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**CNWRA WORK PLAN  
TO ASSIST NRC IN SYSTEMATIC REGULATORY ANALYSIS  
AND DEVELOPMENT OF POTENTIAL REGULATORY  
AND TECHNICAL GUIDANCE ON ISSUES RELATED TO  
VOLCANIC/MAGMATIC HAZARDS**

**I. BACKGROUND**

As indicated by the planned investigative activities related to volcanism outlined in Section 8.3.1.8.1 of the Department of Energy's (DOE) Site Characterization Plan (SCP), volcanic and magmatic processes and events are important elements of the regional geologic setting of the Basin and Range, the physiographic province in which the potential high-level radioactive waste repository site at Yucca Mountain is located. Consequently, such processes and events must be considered in relation to the suitability of Yucca Mountain as a repository site.

The Basin and Range Province lies within a region exhibiting major crustal extension, which occurred principally during the last 15 million years (m.y.) of the Cenozoic Era (Kruse and others, 1991; Wernicke and others, 1988), and Quaternary basaltic volcanism, which may be Holocene in age in the case of Lathrop Wells Cone (Crowe, 1990). Mid-Tertiary intermediate and silicic volcanic rocks have petrologic affinities of both plate convergence and extensional suites in the Southern Basin and Range (Glazner and Bartley, 1984), and appear to be commonly associated in space and time with major crustal extension of several hundred percent locally (Lipman and Glazner, 1991). Basaltic rocks associated with termination of rapid extension occur in the Basin and Range Province, where they commonly overlie tilted and extended Middle Tertiary volcanic sequences containing abundant intermediate to silicic lavas and tuffaceous rocks (Miller and Miller, 1991). Basaltic rocks are characteristically the youngest volcanic units which have been identified in the vicinity of Yucca Mountain (Champion, 1991; Crowe, 1990).

Processes and events which controlled Cenozoic volcanism/magmatism (and tectonism) in the Basin and Range are not adequately understood at present. Knowledge gained from accomplishment of the Systematic Regulatory Analysis (SRA) activities proposed in this work plan will assist the Nuclear Regulatory Commission (NRC) in determination of the need for development of regulatory guidance in regard to volcanism/magmatism, and identification and development of the strategy and methods the NRC may use to determine compliance with the requirements of 10 CFR Part 60. This knowledge will assist NRC staff with review of information to be provided by the DOE in relation to the following factors: assessment of the likelihood of future volcanism at or near Yucca Mountain; evaluation of the potential for volcanic disruption of a repository at Yucca Mountain; evaluation of design for surface and subsurface facilities; coupling of magmatic, tectonic, hydrologic systems; and assessment of site performance.

Under 10 CFR 60.112, the NRC states that the overall system performance objective for the geologic repository after closure requires that the geologic setting be selected and the engineered barrier system be designed to assure that releases of radioactive materials to the accessible environment following permanent closure conform to standards established by the Environmental Protection Agency (EPA) with respect to both anticipated processes and events and unanticipated processes and events. As specified in 10 CFR 60.21(c)(1), information on features of the site that might affect geologic repository operations area design and performance is expressly required to be included in the Safety Analysis Report of the license application. In 10 CFR 60.131(b)(1), structures, systems, and components important to safety are required to be designed so that natural phenomena anticipated at the geologic repository operations area will not interfere with necessary safety functions.

Under the NRC's siting criteria for disposal of high-level radioactive waste in geologic repositories, presented in 10 CFR 60.122, potentially adverse conditions are considered to exist if they are characteristic of the controlled area or if they may affect isolation within the controlled area. The two following potentially adverse conditions related to volcanism/magmatism are specified in 10 CFR 60.122:

- \* 10 CFR 60.122(c)(3) - Potential for volcanic activity of such a magnitude that large-scale surface water impoundments could be created that could change the regional ground-water flow system and thereby adversely affect the performance of the geologic repository.
- \* 10 CFR 60.122(c)(15) - Evidence of igneous activity since the start of the Quaternary Period.

As indicated in 10 CFR 60.122(a)(2)(i) - (iii), the following must be demonstrated to show that a potentially adverse condition does not compromise the performance of the geologic repository: (i) the potentially adverse condition has been adequately investigated, including the extent to which the condition may be present and still be undetected taking into account the degree of resolution achieved by the investigations; and (ii) the effect of the potentially adverse condition on the site has been adequately investigated using analyses which are sensitive to the condition and assumptions which are not likely to underestimate its effects; and (iii) the potentially adverse condition is shown by analysis pursuant to (a)(2)(ii) above not to affect significantly the ability of the geologic repository to meet the performance objectives relating to isolation of the waste, or the effect of the potentially adverse condition is compensated by the presence of favorable characteristics so that the performance objectives relating to isolation of the waste are met, or the potentially adverse condition can be remedied.

