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Safety Assessment

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Dear Don:

SUBJECT: ASSUMPTIONS USED IN THE NONPOWER REACTOR SABOTAGE STUDY

Attached is a detailed review of all assumptions used in the Los Alamos National Laboratory Nonpower Reactor Sabotage Study. The assumptions are as follows.

Section	Assumptions Covering
A	Events Leading to Release
B	Internal Building Transport and Source Terms
C	Transport and Dispersion
D	Cavity Released Model
E	NRC 1.145 Model
F	Gaussian Plume Model
G	Gaussian Puff Model

Most of these assumptions are generic in nature and can be applied to all the reactors considered. Although they are conservative, they are as realistic as possible within the constraints of NRC guidelines and standard industry practice so that the estimations of the consequences of the events will identify the threat to the public as realistically as possible.

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This letter supersedes my letter dated August 2, 1985 (Q-6-85-624). The attached assumptions include clarifying details as requested by NRC during a meeting on August 14, 1985.

Sincerely,

W. D. Zerwekh

WDZ:cl

Attachment as cited

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(u) ASSUMPTIONS USED IN THE NONPOWER REACTOR SABOTAGE STUDY

(u) A. ASSUMPTIONS USED IN GENERATING SCENARIOS.

(c) 1.

(u) 2. The release is assumed to occur immediately before a shutdown for refueling for an equilibrium cycle. Again, this leads to the largest possible source term and therefore is appropriately conservative for any other point in the cycle.

(u) 3. The fuel is assumed to melt upon reaching the melting temperature; that is, no allowance is given for the energy absorbed in the phase transition. This greatly simplifies the TRAC analysis and is conservative because it leads to a prediction of a slightly earlier and larger fuel melt.

(u) 4. No change in geometry is analyzed at melt. Under actual conditions, fuel that had melted would drop out of the core region, removing heat. However, this is not easy to analyze, and therefore, the model leaves the material in place, leading to an over-estimation of the size of melt. However, the size of the error is not large unless a large fraction of the core is predicted to melt, in which case the error is limited by the material available to melt. Hence, this assumption is conservative but not unrealistically so.

(u) 5. The accident analyses presented in the facilities' Safety Analysis Reports (Hazard Summary Reports) are assumed to be acceptable and therefore need not be reanalyzed. This information already has been reviewed and approved by the NRC as appropriately conservative.

(u) 6. It is assumed that the adversary has available to him all information available in the open literature. Because all information about the facilities used in the analyses was from unclassified sources, the adversary can duplicate any scenario that will be presented in the report.

(u) 7. No credit is given to the scenario for random failures. The adversary is credited with a certain level of intelligence and will plan for all events necessary to complete the scenario. It is not logical to assume that a random failure will occur at the precise moment necessary to insure a successful scenario nor is it logical to assume a failure occurrence that prevents completion of the scenario.

(u) B. ASSUMPTIONS USED IN SOURCE-TERM CALCULATIONS.

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(u) For the building wake cavity releases, the following are applicable.

(u) 1. The model conservatively assumed that homogeneous mixing occurred instantaneously.

(u) 2. The release was transported through a single room whose volume was equivalent to the sum of all the individual volumes in the transport path (from the reactor to the building wake cavity). No leakage that might occur through each transport path was allowed.

(u) 3. The leak rate out of the building was assumed to be based on the building leak rate given in the Safety Analysis Report for each facility.

(u) 4. No ventilation or no forced air was assumed.

(u) For the stack level releases, the following was assumed.

(u) 1. The radionuclide cloud was assumed to be released into the nearest volumes for transport through the stack (that is, the shortest path).

(u) 2. The stack flow rates were based on the values found in the Safety Analysis Report for each facility.

(u) 3. No reduction in activity based on any filtration was allowed.

(u) C. ASSUMPTIONS USED IN THE TRANSPORT AND DISPERSION CALCULATIONS

(u) Four models were used to estimate the atmospheric dispersion from a sabotage-induced release for the NBS, Georgia Tech, and University of Missouri nonpower research reactors. The four models included a cavity model used for determining the dispersion characteristics for exposures within the building wake cavity, the NRC 1.145 atmospheric dispersion model for determining exposures for releases heights less than 2.5 times the building height, a Gaussian plume model, and a Gaussian puff release model for short-term releases.

(c)

(u) The following assumptions are applicable to all calculations.

(u) 1. Stable weather conditions were assumed. For the Gaussian plume and NRC models, Pasquill category types E (slightly stable) and F (stable) were used for both Georgia Tech and the University of Missouri. Both of these conditions occur only at night, and usually only in rural settings. Because type F conditions were so infrequent at NBS, only type E conditions were used. The criterion used in this determination was that the condition should exist at least 5% of the time. Stable conditions also were specified for the Gaussian puff calculations. These stability classes, in conjunction with the appropriate windspeeds, were assumed because they resulted in the maximum doses.

