

**U.S. NUCLEAR REGULATORY COMMISSION  
OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS**

**Presentation to  
THE NUCLEAR WASTE TECHNICAL REVIEW BOARD**

**VULNERABILITY OF THE GEOLOGIC REPOSITORY  
TO VIBRATORY GROUND MOTION AND FAULT  
DISPLACEMENT: REGULATORY PERSPECTIVE**

**Presented by  
DR. DINESH C. GUPTA  
U.S. NUCLEAR REGULATORY COMMISSION  
DIVISION OF HIGH-LEVEL WASTE MANAGEMENT**

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## OUTLINE

- **PRINCIPAL REGULATORY REQUIREMENTS**
- **INAPPLICABILITY OF 10 CFR 100, APPENDIX 'A' TO GEOLOGIC REPOSITORY**
- **VULNERABILITY OF GEOLOGIC REPOSITORY TO FAULT DISPLACEMENT AND SEISMIC HAZARDS**

## **REGULATORY REQUIREMENTS**

- **CONTAINED IN 10 CFR PART 60**
- **STATED IN GENERAL TERMS**
- **SPECIFIC GUIDANCE TO BE PROVIDED THROUGH PRE-LICENSING INTERACTIONS, STAFF TECHNICAL POSITIONS, FORMAT AND CONTENT GUIDE, AND LICENSE APPLICATION REVIEW PLAN**

# **PRINCIPAL 10 CFR PART 60 REQUIREMENTS**

## **PERFORMANCE OBJECTIVES**

(10 CFR 60.111-113)

- **PRE-CLOSURE PERFORMANCE OBJECTIVES (10 CFR 60.111) PROVIDE REQUIREMENTS FOR:**
  - **PROTECTION AGAINST RADIATION EXPOSURES AND RELEASES OF RADIOACTIVE MATERIAL**
  - **RETRIEVABILITY OF WASTE**
- **POST-CLOSURE PERFORMANCE OBJECTIVES (10 CFR 60.112 & 113) PROVIDE REQUIREMENTS FOR:**
  - **OVERALL SYSTEM PERFORMANCE**
  - **CONTAINMENT OF HLW WITHIN WASTE PACKAGES**
  - **RELEASE RATE OF RADIONUCLIDES FROM ENGINEERED BARRIER SYSTEM FOLLOWING THE CONTAINMENT PERIOD**
  - **PRE-WASTE-EMPLACEMENT GROUNDWATER TRAVEL TIME**

# **PRINCIPAL 10 CFR PART 60 REQUIREMENTS**

## **DESIGN CRITERIA**

(10 CFR 60.130-135)

- SPECIFY MINIMUM CRITERIA FOR DESIGN OF GEOLOGIC REPOSITORY OPERATIONS AREA, SEALS FOR SHAFTS AND BOREHOLES, AND WASTE PACKAGES
- REQUIRE DESIGN OF ENGINEERED BARRIER SYSTEM TO ASSIST GEOLOGIC SETTING IN MEETING PERFORMANCE OBJECTIVES
- INCLUDE REQUIREMENT FOR PROTECTION OF STRUCTURES, SYSTEMS, AND COMPONENTS IMPORTANT TO SAFETY AGAINST NATURAL PHENOMENA

## **SITING CRITERIA**

(10 CFR 60.122)

- IDENTIFY FAVORABLE AND POTENTIALLY ADVERSE CONDITIONS FOR THE SITE
- NEED TO BE CONSIDERED IN EVALUATING POST-CLOSURE PERFORMANCE (ISOLATION OF WASTE)

**INAPPLICABILITY OF 10 CFR 100, APPENDIX 'A'**  
**TO GEOLOGIC REPOSITORY**

**10 CFR 100, APPENDIX 'A' DOES NOT PROVIDE FOR THE  
DIFFERENCES IN FUNCTION AND PERIODS OF  
PERFORMANCE BETWEEN GEOLOGIC REPOSITORIES  
AND NUCLEAR POWER PLANTS.**

**(DRAFT TECHNICAL POSITION ON INVESTIGATIONS TO IDENTIFY FAULT  
DISPLACEMENT HAZARDS AND SEISMIC HAZARDS AT A GEOLOGIC  
REPOSITORY, JANUARY 1992)**

# **INAPPLICABILITY OF 10 CFR 100, APPENDIX 'A' TO GEOLOGIC REPOSITORY**

## **SPECIFIC ASPECTS REQUIRING DIFFERENT APPROACH**

- **PERFORMANCE OBJECTIVES FOR UNDERGROUND FACILITY REQUIRED TO BE MET FOR THOUSANDS OF YEARS.**
- **SURFACE AND UNDERGROUND FACILITIES DO NOT CONSTITUTE AN ACTIVE SYSTEM LIKE NUCLEAR POWER PLANT.**
- **UNDERGROUND FACILITIES HAVE BEEN OBSERVED TO BE MORE RESISTANT TO EARTHQUAKES THAN SURFACE FACILITIES.**
- **EFFECT OF REPEATED GROUND MOTIONS MAY NEED TO BE CONSIDERED.**
- **SEISMIC LOADS ON UNDERGROUND ROCK MAY BE SUPERIMPOSED ON THERMAL LOADS. ALSO, THERMAL LOADS COULD REDUCE RESISTANCE TO EARTHQUAKES.**
- **DAMAGE MODES FOR NATURAL SYSTEM (E.G., WIDENING OF FAULTS AND CHANGE IN GROUND WATER CONDITIONS) MAY ALSO NEED TO BE CONSIDERED.**

