CARD No. 54
Scope of Compliance Assessments

54.A.1 BACKGROUND

The Compliance Criteria include two general categories of quantitative requirements on the performance of the WIPP that are intended to ensure its safety. The first category consists of the containment requirements at Section 194.34, which implement the general containment requirements of the radioactive waste disposal regulations, Section 191.13. The containment requirements establish limits on the cumulative quantity of radioactive materials that may migrate beyond the specified, subsurface physical boundary that separates the WIPP repository area from the accessible environment. That is, they restrict to very low levels the amounts of radioactive materials that might escape from the WIPP.

The second category of quantitative requirements consists of the individual and ground water protection requirements, which implement Section 191.15. The individual and ground water protection requirements place limitations on both the potential radiation exposure of individuals and the possible levels of radioactive contamination of ground water due to disposal of waste in the WIPP. The individual protection requirement focuses on the annual radiation dose of a maximally exposed hypothetical person living on the surface just outside the boundary to the accessible environment.

The containment requirements and individual and ground water protection requirements are fundamentally different. The containment requirements apply to cumulative releases to the accessible environment over the 10,000-year regulatory period. To demonstrate compliance with the containment standards, DOE is required to consider human intrusion, such as deep drilling, shallow drilling, and mining. In contrast, the individual and ground water protection requirements apply to the doses received by an individual over a human lifespan. Moreover, compliance assessments utilized to demonstrate compliance with the individual and ground water protection requirements need not consider performance of the repository in the "disturbed" scenario. Thus, whereas releases resulting from human-initiated events such as drilling into the repository must be considered to demonstrate compliance with the containment requirements, such intrusion events are not considered in demonstrating compliance with the individual and ground water protection requirements.

As with performance assessments, compliance assessments must consider features, events, and processes (FEPs) and the uncertainties associated with those FEPs. Compliance assessments may be regarded as a "subset" of performance assessments, inasmuch as the latter incorporates FEPs related to undisturbed conditions that are necessary for the compliance assessment. Section 194.54 of the Compliance Criteria, Scope of Compliance Assessments, contains the procedures that must be followed in assessments of the WIPP's compliance with the individual dose and ground water protection requirements.

54.A.2 REQUIREMENT

(a) "Any compliance application shall contain compliance assessments required pursuant to this part. Compliance assessments shall include information which:

(1) Identifies potential processes, events, or sequences of processes and events that may occur over the regulatory time frame."

54.A.3 ABSTRACT

DOE was required to identify the natural processes, events, or sequences of processes and events that may occur over the regulatory time frame. DOE indicated that WIPP FEP analysis was initiated using a FEP list assembled by the Swedish Nuclear Power Inspectorate (SKI). This list included over 1,200 FEPs, which DOE screened to the 900 FEPs that were included in the 1995 Draft CCA. These 900 FEPs were then screened by DOE, based upon the final Compliance Criteria requirements, consequence, and probability for disturbed and undisturbed conditions, to the approximately 240 FEPs included in the October 1996 CCA. EPA reviewed the FEP listing for completeness, accuracy, and justifiability.

54.A.4 COMPLIANCE REVIEW CRITERIA

EPA expected the compliance application to identify potential processes, events, or sequences of processes and events that may occur over the regulatory time frame. EPA's criteria for evaluating the adequacy and comprehensiveness of the FEPs selected and used by DOE to develop performance assessment scenarios, as required by Section 194.32, are discussed in **CARD 32—Scope of Performance Assessments**. EPA expected the CCA to present a logical and comprehensive approach to identifying, classifying, and screening of FEPs for use in the compliance assessment. This approach should be extended to the development, screening, and final formulation of scenarios.

54.A.5 DOE METHODOLOGY AND CONCLUSIONS

DOE addressed the FEP compilation process required by Section 194.54(a)(1) in Appendix SCR and Stenhouse, et al. (1993). DOE identified FEPs using the list assembled by the Swedish Nuclear Power Inspectorate (SKI). The SKI list, which included over 1,200 FEPs, represented a compilation of FEPs identified by nine international organizations. The SKI study divided FEPs into eight different categories based upon location of occurrence and cause: waste, canister, buffer/backfill, repository/near-field, far-field, biosphere, geological/climatic evolution, and future human actions. The first seven of these FEPs apply to compliance assessments as defined by EPA (Section 194.2).

In the 1995 Draft Compliance Certification Application or DCCA (Docket A-93-02, Item II-D-39), DOE modified the final SKI list by reinstating FEPs that had been screened out and removing duplicate FEPs. The DCCA list included approximately 900 FEPs divided into eight categories that apply to undisturbed conditions: waste, canister, backfill, seal systems, repository/near-field, far field, biosphere, and geology/climate. DOE screened these 900 FEPs with the same criteria (UP, DP, SO-C, SO-R, SO-P) that were subsequently used for the CCA (see the discussion of Section194.32(e)(2) in **CARD 32—Scope of Performance Assessments**), but also included categories for FEPS not yet screened (RB), FEPs related to deviations from the design (RD), FEPS concerning potential design changes (RE), FEPs representing reserves of performance, and FEPs considered not relevant to the WIPP performance (NR). Appendix SCR, Attachment A, of the CCA lists all 900 DCCA FEPs.

