Final Report on Review of the U.S. Department of Energy
Yucca Mountain Preliminary Site Suitability Evaluation
and Supporting Documents

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S. Cohen & Associates, Inc. (SC&A) has reviewed, for Clark County, Nevada, the Yucca Mountain Preliminary Site Suitability Evaluation (PSSE; released by the U.S. Department of Energy (DOE) in August 2001) and numerous documents previously issued and stated by DOE to support the PSSE. This report presents the principal results of the reviews.

I. SYNOPSIS OF PRINCIPAL FINDINGS

The regulatory framework is currently incomplete, and the proposed repository can meet regulatory requirements only if the DOE siting guidelines are revised to make total system performance assessment (TSPA) the basis for site suitability evaluation.

DOE has not provided a specific repository design to serve as the basis for site suitability evaluation.

The validity of DOE's performance assessment models and results that support the PSSE is uncertain. Results do not show expected dependence on temperature, and available information does not permit determination of the validity of the models.

A high temperature repository may be unacceptable because of uncertainty issues associated with the effects of temperature on the physical features of the repository, and a low-temperature repository may be unacceptable because of site characterization uncertainty issues associated with need to expand the repository footprint.

Performance of the proposed repository during the regulatory period is directly dependent on the performance of the Alloy 22 outer wall of the waste package. An independent peer review panel has determined that: the data base for Alloy 22 performance is currently weak; current corrosion models are inadequate to support the necessary extrapolations of performance; and there are three sources of potential for changes in the passive film that provides corrosion resistance, but potential for film changes is currently unknown.

Performance assessment results to assess compliance with radiation protection standards show variations for alternative models which suggest that the results are more an artifact of the models used than a realistic reflection of actual performance.

Although performance of the proposed repository depends on the Alloy 22 performance during the regulatory period, DOE has not clearly and singularly characterized the role of the Alloy 22 in overall system performance.

Models that describe the effects of temperature on the physical features of the repository cannot be validated.

Because all program technologies are on the cutting edge of knowledge and understanding, independent peer review of all aspects of DOE's analyses and results is needed in order to have confidence in the scientific basis for site suitability evaluation. Peer review of the supplemental TSPA models and results is especially needed in order to assess the scientific basis for the site suitability evaluation.

II. PRINCIPAL REVIEW FINDINGS

1. The regulatory framework for site suitability findings is incomplete and the validity of DOE findings is therefore uncertain.

The Nuclear Waste Policy Act of 1982 assigned responsibility for generally applicable environmental protection standards for radioactive waste disposal to the U.S. Environmental Protection Agency (EPA). The U.S. Nuclear Regulatory Commission (NRC) was assigned responsibility for regulations to implement the EPA standards and for licensing of disposal facilities, and DOE was given authority to develop regulatory guidelines for determining the suitability of candidate disposal locations. The Nuclear Waste Policy Amendments Act of 1987 directed that only the Yucca Mountain site be initially characterized, and the Energy Policy Act of 1992 (EnPA) directed EPA to develop site-specific radiation protection standards for Yucca Mountain.

The EPA radiation protection standards for Yucca Mountain, 40 CFR Part 197, were made final in June 2001. These standards will be implemented by the NRC regulations, 10 CFR Part 63, and DOE's site suitability guidelines, 10 CFR Part 963. These NRC and DOE regulations will be revisions of previous NRC and DOE regulations (10 CFR Part 60 and 10 CFR Part 960, respectively) that were established prior to enactment of the EnPA; the revisions will be intended to conform to the EPA standards.

At the time the PSSE was issued, neither the NRC nor the DOE regulations had been made final. This is particularly important because DOE's original, and currently effective, siting guidelines, 10 CFR Part 960, state that natural features of the repository system should be the principal basis for performance of the repository system. In contrast, the proposed 10 CFR Part 963 guidelines call for use of total system performance assessments (TSPA) to evaluate performance and do not favor natural barriers over engineered barriers in achieving compliance with the radiation protection standards.

The TSPA approach is essential to the validity of DOE's suitability findings reported in the PSSE because, with the current engineered design, performance of the proposed Yucca Mountain repository is totally dependent on performance of the engineered barriers, rather than the natural barriers, during the 10,000-year regulatory period. Only if the DOE regulations are revised can the proposed repository meet regulatory requirements.

