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Dinesh Gupta
U. S. Nuclear Regulatory Commission
Division of Waste Management
Washington, D.C.

Dear Dinesh:

Enclosed is a draft of "List of Major Underground Structures, Systems and Components for a High Level Nuclear Waste Repository at NNWSI". The draft consists of two parts, the list, and an outline of a proposed prioritization methodology.

The list has been developed by taking as an initial approach simply a comprehensive list of all major components that could conceivably be relevant. The major question in this regard is the level of detail that is deemed appropriate (e.g. waste transporter: one system could be subdivided into numerous components).

The proposed prioritization methodology establishes a rationale that could be followed, starting from the NRC statutory responsibility. Pursuing this in depth would require a detailed study of the repository design, the development of failure scenarios, performance of failure consequence assessments, and finally integration of all results into a rationally ordered prioritization. This is one extreme approach, a comprehensive one. At the other extreme might be a level of effort approach based on professional judgment (e.g. brake failure of a loaded emplacement waste transporter while on the ramp is more serious than failure of the muck haulage system).

Your guidance on the further pursuit of these topics will be welcomed. We look forward to discussing them at our December 18, 1986 meeting in your offices.

Sincerely,

Roger Hart for
Jaak Daemen

RDH/LJG
Enclosures
cc: David Tiktinsky

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LIST OF MAJOR UNDERGROUND STRUCTURES, SYSTEMS AND COMPONENTS FOR A HIGH LEVEL NUCLEAR WASTE REPOSITORY AT NNWSI

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A. Surface Support

1. waste handling building(s)

   a. waste handling/packaging systems
   b. operating support systems (HVAC, radwaste handling systems, utilities and miscellaneous service systems)
   c. operating cells
   d. transfer corridors
   e. operating support areas

2. muck conveyor transfer station

3. muck pile

4. underground personnel facility (change house)

5. office buildings

6. warehouse and storage yard (for underground supplies and materials systems)

7. emplacement exhaust shaft fan and filter buildings

   a. normal exhaust fans
   b. emergency exhaust fans
   c. emergency filtration (HEPA)
   d. stack
   e. controls

8. men and materials shaft intake fan building

9. emplacement ventilation heating/cooling building

10. waste ramp heating/cooling building

   a. intake air cooling coils
   b. intake air heating coils
   c. chillers (all underground ventilation support)
   d. chilled water circulation pumps (all underground HVAC support)

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B. Shafts and Ramps

1. disturbed rock zones around shafts and ramps (near-field)

2. waste ramp

   a. ramp portal
   b. lining
   c. seals
   d. inspection/monitoring system
   e. maintenance system
   f. utilities system (including signalling)
   g. waste transporter

3. emplacement intake shafts (exploratory shaft and escape shaft)

   a. shaft collar
   b. station
   c. lining
   d. seals
   e. inspection hoisting system (including head-frame and hoist house systems)
   f. maintenance hoisting system (including head-frame and hoist house systems)

4. men and materials shaft

   a. shaft collar
   b. station
   c. lining
   d. seals
   e. headframe/hoist house systems
   f. hoisting system
   g. emergency hoisting system
   h. conveyance on/off system
   i. utilities system

5. muck (mined-tuff) ramp

   a. ramp portal
   b. lining
   c. seals
   d. inspection/monitoring system
   e. maintenance system
   f. muck conveyor

6. emplacement ventilation exhaust shaft

   a. shaft collar
   b. station
   c. lining
   d. seals
   e. inspection/hoisting system
   f. maintenance

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7. shaft and ramp geotechnical instrumentation
8. far field rock beyond the disturbed zones

C. Repository Horizon

1. stratigraphic/planar development control systems for excavated entries
2. ventilation control devices
3. waste package position monitoring system
4. waste transporter
5. transfer cask
6. waste emplacement machine
7. waste package extraction machine
8. shield plug emplacement machine
9. shield plug
10. decomissioning systems (including shaft and bore-hole decommissioning seals)
11. underground excavation development system
12. emplacement borehole drilling machine
13. emplacement hole lining/backpacking
14. muck handling system
15. support system for underground openings
16. radiation/industrial/environmental/geotechnical monitoring systems
17. operational/ventilation monitoring and control systems
18. waste package
19. entries and pillars
20. disturbed rock zone around entries and emplacement holes (near-field)
21. far-field rock beyond the disturbed zone

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22. operating support systems

    a. electrical distribution system
    b. utility distribution system
    c. security system
    d. communication system
    e. remote maintenance equipment
    f. underground water discharge system
    g. fire protection system

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Proposed Prioritization Methodology

Following preparation of the list of major underground structures systems and components it is desired that the list be prioritized according to the following:

1. The importance of the structure system, or component with respect to site characterization.
2. The possible radiological consequences of failure of the structure system or component.

In discussing the importance of a structure, system or component in (1) above it may be useful to differentiate between items which are important to safety and those important to waste isolation. Items relating to pre-closure radiological health and safety are considered important to safety; whereas items important to waste isolation relate to inhibiting transport of radioactive material to the accessible environment during the post closure period.

Items important to safety are engineered structures, systems or components which are essential to prevention or mitigation of credible accidents resulting in a radiation dose to body or organ $\geq$ 0.5 rem at or beyond the nearest boundary of an unrestricted area at any time until permanent closure.

Items important to waste isolation include engineered and natural barriers essential for compliance with 10 CFR 60 objective for overall system performance and particular barriers after permanent closure.

