A PERSPECTIVE ON CHERNOBYL

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NT LETTER

Received September 29, 1986

The causes, the detailed sequence, and the consequences of the Chernobyl Unit Four accident will probably be studied and debated for decades. Scientific curiosity and the desire for technical completeness will identify issues on which more research can be done and generate more data that can be analyzed. However, it is important to keep the unknown in pespective with the known.

The accident represents a major disaster for the 31 dead and their families and for the other on-site personnel and emergency workers who received massive doses of radiation and extensive burns (up to 80% in some cases). In spite of the extensive Soviet medical response, it is to be expected that several more of these on-site people will die as a result of the accident. On the other hand, the risk to the Soviet off-site (but nearby) population is so low that lifelong epidemiological studies will be necessary to determine the extent and nature of any risk.

In the economic sense, the accident represents a major cost for the Soviet economy—the shortfall of electricity due to the shutdown of four 1000-MW(electric) plants, the concerns about the safety of the more than one dozen similar units, and the costs of cleanup of the site and the affected towns and villages.

It is strange that, while the health effects and the economic effects are the most difficult to assess—the first because they are so small and the second because of the difference in our economic systems and the assumed lack of liability and punitive damage law in the USSR—much of the uncertainty discussions seem to focus on physical/technical matters either already known or easily calculated, for example, the following:

1. How does our containment design analysis compare with that of the Soviets? At Chernobyl the reactor itself was *outside* the confinement/pressure suppression system. Those items inside confinement such as pumps, valves, pipes, and the cells enclosing them all seem to be intact. Under these conditions, what is the relevance of comparing details?

2. Should this accident revise our view of fission product release from a light water reactor (LWR) accident? Aside from the containment difference, Chernobyl had 1600 vertical tubes at 6.9-MPa steam pressure. When the tops were ripped off these tubes, they became steam-powered cannons blowing fuel fines skyward. The Soviets attribute much of the fission product release to the burning of the graphite (estimated at 250 Mg). With all values adjusted for decay to May 6, there were 12 million curies released on April 26 (the accident itself), but 20 million curies total released on May 3, 4, and 5 (graphite burning). Then the graphite fire was extinguished, and the release on May 6 was 0.1 million curies; by May 9 it was 0.01 million curies. Even with the graphite fire, the steam cannons, and no containment, the source term appears to have been less than some of our codes predict for some LWR accidents. Our on-going source term evaluation program seems to be validated by the accident.

3. Thermal margins? In LWRs, with the exception of the fuel itself, the zirconium alloy cladding is the hottest material around: Everything else is a heat sink. In the Chernobyl design, the graphite is 370°C *hotter* than the zirconium alloy pressure tubes and is therefore a very major (2-Gg) heat source.

While the review of the accident and its consequences continues and new details continue to become available, both to the Soviets and to the world technical community, it is already clear there is a "difference in depth" between the Chernobyl design and U.S. LWR designs. There are differences in basic technology, design concepts, design philosophies, treatment of man/machine interfaces, use of administrative controls, the role of safety reviews and regulations, containment versus no containment, large positive void coefficients, high-speed versus slow-speed control systems, differences in neutronic stability and thermal-hydraulic stability, etc. *The difference in safety is due to all of these items but is not due to any one of these items.* The difference in depth means that violation of administrative rules, or a leak in containment or any other single failure in an LWR, cannot cause the Chernobyl-type accident.

The technical community should continue to assess the accident: We are intellectually obligated to help the Soviets ensure there is never another "Chernobyl Four." But at the same time, we should recognize that the differences in the basic technology, the design concepts and details, the operational controls, and the institutional differences between a Chernobyl-type graphite reactor in the USSR and a commercial LWR in the United States are so fundamental that the Soviet accident does not challenge the framework of U.S. nuclear safety decisions.