**II. TASK DESCRIPTION**

Assistance to be provided to the NRC by the Center for Nuclear Waste Regulatory Analyses (CNWRA, often referred to as the Center) for development of regulatory and technical guidance on issues related to volcanic/magmatic hazards is identified in the Geologic Setting

Program Element section (Section 3.4) of the CNWRA FY92-93 Operations Plans for the NRC's Division of High-Level Waste Management (Revision 1, Change 0, dated September 1991) as Subtask 2.1.6 under Task 2 activities. Since Task 2 activities concentrate on SRA and associated development of regulatory and technical guidance, the purpose of this work plan for volcanic/magmatic hazards is to clearly establish the regulatory framework within which must be determined specific scientific methods, data and information requirements, and analytical and data management tools needed by NRC staff for implementing regulations established by the NRC, developing appropriate guidance for the Department of Energy (DOE), and assessing DOE's compliance with the regulations. CNWRA staff will work with NRC staff to determine if regulatory and technical guidance is necessary and, if so, what is sufficient for the NRC to provide to the DOE on issues related to volcanic/magmatic hazards. It is anticipated that a joint NRC/CNWRA working group on volcanic/magmatic hazards will be assembled for accomplishing the activities outlined in this work plan.

The objectives of this task are to provide technical assistance to the NRC for (i) development of technical positions, staff positions and related regulatory guidance, (ii) development of rules and amendments, and (iii) preparation of technical input for other guidance documents to be provided to the DOE (e.g. - the Format and Content Regulatory Guide and the License Application Review Plan). Geologic Setting Program Element staff will analyze the important issues related to volcanic/magmatic hazards using an approach that includes specification of regulatory history and intent; use of SRA to analyze pertinent parts of 10 CFR Part 60; and identification and development of technical and regulatory bases for preparation of potential prelicensing guidance for the DOE and for participation in interactions with the DOE.

**A. TASK ORGANIZATION**

The activities to be performed in accomplishment of this work plan are divided into five separate phases as shown below. Procedures, training, and coordination to support the activities defined in this work plan will be provided by the Center through the WSE&I Program Element.

- PHASE 1: Apply SRA to Analyze Parts of 10 CFR Part 60 Pertaining to Volcanic/Magmatic Hazards.
- PHASE 2: Conduct a Preliminary Assessment of Potential Existing Compliance Determination Methods (CDM's) for Addressing Volcanic/Magmatic Hazards.
- PHASE 3: Support NRC staff in the Development of Prelicensing Regulatory Guidance for Volcanic/Magmatic Hazards, and in NRC/DOE Technical Exchanges and Related Meetings on Volcanic/Magmatic Hazards.

**PHASE 4: Incorporate SRA Information on Volcanic/Magmatic Hazards into the Program Architecture Relational Database (PADB).**

**PHASE 5: Integrate Regulatory Guidance and Products Related to Volcanic/Magmatic Hazards into the Format and Content Regulatory Guide (F&CRG) and the License Application Review Plan (LARP).**

**B. TASK ACTIVITIES AND DELIVERABLES**

**PHASE 1: Apply SRA to Analyze Parts of 10 CFR Part 60 Pertaining to Volcanic/Magmatic Hazards**

In this phase of the work, CNWRA staff will apply SRA to analyze 10 CFR Part 60 and determine the important issues, problems, and uncertainties related to volcanic/magmatic hazards at the proposed repository site. CNWRA staff will work with NRC staff to determine the regulatory basis for development of potential guidance to the DOE on volcanic/magmatic hazards. The technical aspects of 10 CFR Part 60 which must be analyzed to assess compliance with 10 CFR Part 60 in connection with volcanic/magmatic hazards will also be identified.

**Activity 1.1: Identify pertinent Regulatory Requirements (RR's) in 10 CFR Part 60**

NRC and CNWRA staff will review the current list of RR's contained in the Regulatory Requirements/Regulatory Elements of Proof (RR/REOP) Report, and identify the RR's considered to be both directly and indirectly related to volcanic/magmatic hazards which are appropriate to analyze under this work plan. The deliverable for this activity will be a report identifying the pertinent RR's in 10 CFR Part 60 which are related to volcanic/magmatic hazards (Intermediate Milestone 3702-002-410-001).

**Activity 1.2: Support NRC review of RR/REOP Report**

CNWRA staff will support the NRC review of the RR/REOP Report by providing related technical information and assistance for RRs mutually agreed upon by the CNWRA and the NRC. REOP's will be examined for consistency with the RR's chosen for analysis under this work plan.