2. The PSSE and its principal supporting documents do not describe a specific engineered system design to serve as basis for the performance evaluations. A specific basis for performance expectations has therefore not been provided.

In response to comments on the Viability Assessment (VA), issued in December 1998, DOE devised and characterized five alternative repository designs for future consideration. The design option selected from this suite to be the basis for subsequent studies had, as its principal features, an areal thermal loading of 85 metric tons of uranium (MTU) per acre; spacing between parallel drifts of 81 meters; end-to-end horizontal emplacment of waste packages, each approximately six feet in diameter and 18 feet long, in the drifts; and waste-package designs involving an outer wall of Alloy 22 (a highly-corrosion-resistant nickel-based alloy), an inner wall of stainless steel, and a surface temperature limit of 160 degrees Centigrade. This is a "hot" repository for which water in the pore spaces and fractures in the geologic medium surrounding the drifts would boil and be driven away from the repository horizon.

Reviewers of the Yucca Mountain program (e.g., the Nuclear Waste Technical Review Board, NWTRB) expressed concern that the temperatures associated with the hot repository could cause coupling of thermal, chemical, hydrologic, and mechanical effects, and that this coupling could produce significant uncertainty in performance-assessment results because it is poorly understood and cannot be modeled with confidence. Consideration of a low temperature repository was recommended to DOE.

In response to these recommendations, DOE examined means to achieve a cool repository using the hot repository design. The PSSE states that DOE "...has developed a flexible design..." that permits operation over a range of thermal modes. The thermal mode can be selected by adjustment of factors such as ventilation rates and distance between waste packages in the excavated drifts. The actual performance of the repository system may depend strongly on which operating factors are selected.

DOE performed analyses in support of the PSSE using the hot repository design and conditions that were termed the "high-temperature operating mode" (HTOM) and the "low-temperature operating mode" (LTOM). The basic difference between the two modes was the waste package surface temperature limit of 160 and 85 degrees Centigrade, respectively, for the HTOM and the LTOM.

The temperature limits could be met by various means, including alternative designs and alternative operating conditions. One major option would be to vary the spacing between drifts, but all HTOM and LTOM analyses were done for a drift spacing of 81 meters, i.e., the design parameter previously established by DOE for analysis of post-VA design options. Preservation of the 81-meter spacing simplified DOE's analysis of options; i.e., it enabled use of the same basic design to investigate alternative operating conditions. In adopting this approach, DOE did not consider a design specifically selected for a low temperature repository.

As suggested by the NWTRB, it could be advantageous to select the LTOM option in order to reduce performance uncertainties associated with coupled effects. Operating characteristics to achieve this objective with what is basically a high temperature design (e.g., use of the HTOM design with high ventilation rates) could, however, be impractical and unacceptable.

An alternative, designed-to-the-purpose way to achieve a low temperature repository would be to increase the drift spacing beyond 81 meters. This strategy could, however, require DOE to increase the repository footprint beyond the site area that has been characterized to date as the basis for TSPA evaluations.

Expansion of the repository footprint would necessitate investment of an extended schedule and expanded fiscal resources for site characterization. Additional area would have to be characterized at least to the same extent as has been accomplished for the current repository footprint. Because of the characteristics of the geologic features in the vicinity of Yucca Mountain, it would be necessary to characterize and use, for a low-temperature repository, the area to the north of the current repository footprint. This is the location of a large ground-water hydraulic gradient and is a region of high geologic complexity. The uncertainties in repository performance introduced by having to include this region in the repository footprint could more than offset the uncertainty reduction associated with avoiding the coupled effect issues.

In sum, a high temperature repository at the Yucca Mountain site may be unacceptable because of the coupled effect uncertainty issues and a low-temperature repository may be unacceptable because of site characterization uncertainty issues.

DOE's analyses to date have not, however, been based on a specific design for either the HTOM or the LTOM. A specific basis for obtaining performance assessment results and characterizing their uncertainties for HTOM and LTOM repositories has therefore not been provided.

3. Repository system performance factors depend strongly on temperature, but DOE's evaluations show no significant dependence of performance on temperature. The validity of DOE's performance assessment models and results is therefore highly uncertain.

