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PATHS FORWARD ON IGNEOUS ACTIVITY RISK ASSESSMENTS FOR YUCCA MOUNTAIN

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SIGNIFICANCE OF IA TO TSPA

- Although not required, TSPA-VA evaluated igneous events.
  - Comments warranted to provide timely guidance for subsequent DOE-TSPAs
- TSPA-VA concludes almost no impact on performance from volcanism.
  - Staff question technical bases for numerous process models
- Modeling igneous disruptive events for a repository is a challenge as there are few data or analogs for these conditions.
  - This challenge can be met reasonably and expeditiously
- Current staff analyses show the approximately 1 mrem/yr expected annual dose from volcanism is the largest contribution to total-system risk during a 10,000 yr performance period.
  - Staff note some components of these analyses may under or over estimate risk.
  - Ongoing work to evaluate conservatisms and reduce uncertainties
- DOE will need to present acceptable data, models, and analyses in licensing to adequately address risks from igneous events.

STATUS OF PRIMARY TSPA-VA CONCERNS

Staff's primary technical concerns with TSPA-VA analyses apparently are being addressed by DOE

Informal, collegial communication is greatly facilitating the issue resolution process

- Source-zone models reduce average probability of volcanic disruption $<10^{-8}$/yr, in contrast to prior models used for subissue resolution
  - 1/99 Appendix 7: Average igneous event probability of 1.5×10^{-8}/yr from PVHA = average DOE probability of volcanic disruption.
  - 1/99 Appendix 7: Upper probability bound of 10^{-7}/yr from PVHA also will be used in DOE risk assessments, in addition to average value.

- Eruption characteristics underestimate disruptive capabilities of YMR volcanoes
  - 2/99 Workshop: Greater reliance will be placed on active, violent strombolian analogs to YMR volcanoes.

STATUS OF PRIMARY TSPA-VA CONCERNS, cont.

- Waste Package resilience during volcanic events not supported by models or data with sufficient technical basis
  - 2/99 and 4/99 Workshops: Additional models and data needed to support conclusions of waste package resilience, including coupled thermal, mechanical, and chemical effects of igneous events.

- Effects of igneous events on HLW-form poorly constrained
  - 2/99 Workshop: Additional models and data needed to evaluate waste-form characteristics during igneous events.

- Airborne contaminant plume bypassed the critical group location for most simulations
  - 2/99 Workshop: Parallel approach to groundwater contaminant plume (i.e., always directed toward critical group) is reasonably conservative.

POTENTIALLY SIGNIFICANT SOURCES OF UNCERTAINTY

Magma–Repository Interactions

- Ascending magma has ≈10 MPa overpressure and contains volatiles, thus will flow into drifts
- Scoping calculations indicate large sources of resolvable uncertainty:
  - Intrusion response to rock-stress regime around drifts?
  - Flow velocity into open or partially backfilled drifts?
  - Amount of compaction or mobilization of backfill?
  - Extent of magma flow into drifts?
  - Temperature and composition of magma+gas after emplacement?
  - Conduit characteristics at drift interface?

POTENTIALLY SIGNIFICANT SOURCES OF UNCERTAINTY

Magma–Repository Interactions, cont.

- Relevance to 10,000 yr performance:

  – Flow into a dominantly backfilled drift can compact backfill and disrupt some fraction of waste packages in the drift.

  – Flow into nonbackfilled drifts potentially fails most or all of the waste packages in the intersected drift.

  – 10^{-7} annual event probability and hydrologic transport times probably limit contributions to expected annual dose to <1 mrem/yr.

  – In contrast, lateral breakout of conduit along drift roof may enhance source-term for volcanic transport and increase expected annual dose.

- Technical basis thus needed to evaluate potentially important contributions to expected annual dose from modified volcanic eruption.

POTENTIALLY SIGNIFICANT SOURCES OF UNCERTAINTY

Airborne Particle Concentrations thru Time

- Expected annual dose calculations need to consider contributions from tephra deposits up to 1,000's of years old.

- These deposits are eroded from YMR (>80 ka) and analogs have limitations:
  - Climate, topography, vegetation affect deposit character

- Current assumption is conservative:
  - Airborne particle concentration is constant through time

- Need technical basis to evaluate 0–10,000 yr after eruption:
  - Amount of airborne particulates available in juvenile fall deposits
  - Fine-particle redistribution mechanisms
  - Deposit erosion or burial in YMR setting
  - Leaching of radionuclides from deposit

CONCLUSIONS

- TSPA-VA analyses provide limited technical bases for IA models
  – Inadequate for screening, additional work needed for acceptable models.

- Post-VA interactions show acceptable IA modeling approaches can be developed before licensing.

- Current staff analyses show igneous events make a large contribution total-system risk during the first 10,000 yr post-closure and will need to be evaluated acceptably.

- Active magma-repository interactions may affect a larger number of waste packages than currently modeled with passive interaction; this consequently may increase total-system risk.

- Characteristics of contaminated tephra-fall deposits through time are likely over estimated, but models currently lack a sufficient technical basis to reduce the associated total-system risk.

- Additional work can quantify and reduce these current levels of uncertainty.