During the CCA preparation process, DOE recognized that additional assessment of some of the 900 DCCA FEPs was required to determine whether the screening assignment was correct. DOE initiated a program to address numerous technical issues. DOE conducted approximately 300 studies that can be linked to DCCA FEP analysis. Appendix SCR, Attachment 1, lists the FEPs retained for inclusion in the CCA that underwent additional assessment.

For the CCA FEP list, DOE consolidated, evaluated, and otherwise modified the DCCA list down to approximately 240 FEPs consisting of three categories: natural, waste/repository induced, and human induced. Tables in Appendix SCR, Attachment 1, Appendices A through C (pp. 25-94), show FEPs that DOE eliminated from the CCA listing that had been included under the RD, RE, and NR categories in the DCCA. DOE reassigned those FEPs eliminated from the CCA listings under the RB listing to fit into one of the three CCA categories, with most of these subsequently screened out due to low consequence.

Appendix SCR, Attachment A, Appendix B presents how each of the 900 DCCA FEPs links with the 236 FEPs presented in the CCA. Appendix SCR, Attachment 1, Appendix C, Table C-1, shows those FEPs excluded from the development of the CCA FEP list due to modeling issues, and includes such considerations as boundary conditions in near/far field, correlation issues, initial ground water flow conditions, and time dependance. Appendix SCR, Attachment 1, Appendix C, Table C-2 presents those DCCA FEPs excluded from the CCA FEP list because the issues are not regulated by 40 CFR Part 191. Appendix SCR, Attachment 1, Appendix C, Table C-3 lists those DCCA FEPs excluded from the development of the CCA FEP list because they relate to repository designs different from that which forms the basis of the CCA. This list included issues such as those associated with bentonite backfill, features associated with crystalline (e.g., igneous) rocks, and concerns relating to copper containers. The 236 FEPs retained for analyses were then further screened to approximately 80 FEPs retained for consideration in the PA.

54.A.6 EPA COMPLIANCE REVIEW

EPA reviewed DOE's initial FEP list to determine whether it was comprehensive. In addition, EPA examined information sources used by DOE to compile FEP lists for accuracy of technical information. EPA also examined listings to determine whether DOE's rationale for reducing listings was appropriately documented and technically sufficient. Finally, EPA considered sequences and combinations of events.

Review of FEP Screening

DOE was required to identify, evaluate, and eliminate FEPS and justify these decisions. DOE's screening of FEPs was based on the probability of a FEP occurring, the consequence of the FEP, and regulatory considerations:

- ♦ Probability. EPA assessed DOE's traceability assumptions, approximations, and measure of uncertainties to determine whether they were well documented and adequately justified. EPA examined probabilities to determine whether they were appropriate, well

documented, and in accordance with EPA regulatory requirements. EPA examined sufficiency of all data in terms of quantity and adequacy.

- Consequence. EPA evaluated the DOE screening arguments to determine whether they were supported by data or reasoned arguments. EPA also evaluated potential synergistic effects via different combinations of FEPs. EPA reviewed data specifications (e.g., bias) and assessed the nature of expert elicitations (if used). EPA also assessed a FEP's consequence relative to its time within the regulatory period (e.g., a FEP may not be of concern soon after disposal but may be at a later time). EPA evaluated consequences to determine whether they were appropriate, well documented, and in accordance with EPA regulatory requirements.

- Regulatory. EPA examined DOE's screening rationale to determine whether it was consistent with the physical and temporal constraints for activities and future states in accordance with 40 CFR Part 194. EPA also examined the screening arguments to determine whether they contained appropriate regulatory interpretations.

DOE identified over 1,200 natural and human initiated FEPs assembled from the SKI FEP analysis and analyzed how these could affect the WIPP disposal system. EPA's examination of this listing, as presented in EPA Technical Support Document for Section 194.32: Scope of Performance Assessments (EPA 1998a), indicated that the initial FEP identification and screening performed by DOE was thorough but not sufficiently documented. EPA concluded that DOE adequately identified and considered any natural processes/events that may occur within the regulatory time frame in the WIPP area.

DOE also adequately identified those events and processes and sequences/combinations of events and processes that reflected what may happen in the repository over the 10,000-year regulatory period under undisturbed conditions. EPA concluded that the general screening criteria used by DOE to simplify the DCCA analysis were adequate, and that documentation of DOE's application of screening criteria for FEPS from the DCCA list to the CCA was adequate. For further discussion of FEPs screening, see EPA Technical Support Document for Section 194.32: Scope of Performance Assessments (EPA 1998a).

