U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING

SUBJECT: EFFECTS OF ENGINEERED MATERIALS ON REPOSITORY PERFORMANCE

PRESENTER: JAMES E. HOUSEWORTH

PRESENTER'S TITLE
AND ORGANIZATION: SITE TEST AND DESIGN EVALUATION GROUP LEADER
MANAGEMENT AND OPERATING CONTRACTOR
LAS VEGAS, NEVADA

TELEPHONE NUMBER: (702) 794-1913

LAS VEGAS, NEVADA
APRIL 19-20, 1995

Objectives of Presentation

- Primary materials of interest
- Organizational interactions concerning engineered materials
- Process for interactive communication between performance assessment and design
- Steps in the performance assessment analysis of engineered materials
- Example of current analysis for discharge of organic material in diesel exhaust and planned activities for future improvements

Materials Used for Construction of a Geologic Repository Fall Into One of Four Categories:

Temporary	- removed prior to repository operation
Permanent	- remains in operating repository
Noncommitted	- removed prior to repository closure
Committed	- remains in post-closure repository

Materials Used for Construction of a Geologic Repository Fall Into One of Four Categories:

(Continued)

- Limited subset of all materials that may be committed
  - Construction water
  - Exhaust from diesel equipment
  - Ground support
  - Spills/operational losses
  - Invert and rails
  - Backfill and seals

Materials Discharged from Diesel-Powered Equipment that May Affect Repository Performance

Material	Application
Hydrocarbon vapor	Diesel exhaust
Diesel particulate matter (DPM)	Diesel exhaust
Nitric oxide	Diesel exhaust
Nitrogen dioxide	Diesel exhaust
Sulfur dioxide	Diesel exhaust
Diesel fuel	Spills and operational losses
Lubricating oil	Spills and operational losses
Sulfur-bearing hydrocarbons	Spills and operational losses
Ethylene glycol	Spills and operational losses

Materials Used for Ground Support that May Affect Repository Performance

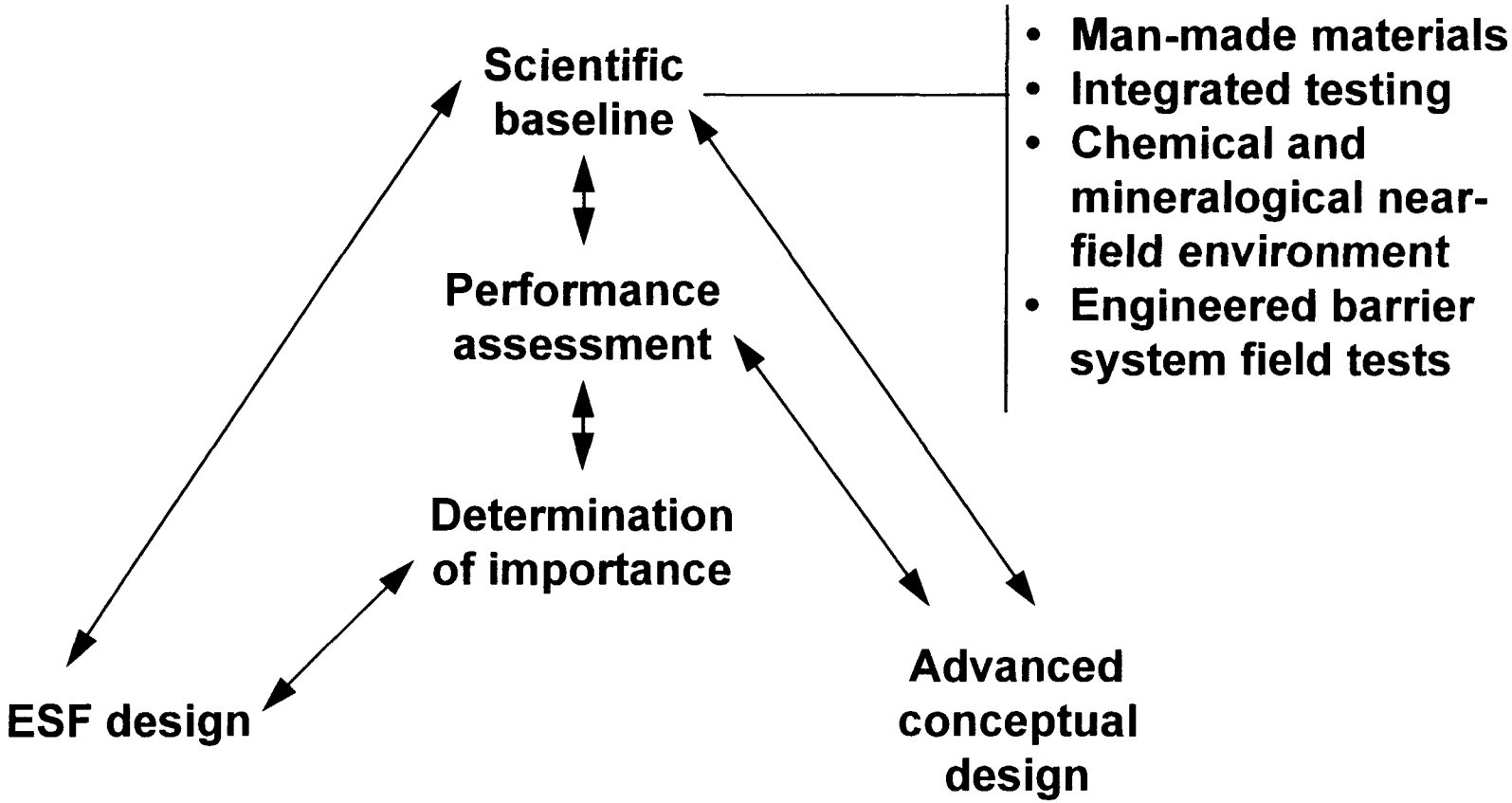
Material	Application
Steel	Rock bolts Steel sets Wire mesh
Cementitious grout	Installing rock bolts; enhancing ground conditions for tunnel boring machine (TBM) excavation
Shotcrete	Applied under poor ground conditions, often with wire mesh

