DISPOSAL OF HIGH LEVEL NUCLEAR WASTE AND MIXED HAZARDOUS WASTE AT

SANDIA NATIONAL LABORATORIES' MIXED WASTE LANDFILL (MWL)

CITIZEN ACTION NEW MEXICO OBJECTION TO APPROVAL OF CERTIFICATE OF COMPLETION FOR CORRECTIVE ACTION COMPLETE, REQUEST FOR A PUBLIC HEARING AND FOR NEGOTIATIONS PRIOR TO A PUBLIC HEARING

January 5, 2015

Introduction

As trustee of public lands, the US Department of Energy (DOE), Sandia National Laboratories (SNL), the US Environmental Protection Agency (EPA) and the New Mexico Environment Department (NMED) have failed to comply with the Resource and Conservation Recovery Act, the New Mexico Hazardous Waste Act, and the public trust doctrine to protect the resources of air, soil and water for this and future generations from disposal of high level nuclear mixed waste at the Mixed Waste Landfill in Albuquerque, New Mexico. In the mismanagement of ultra-hazardous materials for which there is strict liability under the law, the actions of DOE/Sandia, EPA and NMED constitute gross negligence and possible criminal activities. The chief factor considered by Sandia for management of the MWL has been the cost of excavation. Although Sandia possesses the technology for remote robotic excavation and safe storage and processing of the radioactive and hazardous waste from the MWL, concerns for human health and environmental protection have been disregarded by DOE/Sandia.[1]

A chief focus of this objection to approval of a Certificate for Corrective Action Complete is the hazardous waste that was generated by nuclear fuel meltdown tests for which Sandia did not provide full information during proceedings for corrective action. While RCRA does not contain specific regulations that are covered under the Atomic Energy Act and Nuclear Regulatory Commission regulations, RCRA and the New Mexico Hazardous Waste Act require observance of laws that are necessary for the protection of public health and the environment. Thus, the NMED, DOE/Sandia cannot simply turn a blind eye to compliance with regulations regarding land disposal of high-level mixed nuclear waste. Additional matters are the failure of Sandia to install a competent groundwater monitoring network at the MWL and the violation of land disposal regulations for high-level nuclear waste.

Numerous Sandia publications describe that nuclear fuel meltdown tests were conducted in the Annular Core Research Reactor and used canisters that contained metallic sodium. Sandia management memoranda from 1997-2001 along with Radioactive and Hazardous Waste Disposal sheets indicate that canisters containing sodium and high-level nuclear waste were processed in the Hot Cell facility and disposed of in the Mixed Waste Landfill. Sodium is a metal regulated under the Resource Conservation and Recovery Act ("RCRA"). Sodium is explosive in the presence of water. There is the potential that over time the canisters will corrode and the sodium, in contact with moisture, will explode, breach the MWL's dirt cover, and spread radiation from the canisters and other wastes into Albuquerque's air and groundwater. The clear issue is that the NMED should order the excavation of the canisters thought to contain sodium and high-level radioactive waste.

September 2014 DOE/Sandia Soil-Vapor Monitoring Results describe the presence of volatile organic compounds such as PCE and TCE that have leaked 400 ft beneath the MWL. Given the concentrations and the new VOC data the VOC plume is much deeper than 400 ft

and probably has reached groundwater. The sampling results for the VOCs were not obtained at the actual boundary of the MWL; sampling was not conducted beneath the known hot spots for VOC contamination at the MWL. Corrective Action Complete status should not be granted for the MWL because of the new evidence of VOC releases from the MWL. Because there is new statistically significant evidence that release of contaminants has occurred from the MWL, Sandia is required to immediately sample for the full list of groundwater monitoring constituents in 40 CFR Part 264.

Sandia is required to submit a ***permit modification*** to establish a compliance monitoring program within 90 days. Instead Sandia has submitted a request for a Certification of Completeness for Corrective Action despite the fact that releases of contamination in excess of limits are in evidence from soil vapor monitoring. Sandia is required by law to institute corrective action for all releases of hazardous waste from any solid waste management units (SWMU or AOC). Sandia must ensure compliance with groundwater protection standards by: Removing the hazardous constituents and or treating the hazardous constituents in place. Sandia must aim for permanent results, not just a temporary fix. Schedules of compliance must be set for removal of the contamination. [2] Sandia must review the feasibility of excavation of the MWL under condition 5 of the May 26, 2005 Final Order.

The dirt cover placed over the MWL wastes will not be protective and represents an abysmal failure to halt the release of contaminants from the MWL unlined pits and trenches. According to the Environmental Protection Agency, "All landfills will eventually fail and leak leachate into ground and surface water."[3] The dirt cover will be breached by water, insects, animals and potential human intrusion.

