

**REVIEW OF:**

**THE STUDY PLAN FOR FUTURE REGIONAL  
CLIMATE AND ENVIRONMENTS (8.3.1.5.1.6)**

*Prepared for*

**Nuclear Regulatory Commission  
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**DETAILED TECHNICAL REVIEW OF STUDY PLAN 8.3.1.5.1.6  
FUTURE REGIONAL CLIMATE AND ENVIRONMENTS**

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**1 INTRODUCTION**

Assessments of the ability of the proposed high-level waste repository at Yucca Mountain, Nevada to safely contain spent fuel for 10,000 or more years will, in part, be based on the predictions of water flow through and adjacent to the repository using numerical models. A major component of the hydrologic cycle is the local climate. The climate provides the temperature and precipitation regimes from which runoff and infiltration are produced. In order to understand the future hydrology of the site, future climates must also be understood. Study Plan 8.3.1.5.1.6 Future Regional Climate and Environments proposes to investigate likely future climate scenarios at the site to develop parameters needed to allow numerical simulation of the area's hydrology.

**2 REVIEW BACKGROUND**

A preliminary review and acceptance of this Study Plan for Future Regional Climate and Environments was completed by Neil Coleman of NMSS.

This study plan has retained a structure similar to that described for section 8.3.1.5.1.6 in the Site Characterization Plan (SCP; DOE, 1988). Much of the original thinking and wording is retained in this Study Plan's description of objectives of each activity.

**3 REVIEW CRITERIA**

The detailed technical review of this Study Plan is based on the Review Plan for NRC Staff Review of DOE Study Plans, Revision 2 (NRC, 1993). Specifically the detailed review considers:

- Whether the objectives of the Study Plan are consistent with the investigation presented in the SCP and are technically defensible in the context of the overall site characterization program
- Whether the activities, tests, and analyses proposed in the Study Plan are able to provide the data necessary for licensing
- Progress toward resolution of open items

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models and should defer to other study plans (dealing with runoff, infiltration, hydrology, and performance assessment) which will use the climate-related information to constrain their evaluations.

## 6 REFERENCES

DOE. 1988. *Site Characterization Plan: Yucca Mountain Site, Nevada Research and Development Area, Nevada*. Office of Civilian Radioactive Waste Management. DOE/RW-0199. 9 Volumes.

NRC. 1989. *NRC Staff Site Characterization Analysis of the Department of Energy's Site Characterization Plan, Yucca Mountain Site, Nevada*. Office of Nuclear Material Safety and Safeguards. NUREG-1347.

but should be evaluated and discussed separate from the evaluation of likely climate scenarios at Yucca Mountain. Unanticipated processes and events should be included in this DOE study if (in the Commission's words) they are events "... judged not to be reasonably likely to occur during the period the intended performance objective must be achieved, but which nevertheless are sufficiently credible to warrant consideration." [48 Fed. Reg. 28200 (1983)]. For additional information see NRC, 1983.

#### References

Nuclear Regulatory Commission. 1983. *Staff Analysis of Public Comments on Proposed Rule 10 CFR Part 60 Disposal of High-Level Radioactive Wastes in Geologic Repositories*. NUREG-0804. Part 1: 563 pp. and Part 2: Appendices.

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### Comment 3

The use of expert opinion is mentioned explicitly several times and is implicit for other tasks (although not mentioned) in Study Plan 8.3.1.5.1.6 — Future Regional Climate and Environments, however, no formal plan for the use and documentation of the experts is presented.