Materials Used for Ground Support that May Affect Repository Performance

(Continued)

Material	Application
Wood	Blocking of steel sets
Chemical grout	Alternative for enhancing ground conditions ahead of TBM
Resin grout	Alternative for installing rock bolts
Cement admixtures	Used in shotcrete or grout
Plastic mesh	Alternative to wire mesh

Information Flow Concerning Engineered Materials: Scientific Baseline, Performance Assessment, and Design



Communicating Performance Assessment Analyses to Design: the Determination of Importance Process

1. ESF design provides to systems a preliminary design package, including a description of associated field activities
2. Systems classifies structures, systems, and components identified in the preliminary design for inclusion on the Q-list
3. Systems identifies need for performance assessment evaluation of impacts of design and associated field activities on Q-list items (including natural barriers)
4. Performance assessment evaluates potential impacts to Q-list items and documents under the quality assurance program in the determination of importance evaluation
5. Controls on design package and associated field activities are provided to design in the determination of importance evaluation and are implemented in final design package specifications and drawings

Steps in the Performance Assessment Analysis of Engineered Materials

1. Identify and characterize materials that may impact performance
2. Bound perturbations to ambient conditions

   Compare effects of activity on ambient conditions with expected range in ambient conditions
3. Bound effects of change in ambient conditions on performance-related parameters

   Compare effects of change in performance-related parameter with parameter uncertainty
4. Bound effects of change in performance-related parameter(s) on sub-system or total system performance

   Compare effects of change in performance assessment predictions with overall uncertainty for expected case

Example: Discharge of Organic Material in Diesel Exhaust During Construction of the ESF North Ramp

Step 1: Identify potential problems

Assume dissolution of all retained organic material and migration to waste package

Potential effects on <u>geochemistry</u>	Possible sub-system <u>performance affect</u>
Locally reducing conditions	Reduce waste package (WP) corrosion and radionuclide solubility limits
Stimulate microbial activity; locally acidic conditions	Increase WP corrosion and radionuclide solubility limits

Example: Discharge of Organic Material in Diesel Exhaust During Construction of the ESF North Ramp

Step 1: Identify potential problems

Potential effects on <u>geochemistry</u>	Possible sub-system <u>performance affect</u>
Increase aqueous organic concentrations	Increase radionuclide ligand solubility limits; increase WP corrosion
Produce organic colloids	Increase mobile radionuclide solubility; affect radionuclide transport

Example: Discharge of Organic Material in Diesel Exhaust During Construction of the ESF North Ramp

Step 2: Bound perturbations to ambient conditions

- Preliminary design provides
  - Diesel utilization profile along ramp
  - Exhaust volume per unit time of operation
  - Relative position of north ramp to potential waste emplacement locations

Example: Discharge of Organic Material in Diesel Exhaust During Construction of the ESF North Ramp

Step 2: Bound perturbations to ambient conditions

- Assumptions for bounding source term:
  - All DPM deposits on tunnel surfaces
  - Deposition occurs at point of emission
  - All hydrocarbon vapor is ventilated
  - Complete dissolution of retained organic material

Example: Discharge of Organic Material in Diesel Exhaust During Construction of the ESF North Ramp

Step 2: Bound perturbations to ambient conditions

- Model transport of dissolved organic carbon (DOC) to nearest waste package emplacement location
  - Equivalent porous medium
  - Model as 3-D advection-diffusion transport process from line source in upper portion of north ramp
  - Model as 1-D advection-diffusion transport process from infinite plane source in lower portion of north ramp
  - Compute peak DOC concentration at nearest waste package

Example: Discharge of Organic Material in Diesel Exhaust During Construction of the ESF North Ramp

Step 2: Compare effects on ambient conditions with expected variability in ambient conditions

- Estimate DOC variability in natural system
  - Measurements of ambient DOC in the unsaturated zone are not available
  - Estimate using measurements from the saturated zone and other groundwater systems
  - Variability is at least 10% of ambient: conservative compared to other dissolved constituents
  - Compute maximum diesel particulate matter emission concentration to limit perturbed DOC to 10% ambient at nearest waste package

Planned Activities for Future Improvements to Assessment of Organic Matter Discharged in Diesel Exhaust

- Diesel testing program in ESF north ramp to check assumptions on retention of diesel exhaust constituents
- Analog measurements of diesel exhaust products and microbiota in the U_{12N} tunnel at Rainier Mesa
- Theoretical modeling of organic matter from diesel exhaust and fuel in thermally perturbed rock-water system
- Experimental study of H_2O - diesel fuel - Fibercrete system at 200°C