Attachment 4

When prevention alone, rather than mitigation, was the applicant's preferred safety strategy, the applicant applied a leak path factor equal to zero. The applicant used a leak path factor equal to one when the HEPA filters were either unlikely to function as needed or not required to mitigate the event consequences (see "Verification of Low Consequence Events," DSER Section 9.1.1.4.4).

As described in Section 11.4 of this DSER, the staff has questioned the applicant's use of a 99 percent removal efficiency per stage during events that could challenge the function of the filters. Appendix F of Reference 9.3.12 recommends an efficiency of between 99 percent and 95 percent. Therefore, for the purposes of this DSER, the staff has reanalyzed the accident consequences for fire and explosion events using an leak path factor (LPF) of 0.01. The applicant disagrees with the staff on this point. Therefore, the methodology for deriving source terms that was presented by the applicant has not been accepted by the staff and is considered an open issue.

NRC Regulatory Guides 3.71 and 3.35 (see References 9.3.15 and 9.3.14) were used by the applicant to develop source terms for direct radiation and airborne releases resulting from a criticality accident. The staff independently verified the applicant's use of these guides for estimating source terms, and find the applicant's analysis to be consistent with the guidance.

9.1.1.4.3 Dose Assessment for the Site Worker

The applicant's methodology for dose assessment relies on an assumption that the principle human health hazard posed by releases of radioactive material from the MOX facility is inhalation of radioactive material downwind of the facility. Other pathways of exposure would include direct radiation from the passing plume and exposure to ground surfaces contaminated by material depositing on the ground as the plume passes. However, the staff confirmed by calculation that, with the exception of the criticality event, the direct radiation and ground contamination pathways are negligible as compared to the inhalation pathway.

To calculate the 50-year committed effective dose equivalent (CEDE) from inhalation doses from passing plumes, the applicant applied a simple formula involving the source term (Eq. 9.1), the atmospheric dispersion factor (χ/Q), a human receptor's breathing rate (B.R.), and the dose conversion factor (DCF) (from Reference 9.3.4):

$$CEDE_i\,[\text{rem}] = \text{Source Term}_i\,[\text{kg}] \times \chi/Q\,[\text{s m}^{-3}] \times B.R.\,[\text{m}^3\,\text{s}^{-1}] \times DCF_i\,[\text{rem}\,\mu\text{Ci}^{-1}] \times C_i\,[\mu\text{Ci kg}^{-1}]$$

where $CEDE_i$ is the committed dose from the ith radionuclide, and
C_i is the specific activity of the ith radionuclide.

Atmospheric dispersion factors were calculated by the applicant using site-specific meteorological data from the SRS H-Area meteorological tower collected from 1987 through 1996. The ARCON96 model (see Reference 9.3.18) was used to estimate factors for the site worker located 100 meters from the plant stack. The value calculated by the applicant was 4.2E-4 s m^{-3}. The staff verified by independent calculations that the meteorological data used by the applicant in their safety assessment is consistent with data published by the U.S. Department of Energy's (DOE's) SRS for the H-Area meteorological tower (DOE, 1999). The staff also performed independent calculations for the site worker atmospheric dispersion factor and calculated a value of 6.1E-4 s m^{-3}. The staff used this value of the atmospheric dispersion factor to calculate the consequences from controlling events that are presented in Table 9.1-6 of this DSER.

individual leak path factors for successive filter stages, the applicant applied a leak path factor of 10^{-4} for systems relied upon in their safety assessment. The combination of efficiencies in this manner is acceptable to the staff, because it is consistent with the guidance in Reference 9.3.12, Section F.2.1.3, however, the staff has not accepted the value of 10^{-4}.

When prevention alone, rather than mitigation, was the applicant's preferred safety strategy, the applicant applied a leak path factor equal to zero. The applicant used a leak path factor equal to one when the HEPA filters were either unlikely to function as needed or not required to mitigate the event consequences (see "Verification of Low Consequence Events," revised DSER Section 9.1.1.4.4).

As described in Section 11.4 of this revised DSER, the staff has questioned the applicant's use of a 99 percent removal efficiency per stage during events that could challenge the function of the filters (Open Item VS-1). Appendix F of Reference 9.3.12 recommends an efficiency of between 99 percent and 95 percent for severe conditions. Therefore, for the purposes of this revised DSER, the staff analyzed the accident consequences for fire and explosion events using an leak path factor (LPF) of 0.01. The staff's evaluation of HEPA filter efficiencies is described in Section 11 of this revised DSER.

NRC Regulatory Guides 3.71 and 3.35 (see References 9.3.15 and 9.3.14) were used by the applicant to develop source terms for direct radiation and airborne releases resulting from a criticality accident. However, since NRC has withdrawn these guides, the staff used the current guidance in Reference 9.3.12 to estimate the downwind consequences to a site worker of a criticality accident. By so doing, the staff independently evaluated the applicant's source terms, and find that the applicant's analysis is consistent with the current guidance, and is therefore, acceptable.