54.B.1 REQUIREMENT

(a) "Any compliance application shall contain compliance assessments required pursuant to this part. Compliance assessments shall include information which:

(2) Identifies the processes, events, or sequences of processes and events included in compliance assessment results provided in any compliance application."

54.B.2 ABSTRACT

The CCA should list potential processes, events, or sequences of processes and events that may occur over the regulatory time frame and which DOE included in the compliance assessment.

Also, the CCA should identify and explain how "unlikely natural events" were screened out and reference the performance assessment discussion, if this discussion of processes, events or sequences of processes and events also pertains to the compliance assessment.

Once DOE developed the list of 236 FEPs for the CCA, DOE initiated the FEP screening process. In Appendix SCR, DOE provided individual discussions for each of the 236 FEPs included in the CCA. This appendix divides the FEPs into three main categories and indicates whether each FEP was screened out for regulatory, consequence, or probability reasons. If a FEP was retained, Appendix SCR indicates whether it was included as part of the performance and/or compliance assessment.

54.B.3 Compliance Review Criteria

As stated in the Compliance Application Guidance for 40 CFR Part 194 (p. 69), EPA expected the CCA to:

- List in the compliance assessment discussion the potential process, events, or sequences of processes and events that may occur over the regulatory time frame and which were included in the compliance assessment;
- Identify and explain how the screening criterion of "unlikely natural events" was addressed; and
- Identify and reference the appropriate discussions of the performance assessment, if the performance assessment's discussion of processes, events, or sequences of processes and events is used for compliance assessment purposes (see **CARD 32—Scope of Performance Assessments**).

The processes, events, or sequences of processes and events for this section are limited to undisturbed performance, whereby predictions of the behavior of a disposal system, including consideration of the uncertainties in predicted behavior, assume that the disposal system is not disrupted by human intrusion or the occurrence of unlikely natural events (40 CFR 191.12).

54.B.4 DOE Methodology and Conclusions

After narrowing the list of FEPs for the performance assessment to 236, DOE initiated the FEP screening process. In Appendix SCR, DOE provided individual discussions of each of the 236 FEPs included in the CCA. Appendix SCR divided the FEPs into three main categories and indicated whether a FEP was screened out for regulatory, consequence, or probability reasons. If a FEP was retained, Appendix SCR indicated whether it was included as part of the undisturbed or disturbed repository PA.

DOE presented a brief discussion of the screening process for FEPs in Chapter 6.2. The 236 FEPs in the CCA include natural FEPs, waste and repository-induced FEPs, and human-initiated EPs. See the discussion of Section 194.32(e)(1) in **CARD 32—Scope of Performance**

Assessments for more information pertaining to the FEP identification process. To screen out the FEPs, DOE applied the specific criteria shown below (Chapter 6.2.2, p. 6-38 to 6-39):

- Regulation (SO-R): In the process of developing 40 CFR Parts 191 and 194, EPA allowed DOE to eliminate some of the FEPs from consideration. For example, relative to human-initiated EPs, DOE need not consider those events in the long-term future that were screened out based on consequence and/or probability in the present or near future.

- Probability (SO-P): Section 194.32(d) indicates that PAs need not consider processes and events that have less than a one in 10,000 chance of occurring over 10,000 years. DOE provided either qualitative or quantitative arguments pertaining to FEPs screened out based upon probability.

- Consequence (SO-C): DOE eliminated some FEPs based on their consequences according to the following two criteria:

  Insignificant Consequences. DOE eliminated FEPs where "there is a reasonable expectation that the remaining probability distribution of cumulative releases would not be significantly changed by such omissions."

  Beneficial FEPs. FEPs that are potentially beneficial to performance of the disposal system or subsystem were eliminated to simplify the analysis. DOE also stated that this argument "may be used when there is uncertainty as to exactly how the FEP should be incorporated into assessment calculations or when incorporation would incur unreasonable difficulties."

FEPs retained in the PA were accounted for under either calculations of the undisturbed performance or disturbed performance (Chapters 6.2.2.2 and 6.2.2.3, p. 6-40).

DOE concluded in Appendix SCR.1.1 to SCR.1.8 that 16 of the 71 natural FEPs should be retained for the PA for undisturbed performance: stratigraphy, seismic activity, shallow dissolution, saturated ground water flow, unsaturated ground water flow, fracture flow, effects of preferential pathways, ground water geochemistry, physiography, ground water discharge, ground water recharge, changes in ground water recharge and discharge, infiltration, precipitation, temperature, and climate change.

Of the 108 Waste and Repository Induced FEPs considered (Appendices SCR 2.1 through SCR 2.8), DOE concluded that 51 should be retained for undisturbed performance, including but not limited to: disposal geometry, waste inventory, seal physical properties, radionuclide decay and ingrowth, salt creep, backfill chemical composition, changes in the stress field (creep), pressurization (gas), brine inflow, wicking, actinide sorption and solubility, effect of metal corrosion, and colloid transport.