All of the processes and phenomena important to repository system performance are temperature- dependent. For example, chemical reaction-rate processes, such as corrosion, typically double in rate for every 10 degrees Centigrade increase in temperature. For the temperature range considered in DOE's HTOM and LTOM analyses, it would therefore be expected that, from 85 degrees Centigrade to 160 degrees Centigrade, the corrosion rate of the waste package outer wall, Alloy 22, would double by seven-fold, or approximately a factor of 125. DOE's analyses show however, that overall system performance is virtually independent of temperature. The analyses also showed that system performance during the regulatory period is essentially totally dependent on the Alloy 22 performance and that performance of some sub-system elements is dependent on temperature.

DOE 's performance assessments showed a small difference between HTOM and LTOM performance in the first few thousand years, which was attributed to differences in Alloy 22 corrosion rates at HTOM and LTOM temperature conditions. Beyond about 8,000 years, overall performance for the HTOM and LTOM systems was essentially the same.

One possible explanation for the inconsistency between expectation of repository performance on temperature and DOE's finding that performance is essentially independent of temperature is that, because so many factors are involved in total system performance (on the order of 2,000), the effect of changes in Alloy 22 corrosion rate are masked by the combined effect of other factors and the complexity of the integrated and interactive performance models for the various elements of the repository system. If this is the case, DOE's models and results do not distinguish and identify the relevant factors. The compensating effect of each of the factors should be assessed so that there is confidence that the effects of temperature have been adequately considered in the analyses.

DOE has developed a temperature-dependent model for Alloy 22 corrosion and stated that it is a key factor in the performance-assessment results supporting the PSSE. However, as discussed in Section 4 below, available data are not sufficient to serve as a reliable basis for the model or to confirm that the model is realistic. It is possible that corrosion of Alloy 22 does not follow the usual rules for chemical reaction phenomena because it forms a highly passive corrosion film that inhibits "normal" corrosion processes; a model based on conventional corrosion phenomena would then be incorrect. As has been noted by the NWTRB, a fundamental understanding of the mechanisms of formation and stability of the Alloy 22 passive film is essential for reliability in extrapolation of its presence and effectiveness for long periods of time. To date, the essential understanding has not been achieved.

The temperature-dependent Alloy 22 corrosion model may have had a profound impact on DOE's performance assessment results. In the TSPA for the Site Recommendation, which was published by DOE in December 2000 and did not use the temperature-dependent model, the projected annual radiation dose rate at 100,000 years was 10 mrem/yr. In the supplemental TSPA, which was published in July 2001 and did use the temperature-dependent corrosion model, the projected dose rate at 100,000 years was a factor of one million less, i.e., 0.0001 mrem/yr. The basis for the difference in these results may lie in the temperature-dependent corrosion model, but it has not been explicitly addressed by DOE.

Another possible explanation for the lack of difference in HTOM and LTOM results is that use of the same repository design for both types of analyses, with emphasis on differences in operating conditions, did not capture the different effects of temperature that would exist in repositories specifically designed for the different temperature limits. A low-temperature repository, with drift spacings greater than 81 meters, could, for example, have coupled effects impacts on the hydrogeologic regime around the drifts that are significantly different from those for the high-temperature repository.

After about 10,000 years, when the shorter-lived radionuclides have decayed away, the temperature regimes for alternative repository designs would be similar. For performance assessment results for periods beyond 10,000 years to be similar, it would be necessary for there to be no long-term effects of short-term temperature differences, or for performance models to not adequately capture the long-term effects of short-term differences. Available information does not permit determination of the validity of DOE's models with respect to long-term temperature effects.

4. Performance of the repository during the regulatory period is, under DOE analyses, totally dependent on the performance of the Alloy 22 outer wall of the waste package, but the technical basis for confidence in performance of Alloy 22 is and weak and will remain uncertain.

DOE has only recently initiated a comprehensive program for testing the corrosion performance of Alloy 22. Available experience indicates that the alloy is highly corrosion resistant under service conditions that have been experienced to date (e.g., in the chemical industry), but past experience is limited in comparison with the data base for other alloys, and the service conditions have not been comparable to those that might be experienced for disposal in Yucca Mountain.

The EPA standards for Yucca Mountain specify a 10,000-year regulatory time period, for which confidence in understanding of the performance of the engineered and natural barriers (especially the single most important barrier in the repository system, Alloy 22) is required. The DOE testing program has to date developed only about a three-year data base for performance of Alloy 22, and, under present program schedules, the time period for development of the data base could only be extended for a few more years before a license application is to be submitted to the NRC.