**Activity 1.3: Develop proposed Compliance Determination Strategy (CDS) types and submit them to the NRC for approval**

A Compliance Determination Strategy (CDS) will be developed for each RR and its related set of REOP's. The assigned CDS type (classed as Type 1 through Type 5) identifying the scope and level of detail to which the License Application (LA) review process must proceed is to be defined for each RR. CNWRA staff will work with NRC staff to recommend the CDS type for each RR considered for analysis under this work plan, and the

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type selections will be submitted to an NRC team for review and concurrence. The deliverable for this activity will be a report presenting the CDS type for each RR related to volcanic/magmatic hazards (Intermediate Milestone 3702-002-410-002).

**Activity 1.4: Develop Compliance Determination Strategy**

CNWRA staff will work with NRC staff to develop a CDS once a type selection is established. The deliverable for this activity will be a report presenting the CDS's which have been developed for the RR's related to volcanic/magmatic hazards (Intermediate Milestone 3702-002-410-003).

**Activity 1.5: Develop Technical Review Components (TRC's)**

In coordination with NRC staff, CNWRA staff will develop TRC's for each REOP related to volcanic/magmatic hazards. The deliverable for this activity will be a report documenting the TRC's which are developed (Intermediate Milestone 3702-002-410-004).

**Activity 1.6: Analyze regulatory history and intent**

CNWRA staff will review 10 CFR Part 60 and pertinent documentary material (e.g. - NUREG 0804) to determine the regulatory history and the intent of the NRC with respect to regulatory requirements related to volcanic/magmatic hazards. The deliverable for this activity will be a report delineating regulatory history and intent as they relate to volcanic/magmatic hazards (Major Milestone 3702-002-410-005).

**Activity 1.7: Develop Compliance Determination Methods (CDM's) within bounds established by the CDS**

CNWRA staff will work with NRC staff to develop CDM's within the bounds specifically established by the CDS. The deliverable for this activity will be a report presenting the CDM's which have been developed for the RR's, REOP's, and TRC's related to volcanic/magmatic hazards (Intermediate Milestone 3702-002-420-006).

**Activity 1.8: Identification and analysis of Technical Uncertainties**

Technical Uncertainties and Technical Uncertainty Reduction Methods related to determining compliance with the regulatory requirements involving volcanic/magmatic hazards will be identified. Information Requirements (IR's) will also be identified, as required.

**Activity 1.9: Develop and submit draft Options Report**

As the deliverable for this activity, CNWRA staff will prepare and submit a draft Options Report to the NRC (Intermediate Milestone 3702-002-420-007). This report will include

a discussion of RR's, potential CDM's, technical uncertainties, and uncertainty reduction methods related to volcanic/magmatic hazards.

**Activity 1.10: CNWRA presentation to NRC staff on the Options Report**

As the deliverable for this activity, CNWRA staff will make an oral presentation to NRC staff on the Options Report to discuss report contents concerned with SRA as applied to assessment of volcanic/magmatic hazards (Intermediate Milestone 3702-002-420-009). Issues requiring management approval will be determined and clearly stated in the meeting report which will be prepared by CNWRA staff.

**Activity 1.11: CNWRA presentation to NRC management on the Options Report**

As the deliverable for this activity, CNWRA staff will make an oral presentation to NRC Management on the Options Report to discuss report contents concerned with SRA as applied to assessment of volcanic/magmatic hazards (Intermediate Milestone 3702-002-420-010). Issues defined as a result of Activity 1.10 will be confirmed and resolved by appropriate management action.

**Activity 1.12: Develop and submit Final Options Report**

The deliverable for this activity will be the final Options Report concerned with SRA as applied to assessment of volcanic/magmatic hazards (Major Milestone 3702-002-420-011).

**PHASE 2: Conduct a Preliminary Assessment of Potential Existing Compliance Determination Techniques for Addressing Volcanic/Magmatic Hazards**

**Activity 2.1: Identify and recommend modeling and analysis methods to be used in assessment of volcanic/magmatic hazards**

CNWRA staff will conduct a preliminary assessment of potential existing compliance determination techniques for addressing issues related to volcanic/magmatic hazards, and will review the literature on analyses of volcanic/magmatic hazards to determine the methods and computer codes that may be applicable for use in specific CDM's. Analyses methods and codes currently in use by the DOE will be included in the review and assessment. In this activity, CNWRA staff will consider structural control on volcanism, deformation related to volcanism/magmatism, and ground-water variations resulting from volcanic/magmatic events. This effort will provide a connection with modeling work which couples volcanism with ground water hydrology and tectonics. Therefore, this activity will provide a direct tie to the Volcanism Research Project Plan and the Tectonics Work Plan, both of which have previously been prepared and submitted to the NRC. Recommendations for appropriate future Task 3 modeling

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activities will be included in the report submitted for this activity (Intermediate Milestone 3702-002-420-008).