**INAPPLICABILITY OF 10 CFR 100, APPENDIX 'A'**  
**TO GEOLOGIC REPOSITORY**

**BECAUSE OF THESE REASONS, THE NRC STAFF  
CONSIDERS THAT THE REGULATORY REQUIREMENTS  
FOR SEISMIC AND FAULTING DESIGN OF NUCLEAR  
POWER PLANTS, GIVEN IN 10 CFR 100, APPENDIX A, ARE  
NOT APPLICABLE TO THE DESIGN OF GEOLOGIC  
REPOSITORY OPERATIONS AREA.**



## **VULNERABILITY DURING PRE-CLOSURE PERIOD**

- **BOTH SURFACE AND UNDERGROUND FACILITIES VULNERABLE DURING PRE-CLOSURE PERIOD**
- **FOCUS ON DESIGN OF STRUCTURES, SYSTEMS, AND COMPONENTS IMPORTANT TO SAFETY**

### **SURFACE FACILITIES**

- **WASTE HANDLING BUILDING(S) LIKELY TO BE OF PRIMARY INTEREST**
- **TO SOME EXTENT, REQUIREMENTS FOR RADIATION SHIELDING MAY RESULT IN A ROBUST DESIGN FOR WASTE HANDLING BUILDING(S)**

# VULNERABILITY DURING PRE-CLOSURE PERIOD

## UNDERGROUND FACILITY

- DESIGN OF ACCESS AND EMPLACEMENT DRIFTS NEED TO CONSIDER TRENDS OF KNOWN FAULTS
  - NEED TO ALLOW FOR RETRIEVABILITY OF WASTE
  - WASTE EMPLACEMENT HOLES AND WASTE PACKAGES

## GENERAL GROA

- PRUDENCE SUGGESTS CAUTION REGARDING DESIGN OF SURFACE FACILITIES & WASTE PACKAGES TO ACCOMMODATE FAULT DISPLACEMENT
- VENTILATION SYSTEM: NEED TO ASSURE CONTINUED FUNCTIONING; MAINTAIN SEPARATION OF VENTILATION FOR EXCAVATION AND WASTE EMPLACEMENT AREAS
- UTILITY SERVICE SYSTEMS: NEED TO ASSURE CONTINUED OPERATION OF SAFETY FUNCTIONS
- INSTRUMENTATION AND CONTROL SYSTEMS: NEED TO CONTINUE TO MONITOR AND CONTROL BEHAVIOR OF SYSTEMS IMPORTANT TO SAFETY

# **VULNERABILITY DURING POST-CLOSURE PERIOD**

- **DESIGN ENGINEERED BARRIER SYSTEM TO ASSIST GEOLOGIC SETTING IN MEETING PERFORMANCE OBJECTIVES**

## **ENGINEERED SYSTEM**

- **WASTE PACKAGE VULNERABLE DUE TO POSSIBLE SHEARING, EFFECT OF NEARBY FAULTS ON STABILITY AND POTENTIAL WATER CONTACT, EMPLACEMENT MODE**
- **WASTE EMPLACEMENT HOLES: AIR-GAP INTEGRITY, LINER MATERIAL AND THICKNESS, PARTIAL VS FULL LINER**
- **EMPLACEMENT AND ACCESS DRIFTS: REPEATED GROUND MOTIONS AND FAULT DISPLACEMENTS, EFFECT OF UNSTABLE OPENINGS ON FLOW PATHS, EFFECT OF BACKFILL SETTLEMENT (IF BACKFILLED)**
- **SEALS FOR SHAFTS AND BOREHOLES**

# **VULNERABILITY DURING POST-CLOSURE PERIOD**

## **NATURAL SYSTEM**

- **CHANGES IN FRACTURE CHARACTERISTICS: POSSIBILITY OF OPENING UP NEW FRACTURES OR MODIFICATION OF EXISTING FRACTURES.**
- **GROUNDWATER: WATER LEVEL OR HYDRAULIC GRADIENT CHANGES.**

## CONCLUDING REMARKS

- **PERFORMANCE OBJECTIVES, SITING CRITERIA, AND DESIGN CRITERIA IN 10 CFR PART 60 PROVIDE REGULATORY REQUIREMENTS RELATED TO VIBRATORY GROUND MOTION AND FAULT DISPLACEMENTS IN GENERAL TERMS. SPECIFIC GUIDANCE TO BE PROVIDED BY NRC STAFF TO DOE ON 'AS NEEDED' BASIS.**
- **REQUIREMENTS OF APPENDIX 'A' TO 10 CFR PART 100 NOT APPLICABLE TO GEOLOGIC REPOSITORY.**
- **STATE OF THE ART PROVIDES CONFIDENCE IN ABILITY TO DESIGN THE SURFACE FACILITIES AND THE ENGINEERED BARRIER SYSTEM FOR SEISMIC MOTION TO SOME EXTENT. PRUDENCE SUGGESTS CAUTION REGARDING DESIGN TO ACCOMMODATE FAULT DISPLACEMENT.**
- **ADDITIONAL RESEARCH MAY BE NEEDED TO DEVELOP THE ABILITY TO BETTER PREDICT THE RESPONSE OF NATURAL SYSTEM TO FUTURE VIBRATORY GROUND MOTION AND FAULT DISPLACEMENT AND ITS EFFECT ON LONG-TERM REPOSITORY PERFORMANCE.**