CONF-811056--3

EGG-M--08281

DE82 007348

VENTING KRYPTON-85 FROM THE THREE MILE ISLAND UNIT 2 REACTOR BUILDING

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Abstracted from GEND 013:

TMI-2 REACTOR BUILDING PURGE--KR-85 VENTING

Presented to

International Atomic Energy Agency Seminar

Karlsruhe, Federal Republic of Germany

October 5-9, 1981

DISCLAIMER

VENTING KRYPTON-85 FROM THE THREE MILE ISLAND UNIT 2 REACTOR BUILDING

INTRODUCTION

As a result of the March 28, 1979 accident at Three Mile Island Unit 2 (TMI-2), radioactive fission products, including gases, particulates, and iodine, were released into the enclosed reactor building atmosphere from failed fuel in the reactor core. The amount of airborne radioactivity in the reactor building gradually decreased following the accident because most of the fission products were short-lived and decayed quickly. The major radionuclide present in the reactor building atmosphere one year after the accident was ^{85}Kr.

To permit the less restricted access to the reactor building necessary to maintain instrumentation and equipment, and to proceed toward the total decontamination of the facility, General Public Utilities, operators of the facility referred to hereafter as GPU, asked the United States Nuclear Regulatory Commission, or NRC, for permission to remove the ^{85}Kr from the reactor building by venting it to the environment. GPU supported their request with the Safety Analysis and Environmental Assessment Report on the proposed reactor building venting plan. On June 12, 1980, after seven months of licensing deliberations and numerous public hearings, the NRC granted GPU's request. The actual venting took place between June 28 and July 11, 1980.

This report presents an overview of the detailed effort involved in the TMI-2 reactor building venting program. The findings reported here are condensed from a published report entitled TMI-2 Reactor Building Purge--Kr-85 Venting[1].

ALTERNATIVES TO VENTING

GPU evaluated a number of alternatives to the venting plan before requesting permission to vent. Each of several alternatives was evaluated in terms of potential radiation exposure to the public and to plant employees.

For all alternatives it was found that the expected on-site personnel radiation exposure and other considerations were equal to or worse than those for the proposed venting method. It was also determined that none of the alternatives could be implemented as easily as the proposed method could.

LICENSING CONSIDERATIONS

By specific NRC order, licensing approval was required prior to processing the TMI-2 reactor building atmosphere. After GPU completed its initial draft of the Safety Analysis and Environmental Assessment Report, licensing became the key step on the way to venting the reactor building. The licensing procedure was a long and detailed one. During the seven month period when licensing investigations were underway, GPU, the U.S. Environmental Protection Agency, the NRC, and the Pennsylvania Department of Environmental Resources devoted considerable energy to reassuring the public about the safety of the venting plan. For example, these four organizations participated in 15 public meetings with interested citizens groups, 16 meetings with elected officials, and seven press conferences and appearances on public information radio and television shows.

Health Effects

As a result of the licensing investigation, GPU and the NRC both concluded that there would be negligible physical health effects associated with the controlled venting of ^{85}Kr from the reactor building. This conclusion was supported by several other United States federal and state agencies, counsels, and research organizations. The NRC predicted the total off-site dose to the maximum exposed individual would be 11 mrem beta skin dose and 0.2 mrem gamma whole body dose. The NRC predicted the doses would be 63 and 0.76 person-rem for skin and whole body doses for the off-site population of 2.2 million people in a surrounding 50-mile area. Probable effects of these doses are shown here:

Total potential cancer deaths	0.0001
Genetic abnormalities	0.0002
Skin cancer deaths	0.000006

These numbers are insignificant fractions of the number of cancer deaths and genetic abnormalities that will normally occur in the surrounding population of 2.2 million from all other factors.

REACTOR BUILDING VENTING

Reactor Building Source Term

The reactor building atmosphere source term determination involved three types of reactor building air samples: noble gas, particulate matter, and radioiodine. Samples for tritium and gross beta analysis were also obtained.

Prior to June 28, 1980, when venting began, sample results showed the ^{85}Kr level at 1.04 µCi/cc. All other noble gases had decayed to below minimum detectable activity levels of 1 E-6 µCi/cc. Based on an estimated free volume of the reactor building of approximately 56600m^3, engineers calculated a ^{85}Kr reactor building inventory of about 57,000 curies. Following the venting, this inventory was revised downward, as will be discussed later.

The airborne concentration levels of all other isotopes were below the minimum detectable activity limits established in 10 Code of Federal Regulations Part 20. Because of these low levels and because all reactor building venting would be through high efficiency filters, no release of particulate radiation was expected. Krypton-85 was by far the dominant radioactive isotope and was the limiting isotope relative to controlling venting flow rates.