DOE concluded that five of the 57 human-initiated EPS should be retained for the time periods applicable to compliance assessment: potash mining, drilling-induced geochemical

changes, fluid injection-induced geochemical changes, borehole-induced geochemical changes, and changes in ground water flow due to mining.

Tables SCR-1 through SCR-3 show each of the 236 FEPs and their screening results and link these FEPs to specific discussions in Appendix SCR. Table 6-6 of Chapter 6 shows where specific FEPs are discussed in Chapter 6. Appendix SCR, Sections SCR.1 through SCR.3 (pp. SCR-1 to SCR-143) contain a thorough discussion of each FEP, including references to detailed information that supports the FEPs analyses.

54.B.5 EPA COMPLIANCE REVIEW

EPA's detailed review of the CCA indicated that DOE appropriately screened the FEPs, although the limited justification of some FEPs required additional evaluation. EPA found that the following FEPs were appropriately retained in PA but must be further evaluated through inclusion in PA verification testing: N2 (brine reservoirs), W18 (disturbed rock zone), W58 (dissolution of waste), W77 (solute transport), W86 (spallings), W39 (underground boreholes) and H32 (flow through boreholes). This list is not meant to include all parameters modeled in the Performance Assessment Verification Test (see **CARD 34—Results of Performance Assessments** for further discussion of this test). Rather, the list illustrates that many aspects of FEPs included in PA were further evaluated by EPA as part of the Agency's overall PA review. Refer to **CARD 23—Models and Computer Codes**, **CARD 14—Content of Compliance Certification Application**, **CARD 33—Consideration of Drilling Events in Performance Assessments**, **CARD 24 - Waste Characterization**, and associated Technical Support Documents for more detailed discussion of EPA's evaluation of parameters.

EPA concluded that DOE appropriately identified and screened FEPs pertaining to undisturbed performance. Criteria for screening FEPs were adequately described and implemented. DOE appropriately identified and discussed the effects of the sequences and combination of FEPs that resulted in modeled scenarios. See EPA Technical Support Document for Section 194.32: Scope of Performance Assessments (EPA 1998a) for further discussion of individual FEPs.

54.C.1 REQUIREMENT

(a) "Any compliance application shall contain compliance assessments required pursuant to this part. Compliance assessments shall include information which:

(3) Documents why any processes, events, or sequences of processes and events identified pursuant to paragraph (a)(1) of this section were not included in compliance assessment results provided in any compliance application."

54.C.2 ABSTRACT

The CCA should list the processes, events, or sequences of processes and events that were considered but not included in compliance assessment analyses. The CCA should also discuss the reasons why processes, events, or sequences of processes and events were not included in compliance assessment results.

DOE included 236 FEPs in Appendix SCR and Chapter 6.3. For each FEP, DOE provided a description and a generalized rationale for screening classifications. DOE screened out 55 of the 71 Natural FEPs, 57 of the 108 Waste and Repository-Induced FEPs, and 51 of the 57 Human Initiated FEPS for the undisturbed scenario (Appendix SCR, Table SCR-3).

EPA reviewed Appendix SCR, numerous CCA references, and FEP screening records packages in the Sandia National Laboratories Records Center. The specific items reviewed are discussed in EPA Technical Support Document for Section 194.32: Scope of Performance Assessments (EPA 1998a). Of the FEPs DOE screened from consideration in the PA, EPA questioned some of the screening arguments, which were subsequently resolved through the provision and review of supplemental information.

54.C.3 Compliance Review Criteria

Refer to Section 54.A.4 above for review criteria. Additionally, EPA expected the compliance application to:

- ♦ List the processes, events, or sequences of processes and events that were considered but not included in compliance assessment analyses; and

- ♦ Discuss the reasons why processes, events, or sequences of processes and events were not included in compliance assessment results.

54.C.4 DOE Methodology and Conclusions

For each of the 236 FEPs identified in Chapter 6.3 and Appendix SCR, DOE provided a description and a generalized rationale for screening classifications. Of the 236 FEPs analyzed, 154 were screened out based on either regulatory, low consequence, or probability considerations. Appendix SCR included DOE's rationale for screening for each of the 236 CCA FEPs. Of the 71 Natural FEPs identified, DOE screened out 55 FEPs (Appendix SCR, Table SCR-1):

SO-C	Changes in regional stress	Regional tectonics
	Regional uplift and subsidence	Changes in fracture properties
	Magmatic activity	Lateral dissolution
	Fracture infills	Density effect on ground water flow
	Thermal effects on ground water flow	Hydrogeological response to earthquakes
	Saline intrusion (chemistry)	Freshwater intrusion (chemistry)
	Changes in ground water Eh	Changes in ground water pH
	Effects of dissolution	Mechanical weathering
	Chemical weathering	Aeolian erosion
	Fluvial erosion	Mass wasting(erosion)
	Aeolian deposition	Fluvial deposition
	Lacustrine deposition	Mass wasting (sedimentation)
	Soil development	Stream and river flow
	Surface water bodies	Lake formation