Background

During the 1970s and 80s, Sandia National Laboratories ("Sandia") conducted numerous "severe accident" nuclear fuel meltdown tests in the Annular Core Research Reactor ("ACRR"). Sandia buried and disposed of test canisters from those experiments, which contained source, special nuclear, or byproduct material and high-level nuclear and hazardous waste,[4] into the unlined pits and trenches of the Mixed Waste Landfill ("MWL"). The highly radioactive canisters lie above the sole source aquifer that serves as drinking water for Albuquerque, New Mexico. The high level mixed waste in the MWL will remain toxic for millennia without isolation from the environment in the shallow, unlined pits and trenches. There is the potential for human intrusion, airplane crashes, construction activities and explosions within the MWL.

Contrary to Sandia's claims that the MWL is a low-level mixed waste landfill, Sandia placed and continues to leave high level mixed waste in the MWL in violation of federal law.

Sandia Labs is located on Kirtland Air Force Base. The MWL lies above the drinking water aquifer that supplies Albuquerque's municipal wells. In 1956 a radioactive disposal site at Sandia Technical Area II (TA-II) was closed. The Radioactive Waste Dump (later called the "Mixed Waste Landfill") in TA III was thereafter operated from 1959 to December 1988 for disposal of all radioactive materials at Sandia.[5] The MWL is 2.6 acres in size with the classified section of the MWL being 0.6 acre. The MWL is misnamed as a landfill because it lacks protective features such as a liner and leachate collection to legally qualify as a landfill.

Sandia has disposed of extremely dangerous high level mixed hazardous waste in an urban setting surrounded by residential growth and neighborhoods with low income and minority persons. The Pueblo of Isleta is located to the south of the MWL. The Pueblo considers itself to be culturally affiliated to archaeological sites and traditional cultural properties located across the Kirtland AFB and claims traditional use of the area before restricted access became effective. In 1996 Isleta Pueblo sued the Department of Energy for failure to conduct a Site-Wide Environmental Impact Statement (SEIS). When DOE finally performed the SEIS (1999), the Pueblo of Isleta identified concerns related to protection of groundwater supplies and

groundwater quality. No EIS has been performed since 1999 for Sandia Labs so that environmental justice concerns continue to be ignored by Sandia relative to the MWL and the Pueblo of Isleta; a new EIS is long overdue. The Pueblo of Isleta was not informed of the disposal of High Level nuclear mixed waste at the MWL.

The planned 35,000 residential home and office development of Mesa del Sol is to the west of the MWL and the Albuquerque International Sunport is approximately 5 miles to the north.

I. Legal requirements for the disposal of High-Level Waste

Federal law requires that the disposal of high level waste (HLW), spent fuel, or transuranic radioactive wastes must take place in disposal systems designed to protect the environment by permanent isolation for 10,000 years after disposal. (40 CFR 191.13(a). High-level wastes are the highly radioactive materials produced as a by-product of the reactions that occur inside nuclear reactors. High-level waste takes the form of spent (*used*) reactor fuel when it is accepted for disposal.[6]

Sandia's disposed of high-level waste, spent fuel, transuranic waste, source material, special nuclear material and by-product material in the MWL in unlined pits and trenches above Albuquerque's drinking water aquifer. Thus, Sandia has failed to comply with the Department of Energy Organization Act, 42 U.S.C. 7101, and the Atomic Energy Act of 1954, as amended, 42 U.S.C. 2011, requiring DOE to protect public health and safety, as well as the safety of workers at DOE facilities, in conducting its nuclear activities. DOE/Sandia have violated Order 450.1 that requires the implementation of sound stewardship practices that are protective of the air, water, land, impacted by Department of Energy (DOE) operations.

During the December 2004 RCRA proceedings and up to the present, Sandia's failure to report the presence of High Level mixed waste represents the omission of substantial and material facts.[7]

Sandia failed to make an application to the Nuclear Regulatory Commission to obtain a either an exemption or a license for the disposal of the radioactive waste at the MWL as a land disposal facility.[8] Sandia failed to obtain a Resource Conservation and Recovery Act ("RCRA") permit for the disposal of hazardous waste at the MWL.[9] As contractor for the Department of Energy (DOE), Sandia failed to comply with 10 CFR § 830 to maintain complete and accurate records of disposals in the MWL, as necessary to substantiate compliance with the requirements for the safety of Sandia as a nuclear facility. Reporting requirements of RCRA for hazardous waste inventory, manifests and transport were also largely ignored.

