts with the metal fuel to and tends to be retained in the fuel, which is consistent with the lower than expected concentrations of Iodine found in the sodium and on the internal structures. The cover gas contained primarily inert gas fission products which were pumped to the decay storage tanks and vented after levels were sufficiently reduced by radioactive decay.

Based on the known physical mechanisms to retain volatile fission products in the fuel and sodium, the limited amount of melt that could have formed to release FPs, the primary release from the SRE fuel damage accident should have been the noble gases that were vented from the decay storage tanks.

Your Description:

Please tell us what you believe happened during and as a result of the accident.

Name: ______________________________

Street Address, City, State, Zip: ______________________________

Telephone: ____________________ **Email:** ____________________

Written descriptions of the accident submitted by interested members of the public today through September 14, 2009 will be compiled for a appendix to the Environmental Impact Statement for Remediation of Area IV of the Santa Susana Field Laboratory. The appendix will be titled "*Community Perspectives on the July 1959 Sodium Reactor Experiment Accident*.." To submit your description of the accident for inclusion after leaving the Workshop today, please send it via:

- US Mail to Ms. Stephanie Jennings, DOE NEPA Document Manager, P.O. Box 10300, Canoga Park, CA 91309
- or Fax to (818) 466 8730
- or E Mail: etec-energy@EMCBC.DOE.GOV