	River flooding	Seas and oceans
	Estuaries	Coastal erosion
	Marine sediment transport and disposition	Sea level changes
	Plants	Animals
	Microbes	Natural ecological development
SO-P	Salt deformation	Diapirism
	Formation of fractures	Formation of new faults
	Fault movement	Volcanic activity
	Metamorphic activity	Deep dissolution
	Solution chimneys	Breccia pipes
	Collapse breccias	Saline intrusion (flow)
	Freshwater intrusion (flow)	Natural gas intrusion
	Impact of large meteorite	Glaciation
	Permafrost	

Of the 108 Waste and Repository-Induced FEPs, 57 were screened out by DOE (Appendix SCR, Table SCR-2):

SO-C	Container form	Seal chemical composition
	Backfill physical properties	Post-closure monitoring
	Heat from radioactive decay	Radiological effects on waste
	Radiological effects on containers	Radiological effects on seals
	Subsidence	Thermal effects on material properties
	Thermally-induced stress changes	Container integrity
	Differing thermal expansion of repository	Investigation boreholes components
	Radiolysis of cellulose	Movement of containers
	Radioactive gases	Mechanical effects of backfill
	Precipitation	Convection
	Organic complexation	Kinetics of organic complexation
	Effects of radiation on microbial gas generation	Effects of pressure on microbial gas generation
	Radiolysis of brine	Helium gas production
	Concrete hydration	Rinse - Particulate transport
	Kinetics of speciation	Transport of radioactive gases
	Electrochemical effects	Kinetics of precipitation and dissolution
	Chemical gradients	Localized reducing zones
	Alpha recoil	Organic ligands
	Accumulation in soils	Exothermic reactions
	Electrophoresis	Chemical degradation of backfill
	Osmotic processes	Biofilms
	Enhanced diffusion	Soret effect
SO-P	Nuclear criticality: heat	Large scale rock fracturing
	Nuclear explosions	Galvanic coupling, corrosion
	Reduction-oxidation fronts	Galvanic coupling, transport

SO-R	Plant uptake	Animal uptake
	Ingestion (SO-C, Section 191.15)	Inhalation (SO-C, Section 191.15)
	Irradiation (SO-C, Section 191.15)	Dermal sorption (SO-C, Section 191.15)
	Injection (SO-C, Section 191.15)	

Of the 57 Human Initiated EPS, 51 were screened out by DOE (Appendix SCR, Table SCR-3) for the historical, ongoing, and near future time periods applicable to the undisturbed scenario (as indicated in Appendix SCR, pp. SCR-97 to SCR-98, compliance assessment must include human activities initiated prior to and in the near future after submission of the compliance application. The term "historical, ongoing, and near future" is used by DOE to describe this time period):

SO-C	Oil and Gas Exploration	Potash Exploration
	Water resources exploration	Oil and Gas Exploitation
	Ground water exploitation	Other resources (drilling)
	Enhanced oil and gas recovery	Other resources (excavation)
	Archeological excavations	Explosions for resource recovery
	Underground nuclear testing	Drilling fluid flow
	Oil and gas extraction	Drilling fluid loss
	Liquid waste disposal	Blowouts
	Hydrocarbon storage injection	Ground water extraction
	Borehole -induced mineralization	Enhanced oil and gas production
	Surface disruptions	Natural borehole fluid flow
	Reservoirs	Damming of streams or rivers
	Altered soil or surface water chemistry by human activities	Changes in ground water flow due to explosions
		Irrigation
	Changes in geochemistry due to mining	Borehole-induced solution and subsidence
	Ranching	

SO-R	Archeological investigations	Geothermal
	Liquid waste disposal	Hydrocarbon storage drilling
	Deliberate drilling intrusion	Tunneling
	Construction of underground facilities	Waste-induced borehole flow
	Deliberate mining intrusion	Greenhouse gas effects
	Land use changes	Damage to the ozone
	Lake usage	Sea water use
	Acid rain	Fish farming
	Demographic changes and urban development	Estuarine water use
	Coastal water use	

SO-P	Flow through undetected boreholes

A single FEP, loss of records, was considered not applicable by DOE relative to the historic, ongoing, and near future time period(s).

DOE screened numerous issues from consideration, including lateral dissolution (SO-C), deep dissolution (SO-P), near surface geomorphic processes (SO-C), and related subsidence in the geologic units of the disposal system (SO-C). DOE assessed fluid injection activities in the WIPP area and performed modified BRAGFLO analysis of the disposal system, assuming injection wells at the south and northern boundaries of the WIPP. DOE concluded that the injection well activities would have little or no effect on the WIPP's containment of waste, and screened out the effects of injection wells (i.e. waste disposal and water flooding) based upon low consequence in the historical/current/near future.