Sandia has failed to comply with the May 26, 2005 Final Order to perform five-year excavation reports for the MWL.[10] The New Mexico Environment Department and the Environmental Protection Agency Region 6 have allowed blatant violations of law for the MWL and colluded in allowing and keeping groundwater monitoring violations at the MWL secret from the public.[11] Sandia and the NMED knew that data from the groundwater monitoring network was not reliable and representative to provide accurate data as a basis for the decision to install a dirt cover above the MWL. An August 10, 2007 email was sent to William Moats from EPA Region 6 describing the flawed groundwater monitoring network at the MWL and the need for replacement of groundwater monitoring wells. NMED has failed to include the document as part of the administrative record for the MWL. Sandia has failed to comply with groundwater monitoring requirements for the MWL as a "regulated unit" that received hazardous waste after July 26, 1982. 40 CFR 264.90-100. Compliance monitoring under 264.90-100 is required due to the new evidence of groundwater contamination. The NMED withheld 2006 TechLaw, Inc. documents regarding the unprotective features of the dirt cover installed at the MWL.[12] NMED

has not included the 2006 TechLaw, Inc. or the Court of Appeals decision as part of the Administrative Record for the MWL.

The permit and the permit modification must contain terms and conditions as necessary to protect human health and the environment. NMSA 1978 § 74-4-4.2.C. and 20 NMAC 4.1.900 incorporating 40 CFR 270.32(b)(2). Sandia knowingly and willfully misrepresented material facts in their application for the 2004 Class 3 Permit Modification and for the 2014 Class Certificate of Completion for Corrective Action in violation of NMSA 1978 § 74-4-4.2.D(1). DOE/Sandia failed to provide full information about the fuel pins and nuclear meltdown tests performed in the 1970s and 80s and the disposal of much of the test material in the MWL that was high level waste. Sandia failed to provide the information about the meltdown tests and the wastes from those test disposed of in the MWL to the Congressionally appointed WERC consortium during 2001-03. These issues must be addressed, in order to protect human health and the environment, as required by applicable state and federal law. For example, "TRU waste remains radioactive for very long periods of time; its isolation from the human environment is essential to protect the public health and safety." *State of New Mexico v. Watkins,* 969 F.2d 1122, 1124 n.1 (D.C.Cir.1992). DOE/Sandia fail to acknowledge or address uncontroverted evidence in the record regarding both the occurrence of TRU and "greater than Class C" radioactive waste at the MWL and the release of VOCs, SVOCs and metals from locations where they were placed in the MWL, that is therefore contrary to law.

Adoption of the 2014 Class 3 Permit Modification application would result in the NMED's approval of disposal of high-level mixed waste, transuranic waste and "greater than Class C" radioactive waste in a manner contrary to 40 CFR § 191 *et seq.* and, as such, would constitute "willful disregard for environmental laws of any state or the United States" by NMED and SNL/DOE contrary to NMSA 1978 § 74-4-4.2(4).

A significant requirement of RCRA for the issuance of a facility wide permit for a facility such as Sandia is that prior contamination at the facility must be cleaned up. NMED has done nothing to enforce any corrective action cleanup at the MWL and separated the MWL from the Sandia Hazardous Waste Permit hearing process so that the failure to clean up the MW could not be raised by the public. Instead NMED has delayed cleanup for so long that contaminants from the MWL have traveled to the groundwater beneath the MWL. The NMED has failed to provide a responsible, transparent course of action to protect the public and the environment from the MWL. Rather than protect the public, NMED staff have repeatedly sought to protect only their own personal reputations by flaunting the law, hiding relevant documents and information from the public, disregarding scientific fact, allowing Sandia to fail to characterize the MWL wastes, allowing shoddy monitoring and reporting by Sandia, ignoring the serious contamination that is spreading from the MWL and writing responses to public comments that are knowingly false. Unfortunately, NMED is completely incapable of policing its own operations by any independent oversight.

Colonias Development Council v. Rhino Environmental Services, 138 N.M. 133, 117 P.3d 939 (2005) held that public hearing requirements in environmental statutes implied the necessity of full consideration of the public's concerns and that "social well-being" included considerations beyond technical requirements for granting a landfill permit. The Corrective Action Complete Permit Modification fails to consider the public concern for the long term threat to public health and safety from the High Level and TRU waste disposed of in the MWL as well as the RCRA wastes that are contaminating groundwater and the vadose zone.

