Attorney General of New Mexico

PO Drawer 1508
Santa Fe, New Mexico 87504-1508

505/827-6000
Fax 505/827-5826

TOM UDALL
Attorney General

MANUEL TIJERINA
Deputy Attorney General

August 14, 1998

Dr. Robert S. (Stu) Dinwiddie
Hazardous and Radioactive Materials Bureau
New Mexico Environment Department
P.O. Box 26110
Santa Fe, NM 87502

Dear Dr. Dinwiddie:

The following are two enclosures unintentionally omitted from the submission of August 13, 1998. Please do not hesitate to contact me if you have any questions.

Very truly yours,

Geoffrey H. Fettus

GEOFFREY H. FETTUS
Assistant Attorney General

Enclosures

Enclosures:

1. IEER Declaration with attachments of June 5, 1998.

2. IEER Review, July 7, 1998.

3. IEER Review, August 6, 1998.

4. DOE Sampling and Analysis Plan for TA-55-43 waste stream at Los Alamos National Laboratory.

5. Declaration of Dr. Ian W. Farmer.

6. Declaration of Dr. Lokesh Chaturvedi.

STATE OF NEW MEXICO)
) ss.:
COUNTY OF SANTA FE)

AFFIDAVIT OF IAN W. FARMER

Ian W. Farmer, being duly sworn, deposes and says:

1. My name is Ian W. Farmer, and I reside in the city of Newcastle upon Tyne, England.

2. I am the chairman of Ian Farmer Associates, Ltd., a geotechnical consulting firm. I have held this position since 1983.

3. My educational and professional background is as follows:

B.Sc., Mining Engineering, University of Nottingham
Ph.D., Civil Engineering, University of Sheffield
D. Eng., University of Sheffield
Fellow, Institution of Civil Engineers
Fellow, Institution of Mining & Metallurgy
Member, American Society of Civil Engineers
Chartered Engineer, England
Professional Engineer, Arizona

4. In 1968 through 1972 I was employed as a geotechnical engineer with the Cementation Company. In 1972 through 1976 I was a Lecturer in Engineering Geology at the University of Durham. In 1976 through 1984 I held the position of Reader in Geotechnical and Mining Engineering at the University of Newcastle upon Tyne. In 1984 through 1991 I was a professor of Mining Engineering at the University of Arizona; in 1987 through 1990 I was also acting head of the Mining and Geological Engineering Department at the University of Arizona. In 1983 I founded my own company, now

known as Ian Farmer Associates, Ltd. I am also an Adjunct Professor at the University of Arizona and a Visiting Professor at the University of Leeds.

5. I am the author of several books on rock mechanics and engineering geology, including Engineering Behavior of Rocks, Principles of Engineering Geology (with P.B. Attewell), Coal Mine Structures, and Fluid Flow in Discontinuous Rocks (with C.H. Lee). I have published more than 100 technical papers in the fields of geotechnical and mining engineering. I have carried out research projects related to the time dependent constitutive relationships for salt rocks, the mechanical performance of full column resin anchored rock bolts, field instrumentation, and roof support systems.

6. In connection with the Waste Isolation Pilot Plant ("WIPP"), I was a member of the Geotechnical Panel on the Effective Life of Rooms in Panel 1, convened by the U.S. Department of Energy ("DOE") in April 1991 to assess the time span over which the panel 1 rooms would be usable for proposed underground tests. At that time it was my estimate that the roof support rock bolts in the rooms in panel 1 would begin to fail at the five year point. A copy of my report is attached (ex. 1; see p. 9).

7. I visited the WIPP underground on June 3, 1998 and studied the rooms in panel 1. I was able to observe roof fracturing that was considerably more extensive than in 1991. Four of the rooms, rooms 4, 5, 6, and 7, were quite badly fractured, although adequately supported. The roof-to-floor convergence rate remains substantial at approximately 3 inches per year.

8. Room 7 is the first room in which waste is planned to be emplaced, I am told. Recently, within the last two or three months, a new series of rock bolts has been installed in the roof of room 7. There are three rows of resin anchored bolts installed in

the center of the room and two rows of mechanically anchored bolts anchored along the side walls of the room.