Moreover, the service conditions in the repository, in terms of temperatures, ground-water contaminations conditions, and changes in repository conditions with time, are uncertain, and the basis for testing conditions is therefore also uncertain. The basis for expectations for Alloy 22 performance in the repository during the regulatory period is therefore uncertain and, as discussed below, will remain so.

A core technical issue for Alloy 22 performance is the long-term stability of the protective surface film that provides the corrosion resistance that has been observed in service conditions and durations to date. It will never be possible to experimentally demonstrate performance of the corrosion film for the regulatory period and repository service conditions; it will be necessary to use judgment to extrapolate data by a factor of 1,000 or more. This is an highly fragile basis for asserting performance expectations for the barrier that is singularly responsible for repository performance and compliance with the radiation protection standards.

DOE established an independent Waste Package Materials Performance Peer Review Panel which issued an Interim Report on September 4, 2001. The Panel report stated that "...significant technical issues remain to be settled; the Project staff needs to enhance the technical basis for assessing the long-term performance of the proposed waste packages at this site". The Panel report also "...identifies specific areas worthy of attention or increased emphasis".

The Panel report noted that whether or not the waste package will resist significant general corrosion for 10,000 years depends on what changes take place in the passive films. The report described three potential causes for changes in the passive film: changes in the intrinsic nature of the film; changes that result from changes in the environment, and changes that result from changes in the alloy. DOE is planning experimental work and development of models to address these potential causes of change in the protective film. The Panel report notes that extrapolation of data over three orders of magnitude will be greatly aided by models, but the report states that the Project has not clearly identified experiments that will test the validity of particular models.

The Panel report also addresses issues of localized corrosion, such as pitting or crevice corrosion, and stress corrosion cracking. These types of corrosion can occur as a result of factors such as surface roughness or weld-related stresses. The report identified issues related to localized corrosion that have not been addressed sufficiently, and also identifies deficiencies in the current program concerning stress corrosion cracking.

Overall, the Panel's Interim Report confirmed that the current basis for projecting the future performance of Alloy 22 is weak; that there are deficiencies in the current DOE program; that extrapolation over three orders of magnitude of time will be necessary; and that reliable models will be needed to justify and defend the extrapolations. The fundamental issue at present is whether or not the present data base and models are sufficient to make and defend a site suitability evaluation, especially when the performance of the repository system depends critically on the performance factor, Alloy 22, for which the information base is weak and uncertain.

5. DOE's performance assessment results to assess compliance with radiation protection standards show great variations which depend on modeling methods and assumptions. The reliability of the models, and of the results as a measure of performance, is therefore suspect.

DOE has issued six comprehensive TSPA reports since 1991. DOE intended early reports to be guides for efforts such as site characterization and engineered design selection. The TSPA for the Viability Assessment (TSPA-VA), issued in December 1998, provided the basis for determining, at that time, that work to evaluate the Yucca Mountain site should go forward. Critiques of the TSPA-VA led to major revisions of the repository engineered design concept; the design concept that emerged, which had as a principal feature the design parameter of 81-meter spacing between excavated drifts, has been the basis for the TSPA evaluations associated with the Site Recommendation.

The TSPA to support the Site Recommendation, TSPA-SR, was issued in December 2000. In response to criticisms of major weaknesses in the technical basis for the TSPA-SR (e.g., comments from the NWTRB), DOE made major revisions to the models and assumptions used in the TSPA-SR, and also updated the scientific basis for the analyses by incorporating recent data additions. DOE also quantified uncertainties that had not been quantified in the TSPA-SR. Results of these efforts were described in the "supplemental TSPA", herein termed the S-TSPA, which was issued in July 2001 and supported by the "FY01 Supplemental Science and Performance Analyses (SSPA), Volume 1". The S-TSPA is Volume 2 of the SSPA.

The technical differences between the TSPA-SR and the S-TSPA models are extremely difficult to identify and characterize on the basis of the DOE documentation. Technical factors are described only in overview in the documents supporting the PSSE and are referred downward through as many as four tiers of documentation. Many of the documents in the tiers are not available for public review.