Moreover, in March 2012, the DNFSB documented serious deficiencies in Sandia's Documented Safety Analysis for the Annular Core Research Reactor (ACRR) for quality assurance (QA) and software quality assurance (SQA). The DNFSB concluded: "In the aggregate, these issues challenge the assurance that structures, systems, and components or processes at ACRR will perform their safety function."[13]

The DOE funds the NMED Oversight Bureau creating a conflict of interest that has resulted in the lack of independent review for the MWL.

II. The Mixed Waste Landfill – "Imminent and Substantial Endangerment"

The 2.6 acre "Radioactive Waste Dump," later called the Mixed Waste Landfill operated from 1959 to December 1988. The MWL is located in Technical Area 3 (TA-3) and has seven trenches in its 2 acre unclassified area and several dozen pits in the 0.6 acre classified section.

The shallow pits and trenches of the MWL lie above Albuquerque's sole source drinking water aquifer and have released hazardous and radioactive contamination to the vadose zone and groundwater. Releases beneath the MWL pits and trenches include but are not limited to tritium, nickel, beryllium, cadmium, nitrates, PCE and TCE. Thousands of pages of Radioactive and Toxic Material Disposal sheets (RTMDS) were obtained from FOIA requests by Citizen Action. Some of those are shown in the Appendix. The RTMDS link the fresh and irradiated reactor fuel pins, the ACRR meltdown experiments and the Hot Cell experiments with disposal in the MWL. Unfortunately, the RTMDS do not span the entire period of MWL operation from 1959 to December 1988. No sheets were provided for 1986-88.

The majority of the thousands of RTMD sheets do not fully describe the wastes that were contained in the plastic bags, poly bags, plastic bottles, cardboard boxes, wooden pallets, cardboard drums, steel drums, canisters and cans. All the containers are subject to rust and decay and release of their contents. What is clear from the RTMDs is that a wide variety of wastes were dumped in the MWL that included wastes from around the world – Germany, Japan, the Marshall Islands, the Nevada Test Site, Kirtland Air Force Base, numerous lab facilities at Sandia, Los Alamos National Laboratory, Idaho National Laboratory, Three Mile Island, and Military bases, There are S/N [serial numbers?] on many RTMD sheets that fail to identify what wastes were being disposed of in relation to the S/N notification. Many of the RTMDS wastes are vaguely described only as cleaning wastes, routine reactor wastes, test waste, machine chips, machine turning wastes, miscellaneous wastes, filter waste, component waste, irradiated components, lab analysis material, MFP [Multiple Fission Products], source,or by-product material, Thus, the inventory of radioactive and toxic materials disposed of in the MWL is unknown to a large degree due to the vague, incomplete and "classified" descriptions of the wastes.

An April 29, 2004 Consent Order described sites at Sandia that included the MWL as "an imminent and substantial endangerment to public health and the environment."[14] No corrective action is in place or under consideration to excavate the MWL to remove the canisters containing high level waste and other wastes to prevent these sources of contamination from being released to the groundwater.

The 2004 hazardous waste permit modification proceedings of the Sandia Resource Conservation and Recovery Act ("RCRA") permit for the MWL resulted in an NMED May 26, 2005 Final Order for corrective action. The MWL did not obtain a RCRA permit as a hazardous waste disposal facility. Despite the presence of high level mixed waste in the MWL, a defective groundwater monitoring network, the unsuitability of the dirt cover and contamination of the groundwater, Sandia has not complied with the 2005 Final Order requirement to report on the feasibility of excavation for the MWL "every five years."[15]

In 2012, a technical review for the MWL was scheduled to be performed by DOE Environmental Management (EM) by the Consortium for Risk Evaluation with Stakeholder Participation (CRESP). The CRESP review was cancelled by DOE EM Frank Marcinowski on the basis that the 5-year review for excavation would be performed by Sandia. A lawsuit is pending regarding Sandia's failure to perform the five-year review requirement and NMED's failure to enforce and modifying its own 2005 Final Order by extending the 5-year review for nine years.

Sandia argues in 2014 Court of Appeals filings that the meaning of "every five years" is vague and ambiguous. However, in an October 2005 Alibi article, Dick Fate, the environmental restoration manager for project closure with Sandia was telling a far different story to the press and public:

> "[T]he site will also remain closely monitored, and will be re-evaluated every five years to see if there are any signs that it should be excavated. But Fate said the site is different from other sites, in that the landfill is not active enough to outweigh the risk of excavating it. He added that there are also some materials in the site (like radium 226, beryllium and cobalt 60) that, if brought to the surface, would be unable to be moved to another site, due to both their cumbersomeness as well as restrictions placed on other waste sites in terms of what they can accept. The cobalt 60 buried in the site, for instance, is encapsulated in two trucks of concrete, along with lead and steel, said Fate. 'It's too big to move.'"[16]

