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MINUTES OF THE WORKING GROUP ON HUMAN INTRUSION
OF THE ADVISORY COMMITTEE ON NUCLEAR WASTE
OCTOBER 23, 1990, BETHESDA, MARYLAND

The Working Group on Human Intrusion of the Advisory Committee on Nuclear Waste was convened by Working Group Chairman William J. Hinze at 8:30 a.m. on Tuesday, October 23, 1990, at 7920 Norfolk Avenue, Bethesda, Maryland.

{Note: For a list of attendees, see Appendix I. ACNW members, Drs. William J. Hinze, Dade W. Moeller,1 and Paul W. Pomeroy were present. ACNW consultant, Mr. John Corbett was also present.]

The Chairman said that the agenda of the meeting had been published in the Federal Register. He stated that the meeting was being held in conformance with the Federal Advisory Committee Act and the Government in the Sunshine Act, Public Laws 92-463 and 94-409, respectively. He also noted that a transcript of the meeting was being made, and would be available in the NRC Public Document Room as the Gelman Building, 2120 L Street, N.W., Washington, D.C.

(Note: Copies of the transcript taken at this meeting are also available from the Ann Riley & Associates, Ltd., 1612 K Street, N.W., Washington, D.C. 20006.]

[Ms. Charlotte Abrams was the Designated Federal Officer for the meeting.]

The ACNW Working Group on Human Intrusion was held to discuss the

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potential for and impact of human intrusion on a high-level waste (HLW) repository. Speakers included:Mr. Floyd Galpin, Environmental Protection Agency; Ms. Kate Trauth, Sandia National Laboratories; Mr. Steve Frishman, State of Nevada Department of Nuclear Waste; Dr. James Channell, New Mexico Environmental Evaluation Group (EEG); and Mr. Rudy Baier, Mr. John Bebout, and Mr. Jean Juilland, Bureau of Land Management (BLM). Representatives of the NRC staff, Science Applications International Corporation, and the Center for Nuclear Waste Regulatory Analyses (CNWRA) also made statements.

The meeting was opened with a statement of purpose by Dr. Hinze. The intent of the Working Group was to gain a better understanding of the impacts and problems associated with potential human intrusion of a generic HLW repository. Dr. Hinze referred to the March 1990 ACNW meeting where the Committee heard comments from a representative of Sandia on the difficulty of assessing the impacts of human intrusion on the WIPP site and assessing compliance with the EPA standard. At that time the Committee was told that evaluations of the anticipated performance of the WIPP indicate that, for the disturbed state, human intrusion is the dominant contributor to risk. Human intrusion may also be a dominant contributor to risk in the performance assessment of a HLW repository.

Dr. Hinze also referred to recent ACNW letters on the EPA standards

and human intrusion. He noted that 10 CFR Part 60 requires that site characterization investigations include an analysis of whether the presence of natural resources, a potentially adverse condition, exists at a proposed site. He also questioned whether "realistic" guidance for human intrusion had been provided in 40 CFR Part 191, Appendix B, or should this guidance be re-examined?
He further noted that although Appendix B is included as guidance only, how will a failure to meet this guidance be perceived by the public?

A third item noted in the opening statement dealt with the question of whether, given the problems with assessing the impacts of human intrusion, it would not be more realistic to require and take credit for institutional control to prevent human intrusion. The rationale behind 40 CFR Part 191 not allowing credit for institutional control beyond 100 years was questioned.

Dr. Hinze also noted the difficulties in predicting human intrusion due to technological advances and economic changes.

Mr. Floyd Galpin of the EPA, Office of Radiation Protection, presented the rationale for why EPA included human intrusion in 40 CFR Part 191. He acknowledged that the Agency realized that the analysis of human intrusion would not be easy and therefore, tried to make the regulations and guidance helpful. In 1985, in their preliminary analyses of sites, the EPA noted that human intrusion

could cause releases. The probability of human intrusion varies from site to site; therefore, EPA believed that this was not only a generic problem, but it was also a problem for the implementing agencies and the site developer.

The EPA also recognized that the consequences of intrusion varied based on the geologic media, resources present, and spacing of the HLW canisters.