The effects of the changes between the TSPA-SR and the S-TSPA are most evident in the results of the TSPA evaluations. DOE states, in the PSSE, that the principal difference in the models is in adoption of a temperature-dependent model for Alloy 22 corrosion and revision of solubility parameters for radionuclides such as Neptunium 237 in the S-TSPA evaluations. "Other model changes" are also noted but not specifically identified.

There are large differences in the performance evaluation results for the TSPA-SR and the S-TSPA. For example:

> The TSPA-SR results show no doses until after 20,000 years; the S-TSPA shows doses on the order of 0.0001 mrem/yr for periods from about 2,000 years all the way out to 100,000 years. The S-TSPA doses for time periods less than 10,000 years are the result of assumed waste package weld failures.
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> In the TSPA-SR analyses, projected dose levels rise by a factor of one million in the time interval from 10,000 to 100,000 years, i.e., from 0.0001 to 100 mrem/yr. As noted above, the S-TSPA analyses show constant dose levels of about 0.0001 mrem/yr during this period.
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> The cause for the difference between TSPA-SR and S-TSPA dose results for the 10,000 to 100,000-year time frame is not stated and cannot readily be inferred from the documentation. However, information presented in Figure 4.1-8 of the S-TSPA document (Volume 2 of the SSPA) can be interpreted to show that the contribution of Np-237 to the dose at 100,000 years is a factor of about 2 million less for the S-TSPA results in comparison with the TSPA-SR results. This finding would suggest that the solubility of neptunium was revised downward by about a factor of one million for the S-TSPA evaluations.
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> As noted earlier, the S-TSPA found dose evaluation results to be virtually independent of temperature, even though the processes and phenomena important to performance are

temperature-dependent.

These findings suggest that DOE's TSPA results are much more an artifact of the models used than a realistic reflection of actual performance. For example, the S-TSPA dose history results are virtually totally dependent on highly contrived assumptions concerning waste-package weld failures, and they suggest that values for Np-237 solubilities used in prior TSPA evaluations must have been in error by about a factor of one million.

The comparisons of the TSPA-SR and S-TSPA results, and recognition of the factors and assumptions that give rise to the results, reduce confidence in the results. Better explanation and justification of the performance models, data, and assumptions are needed in order to have confidence that the TSPA evaluations provide a realistic evaluation of repository performance and that the S-TSPA results provide a reliable basis for the PSSE.

6. DOE uses "one-off" analyses to assess the contributions of individual performance factors to overall system performance, but has not reported an analysis in which the contribution of the most important performance barrier, the Alloy 22 wall on the waste packages, is clearly evaluated.

The "one-off" analyses involve one-at-a-time removal of models for individual performance factors from the total system performance model in order to assess the contribution of that factor to overall performance. DOE has performed these analyses for a large number of repository system performance factors. Results for many of the analyses are reported graphically, in terms of the effect of removal of the performance factor on mean annual dose, in Section 3 of the S-TSPA document (Volume 2 of the SSPA).

The results of the one-off analyses vary widely in terms of their indication of the effects of the individual performance factors on mean annual dose. For example, removal of the performance factor termed "in-drift chemistry" had no effect on mean annual dose. This result indicates that this barrier does not contribute to system performance.

In contrast, accounting for the temperature dependence of Alloy 22 corrosion has a dramatic effect on mean annual dose (Figure 3.2.5.3-2, page 3F-28, of the S-TSPA document). These results show that accounting for the temperature dependence of Alloy 22 corrosion changed the time at which mean annual dose is initiated at the 0.001 level from about 16,000 years to about 26,000 years, and the predicted dose at 100,000 years decreased from about 70 mrem/yr to 0.1 mrem/yr. Without accounting for the temperature dependence of Alloy 22, the EPA individual protection standard of 15 mrem/yr is exceeded at about 60,000 years; with temperature dependence accounted for, the dose at this time is about 0.03 mrem/yr. Overall, therefore, these results indicate that accounting for the temperature dependence of Alloy 22 corrosion in the general corrosion models greatly decreased the predicted radiation doses.

DOE has also performed one-off analyses for "sub-system" Alloy 22 performance factors such as localized corrosion and stress-corrosion cracking. DOE has not, however, reported S-TSPA results for total removal of the Alloy 22 barrier from the repository. In view of the importance of this barrier to system performance during the compliance period, it is important to know what the performance of the repository system would be in comparison with radiation standards, using the S-TSPA model, if the Alloy 22 barrier were assumed not to be present at all. Only this analysis would give a true picture of the effect of the Alloy 22 on overall system performance under present modeling assumptions that provide the basis for the PSSE.