III. A Brief History of the Fuel Meltdown Tests

After the accident at the Three Mile Island Unit 2, the United States Nuclear Regulatory Commission (NRC) initiated a severe accident research program, the general purpose of which was to develop a basis for evaluating reactor core melt progression and threat to public health. During the early 1970s Sandia conducted data analysis, fault tree analysis and consequence modeling that was used in the 1975 Reactor Safety Report (WASH-1400). A 4/6/76 Radioactive and Toxic Material Disposal Sheet for the MWL shows disposal of "Concrete Crucibles Used in Reactor Safety Studies." In the late 1970s and early 1980s, Sandia National Laboratories conducted numerous experiments in which both fresh and irradiated commercial nuclear fuel rods were melted down in canisters placed inside the core of the ACRR, earlier known as the Annular Core Pulse Reactor or "ACPR." The ACRR is a pool type reactor with a dry irradiation space that allowed the experimental canisters to be placed in the center of the core. See Figure

Severe accidents (beyond-design basis accidents, the "China-syndrome" or "meltdowns") for nuclear reactors came into regulatory consideration shortly after the issuance of the Reactor Safety Report (WASH-1400) in 1975. The earliest rules for containment were given in the Reactor Site Criteria, 10 CFR 100 published in 1962. 10 CFR 100 introduced the concepts of a maximum credible accident, subsequently referred to as the design-basis accident (DBA) or design basis loss-of-coolant accident (LOCA), and the expected leak rate from the containment.[17]

The simulation of meltdowns using fresh fuel and irradiated fuel pins for computer modeling was accelerated after the Three Mile Island accident in March 1979.[18] There were two different series of tests performed in the core of Sandia's ACRR: 1). The Light Water Reactor (LWR) and Boiling Water (BWR) tests that used water or gasses as a coolant, but never liquid sodium. 2. The Liquid Metal Fast Breeder Reactor tests that only used a sodium coolant. <u>The distinction as to which experiments the canisters came from is an important one.</u>

The radionuclide Na-22 is produced by the activation of metallic sodium in the core of a nuclear reactor. Sodium is an extremely reactive alkali metal in air or water. Metallic sodium is used as a neutron moderator and a coolant for thermal energy transfer from the reactor core of a Liquid Metal Fast Reactor. The problem of radioactive sodium waste treatment and conditioning is so serious that the International Atomic Energy Agency addressed the issue of sodium waste management in an international context. (See IAEA-TECDOC-1534, pp.1 and10-11). Experimental packages using sodium were irradiated in the ACRR and Na-22 is found in combination with other radionuclides such as Cs-137 and Tritium.

During the Phase II RCRA Facility Investigation sodium was merely viewed as an "essential nutrient." No reference was made to the presence of Na-22 in the MWL as is indicated from Radioactive and Hazardous Material Disposal Sheets (RTMDS).

Sandia memoranda written during the period 1997-98 identify concerns about removal and inspection of the canisters for hazardous waste that were buried in Pits 35 and 36 at the MWL because of the suspected presence of sodium. Sodium catches fire in the presence of oxygen and is explosive in water. The canisters containing spent fuel and sodium can explode from corrosion that would allow moisture to enter the canister.[19] The potential release of specific long-lived radionuclides buried in corroding canisters demands excavation of the MWL. The types of stainless steel or other material that the canisters were made of and the fabrication process used to form them is unknown and would be a determinant of how soon the canisters in the MWL could corrode.

"Source Term" is the terminology used to refer to the fission products that are released under different accident scenarios from the core of a light-water reactor into the containment or outside the containment (to the environment) and that is postulated for the purpose of calculating off-site doses.[20] NUREG-1465 referred also to "Alternative Source Term" as the fission products that would be released from reactors other than LWRs, such as Liquid Metal Fast Breeder Reactors ("LMFBRs"), also referred to as Liquid Metal Reactors ("LMRs").

IV. The Fuel Pins and Canisters Used in the Experiments

See Set A Figures in Appendix II

V. What happened to the fuel pins and equipment during the melt down experiments?

Commercial nuclear fuel pins were shipped to Sandia "from reactors all over the world"[21] and then were irradiated and melted down inside stainless steel canisters in nuclear reactor experiments conducted in the ACRR located in Technical Area 5 ("TA 5").