Venting Control

The venting of ^{85}Kr from the TMI-2 reactor building was carefully controlled to comply with the limits mandated by modifications to Technical Specifications for releases to the environment. The Technical Specifications required that neither of the following two limits be exceeded during venting: 15 mrem skin dose or 5 mrem whole body dose at the site boundary.

A computer program operating continuously during venting calculated the allowable venting flow rate at least once each hour. This rate was based on the ^{85}Kr concentration in the reactor building, the current meteorological conditions such as wind speed, wind direction, and stability, and a conservative allowed mrem/hr off-site exposure limit, which was 0.3 mrem/hr skin and 0.1 mrem/hr whole body. Based on these inputs, the computer program performed atmospheric dispersion and radiological exposure calculations to determine the maximum allowable venting rate.

Venting Systems

The decontamination of the TMI-2 reactor building atmosphere was accomplished using two existing systems which were modified for the venting program. The Modified Hydrogen Control System was capable of venting at rates from 0 to 0.28m^3/s. Venting at rates above 0.28m^3/s and on up to 8.73m^3/s was done with the modified "B" train of the Reactor Building Air Purge and Purification System. The allowed venting rate was calculated by the computer program mentioned above.

Venting Chronology

The venting operation ran smoothly following an initial problem which occurred four minutes into the venting operation. High alarms sounded on the particulate channels of both radionuclide detectors in the plant stack. These were set at 80% and 50% of the Technical Specifications limit of 0.3 μCi/sec respectively. Following shutdown of the system, the particulate filters from both these monitors were removed and analyzed but they showed no particulate activity. Engineers concluded that the particulate detectors were responding to the ^{85}Kr in the system.

The only other notable event occurred when the faster-venting Modified Reactor Building Air Purge and Purification System was first used. Krypton-85 concentration levels in the Auxiliary Building rose, at one point, to approximately 186 times the maximum permissible concentration level.

Engineers stopped the venting, and found leaks in two ventilation system ducts. When these leaks were sealed, Auxiliary Building ^{85}Kr concentration levels dropped back to within permissible levels.

POST-VENTING ANALYSIS

Initial activity counts after the venting showed that a total of 34,414 curies of ^{85}Kr had been released, as compared to the estimated ^{85}Kr inventory of 57,000 curies. To account for the difference in these two counts, GPU looked for errors in calculations of both the number of curies released, and the estimated original curie inventory.

The original ^{85}Kr concentration estimate was about 0.2 uCi/cc too high. A revised estimate of 0.8 uCi/cc corrected the original curie inventory in the reactor building to approximately 44,600 curies, not 57,000 curies. In addition, GPU investigations revealed that errors in plant stack velocity and plant stack ^{85}Kr concentration calculations caused too low a measurement of the amount of ^{85}Kr released. When corrected for these errors, the released ^{85}Kr count was approximately 44,132 curies, not 34,414 curies. This revised activity count of 44,132 curies is reasonably close to the revised estimate of an inventory of about 44,600 curies.

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

Several environmental monitoring programs operating in conjunction with the venting program represent the most extensive monitoring effort ever instituted at a commercial nuclear facility. Monitoring stations were thickly scattered throughout the area to insure effective monitoring of ^{85}Kr levels in the environment and to verify off-site dose predictions. One of the principal concerns was to establish monitoring programs which had credibility with the general public and which would accurately measure and report the findings. The U.S. Environmental Protection Agency and five other organizations participated in the monitoring. A Citizens Radiation Monitoring Program, supervised by the Pennsylvania State Department of Environmental Resources, supplemented these government programs.

The Citizens Radiation Monitoring Program evolved independently of the reactor building ^{85}Kr venting plans, but its operation during the venting period added extra credibility to the already extensive monitoring efforts. In this program, citizens selected by their local officials monitored radiation detectors in their communities.

None of these monitoring programs recorded off-site radiation levels above the limits established for venting by the NRC. In fact, most of the recorded radiation levels were well within normal background radiation levels for the area.

Conclusions

In conclusion, then, we see that the venting of the TMI-2 reactor building was a careful operation. At no time during the venting was there a danger to public health and safety, nor to the environment. Careful predictions had estimated that releases to the environment would be well within safe levels, and monitoring of the venting proved those predictions true:

- No significant amounts of particulate radiation were detected.
- Off-site integrated doses from the vented ^{85}Kr did not exceed NRC guidelines of 15 mrem skin dose and 5 mrem whole body dose.
- ^{85}Kr dose estimates suggest the maximum off-site doses were 2 to 5 mrem skin dose and less than 1 mrem whole body dose.

REFERENCES

1. L.J. Kripps, TMI-2 Reactor Building Purge--Kr-85 Venting, GEND 013, March 1981.