54.C.5 EPA COMPLIANCE REVIEW

EPA reviewed Appendix SCR, numerous references, and FEP screening record packages in the Sandia National Laboratories Records Center. The documents reviewed are specified in EPA Technical Support Document for Section 14.32: Scope of Performance Assessments (EPA 1998a). The tables discussed in Section 54.C.4 above show FEPs that DOE screened from consideration in the PA. EPA questioned some of the screening arguments for the FEPs listed below in letters to DOE (Docket A-93-02, Items II-I-01 and II-I-17):

- N22—Fracture Infills
- N38—Effects of Dissolution
- H27—Liquid Waste Disposal; and
- H28—Enhanced Oil and Gas Production.

FEPs N22—Fracture Infills and N38—Effects of Dissolution are directly related to fractures within supra-Salado units. EPA questioned the impact that dissolution would have on supra-Salado unit transmissivity. DOE submitted additional information that EPA found adequate to support DOE's conclusion that fracture infill and dissolution are not expected to occur extensively beyond what occurred in the past 10,000 years (Docket A-93-02, Items II-H-45 and II-I-24). See Section 194.14(a) of **CARD 14—Content of Compliance Certification Application** for additional discussion of fracture fill and dissolution. FEP N38 was addressed by Corbett and Knupp (1996) and further clarified by DOE in supplemental documentation (Docket A-93-02, Items II-H-45 and II-I). FEPs H27—Liquid Waste Disposal and H28—Enhanced Oil and Gas Production are fluid injection scenarios that DOE supported with additional modeling (Stoelzel and Swift, 1997). See Section 194.32(c) of **CARD 32—Scope of Performance Assessments** for further discussion of FEPs H27 and H28.

54.D.1 REQUIREMENT

(b) "Compliance assessments of undisturbed performance shall include the effects on the disposal system of:

(1) Existing boreholes in the vicinity of the disposal system, with attention to the pathways they provide for migration of radionuclides from the site."

54.D.2 Abstract

The CCA must include evidence that the compliance assessment calculations include the effects of existing boreholes in the vicinity of the disposal system, and explain how existing boreholes were considered. DOE included an assessment of the effects of existing boreholes and concluded that available information indicated that natural borehole fluid flow through abandoned boreholes would be of very little consequence during operational phase activities. Flow through undetected boreholes on the WIPP site was screened out based upon low probability.

EPA reviewed DOE's arguments concerning natural flow through abandoned boreholes within the LWA area, including natural fluid head conditions, abandonment techniques, and the number and location of abandoned boreholes.

54.D.3 Compliance Review Criteria

EPA expected the compliance application to include documentation that the compliance assessment calculations included the effects of existing boreholes in the vicinity of the disposal system, and to explain how existing boreholes were considered.

54.D.4 DOE Methodology and Conclusions

DOE included an assessment of the potential effects of existing boreholes as part of its FEP screening analysis. The results of this assessment were presented in Appendix SCR.3.3.1.4. DOE concluded that available information indicated that natural borehole fluid flow through abandoned boreholes would be of very little consequence during operational phase activities, based, for example, upon known hydrologic head conditions. DOE identified borehole fluid flow to be of importance if such a borehole penetrated a Castile brine reservoir under the repository. Because this scenario involves human intrusion, DOE considered it in the performance assessment and not the compliance assessment. DOE did not consider abandoned borehole flow induced by waste-related conditions because it was screened out for regulatory reasons in accordance with Section 194.25. In addition, DOE screened out the occurrence of flow through undetected boreholes based on low probability, claiming that the occurrence of such boreholes in the controlled area is highly unlikely given the intense scrutiny given the site over the past 25 years (Appendix SCR.3.3.1.4).

54.D.5 EPA Compliance Review

EPA reviewed DOE's arguments concerning natural flow through abandoned boreholes within the LWA area, including natural fluid head conditions, abandonment techniques, and number and location of abandoned boreholes. EPA concluded that DOE's screening arguments and documentation are reasonable. See EPA Technical Support Document for Section 194.32: Scope of Performance Assessments (EPA 1998a) for further discussion of EPA's consideration of existing boreholes.

54.E.1 REQUIREMENT

(b) "Compliance assessments of undisturbed performance shall include the effects on the disposal system of:

(2) Any activities that occur in the vicinity of the disposal system prior to or soon after disposal. Such activities shall include, but shall not be limited to: existing boreholes and the development of any existing leases that can be reasonably expected to be developed in the near future, including boreholes and leases that may be used for fluid injection activities."

54.E.2 ABSTRACT

The compliance application must identify any activities that occur in the vicinity of the disposal system prior to or soon after disposal and must demonstrate which processes, events or sequences of processes and events were included in the compliance assessment calculations (e.g., existing boreholes and fluid injection).