Other points of Mr. Galpin's presentation were:

- The EPA believed that a separate analysis was needed for intrusion and that the problem should first be examined in a deterministic manner and then folded into the probabilistic evaluation.

- They also recognize the need for expert judgment to enter into the evaluation of intrusion.

- They are rethinking intrusion and may suggest different forms of analysis.

- The EPA, in 1985, also believed that by having intrusion in a standard that had received public review, they would circumvent some of the debate that could occur during licensing.

- The EPA saw no reason for different limits to apply to different causes. Risk was made the same for causative mechanisms such as volcanism and human intrusion.

- Intrusion, in the context of the standard, is a cause that results in a release to the general environment and a collective exposure. There is no dose limit for the individual intruder. Only the release to the accessible environment is addressed by the EPA standards.

- For active institutional controls, credit may be taken for only the first 100 years of the life of the repository. Part of the rationale for this was not to place a burden on future generations to maintain the repository. This does not mean that the EPA assumed a loss of civilization.

- Some credit is allowed for passive controls to intrusion such as monuments, records, or deeds. Government ownership is considered one of the strongest passive controls. Also physical barriers, both on the surface and in the subsurface should be considered as important. However, passive control credit is limited to less than 100 percent.

- The EPA believed that it was the role of the DOE to propose what kind of credit should be taken for passive controls and justify that position.

- The Nuclear Waste Policy Act makes it clear that ownership of the repository should remain with the government forever.

- The guidance in Appendix B for the number of boreholes per square kilometer and drill hole sealing were intended to be guidance to what should be considered as the worst case. The EPA is reconsidering this guidance during the current re-promulgation period.

- For drill hole sealing natural fill was selected as the worst case scenario (i.e., most conservative), because it was believed to approximate rubble falling back into the hole, rather than the act of an individual plugging the hole with fill or concrete.

- The 30 drill holes per square kilometer limit was based on petroleum scenario information from the U.S. Geological Survey. The 3 drill holes per square kilometer limit was related to mineral exploration in areas where petroleum would not be expected.

- It was the intent of the EPA that the site developer would make an assessment of the region of the site to determine the appropriate density of drill holes and the appropriate assumptions to make regarding fill. The EPA staff has had

recent discussions of the problem of drill hole density with the NRC and U.S. Geological Survey. The numbers in Appendix B could be dropped.

- EPA has not conducted any analysis that shows a site will fail due to human intrusion.

Mr. Dan Fehringer of the NRC staff described some of the interactions between NRC and EPA. These interactions began in the late 1970's and were informal gatherings to review the various drafts of the standards. There were also written comments to the EPA from the NRC staff. Recently, the NRC staff has transmitted some comments to the EPA on Working Draft 2 of the standards. One of these comments recommended a way to reword the containment requirements section of the EPA standards. The current wording of those requirements says that there shall be less than one chance in 1,000 that releases will exceed ten times the values in 40 CFR Part 191, Table 1. The suggested rewording is "The release from any process, event or sequence of processes and events that is sufficiently credible to warrant consideration will not exceed ten times Table 1." Therefore, the focus is now on processes and events that are sufficiently credible to warrant consideration and the consequences of those processes and events. This is intended to place the focus on the size of releases rather than the probability that they will occur in the unlikely category. The NRC has proposed a three-step concept with three things to be

considered in a safety assessment. These are:

1. normal operation, including some types of disruptions that are so likely to occur that they are almost part of normal operations (in reactors, anticipated operational occurrences);
2. accident conditions, including things that are unlikely, but are still credible; and
3. incredible conditions, including those conditions that are so speculative and unlikely that they do not warrant consideration as part of the licensing review.

Mr. Fehringer stated that for the normal operation category it is necessary to examine the probabilities and the consequences of releases. In the accident condition category only the releases would be considered, and probabilities would not be assigned. Incredible conditions would not be regulated.