The fuel pins included irradiated pins and fresh pins. The fuel pins came from commercial reactor locations in Mol, Belgium and were also manufactured at Pacific Northwest Laboratory (PNL Batelle), Clinch River Breeder Reactor and the German Nuclear Research Center, KFK. Some of the commercially manufactured fuel pins were previously irradiated in reactors such as the Belgian Reactor 3 (BR3). Some of the PNL fuel was irradiated at the EBR-II reactor at the Idaho National Engineering and Environmental Laboratories ("INEEL") now named Idaho National Laboratories, "INL").

The fuel materials used in the experiments were housed in experiment capsules or packages that included primary and secondary containment. The experiment packages inside the inner stainless steel canister contained fresh commercial reactor fuel along with irradiated fuel supplied from other commercial nuclear reactors. The oxide fuels were secured in the primary containment canisters (cans) machined from stainless steel tubes. The primary inner can, with fuel in place, was slipped inside a secondary can of slightly larger diameter. This "nested" configuration was then lowered through a hole in the floor and placed next to the core of the ACRR for varying times depending upon the nature of the experiments.[22]

Initially, the canisters held fresh fuel and irradiated fuel surrounded by zircaloy cladding. All the tests created high-level waste due to high temperatures above 2500º K (4040º F) from irradiation in the ACRR that disrupted, melted and/or vaporized the fuel packages and fuel cladding inside the inner canisters. Note that stainless steel melts at 1700º K! The outer canister was also irradiated by the ACRR and became radioactive with Cobalt-60.

The experiments used mirrors to reflect the fuel pin response through quartz windows to telescopes and high speed cameras that could take up to 1000 frames per second and observe the progression of a fuel meltdown.

The phenomena observed during the tests under high temperatures were fuel swelling and cracking, release of radioactive gasses, melting of cladding, production of hydrogen from oxidation of zircaloy and stainless steel, dispersal of the fuel by foaming or rapid spray-like disruption, the relocation of liquefied fuel/cladding mixtures and formation of blockage regions by the refreezing of previously molten components around intact fuel rods in cooler regions. The debris was released into the test chamber of the canister and much of it puddled as molten debris in the lower section and bottom or became plated on the sides of the canisters as shown in the images. See Appendix II.

Comment [O1]: add images

Associated with these Sandia severe accident meltdown experiments was the release of radioactive gases to Albuquerque's airspace.

The information from these many experiments aided in the development and validation of state-of-the-art computer codes, such as Melt Progression Phenomenology Code Development (MELPROG), Methods for Estimation of Leakages and Consequences of

Releases (MELCOR), Boiling Water Reactor Severe Accident (BWRSAR), and SCDAP (a code that calculates the progression of damage to the reactor core). More than 30 source term tests were conducted at Sandia to evaluate severe accident conditions for Light Water Reactors (LWRs) and Liquid Metal Fast Breeder Reactors (LMFBR).

The distinguishing feature between the tests for LWRs and the LMFBRs was the type of coolant used in the tests. The LWRs used water as a coolant and the LMFBR tests used a sodium coolant. The tests had different names such as, TRAN (transition phase series), Prompt-Burst Experiments ("PBE"), Sandia Transient Axial Relocation ("STAR"), Effective Equation of State ("EEOS"), Fuel Disruption ("FD") experiments, Damaged Fuel experiments ("DF"), Degraded Core Coolability ("DCC"), Source Term ("ST"), and Debris Bed. HRR (high ramp rate) tests that were part of the STAR series simulated fuel disruption under prompt burst conditions that exhibited the spray of molten fuel at temperatures that could rise up to 10,000º K.

The history of the development of different "severe accident" analyses proceeded in stages from the early operation of light water reactors (LWRs) to Liquid Metal Fast Breeder Reactors ("LMFBRs") that were sodium cooled fast reactors. The regulations of the Nuclear Regulatory Commission changed over time to accommodate the various types of tests used for investigation:[23] 1). an instantaneous release to containment; 2) probability that the containment would fail and 3) a methodology to investigate postulated accidents by presenting release rates for materials of interest to radiological consequences for various release phases (coolant, gap, melt, ex-vessel, late in-vessel).[24] The first two types of investigations were used to license existing LWRs prior to the accident at Three Mile Island (3MI) in 1979. The third type of investigations proceeded after the 3MI accident and allowed for the relicensing of LWRs and for Alternative Source Term safety studies dealing with sodium cooled breeder reactors.