9. As I understand the emplacement process, DOE plans to put drums or boxes of waste three-high in the rooms and to stop maintaining the roof above the area of waste emplacement. Roof performance will continue to be monitored by remotely read instrumentation. Further, I have been told that the delivery schedule for waste is quite uncertain. If retrieval is called for, the timing of that requirement is also unknown. It should also be noted that I have seen no plans for retrieval of waste. I do not know what storage location would be used to accommodate the retrieved waste. The apparent lack of a plan, storage location, and other logistical elements is important, because it means that the process is likely to take a considerable amount of time, and during that time the conditions in the room would deteriorate. When it is retrieved, hypothetically, the most recently emplaced waste would be retrieved first, and the earliest emplaced waste would be retrieved last. Thus, the earliest emplaced waste would remain in an area without maintenance for the duration of the process of emplacement and retrieval.

10. In my view, if waste is emplaced in room 7, there will be a window of approximately two years from now during which waste may be placed in and removed from the room. After that time the level of certainty with which I can foresee retrieval is reduced. When the support system begins to fail, the signs of basic instability will become apparent. Bolts will begin to break in shear and in tension, and the rock salt will begin to break around the bolts. At that point segments of the roof will begin to fall into the mesh that is hung from the roof. Without further maintenance, the room will then be too unsafe and unpredictable in its behavior to enter.

11. Based on my understanding that emplacement of waste in room 7 may take approximately one year, it may be assumed that retrieval will consume approximately twice that amount of time, or two years. To be certain of retrievability without additional support and maintenance the first-emplaced waste would need to be retrieved two years after its emplacement. Assuming the process takes longer than two years, retrieval will become increasingly difficult, as roof conditions deteriorate, until retrievability becomes impossible.

IAN W. FARMER, Ph.D., P.Eng.

Dated: 5 June 1998

SUBSCRIBED AND SWORN TO before me by Ian W. Farmer, Ph.D., on the 5th day of June, 1998.

Notary Public

My commission expires: 7/8/2008

STATE OF NEW MEXICO)
) ss.:
COUNTY OF BERNALILLO)

AFFIDAVIT OF LOKESH CHATURVEDI, Ph.D.

Lokesh Chaturvedi, being duly sworn, deposes and says:

1. My name is Lokesh Chaturvedi, and I reside in the City of Albuquerque, County of Bernalillo, State of New Mexico.

2. I am employed as the Deputy Director of the Environmental Evaluation Group ("EEG") and have been so employed since March 1988. From June 1982 to March 1988 I was employed by EEG as Senior Engineering Geologist.

3. My resume is attached. My background is as follows. I received a Ph.D. in Geological Sciences from Cornell University in 1969, a M.S. in Civil Engineering from Purdue University in 1965, a M.Sc. in Applied Geology from University of Roorkee in Roorkee, India, in 1963 and a B.Sc. in Geology, Physics, and Mathematics from Maharaja's College in Jaipur, India, in 1960. I have taught courses in Introductory Geology, Physical Geology, Geology for Engineers, Introduction to Geological Engineering, Site Investigation, Engineering Geology, Subsurface Exploration, Environmental Geology, Hydrogeology, Soil Mechanics, Rock Mechanics, Geomorphology, and Geological Oceanography at both undergraduate and graduate levels. I have published since 1968 eighty research papers, as author or co-author, on subjects of Radioactive Waste Disposal, Remote sensing, Geothermal Hydrology, and Mechanical Properties of Rocks. I have performed funded research projects in site evaluation for radioactive waste disposal, geothermal hydrology and multispectral remote sensing, and I have performed several professional consulting projects in the areas of

hydrogeology, subsurface exploration, engineering materials, and nuclear waste disposal site investigation.

4. EEG was established in 1978 to conduct independent technical evaluation of the Waste Isolation Pilot Plant ("WIPP") project to ensure protection of public health and safety and the environment. The funding for EEG is provided 100% through appropriations to the Department of Energy ("DOE"). EEG has offices in Albuquerque and Carlsbad. EEG performs independent technical evaluation of the WIPP project as well as independent environmental monitoring of air, water, and soil at the WIPP site and in nearby communities. EEG has published seventy EEG reports and numerous other papers addressing scientific and technical aspects of WIPP. I have visited the WIPP site on about 60 occasions, including approximately 50 underground visits.