### Basis

- In a discussion of “reasonably probable” on page 3 it is stated “... local climate scenarios identified as reasonably probable over the period of concern are credible to knowledgeable climatologists. Ultimately, the determination depends upon **expert judgments.**” [emphasis added]
- Relative to developing Reference Local Climate Scenarios (RLCS) the Study Plan states on page 13 “To provide additional assurance regarding the soundness and defensibility of project approaches, interpretations, and conclusions, **nationally and internationally respected climatologists, including both paleoclimate experts and numerical modelers,** will be consulted and their opinions documented.” [emphasis added]
- On page 16 it is stated “... **expert judgment** must be brought to bear to ascertain whether the validation is adequate for Yucca Mountain Project (YMP) purposes.” [emphasis added]
- Also, on page 16 the Study Plan states “**Expert opinion** may also enter in deciding to use a model significantly different from the one tentatively selected.” [emphasis added]
- On page 23 it is stated “Confidence in the process [selecting global climate state and the initial and boundary conditions] will be enhanced by making use of a range of **expert opinion** early in task execution.” [emphasis added]
- On page 3 the use of experts (climatologists) is implied in the statement “... but rather the output of climatologists making use of climate model results together with other information available to them.” It is likely that the other information would include expert judgments.
- On page 7 it is stated “Defensible bounds can also be placed ... defensible estimates ... can also be made. ... defensible limits can be placed.” It is likely that the most credible bounds, estimates, and/or limits would come from the use of experts.
- On page 9 it is stated “To render that insight quantitative, one needs to run one or more carefully chosen and validated GCMs for selected sets of global boundary conditions. The sets are selected to emphasize conditions likely to favor enhanced infiltration at Yucca Mountain.” It seems that expert judgment of infiltration specialists and climatologists is implied.
- Model validation of GENESIS and RegCM codes seems to imply that experts will be needed to establish and evaluate intercomparisons and indices of success.
- The issue of chaotic behavior of GCMs discussed on page 17 is suggested to be addressed by “... sensitivity studies as well as through more fundamental consideration of the stability of the solutions to the equation sets actually utilized.” This “fundamental consideration” is well-suited to the use of experts.

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a methodology of expert elicitation deemed acceptable by the NRC. Additional insight on the acceptable methodology is provided in NUREG/CR-5411(Bonano et. al, 1990).

References

Bonano, E.J., S.C. Hora, R.L. Keeney, and D. von Winterfeldt. 1990. *Elicitation and the Use of Expert Judgment in Performance Assessment for High-Level Radioactive Waste Repositories*. NUREG/CR-5411. Washington, DC: Nuclear Regulatory Commission.

DeWispelare, A.R., L.T. Herren, M. Miklas, and R.T. Clemen. 1993. *Expert Elicitation of Future Climate in the Yucca Mountain Vicinity - Iterative Performance Assessment Phase 2.5*. CNWRA 93-016. San Antonio, TX: Center for Nuclear Waste Regulatory Analyses.

Comment 5

There is some confusion in Study Plan 8.3.1.5.1.6 — Future Regional Climate and Environments regarding the contribution to be made by the climate study to the hydrology studies and thence to the performance assessment of the repository.

Basis

- In the Abstract it is stated “The objective of the study is to evaluate parameters relevant to repository performance for reasonably probable local climate scenarios for the Yucca Mountain area that are most challenging to repository integrity over the period of concern.”
- On page 1 it is stated “The term *parameters relevant to repository performance* means the specific information needed to model hydrology, and hence, to model repository performance.”
- Later on page 1 it is stated “The parameters of interest here include, but may not be limited to, precipitation (rain and snow separately), precipitation rate, wind speed and direction, surface insolation, surface albedo, surface temperature, near-surface air temperature and relative humidity, surface soil moisture, surface pressure, evapotranspiration potential, and actual evapotranspiration.”
- It is further stated on page 1 “These are the time-dependent parameters that, together with site-specific surface and subsurface geological characteristics, determine surface and subsurface hydrology, e.g., surface runoff, water storage as a function of depth, infiltration as a function of depth, and other related parameters.”
- On page 2 it is stated “Repository performance modelers need scenarios for infiltration (unsaturated zone water fluxes) at the proposed repository depth over the entire area of the candidate site.”
- Also on page 2 it is stated “Thus global and even regional climate scenarios are only of derivative interest. They strongly influence the local climate scenario, but are not themselves the focus of ultimate interest.”
- On page 9 it is stated “It is clear, for instance, that the climate system involves the coupled interactions of the atmosphere, the hydrosphere, the cryosphere, the lithosphere, and the biosphere. Available models have not mastered the problem of coupling even the atmosphere and the ocean in a fully interactive manner, much less all the spheres simultaneously.”
- On page 28 it is noted “Clearly, development of RLCS [Reference Local Climate Scenarios] will require considerable interaction with anticipated users of the information to be produced. These potential users include those involved directly in assessing the long-term waste isolation performance of the potential repository system and those responsible for modeling the future hydrology of the Yucca Mountain site.”
- On page 31 the Study Plan says “A subsurface hydrology model must bridge the interface between the atmosphere and subsurface and therefore requires development of an understanding of the coupling between atmospheric climate processes and subsurface hydrologic processes. ...