Mr. Fehringer stated that 10 CFR Part 60 defines human intrusion as being an unanticipated event. Human intrusion events would fall into the accident conditions category and the consequences of those events would need examination, but not the probabilities of those scenarios. Steps in making a safety assessment to evaluate compliance with the standard would include:

1. list all conceivable processes and events without regard to probability;
2. quantitatively determine which of those are sufficiently credible to warrant consideration;

3. form scenarios using an event tree methodology or other method;
4. screen scenarios that are not considered sufficiently credible;
5. evaluate releases for each scenario that was retained in the analysis and if those releases are greater than ten times Table 1, the site is unacceptable unless there is a way to fix or compensate for the problem; and
6. estimate the probabilities of the more likely scenarios and construct a CCDF to determine the probability that releases would be greater than Table 1.

Mr. Fehringer stated that although EPA is considering this concept, the suggestion for it was made by the NRC staff and has not received endorsement by either the Commission or the ACNW. The staff is preparing a paper that will ask for those endorsements in the near future.

Committee members stated that they were pleased to hear of the staff's plans.

Mr. Rudy Baier, a Petroleum Engineer with the Bureau of Land Management, discussed drill hole sealing standards and compliance with existing regulations for sealing. Mr. Baier works for the division of the BLM that supervises oil and gas drilling, including production and well abandonment on Federal and Indian lands. In a recent report of the Inspector General of the Department of Interior it was stated that lease operators were not properly plugging wells. An additional concern in the report was that a significant number of wells in the U.S. were either improperly plugged or not plugged at all.

Mr. Baier stated that the BLM's policy for well abandonment was that abandonment could not occur until the operator had received prior approval from the BLM. Plugging of wells is done to ensure that the operations "conform with the current available technology and practice, afford adequate safeguards for the environment, result in proper reclamation of disturbed land, protect underground sources of fresh water and other leasable minerals, and protect the public health and safety." He emphasized that the available technology has and will change over time. Changes include drilling methods and differences in plugging media. Other important points of Mr. Baier's discussion were:

- National standards for plugging are set based on industry practices and what can adequately protect the environment.

- BLM regulations do not apply to holes drilled on private land. State regulations cover those plugging operations. State regulations vary greatly from state to state. In some states, if the well is on Federal land, the operator is advised also to look at the state regulations and to use the most stringent of the two regulations.

- Approximately 20 percent of holes are on Federal lands. The percentage is much greater (up to 50 percent) if only the western states are considered.

- It would be very difficult for an operator to site, drill, and move out without detection, but the BLM lacks the capability to witness all plugging operations. They do require that all plugging operations in critical areas such as areas of mineral deposits or water basins be witnessed.

- The BLM has concluded as a result of a recent study that there is not a high risk of operators not plugging wells. For an operator to drill a well on federal land he must post a bond with the government to ensure that the well will be plugged, the surface will be cleaned up, and the Federal or Indian royalty will be paid. If a company refuses to plug a well they will not be given any more federal leases.

- Operators must send the BLM a request to plug and abandon a hole. This is reviewed by engineers, geologists, and environmental experts of the BLM. If the request is acceptable, abandonment will be scheduled and the authorized BLM officer will decide whether to witness the plugging of the well. If the plugging is witnessed, there are usually specific items in the plugging operation that will be examined. All abandonment operations where fresh groundwater or mineral resources are found must be inspected at least once during the operation. This constitutes approximately 50 percent of all holes in the western U.S. There is no follow-up inspection. In the rare case that the plug is found to be leaking, it will be replugged.

- The BLM requires a cement plug over the surface of the hole. An attempt is made to isolate water zones or valuable minerals by placing cement above and below that horizon.

- The intervals that do not have cement plugs are required to be filled with a mud of sufficient density to exert hydrostatic pressure exceeding the greatest pressure encountered in the hole.

Mr. John Bebout of the BLM spoke about the guidance in 40 CFR Part 191, Appendix B regarding the number of drill holes per unit area. He stated that the BLM establishes "reasonable foreseeable

development scenarios" to determine what the maximum development of a petroleum field may be. EPA's density of 30 holes per square kilometer is about an eight acre spacing per well. States set spacing requirements for drilling based on what is needed to protect the groundwater or environment and to protect the financial investment of the company doing the drilling. For this reason, Mr. Bebout suggested that the EPA should first look at what spacing the states require to establish more realistic drill hole densities. Some states have more than one set of density criteria based on the depth proposed for the drilling. For Nevada, that spacing is 40 acres for holes 5,000 feet or less and 160 acres for holes deeper than 5,000 feet. For mineral exploration that spacing can be much denser, under the proper circumstances.