VI. Sandia Memoranda obtained by Citizen Action under the Freedom of Information Act ("FOIA")[25] show that extremely "hot" canisters from irradiation in the ACRR, were buried and disposed of at Sandia's Mixed Waste Landfill ("MWL") in unlined, shallow pits and trenches.[26]

The 1977 Energy Resource Development Authority ("ERDA") report, *SNL Assessment of Radioactive Waste Burial Ground Operation at Sandia Laboratories, Albuquerque,* identified that a hot cell facility would be constructed at Sandia to begin operations in 1978 to handle "TRU waste with significant external radiation and requiring retrievable storage."[27] The Hot Cell Facility, located in Technical Area 5 was used primarily for preparation of experiments and for examination of the condition of the source material after the simulated meltdown of the nuclear fuels that were placed in the ACRR reactor core. At Sandia's Hot Cell Facility, post-irradiation examination ("PIE") could be performed after experiments to observe the condition of the fuel in the canisters. Some canisters were disassembled at the hot cell for post-irradiation destructive examination.[28] During the post-irradiation examination of canisters in the hot cell, cross-contamination of the inner and outer canister used in the tests likely occurred. Sandia Radioactive and Toxic Material Disposal sheets substantiate that large quantities of waste were sent from the hot cell facility and the ACRR for disposal in the Radioactive Waste Dump (MWL). The Radioactive and Hazardous Material Disposal sheets also show that atomic bomb debris from the Marshall Islands and the Nevada Test Site were disposed of in the MWL.

The 1977 ERDA report described the planning for the emplacement of radioactive waste into the Sandia Radioactive Waste Dump, later called the Mixed Waste Landfill. The ERDA report at page 9 states:

> "The pit area is used to dispose of all radioactive devices with a security classification. In addition, it is used to dispose of radioactive sources greater than about 10 microcuries, i.e., any waste considered to be a significant health hazard."

At pg. 10, the ERDA report states:

> "Currently, all radioactive waste generated at Sandia Laboratories Albuquerque [SLA] is buried at SLA." (Emphasis supplied).[29]

A December 21, 1984 Radioactive Waste Study (G. J. Smith to J. C. Vandermolen) describes the Area III Classified Disposal Area:

> "[R]adioactive chemicals as well as classified toxic materials may be assumed to be found at this facility. Certain pits were designed to contain special projects. The radioactive acid pit located in the SE corner of the facility was used to dispose of contaminated chemicals including solvents and acids prior to 1969. A 'Plutonium Arc Tunnel' and related materials containing pure Pu-239 microspheres ranging in size from 2to 20 micron in diameter ate buried in one pit. A 'Beryllium catcher' containing lumps to fine particles of Be is buried in a separate rectangular pit. Two pits contain uranium fragments and uranium-contaminated soil although D-38 can probably be found in all of the pits. Some alpha-emitting materials may also be buried in the unclassified disposal site. Eleven drums of TRU waste under the 100 n/Ci/gram have been buried in trench E as well as additional drums originating from Lovelace Inhalation Toxicology Research Institute."

The 119 drums of waste from Lovelace contained Plutonium- 238, 239 and Americium.

There can be no argument that certain meltdown experiments conducted in the ACRR did not contain metallic sodium used as a coolant. A November 1984 Sandia Memo (FOIA#38) entitled *Excess Special Nuclear Materials, p.3,* describes that for the Hot Cell Facility:

> the major portion of time is required for the disassembly of DCC, PAHR and PB experiments and the destruction of the metallic sodium in the PAHR and PB experiments."
>
> Large blocks of Hot Cell time are required to disassemble the experimental packages – in particular the DCC and PAHR experiments. Therefore, it is anticipated that no more than 2 experiments/year will be disassembled. Thus the estimate hours would be spread over several years.

The 1984 Memo (#38), p. 60, List 15B states:

> The experiments in this list contain fully enriched UO2 under approximately 3kg of metallic sodium. UO2 contents range from 2.4kg UO2 to 8.1kg UO2. These experiments will have to be disassembled in the hot cell and the metallic sodium chemically reacted with alcohol(s).
> …
> Prior to initiation of any reaction of the metallic sodium with the alcohol(s) it would be advisable to have some person(s) perform criticality calculations with respect to the configuration (diameter and height) of the UO2 bed and the quantity of alcohol allowable…

…

The 1984 Memo, p. 62, List 15C, Irradiated Material suggests that burial was previously used for experimental packages containing metallic sodium,:

> This is a list of PBE experimental packages which need to be disassembled. All of the experiments except AC-1 contain a UO2 fuel pin with metallic sodium, AC-1 is a uranium carbide pin. I do not believe that it is economically justified to perform the disassembly and to reclaim the UO2 and/or UC. **However, I also understand that it is no longer possible to bury packages containing metallic sodium.** (hence we are between a rock and a hard place). It is suggested that this be further investigated with DOE/AL and b6, Environmental Protection and Hazardous Waste Management). (Emphasis supplied).
>
> All work should be done in the hot cell.