7. Interactions between thermal, hydrologic, chemical, and mechanical phenomena may control repository performance and performance-evaluation uncertainty, but DOE's models for these phenomena cannot be confirmed.

Temperature-driven hydrologic, chemical and mechanical phenomena and interactions (so-called "coupled effects") are expected in the geologic formations around the repository. Such interactions are, for example, the basis for DOE's high-temperature repository concept, in which high temperatures within the repository would drive water in the rocks away from the repository until temperatures are low. Water might then flow back to, and into, the repository under low-temperature conditions, which would be attained after about 10,000 years. Thermal driving forces for corrosion and radionuclide release would be reduced at that time and beyond, but mechanical and chemical alterations might have occurred at the high temperatures so that flow paths for water in the rocks have been altered and the contaminant characteristics of the water, which affect its capacity to corrode engineered materials in the repository, are changed.

DOE has developed performance models for coupled effects, but their validity is highly uncertain. Because of the heterogeneity and variability of the geologic formations and flow paths, a reliable model of the physical system and its potential for alteration, e.g., by chemical mineralization in fractures, cannot be established and tested experimentally. Similarly, the theoretical and experimental data bases for alterations to contaminant characteristics of water that can enter the repository and would corrode the engineered materials, such as the drip shields and the Alloy 22 outer wall of the waste packages, are weak, cannot be experimentally verified, and cannot be extrapolated reliably, especially for long periods of time.

Therefore, the effects of temperature on the physical characteristics of the natural system, their variation with time, and their effects on repository system performance cannot be reliably assessed. As a result, the reliability of DOE models addressing these performance factors cannot be assessed. Moreover, the reliability of models and assessment results cannot be significantly improved through experimental programs. "Residual uncertainty" factors associated with these coupled phenomena can be identified, and they may dominate the uncertainty in predictions of repository performance, but this uncertainty also cannot be assessed.

As noted and discussed in Section 3 above, results of DOE's HTOM and LTOM analyses show no difference in repository-system performance for the high- and low-temperature repositories after about 10,000 years. These results imply that coupled effects during the period up to 10,000 years, when repository temperatures differ significantly, either had no significance or no persistent consequences, e.g., no permanent changes in the geohydrologic flow paths. DOE's coupled effect models were used to produce these results; as stated above, the reliability of the DOE models cannot be assessed.

8. Comprehensive, independent peer technical review of all aspects of DOE's analyses and results is needed in order to have a defensible scientific basis for the site suitability evaluation.

DOE's technical work for the Yucca Mountain program involves unprecedented model development, data extrapolation, application of assumptions, and use of judgment. Independent assessment of these efforts is essential in order to establish a measure of confidence in the methods used and the results obtained.

The DOE program has made use of peer reviews in selected areas (e.g., the Waste Package Materials Performance Peer Review Panel cited above). Because all program technologies are on the cutting edge of knowledge and understanding, similar efforts are needed in each of the technical areas important to the scientific basis for site-suitability evaluation.

Accomplishment of independent peer review will require expert personnel and a significant investment of time and fiscal resources. The information to be addressed will be difficult to extract and assess because of the way it is scattered throughout the DOE documents and tiers of documents. Use of information and concepts by DOE has evolved with the sequence of documents as they have been issued, and substantive information that is the basis for what was done (which is only described in overview in documents such as the PSSE) can only be obtained by tracing back through the time sequence of documents.

Much of the substantive information is contained in the Analysis Model Reports (AMRs), the Process Model Reports (PMRs), and topical technical reports that underlie the AMRs and PMRs. There are nearly 200 AMRs and PMRs, and apparently there are several thousand topical reports. The topical reports are referenced in the AMRs and PMRs and are not generally available.

In order to assure that the peer reviews themselves are effective and defensible, DOE will have to make all essential documents available. DOE will also have to expect and plan that the scientific basis for site-suitability evaluation is not adequate until all essential peer reviews are completed. In particular, because the S-TSPA methods and results, which are the basis for the PSSE, differ significantly from those for the TSPA-SR, DOE must accomplish a comprehensive, independent peer review for the S-TSPA.