Other important points of Mr. Bebout's presentation were:

- Segregation of drill hole density by rock type is not realistic, due to the instances in which there may be igneous rocks overlying sedimentary. In those cases there may often be petroleum and mineral production from both horizons.

- It is not meaningful to apply a generic average for drill hole density to any specific area of the U.S.

- It may be possible to predict trends for exploratory frequency for the next 25 to 50 years, but not beyond that time period.

Mr. Robert Browning, Director DHLWM, stated that the presentation by Mr. Bebout illustrated that prescriptive quantification does not work and guidance should be provided on a case-by-case basis. He encouraged EPA to eliminate much of the specific guidance.

Mr. Galpin asked if the BLM had any written guidance on drilling trends and densities. The BLM presenters and Dr. Hinze referred him to the American Petroleum Institute as a possible source for this information.

Mr. Browning described some of the thinking of his staff. He believes that problem is a two-phased one in which the first concern is the selection of a site that has no resources that will be attractive to future generations. The second concern pertains to the consideration that there may be some form of intrusion to mine the wastes, themselves.

Mr. Jean Juilland of the BLM expressed concern that drilling outside the boundaries of the repository might affect the isolation of the waste. He stated that for different minerals the density and depth of drilling may vary. He also stated how difficult it is to predict what size and types of mineral or hydrocarbon deposits may be considered economic in the future.

Mr. Juilland also stated that it would be very rare for anyone to drill prior to staking a claim and registering that claim. Lands

under federal control would also be less likely to be drilled without the regulating authorities having knowledge of the event.

Ms. Kate Trauth from Sandia National Laboratories discussed how Sandia is addressing human intrusion through the use of expert judgment. A program was set up to examine future societies, possible markers, and engineered barriers for the WIPP site. The members of these panels were independent of agencies working on the project and were from a broad range of backgrounds. Ms. Trauth went through a description of the types of panels, the composition of a typical panel, their proposed tasks, work accomplished thus far, and preliminary conclusions.

The futures panel is composed of 16 individuals divided into four groups of four, each working independently. Most of the individuals were not scientists, but prior to their evaluations they were given a tour of WIPP and provided information on the technical issues at WIPP. One of the items the futures panel looked at was the probability of future societies drilling for resources at the WIPP site and the modes of intrusion.

Ms. Trauth also described in detail the various meetings and results of some of the work by the markers (e.g., some type of edifice to mark the HLW site and warn of the potential danger) panel. The engineered barriers panel has not yet met.

The markers panel had to consider details such as the design of the markers and the projected performance of those markers. The barriers panel will have the task of considering physical barriers to reduce drilling or other forms of intrusion.

One scenario considered by the panels was the possibility of intrusion due to the reopening of WIPP for additional waste storage. This could possibly result in inadvertent penetration of a canister.

The object of the panels exercise is to provide information for the assessment of the performance of the WIPP repository. The outcome will provide scenarios based on expert opinion that are likely and need consideration. Results of the panels task is preliminary.

Dr. Hinze pointed out that one of the primary reasons for the concerns over human intrusion were statements that human intrusion is the chief influencing factor for performance assessments at the WIPP. He asked if the fact that there was groundwater located above and below the site also affected the potential for human intrusion. Ms. Trauth stated that scenarios had been considered where drill holes into the repository would not remain plugged thus allowing a connection between the groundwater and the repository.

Dr. James Channell of the New Mexico Environmental Evaluation Group

discussed WIPP from the state's perspective. He stated that "although there is a little bit of water" associated with the WIPP horizon, "it is difficult to conceive of any likely event not involving human intrusion that would cause problems." He discussed why WIPP is an attractive target for human intrusion and assumptions for human intrusion at WIPP.