DOE identified activities that could potentially occur in the vicinity of the WIPP, including: oil and gas exploration; exploitation and extraction; potash exploration and exploitation; fluid injection related to oil and gas production; sulfur coreholes; hydrocarbon and gas storage; brine wells for solution mining; water supply wells; and geothermal resources. Several of these activities—notably geothermal resources and drilling for hydrocarbon storage—were determined not to occur in the vicinity of the WIPP (p. SCR-103). DOE determined that none of the remaining activities is expected to have a significant impact on the WIPP prior to or soon after disposal. DOE also screened out fluid injection based upon low consequence, and included information on leases in vicinity of the WIPP.

54.E.3 COMPLIANCE REVIEW CRITERIA

As stated in the CAG (p. 70), EPA expected the compliance application to:

- Identify any activities that occur in the vicinity of the disposal system prior to or soon after disposal; and

- Demonstrate which processes, events or sequences of processes and events were included in the compliance assessment calculations, including, but not limited to existing boreholes and the development of any existing leases that can be reasonably expected to be developed in the near future, including boreholes that may be used for fluid injection activities.

54.E.4 DOE METHODOLOGY AND CONCLUSIONS

In Appendix SCR (p. SCR-97 to SCR-98), DOE divided human-initiated activities into three categories: 1) those that already occurred; 2) those that might be initiated during the operational phase, and 3) those that might be initiated after disposal. In its discussion of current and near-future human activities, DOE addressed the following activities occurring in the

Delaware Basin and, potentially, near the WIPP (Appendix DEL, Tables DEL-3 and DEL-7; Appendix SCR, p. SCR-102 to SCR-103):

- Oil and gas exploration, exploitation, and extraction, including enhanced oil recovery.
- Potash exploration and exploitation.
- Fluid injection related to oil and gas production (class 2).
- Sulfur coreholes.
- Hydrocarbon (gas) storage in geologic reservoirs.
- Gas reinjection.
- Brine wells for solution mining (salt water mining).
- Water supply wells.
- Geothermal resources.

DOE concluded in Chapter 6.2.5 (pp. 6-58 to 6-61) that oil and gas exploration and exploitation and water and potash exploration are the principal human-initiated activities that need be considered for the PA. However, DOE excluded consideration in the compliance assessment of these activities soon after disposal, assuming that active institutional controls would preclude the installation of any borings on the WIPP site in the near future. (Active institutional controls are discussed in **CARD 41—Active Institutional Controls**.) DOE also examined current enhanced oil recovery and fluid injection related to oil and gas production. These activities occur in the Delaware basin and in the immediate area of the WIPP. Appendix DEL presented the location of injection wells in the immediate WIPP area.

DOE described exploration, exploitation (e.g., oil field development drilling once reserves are discovered), and extraction of oil and gas resources in Appendix SCR.3.2.1.1. DOE screened out the possibility that oil and gas extraction activities that have occurred thus far would affect the WIPP.

As described in Appendix SCR, DOE's screening of FEPs considered the possibility of both subsidence and pressure gradients in the disposal system due to oil and gas extraction during the near future, stating that surficial and associated geologic material subsidence will be minimal to nonexistent. DOE stated that subsidence due to mining would be less than five feet, and subsidence due to oil and gas extraction would be significantly less. DOE ruled out pressure gradients caused by oil and gas extraction based upon low consequence. DOE indicated that fluid extraction could affect the repository horizons outside of the controlled area due to failed borehole casings. However, oil and gas extraction occur from reservoirs so far below the disposal horizon that pressure gradients in these horizons would affect the WIPP only if the casing failed (Stoelzel and O'Brien 1996). Casing failure rarely occurs.

In addition, DOE noted that oil and gas extraction includes enhanced oil recovery activities, primarily water flooding. Stoelzel and O'Brien (1996) evaluated the effects of fluid injection/water flooding from two hypothetical boreholes near the WIPP using the BRAGFLO code, with some modified parameters and assumptions to fit the water flood conditions (e.g., a modified grid system). Stoelzel and O'Brien concluded that although a worst case realization did result in brine inflow from the injection location to the repository over an approximately two-mile distance within anhydrite interbeds of the Salado, the value of cumulative brine inflow was relatively small and within the bounds of brine inflow values calculated for the undisturbed scenario. Therefore, DOE eliminated the water flood FEP based upon low consequence for the current and near future periods. DOE subsequently revisited this scenario assuming a modified injection simulation period, increased Bell Canyon (injection zone) transmissivity, and reduced disturbed rock zone (DRZ) volume (Stoelzel and Swift, 1997). DOE again concluded that waterflooding could be eliminated based on low consequence.