5. I have prepared this affidavit at the request of the Attorney General of New Mexico to address the condition of the underground panel 1 rooms, in which DOE now plans to emplace radioactive waste. I understand that DOE has asserted that, should waste be emplaced in those rooms by DOE, and should the Court later determine that such waste should be retrieved, it would not be difficult to retrieve the waste for storage elsewhere. In my judgment, however, retrieval of the waste after any significant time is likely to present severe practical problems, because of the age and deteriorating conditions of the panel 1 rooms.

6. WIPP, as the Court is aware, is located in southeastern New Mexico about 26 miles to the east of Carlsbad. The WIPP site is a four mile by four mile square. The underground waste disposal area, called the repository, is excavated in salt beds of the Salado Formation 2150 feet below the surface. There are four vertical shafts connecting

the repository to the surface. The repository, when completed, will consist of 56 underground rooms and connecting tunnels, called drifts. Each room is planned to be 300 feet long, 33 feet wide, and 13 feet high (as initially excavated). Contact-handled transuranic ("CH-TRU") waste is planned to be emplaced in 55-gallon drums, stacked three high in rooms and drifts. Some of the waste will also be contained in Standard Waste Boxes ("SWB's"), also stacked three high. Magnesium oxide (MgO) backfill is planned to be emplaced along with the CH-TRU waste. The MgO will be contained in plastic sacks of various sizes; some of these, called "supersacks," are planned to be placed on top of the stacks of waste drums and boxes. In addition, remote-handled transuranic ("RH-TRU") waste is planned to be emplaced in cylindrical containers about ten feet long and two feet in diameter, inserted into horizontal holes drilled in the walls of the rooms and drifts.

7. The stability and longevity of the underground rooms has been a matter of concern at WIPP since at least the early 1990's. It has long been understood that the salt beds at WIPP would converge around the waste, close, and ultimately encase the waste; indeed, such is the purpose of selecting salt beds for disposal. However, after the initial excavations it was found that the behavior of the beds differs somewhat from expectations. First, the rate of convergence of roof and floor was approximately three times the expected rate. The model of geomechanical behavior used by DOE has had to be significantly modified to reproduce this behavior. Second, due to the presence of layers of brittle rock in the salt beds, the WIPP repository has shown an unexpected amount of brittle fracture behavior, as distinguished from the plastic deformation expected by DOE. Brittle behavior is marked by more sudden and abrupt movements than plastic behavior,

and it is more complex to model and predict. These observations, in particular the enhanced closure rate, indicate that the projected life of the rooms will be less than originally expected.

8. Significant attention has been addressed to stability problems as a result of large-scale fracture behavior in disposal rooms. Four Site and Preliminary Design Validation ("SPDV") rooms were excavated in 1983 to study geomechanical behavior. Within three years signs of deterioration appeared. Fractures occurred in the roof, walls, and floors of SPDV rooms 1 and 2. In April 1989 extensive fracturing was observed in SPDV room 1 by personnel drilling holes for roof bolts. Specifically, dust emerged from previously drilled holes in the roof as holes were drilled up to 60 feet away. Apparently, dust was carried in fractures behind the roof surface.

9. Rock falls were observed thereafter. On February 4, 1991, a slab of rock, estimated by DOE to weigh 700 tons, broke loose from the roof of room 1 and fell to the floor. This event occurred in less than eight years after the room was excavated. Another roof fall occurred in SPDV room 2 on June 12, 1994.

10. The first of the planned eight panels of the repository was excavated in two stages. The panel entry in S 1950 drift, room 1, and the parts of rooms 2 and 3 were excavated in May 1986 - March 1987. Mining restarted in January 1988, and the panel was completed in June 1988. These rooms were planned for an "operational demonstration," starting in October 1988. They were fitted with 10 ft long anchor bolts at 4 ft spacing in the roof, with the intention of keeping the rooms open for up to seven years. Plans changed, and by 1990, the plan was to use only one room for the "Bin Tests," which required continuous access by scientific and maintenance personnel. DOE

assembled a group of 11 geotechnical experts (including one Sandia National Laboratory and two Westinghouse employees) in April 1991 for advice on the stability and life span of the panel 1 rooms. I attended the deliberations of this group of experts. The group concluded:

> "If no additional remedial measures are taken, the rooms in the panel are likely to have a total life from seven to eleven years from the time of excavation using the currently installed roof support system, consisting of rockbolts. They indicated that the rockbolt had some beneficial effects, but agreed that it was not possible to measure their effectiveness. Estimates made by individual panel members of room life extension due to the bolting varied from a few months to several years. In conclusion, the panel believed that modifications, enhancements, and regular maintenance would be required for the rooms in panel 1 to perform satisfactorily over the assumed nine year test period starting July 1991." (Exhibit 1).