According to Dr. Channell, WIPP is located in a mineral-rich area with a history of exploration. "About half of the area underneath the planned waste storage rooms contains a pressurized brine reservoir." Without the consequences of human intrusion this would probably not be a problem.

Important points of Dr. Channell's presentation were:

- The initial problems Sandia had in the preliminary evaluations of the site were, in part, due to the design. Some solutions are:
  - The facility will be back-filled. There are plans to seal the repository into approximately 10 compartments, thus reducing the amount of waste that could be impacted by a single intrusion.
  - The containers will have approximately 50 percent void space and there will be 30 percent void space in the backfill. The consequences of human intrusion may also

be reduced by the spacing of the waste.

- Alternate waste forms for the site are being studied to reduce the volume of waste.

- There is a high creep closure rate at the site.

- The WIPP site was not picked to avoid an exploration area.

- Mitigation measures for WIPP have been discussed. These include pumping the brine reservoirs, but they may repressurize.

- EEG supports the use of outside experts through the performance assessment period as a means to try to develop a consensus on the assumptions that will need to be made about the site.

- Changes in the EPA standards may cause problems or changes in the WIPP approach. In 1987 the Attorney General of New Mexico and DOE entered into a modification of the cooperative agreement. That modification included a provision that DOE would continue to evaluate the WIPP on the basis of the remanded standard.

- Sandia is assuming that, in the case of human intrusion, only

very small releases will come to the surface in the form of material attached to the drill bit, in the drilling mud, or in material circulated to the surface for a brief period.

- EEG supports the panels approach set up by Sandia, but they question whether it will add to the degree of credibility.

- EEG has commented to EPA that the hundred years limit for credit for active control should not be as rigid as it appears.

- The things being done at WIPP to ensure that the human intrusion standards are met will make the repository safer. These compare with the subsystem performance requirements in 10 CFR Part 60 that "add extra safety to a repository whether your analysis showed you needed it or not and WIPP has none of these."

Mr. Browning raised the question of whether an intruder would not first conduct geophysical testing of an area before drilling and if the geophysical tests would not show the presence of some anomaly due to the waste. Mr. Corbett stated that there will not be a large density difference between the backfill chosen and the site. The waste containers will cause an anomaly that might entice someone to drill.

Dr. Hinze asked about the potential for petroleum exploration at the site. Dr. Channell stated that no consideration has been given to ways of trying to reduce the possibility by exploiting the petroleum prior to the emplacement of the waste.

Mr. Steve Frishman of the State of Nevada discussed how and why human intrusion should and can be integrated into performance assessments. He stated that early studies examined the question of the effect of human interference on a repository. There is a large difference in inadvertent intrusion and intentional intrusion and how each should be considered. Points of his discussion were:

- The first line of defense against human intrusion is avoidance of a site that provides incentives for disruptive human activities. This is the basis for geologic disposal.

- Part 60 siting criteria show potential for human intrusion and the presence of natural resources as a potentially adverse condition (PAC). If an adverse condition exists it must be shown that the PAC can be compensated by a combination of favorable characteristics or be remedied. This discourages a site that would be attractive for intrusion.

- Active institutional controls and permanent markers add another layer of protection against intrusion.

- The engineered barriers can provide additional protection.

- If the siting criteria in 10 CFR Part 60 are followed, then the incentive for intrusion is reduced and this reduces the associated uncertainty. Then human intrusion can be treated as an unanticipated event.

Mr. Frishman stated that several assumptions should be made. These are:

1. that the value to future generations of potential resources within the site can be assessed adequately under the provisions of Part 60;
2. that during site characterization the potential for natural resources will be assessed well enough to prove there is no problem;
3. that an understanding of the nature of radioactivity and its hazards will be retained in the future; and
4. that relevant records are preserved and remain accessible after permanent closure of the repository.

Mr. Frishman also expressed concern with the effect of human intrusion outside of the repository on the local hydrologic conditions and potentially the waste.