**PHASE 3: Support NRC Staff in Development of Prelicensing Regulatory Guidance for Volcanic/Magmatic Hazards, and in Technical Exchanges and Related Meetings on Volcanic/Magmatic Hazards**

CNWRA staff will provide support the NRC in development of prelicensing regulatory guidance for volcanic/magmatic hazards. CNWRA staff will provide support to the NRC for NRC/DOE technical exchanges and related meetings on volcanic/magmatic hazards, as required.

**PHASE 4: Incorporate SRA Information on Volcanic/Magmatic Hazards into the PADB**

CNWRA staff will incorporate into the PADB any SRA information on volcanic/magmatic hazards related to REOP's, TRC's, CDS's, CDM's, uncertainties, uncertainty reduction methods, and detailed IR's which has not been previously included in the database. The deliverable for this activity will consist of completion of input of information into the PADB.

**PHASE 5: Integrate Regulatory Guidance and Products Related to Volcanic/Magmatic Hazards into the F&CRG and the LARP**

CNWRA staff will integrate and incorporate regulatory guidance and products related to volcanic/magmatic hazards into the F&CRG and the LARP. CNWRA staff will provide technical support for developing aspects of the NRC license application and performance assessment review process related to pertinent regulatory requirements concerned with volcanic/magmatic hazards.

### **III. ESTIMATED LEVEL OF EFFORT**

Information on cost and general scope for the volcanic hazards work plan is included in the CNWRA FY92-93 Operation Plans for the Division of High-Level Waste Management of the NRC.

### **IV. SCHEDULE/MILESTONES**

The ability for CNWRA to adhere to the milestone schedule presented below for submission of products related to this work plan is strongly dependent upon several factors. To accomplish the work outlined in this plan under the schedule shown, it will be necessary that staff selected for the joint NRC/CNWRA working group on volcanic/magmatic hazards be available for participation in the activities outlined in this work plan.

Duration of review periods and scope of responses required from CNWRA staff to address review comments could cause revisions of the schedule. Higher-priority reactive work which requires involvement of the same CNWRA and NRC staff working on activities under this work plan could necessitate unexpected schedule revisions. Schedule revisions could also occur because of modifications required in RR's or REOP's based on results of the ongoing discussions between the NRC and CNWRA concerning the 10 CFR 60.112/10 CFR 60.122 issue. Timely development of appropriate SRA procedures by the NRC and CNWRA will be very important in adhering to the schedule shown. Appropriate and timely training of all CNWRA and NRC personnel working on activities given in this work plan will be required to meet pertinent Quality Assurance requirements.

**V. TECHNICAL CONTACTS**

|                       |                 |               |
|-----------------------|-----------------|---------------|
| NRC Manager:          | David Brooks    | (301)492-3457 |
| NRC:                  | Phil Justus     | (301)492-3460 |
| NRC Subtask Leader:   | John Trapp      | (301)492-0509 |
| NRC:                  | Keith McConnell | (301)492-0532 |
|                       |                 |               |
| CNWRA Manager:        | John Russell    | (512)522-5183 |
| CNWRA Subtask Leader: | Gerry Stirewalt | (703)979-9129 |
| CNWRA:                | Steve Young     | (512)522-5247 |

**FY 92-93 INTERMEDIATE MILESTONES**

| <b>WORK ITEM</b> | <b>COMPONENT</b> | <b>TITLE</b>   | <b>DATE</b>       |
|------------------|------------------|--|-------------------|
| 410-001          | Activity 1.1     | Identify pertinent regulatory requirements in 10 CFR Part 60                 | December 20, 1991 |
| 410-002          | Activity 1.3     | Develop proposed CDS LA Review type (Type 1 - 5) and submit for NRC approval | March 6, 1992     |
| 410-003          | Activity 1.4     | Develop Compliance Determination Strategy                                    | June 5, 1992      |
| 410-004          | Activity 1.5     | Develop Technical Review Components  | September 4, 1992 |
| 420-006          | Activity 1.7     | Develop Compliance Determination Methods                                     | May 7, 1993       |
| 420-007          | Activity 1.9     | Develop and submit Draft Options Report                                      | June 18, 1993     |
| 420-008          | Activity 2.1     | Compliance Determination Techniques, Methods and Codes Recommendation Report | July 9, 1993      |
| 420-009          | Activity 1.10    | Prepare for and conduct CNWRA presentation to NRC staff on Options Paper     | July 23, 1993     |
| 420-010          | Activity 1.11    | CNWRA presentation to NRC management on Options Paper                        | September 3, 1993 |

**FY92-93 MAJOR MILESTONES**

| <b>WORK ITEM</b> | <b>COMPONENT</b> | <b>TITLE</b>                            | <b>DATE</b>        |
|------------------|------------------|---|--------------------|
| 410-005          | Activity 1.6     | Analyze regulatory history and intent   | September 30, 1992 |
| 420-011          | Activity 1.12    | Develop and submit Final Options Report | September 30, 1993 |

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## VI. REFERENCES CITED

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