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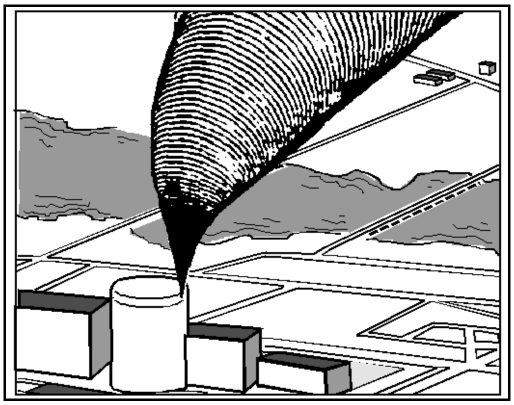
Offsite Consequences of Core Damage Accidents



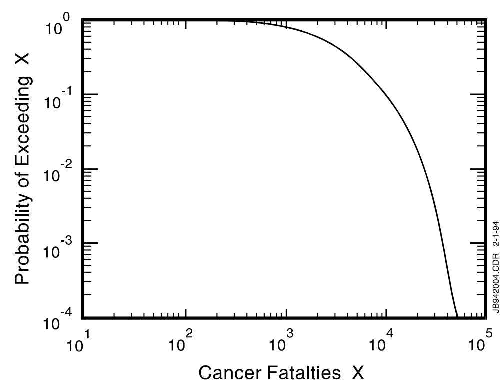
Airborne Radioactive Effluent Plume

The risk of a core damage accident at a typical U.S. commercial nuclear power reactor is about 10^{-4} to 10^{-5} per year, according to current probabilistic risk analysis (PRA) studies. Core damage accidents can lead to large releases of radioactivity inside a plant. Releases outside the plant may be small (Three Mile Island, 1979) or large (Chernobyl, 1986).

Nuclear utilities examine offsite consequences of hypothetical accidents in order to detect plant vulnerabilities, assess emergency planning, and make cost/benefit comparisons. To support such efforts, the offsite consequences of a hypothetical core damage accident can be calculated using the MAAP and MACCS computer codes. MAAP (Modular Accident Analysis Program) determines the release of radioactivity to the environment. MACCS (MELCOR Accident Consequence Code System) calculates resulting radiation doses, health effects and economic cost.

Recent Individual Plant Examinations (IPEs) for PWRs have identified steam generator tube rupture (SGTR) sequences in which the steam generator safety valve sticks open as being a significant contributor the to probability of a large offsite release. A typical MAAP/MAACS result for such a case is shown in the figure below. In this example 94% of the noble gases, 38% of the volatile fission products (e.g. CsI), and 5% of the non-volatiles were released from the reactor coolant system directly to the environment (containment bypass). The figure shows the probability distribution of resulting cancer fatalities in an exposed population of 10 million, based on the plant-specific probabilities of different weather conditions possible at the site. This translates to a mean probability of 5000 eventual cancer deaths and a predicted mean cost of 2.1 billion dollars.

Fortunately, only a small fraction of core damage events is expected to lead to consequences as serious as those shown in the figure. In the vast majority of cases, the containment is intact and not bypassed. With an intact containment, releases of radioactivity are due to leakage and are small. Simply delaying containment failure can dramatically reduce radioactivity releases and offsite impact.



Complementary Cumulative Distribution Function for Cancer Fatalities

The following table compares the offsite consequences predicted by MAAP/MACCS for three typical PWR sequences: the SGTR described above, a large LOCA with containment rupture 37 hours into the accident, and a small LOCA in which the containment remained intact. In the two LOCA events, no early fatalities were expected, average cancer fatalities were less than 10 (based on an exposed population of 10 million), and the average cost was less than 10 million dollars.

Event	Early Fatalities	Eventual Cancer Fatalities	Cost (millions of dollars)
SGTR	0.006	5000	2100
Large LOCA	0.0	6	7
Small LOCA	0.0	2	5

The MAAP code, developed by FAI, is distributed through the Electric Power Research Institute, while the MACCS code was developed for the U.S. Nuclear Regulatory Commission. FAI has performed calculations as described above according to 10CFR50 Appendix B Quality Assurance requirements, for PWR, BWR, and other nuclear plant designs. We welcome the opportunity to provide you with additional details on offsite consequence calculations using these codes.

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