At the end of the meeting speakers were asked to state any important points or conclusions they had. Mr. Galphin stated that the WIPP site is sufficiently different from the Yucca Mountain site that it may not be good to extrapolate from occurrences at one to the other. He also expressed concern that both the treatment of human intrusion and how it fits into the total considerations of the site be considered.

Drs. Hinze and Moeller both stated that one of the major inputs to the meeting was the fact that statistics regarding drilling can be misleading.

Mr. Galpin stated that the EPA perceives intrusion as being applicable within the context of the standard. The intrusion scenarios are not within the context of the individual dose or the groundwater standards, because they are for undisturbed performance, but the intrusion considerations are appropriate for the containment requirement.

Speakers and participants stated their support for the less formal type of forum provided by the Working Group format. They stated that there was less inhibition and a better exchange of ideas due to open discussion.

II. ADVISORY COMMITTEE COMMENTS ON THE WORKING GROUP MEETING ON HUMAN INTRUSION
OCTOBER 23, 1990 - 8:30 a.m. - 4:15 p.m.

Attendance: Dade W. Moeller, Paul Pomeroy, William Hinze (Chairman), John Corbett (Consultant)

Presentations: F. Galpin (EPA), R. Baier, J. Julian, J. Bebout (BLM), K. Trauth (Sandia), J. Channell (New Mexico Environmental Evaluation Group), S. Frishman (State of Nevada Waste Project Office).

Purpose: Informal, information meeting regarding to the potential for the impact of human intrusion of a high-level waste repository.

Significant points resulting from the meeting:

1) Considering the requirements for siting of HLW repositories, care must be exercised in using the WIPP as an example for performance assessments of generic HLW repositories.

2) The EPA representative stated that, although any radionuclide releases resulting from human intrusion must comply with the EPA standards (Table 1), there are no limits for exposures to the intruder. The 40 CFR 191 preclosure dose limit of 0.25 mSv/year does not apply.

3) The EPA and NRC staffs are working jointly on the NRC's comments on EPA's Working Draft No. 2. Specifically, comment 7 (August 27, 1990, letter from R. Browning to R. Guimond) of the NRC staff is being rewritten to include a basic concept that suggests that a three-fold classification scheme be considered, that is: a) normal operation, b) accident conditions (unlikely but credible events including human intrusion), and c) "incredible" conditions which need not be considered. The NRC staff will be bringing these revisions to the ACNW for comment.

4) It is unclear how analyses of human intrusion events should be integrated into the PA for a HLW repository. The ACNW plans to schedule a Working Group meeting on this topic.

5) Information provided to the Working Group by the Bureau of Land Management shows that statistics on drill hole densities can be misleading when applied to specific HLW sites. There are several possible sources of drilling information that should be investigated, including the American Petroleum Institute, the Independent Oil and Gas Producers Association, and Petroleum Information.

6) Borehole seals on federal lands are highly controlled and monitored to prevent communication of fluids and gases over the depth of the hole. Sealing of drill holes on private land is complicated by highly variable requirements among the States. The guidance in Appendix B of the EPA standards does not acknowledge these differences.

7) The DOE is using panels of experts to evaluate the probabilities for human intrusion at the WIPP site. Although the results reported at this meeting were preliminary, it is not clear to the ACNW that the panels have adequate technical input.

8) A representative from the State of Nevada stated that, in the case of deliberate human intrusion into a HLW repository, the intruders will have sufficient technical knowledge of the wastes and sufficient information to mitigate the problems resulting from the intrusion and thus can be anticipated to take remedial measures.

9) The first line of defense against inadvertent human intrusion is to avoid resource areas that are likely to be drilled and thus are subject to intrusion. If the siting criterion of 10 CFR Part 60.122 (c)(17) is followed, this first line of defense will be established. The DOE Study Plans for natural resource assessment and NRC and State of Nevada reports on

human intrusion, natural resource potential and natural resource investigations methods will be topics that will need further consideration by the Working Group.

10) There is a need for guidance on proper methods for computing collective doses to the general public arising from Nuclear Waste Management activities. The ACNW plans to convene a Working Group meeting to discuss this issue. Organizations having input include NCRP, ICRP, and CHIRPPIC.