9.1.1.4.3 Dose Assessment for the Site Worker

The applicant's methodology for dose assessment relies on an assumption that the principle human health hazard posed by releases of radioactive material from the proposed MOX facility is inhalation of radioactive material downwind of the facility. Other pathways of exposure would include direct radiation from the passing plume and exposure to ground surfaces contaminated by material depositing on the ground as the plume passes. However, the staff confirmed by calculation that, with the exception of the postulated criticality event, the direct radiation and ground contamination pathways are negligible as compared to the inhalation pathway.

To calculate the 50-year committed effective dose equivalent (CEDE) from inhalation doses from passing plumes, the applicant applied a simple formula involving the source term (Eq. 9.1), the atmospheric dispersion factor (χ/Q), a human receptor's breathing rate (B.R.), and the dose conversion factor (DCF) (from Reference 9.3.4):

$$CEDE_i\,[\text{rem}] = \text{Source Term}_i\,[\text{kg}] \times \chi/Q\,[\text{s m}^{-3}] \times \text{B.R.}\,[\text{m}^3\,\text{s}^{-1}] \times DCF_i\,[\text{rem}\,\mu\text{Ci}^{-1}] \times C_i\,[\mu\text{Ci kg}^{-1}]$$

where $CEDE_i$ is the committed dose from the ith radionuclide, and
C_i is the specific activity of the ith radionuclide.

Atmospheric dispersion factors were calculated by the applicant using site-specific meteorological data from the Savannah River Site (SRS) H-Area meteorological tower collected from 1987 through 1996. The ARCON96 model (see Reference 9.3.18) was used to estimate factors for the site worker located 100 meters from the plant stack. The value calculated by the applicant was 6.1E-4 s m^{-3}. The staff verified by independent calculations that the meteorological data used by the applicant in their safety assessment is consistent with data published by the U.S. Department of Energy's (DOE's) SRS for the H-Area meteorological tower (DOE, 1999). The staff also performed independent calculations for the site worker atmospheric dispersion factor and calculated a value of 6.1E-4 s m^{-3}. The staff used this value of the atmospheric dispersion factor to calculate the consequences from controlling events that are presented in Table 9.1-6 of this DSER.

The breathing rate of 3.47E-4 m^3 s^{-1} assumed by the applicant is consistent with guidance provided by the NRC in Regulatory Guide 1.25 (see Reference 9.3.13), and is equivalent to a volume of 10 cubic meters inhaled during an 8-hour workday. This assumption is based on NRC guidance applicable to fuel handling and is, therefore, acceptable to the staff for use in the applicant's safety assessment.

EPA dose conversion factors used by the applicant (Reference 9.3.4) are based on the recommendations of the International Commission on Radiation Protection (ICRP). These are the same recommendations that form the basis for NRC radiation protection standards in 10 CFR Part 20. Therefore, these factors are acceptable to the staff.

The source of values for C_i, the specific activity of the i^{th} radionuclide, were not provided by the applicant. The staff used information provided in ICRP Publication 38 (see Reference 9.3.8) in its independent evaluation.

The results of the staff's independent evaluation of bounding event consequences for site workers is provided in revised DSER Table 9.1-6. For many events, the PSSC applied to reduce the risk of the event would actually lower the likelihood of the event. A significant margin of safety exists for all of the mitigated events. The smallest margin is about a factor of ten between the 2.6 rem acute TEDE consequence to the site worker resulting from a fire and the 25 rem acute TEDE intermediate consequence threshold.

9.1.1.4.4 Verification of Low Consequence Events

Unmitigated event consequences result from an accident sequence when mitigative controls either fail or do not exist. Unmitigated event consequences are those consequences calculated by the applicant prior to determining and taking credit for PSSCs that would reduce the risk of the event. However, in some cases the unmitigated event consequence is so low that it falls below the intermediate consequence threshold values for workers specified in 10 CFR 70.61(c)(1). These events, referred to as "low" consequence events, require no PSSCs to lower the risk. The applicant identified 22 hazard assessment events as low consequence events. Sixteen of these were loss of confinement events, three were fires and three were load handling events.

The staff performed independent calculations to verify the applicant's assertion that some events would be low consequence events and would not require PSSCs to further reduce the accident risk. Based on the staff's confirmatory analysis, the staff accepts the applicant's categorization in its hazard assessment of the 22 events as being low consequence events.

9.1.2 Radiation Protection Program

The purpose of this review is to determine whether the applicant's radiation protection program is adequate to protect the radiological health and safety of the workers and to comply with the regulatory requirements of 10 CFR Parts 19, 20 and 70, to the extent such programmatic