In other words, the rooms in panel 1 could remain stable without additional support for a period of 2 to 6 years from April 1991, i.e. until 1993 with high confidence and until 1997 with decreasing confidence. Obviously, these projections of room life without additional remedial measures have expired.

11. Thereafter an elaborate "supplementary roof support system" was installed in room 1 of panel 1, when bin tests were planned. The purpose of this system was to "extend the life of room 1 to allow completion of the experiments, for an additional period of up to seven years (from July 1991)." (Exhibit 2). The system consists of additional roofbolts, steel channel beams, lacing cables and wire meshing. Each of the 286 roofbolts was fitted with a load cell for continuously monitoring the performance of the roofbolts. The system is not designed to prevent the creep of rock into the room, but to contain and support the detaching roof slab while allowing it to be lowered. Most of the load is carried by the rockbolts. The bolts are to be periodically detensioned when the load

reaches 20,000 pounds. For several years the frequency of detensioning has been about once every five weeks.

12. All the rooms of panel 1 were fitted with 10 ft long pattern bolts in the roof in 1988-89. Supplementary support system (a variation of the room 1 system) was installed in room 2 in 1991. Thus, rooms 1 and 2 have the yielding supplementary roof support system, but rooms 3 through 6 have only the original and some additional roofbolts and wire meshing. Room 7 was rebolted in 1993-94 with pattern bolts, weld mesh and slings, and a tertiary system of roof bolts and wire meshing has been installed in this room in April, 1998 to prepare the room for receipt of waste. In addition to the roof stability problems, all the rooms also face problems due to floor heave and spalling of the walls in the rooms, for which periodic maintenance is required.

13. DOE presented its "Panel 1 Utilization Plan" at a meeting of "WIPP Stakeholders" on May 19, 1994. The plan, briefly, is to continue using panel 1 rooms for waste disposal. DOE maintained that it would not be wise to excavate panel 2 until the DOE is certain that it would be used for waste disposal. DOE estimated that it would take three years to excavate a new panel, causing an unacceptable delay between getting all the approvals and starting waste emplacement. I pointed out at this meeting that the four SPDV rooms were excavated in six weeks, between March 9, 1983, and April 25, 1983, and the panel 1 was excavated in a total of 15 months even with an interruption of nine months between the two phases of excavation. In fact, according to DOE, "Rooms 4 through 7 were completed, in 1988, within approximately one month after the start of excavation." (Exhibit 3).

14. What is the safe life of the rooms with a supplementary roof support system? The design report for the system stated the goal was to "extend the life of Room 1 to allow completion of the experiments, for an additional period of up to seven years (from July 1991)" (Exhibit 2). DOE has claimed that the room 1 support system was installed to minimize the need for ground control (i.e., maintenance) activities during experiments; otherwise DOE asserts, the rooms can be kept stable by ground control activities. Since the process of waste emplacement would not allow maintenance of the roof, floor, or walls where waste has been emplaced, it was obvious in 1991 that supplementary roof support systems would have to be installed if these rooms were to be used. The system installed in 1998 in room 7 is different and less elaborate than the one used in room 1. Also, room 7 in 1998 is 7 years older, as indeed all the rooms are, compared to room 1 in 1991. Furthermore, the room 1 system has also required periodic maintenance in the form of detensioning of the roof bolts. Therefore, any prediction of the life of the room 7 tertiary support system, in the absence of maintenance, is speculative.