(u) 2. Appropriate wind speeds for the above types of weather conditions were taken from Slade (1968). For type E stability conditions, the wind speed used was 3 m/s, and for type F stability conditions, the wind speed used was 1 m/s. For the puff model calculations, wind speeds of both 1 m/s and 3 m/s were used. This again was consistent with the 5% criteria.

(u) 3. The above weather conditions were assumed to persist for the entire release period so that the concentrations at the location of the receptor would be maximized. The short durations of the release scenarios (a few hours) ensure the likelihood that the stable meteorological conditions can persist throughout the exposure time, thus maximizing the dose commitment to the receptor.

(c) 4.

(c) 5.

(u) 6. For the Gaussian plume and NRC models, the Pasquill-Gifford curves for estimating the standard deviation of the distribution of material in the cloud was used. These curves are used widely and were taken from actual diffusion experiment results for distances of less than 1 km in an open field.

(u) 7. The receptor was assumed to be located in the centerline of the downwind direction. This assumption is the most conservative because any slight shift in wind direction would result in reduced concentrations and subsequently lower exposures to the receptor. The maximum exposures are received by a receptor located directly downwind and in the centerline path of the radionuclide cloud.

(u) 8. The particulates were assumed to be less than 10 μm in diameter. This size was assumed to ensure that they are in the respirable range.

(u) 9. The release fractions of the noble gases, halogens, and particulates from the core melt were assumed to be 100%, 50%, and 1%, respectively.

and an additional 50% reduction of the iodines was assumed to account for removal of the airborne iodine through various physical phenomena (that is, adsorption, adherence, and so on) as outlined in TID 14844. This constitutes a release of ~15% of the gross fission product activity (Blomeke and Todd, 1958). These are very conservative assumptions that may lead to doses that are much too high in some cases; however, they are the currently accepted fractions.

(c) 10.

(u) 11. The thyroid dose calculations conservatively assumed that all of the material inhaled at the receptor location was respirable. The external dose calculation assumed that the cloud exposing the receptor is semi-infinite. This assumption produces the maximum exposures.

(u) 12. No credit was given for any filtration.

(u) 13. The stack plume releases were assumed to possess no driving forces other than momentum, and therefore, the plumes were assumed not to have risen significantly. This assumption produces the highest exposures for the receptor at the site boundary.

(u) D. ASSUMPTIONS USED IN THE CAVITY MODEL

(u) The following assumptions are applicable only to the cavity model used in the calculations.

(u) 1. The release was entrained entirely into the building wake cavity. This was the most conservative case because none of the radionuclide material initially was released from the cavity. This assumption produced the maximum dose.

(u) 2. As a result of the turbulence inside the cavity, the material mixes fairly rapidly. Realistically, there will be some nonuniformities in the concentration of radionuclides within the building wake cavity; however, the model estimates an average concentration of radionuclides within the cavity. The receptor was assumed to be located inside the building wake cavity; however, because it would be impossible to predict exactly where, he was not assumed to be situated directly at the release point. This assumption was assumed to be realistic and not extremely conservative.

(u) 3. The constant value C in the cavity model equation can have a value between 0.5 and 5.0. It was assumed conservatively that the value was between 0.5 and 1.0, which were the values used in this calculation because higher numbers would indicate more rapid dispersion and therefore lower doses.

(u) E. ASSUMPTIONS USED IN THE NRC 1.145 MODEL

(u) The following assumptions are specific to the NRC model used in the calculations.

(u) 1. The release height was assumed to be less than 2.5 times the height of the nearest building. This assumption was required for the equations used in the NRC model calculation to be directly applicable.

(u) 2. The three equations used in the calculation incorporate the dilution caused by the building wake effect and also the meander effect that results during stable weather conditions and low wind speeds. For type E and F weather stability conditions, the meander factors were 2.1 and 4.0, respectively.

(u) F. ASSUMPTIONS USED IN THE GAUSSIAN PLUME MODEL

(u) The following assumptions were made specifically with regard to the Gaussian plume model.

(u) 1. When making a dry deposition correction, the average deposition velocity of the particulates was assumed conservatively to be 0.003 m/s. This produced the highest exposure.

(u) 2. The buoyancy correction factor was obtained by assuming that the release was not heated. This was a conservative assumption as buoyancy would decrease the ground level concentrations near the release.

(u) 6. ASSUMPTIONS USED IN THE GAUSSIAN PUFF MODEL

(u) The following assumptions are specific to the Gaussian puff model calculations.

(u) 1. The same assumptions for the dry deposition correction factor and buoyancy effects used in the Gaussian plume model calculations also apply to the puff release.

(u) 2. The radius of the release from the stack was assumed to be the stack radius. For the ground-level release, the radius and height were assumed to be half the height of the door. This height was the more conservative approach.

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