Hydrocarbon storage takes place in the Delaware Basin but involves reinjection of gas into pre-existing boreholes into depleted reservoirs. DOE indicated that this procedure does not involve installation of new boreholes, and since hydrocarbons would be injected into existing reservoirs well below the disposal system, the consequence of this activity in the present or near future would be relatively minimal (Appendix SCR.3.2.1.1). DOE eliminated this activity based on low consequence.

Salt water mining is discussed in Appendix DEL, which indicates that there is a single salt water mine in the WIPP area (Appendix DEL, Tables DEL-3 and DEL-7). DOE did not include salt water mining as a FEP in the CCA, although it was considered in the DCCA. See Section 194.32(b) of **CARD 32—Scope of Performance Assessments** for additional discussion of salt water mining. DOE did not consider geothermal energy and sulfur exploration potentially exploitable resources and therefore screened them out. As summarized above, DOE considered water wells but screened them out due to low consequence (Appendix SCR, p. SCR-103, Table SCR-3).

DOE included an assessment of the potential effects of existing boreholes as part of its FEP screening analysis. Refer to Section 194.54(b)(1) of this CARD for discussion of existing boreholes. DOE screened out the potential effects of existing boreholes based upon low consequence.

Appendix DEL described the current oil and gas exploration and exploitation activities in the Delaware Basin and immediate WIPP area. Also, NMBMMR (1995) presented the location of oil fields in the WIPP area. The CCA includes maps in Appendices DEL and DMP showing the location of existing leases. These maps were assembled by DOE based on current legal descriptions of mineral rights leases on file in government and commercial data bases and include the location of existing fluid injection wells and associated leases.

54.E.5 EPA Compliance Review

DOE screened out the possibility that oil and gas extraction would affect the WIPP based upon low consequence. EPA concurred with DOE's decision and concluded that the FEP

screening appropriately considered the possibility of both subsidence and pressure gradients in a system due to oil and gas extraction. Appendix SCR adequately supports the conclusion that surficial and associated geologic material subsidence will be minimal to nonexistent. Based on this review and evaluation of the discussion in Appendix SCR, EPA concluded that DOE considered the appropriate issues, and that the technical conclusions reached by DOE regarding current and near future screening of oil and gas extraction activities were valid.

EPA concluded that screening out drilling for the purpose of liquid waste disposal appeared appropriate, although EPA initially questioned DOE's assumptions regarding screening of liquid waste disposal (and waterflooding). EPA's initial assessment of DOE's screening results indicated that liquid injection FEPs, including enhanced oil recovery and salt water disposal (Class 2), were not appropriately modeled. The screening assessment used by DOE appeared to be inadequate for injection-related activities, including liquid waste disposal. EPA performed its own independent analysis, which showed that the injection analysis must include the nature of anhydrites, duration of injection activities, and presence of leaking boreholes (EPA 1998b). EPA also independently modeled the injection well scenario and concluded that, although scenarios can be constructed that move fluid to the repository via injection, the probability of such an occurrence is less than one in 10,000, given the necessary combination of natural and human-induced events. See EPA Technical Support Document for Section 194.32: Fluid Injection Analysis (EPA 1998b) for detailed results of EPA's analysis. See **CARD 32—Scope of Performance Assessments** for a discussion of EPA's analysis of fluid injection.

DOE screened out induced system changes due to hydrocarbon storage operations that have occurred thus far in the area based on low consequence. EPA concluded that this screening was appropriate.

Brine extraction activities were not specifically addressed by DOE in the CCA, but EPA assumed that DOE screened it from the DCCA list based on consequence. EPA's analysis showed that, while solution mining of halite may not be occurring in the immediate vicinity of the WIPP, it is occurring near Carlsbad, approximately 26 miles from WIPP. EPA requested additional detail from DOE (Docket A-93-02, Item II-I-17). DOE responded with a memorandum prepared by Hicks (Docket A-93-02, Item II-I-31), as well as other information in response to public comments (Docket A-93-02, Item II-H-45). DOE's supplemental information sufficiently addressed EPA's concerns regarding brine cavity development, duration of solution mining, and potential development. EPA reviewed this information and concurred that salt water mining should be screened out for the current and near future periods. EPA also concurred with DOE's screening out of water supply wells and geothermal energy boreholes for the current and near future periods.

Although DOE did not specify oil and gas field life in detail for each field near WIPP in Appendix DEL, EPA found that it was possible to derive the expected active lifetimes of oil and gas fields from information presented in that Appendix. EPA agreed that the lease life estimation values presented in the CCA were reasonable, although EPA asked DOE to consider the effects of longer injection periods (Docket A-93-02, Item II-I-17). DOE responded to this request as part of the second injection well analysis prepared by Stoelzel and Swift (1997), who included longer injection periods in their analysis. Specific field lives were not addressed in the CCA, but a significant amount of production data was included from which EPA could estimate overall field

life. See **CARD 32—Scope of Performance Assessments** for EPA's detailed assessment of leases in the WIPP area.

54.F REFERENCES

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