15. Excavated areas require periodic maintenance. In areas without roof support, it consists of removing the unstable parts of the roof. In areas with roof bolts, broken bolts have to be replaced, and some areas are bolstered with additional bolts. The system as presently installed in room 1 requires periodic detensioning of various roofbolts, currently about once every five weeks. Periodic stabilization of the drummy areas of the walls will be necessary and the floor also has to be periodically milled and the cracks filled using crushed salt. The DOE position on the panel 1 safety is as follows:

> "Panel 1 is safe and can be maintained in a safe condition indefinitely as long as maintenance can be performed." (Exhibit 4).

Since it will not be possible to conduct the required maintenance activities such as monthly detensioning of the roof bolts in room 1 and replacement of broken roof bolts of the tertiary system in room 7, the basis of the DOE's confidence, i.e., the opportunity to perform maintenance, will not exist after waste is emplaced.

16. EEG in 1996 requested Dr. Hamid Maleki of Maleki Technologies, Inc. to assess the stability of the panel 1 and the E 140 drift during the first seven years of waste emplacement operations. For this analysis, we assumed the DOE projection of April 1998 to be the starting date for waste emplacement, but made a more realistic assumption of seven years to fill panel 1, rather that the 2.5 years projected by the DOE. The capacity of panel 1 is 81,000 CH-TRU drum-equivalents, plus RH-TRU that the DOE expects to have available for disposal in 2002. Dr. Maleki recommended that DOE abandon panel 1 and mine a new panel after the decision has been made to use WIPP as a repository.

17. The WIPP facility was excavated much earlier than its intended use and requires continuous maintenance to be ready for operation until all other requirements for starting the operations have been satisfied. Judging from the past experience, a new repository panel can be excavated in about six months. EEG likewise recommended abandoning panel 1 and excavating a new panel for waste emplacement, once all the necessary certifications and permits have been received.

18. I visited the underground with Dr. Maleki and Dr. Ian Farmer, EEG consultants, on June 3, 1998 and observed conditions in the panel 1 rooms. In my opinion the overall condition of the panel 1 rooms is very poor. Convergence rates of the panel 1 rooms have continued as observed in earlier years. Visible fracturing in the roofs of all of the rooms is more pronounced than two years ago. Maintenance is required on an

ongoing basis in all of the rooms. The rooms which are supported by rock bolts are all beyond the end of their useful life, as projected by the DOE's 1991 geotechnical panel. In my opinion, it would be unwise from a safety standpoint to emplace waste in any of the panel 1 rooms at this time. If waste is emplaced, the result is likely to be that room 7 will be partially filled during the first year of operations. In this situation the converging roof would descend onto the waste stack, but in the unfilled part of the room may fall abruptly, as in the roof collapse of SPDV room 1. Such a situation could cause a breach of containment and escape of radioactivity.

19. It must be kept in mind that, if waste is emplaced in any room at this time, maintenance must cease, at least in the waste-filled area. In estimating the feasibility of retrieval of waste, one must assume that retrieval, if needed, may commence at some future time, such as perhaps six months from now, and that such retrieval may require a similar period of time to complete. Further, one must assume that the rooms would not have been maintained since they were filled. In my opinion such retrieval would be difficult and risky. I so conclude because none of the roof bolting methods has been shown to reduce the rate of room convergence at WIPP. Moreover, how long one of these aging rooms will last with maintenance suspended is extremely dubious. Without maintenance and replacement of broken bolts, the bolt failure rate is expected to increase in a domino effect and increase the potential of roof collapse.

20. DOE now plans to emplace waste initially in room 7, a room which has been equipped with a tertiary support system consisting mainly of rock bolts. The stable and useful life of that room, as estimated by DOE's geotechnical panel, ended in 1997. With maintenance suspended, it is not possible to have a high degree of confidence in the roof

stability of that room. I recommend that none of the panel 1 rooms be used for disposal, and I emphatically recommend that such rooms not be put to use with the expectation of having access and retrieving waste at some uncertain future time, because the useful life of such rooms, and the time during which there will be access for retrieval purposes, cannot be predicted with any assurance.

Lokesh Chaturvedi

LOKESH CHATURVEDI, Ph.D.

Dated: June 5, 1998

SUBSCRIBED AND SWORN TO before me by Lokesh Chaturvedi, Ph.D., on this 5th day of June, 1998.

Margaret Aurea

Notary Public

My commission expires: 7/8/2000