The relative importance of items important to safety can be assessed by asking the following questions of each item:

1. Can failure of the item initiate a credible accident, that if unmitigated could result in radiation exposure in the unrestricted area exceeding the 10CFR20 regulatory limit, as required by 10CFR60.131.b.

2. Can the item be essential to the prevention of a postulated credible accident, that if unmitigated could result in radiation exposure in the unrestricted area exceeding the 10CFR20 regulatory limit, as required by 10CFR60.131.b.

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3. Can the item be essential to the mitigation of a postulated credible accident that could result in radiation exposure in the unrestricted area exceeding the 10CFR20 regulatory limit, as required by 10CFR60.131.b?

4. Can failure of the item result in failure of an "important to safety" item under accident conditions when that "important to safety" item must function?

The relative importance of items important to waste isolation can be assessed by asking the following question of each item.

1. Is the item essential for compliance with the 10CFR60 performance objective for:

   1a. Ground-water travel time?
   1b. Waste package containment?
   1c. Engineered barrier controlled release?
   1d. The overall system?

2. Does the site characterization activity represent a potentially adverse condition (as defined in 10CFR60.122) with respect to compliance with the 10 CFR60 performance objective for:

   2a. Ground-water travel time?
   2b. Waste package containment?
   2c. Engineered barrier controlled release?
   2d. The overall system?

3. For engineered systems, does the item have a potential for causing noncompliance with the 10CFR60 performance objective for:

   3a. Ground-water travel time?
   3b. Waste package containment?
   3c. Engineered barrier controlled release?
   3d. The overall system?

The relative significance of radiological consequences of failure of the structure system or component can be assessed by asking the following questions.

1. Can a credible accident relating to release of radiation be hypothesized which could influence the item?

2. Can a sufficient inventory of radioactive material exist relative to the item?

3. Can a mechanism for radiation release under a selected accident condition involving the item develop?

4. Can a reasonable transport of radioactive material from the source to the site boundary or to the accessible environment be hypothesized?

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Example outline for a detailed section

Major component: emplacement hole

Subcomponents:
- rock
- liner (if used)
- waste package
- hole shield

Prioritization in terms of

- site characterization: high priority

  reasons: hole stability depends on in situ conditions, i.e. stability predictions require site characterization, including:

  - rock strength (in the broad sense, i.e. including effects of discontinuities, thermal loading, chemical alterations, etc.)

  - stress field

  - rock deformation (particularly with regard to liner loading, package loading (especially if unlined), liner deformation, etc.)

- radiological consequences: potentially high priority. Detailed and precise prioritization would require a failure and consequence analysis. However, it appears intuitively (and superficially) that radiological consequences might exist. Examples:

  - package failure,e.g. as a result of:

    - discontinuous (e.g. earthquake triggered) large deformations along a fault intersecting an emplacement hole

    - highly unequal/nonuniform package/canister loading as a result of localized emplacement hole failure

  - retrieval complications, e.g. with enhanced risk of radiological exposure during retrieval, as consequence of canister damage resulting from effects as per above

The regulatory basis rests in the potential for retrieval complications , risk of radiological exposure during operations, risk of radiological exposure during retrieval, uncertainty about meeting containment performance, uncertainty about meeting isolation (release rate) requirements.

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Parameters that need to be measured

Rock strength, stiffness, stress

Tests that need to be performed

- Rock characterization tests: strength,stiffness
- Site characterization: resolve representativeness issue, i.e. is information basis sufficient to provide reasonable assurance that all (or most) emplacement holes will perform satisfactorily
- Emplacement hole performance demonstration tests

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Example outline for a detailed section

Major Component: emplacement ventilation drifts

Subcomponents:
- rock
- reinforcement (if used)
- liner/support (if used)

Prioritization in terms of

- site characterization: high priority

  reason: maintaining ventilation circuits will require stable drifts. Present design concepts (SAND83-1877) call for monitoring ventilation in all access drifts throughout the retrievability period. Assuming that no parallel ventilation component will be provided, this implies that no substantial rock fall can be tolerated, as this would potentially alter airflow patterns

  Site characterization is required in order to perform drift design, reinforcement /support design, and long term stability evaluation

- radiological consequences: uncertain without analysis, but judged most likely low to medium

  reason: radiological consequences would require a sequence of failures prior to permanent closure, i.e. would require release from engineered barriers/emplacement/hole) and from emplacement errors (according to present design most likely to be isolated from the access drifts - ventilation circuit)

Possible failure scenarios:

1) ventilation drift failure, e.g. localized but substantial collapse, resulting in altered air flow pattern

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2) radiological contamination of air in emplacement ventilation system, e.g. as a result of canister failure

   - release along emplacement hole/emplacement room/ventilation (access) drift or:

   - release through rock from package to access drifts

Presumably failure consequences can be minimized by monitoring ventilation circuit (e.g. air velocities, pressues), which should instantaneously detect any substantial blockage. An argument can be made that, with reliable and appropriate monitoring, a failure of this type should be detected readily. With appropriate provisions for standby equipment and crews, failures of this type should be amenable to rapid clean up and repair.

Similarly, an argument can be made that regular inspection and monitoring of all ventilation drifts should allow early detection of deterioration, and hence preventive and remedial action.

In sum, although failure scenarios can be developed, that suggest a conceptual radiological release, numerous corrective and preventive measures can be taken and incorporated in the repository design, resulting in a low probability of substantial radiological releases.

Parameters that need to be measured:

- rock mass classification parameters
- mechanical stability analysis parameters

Associated tests:

- strength, stress, monitoring