The 1984 Memo at List 18 entitled Power Burst Experiments, recognizes that the presence of sodium would be the burial of mixed waste, p. 75-76:

> As I stated earlier, I would prefer to bury these experiments intact 'sans' the shields. Economics do not justify the disassembly. These experiments would be mixed waste if buried intact.

At p.76, the 1984 Memo's unnamed author refers to the Uranium carbide samples cut from the PBE experiments:

> Again, these are mixed waste - each sample contained metallic sodium – however, over the storage life of – 8 years, I believe we now have a mix of sodium oxide, hydroxide, and possibly some metallic sodium. Economics do not justify the expenditure of manpower to clean up the sodium and sodium compounds and/or to reclaim the SNM.

During the years 1997-98, memoranda and documents written by Sandia managers and Department of Energy (DOE) personnel along with employee interviews describe the disposal of canisters in "vertical, small-diameter holes drilled into the bottom of the MWL trenches." Concerns are stated about the presence of sodium in the disposal of four highly radioactive canisters (also called "cans") at Pits 35 and 36 in Sandia's Mixed Waste Landfill. Pits 35 and 36 contained one can and three cans, respectively. The 1997-1998 Sandia memoranda do not describe the actual dates of the disposal of the canisters in the MWL nor the name(s) of the experiment(s) which generated the radioactive waste contained in the canisters. One of the cans in Pit 36 is "mummified."

The February 20, 1997 Peace, March 20, 1997 Cox, and April 1, 1997 Cox memoranda describe the fact that the MWL classified area pits 35 and 36 contained four cans 9 inches in diameter and 16 or 20 feet long, with the actual diameter and length of each can unknown. The Peace 2/20/97 memo stated, "These cans are containment canisters which were constructed and used in TA 5 in the mid-1980s for experiments involving oxide nuclear reactor fuels." The canisters were disposed of in the Mixed Waste landfill classified area pits 35 and 36 containing 1 and 3 cylindrical "cans" respectively. The February 20, 1997 Peace memorandum identified the basis of his information:

> "Verbal reports from Sandia employees involved in these tests confirmed that the cans in Pits 35 and 36 came from TA 5 and the source term tests."

The disposal of cans in the MWL's unclassified trenches represents the most likely disposal method routinely used by Sandia. The Peace February 20, 1997 memorandum states that:

> "[A]dditional cans were disposed of in small, vertical holes drilled in the bottom of unspecified trenches at the MWL. … There is no doubt that there are additional cans in the landfill, but their location is unknown."

The main reason that there is any awareness of the radioactive waste canisters being in the vertical holes drilled in the bottom of the trenches is because the 2/20/1997 Peace memo was obtained through the Freedom of Information Act. That the four canisters were disposed of in Pits 35 and 36 represented a disposal method that deviated from the normal course of drilling holes in the bottom of the trenches. According to Peace, the TA 5 employees were "confused" as to why the cans were disposed of in Pits 35 and 36 because the experiments were not classified and the pits were in the classified area of the dump. The February 20, 1997 Cox memo to Jackson and Gould states:

> "TA 5 employees were confused as to why the cans were in Pits 35 and 36 because these tests, as well as the cans were not considered classified. The obvious reason is that the landfill was scheduled for closure, so all spent cans were hastily disposed of before the closure date. There was not enough time to contract a drilling rig to drill holes in the trenched area of the landfill so the cans were dropped in available classified area pits where they reside today."

It is unknown how deep or how many holes were drilled into the bottom of the MWL trenches for disposal of the canisters.

Peace (2/20/1997) describes Pit SP-4 that contained reactor vessel plates of unknown origin, number, size, or configuration, and; Pit SP-5 contained a lead burial cask with twelve Co-60 sources, and it is unknown whether the pit was filled and compacted before a concrete cap was installed.

The lack of characterization of the contents of the additional cans that were disposed of by drilling holes in the bottom of MWL trenches and the failure to identify their locations further violates federal laws for protection of the public from radioactive and hazardous waste.

It is also interesting to note the statement in the 2/20/1997 Peace memo:

> "The nested cans were then removed from the core and disassembled to study the source term of a simulated meltdown of oxide fuels. The fuels consumed in the tests were removed from the primary can but both the primary and secondary cans became activated during the tests due to neutron capture. "

The statement conflicts with Peace's statement that describes:

> "If the cans were known to be contaminated or if time was not allowed for decontamination, they were mummified before disposal."

Probably only the intact pins could be removed and examined while the melted pins and debris were disposed of in the canisters in the MWL. According to Peace 2/20/1997:

> "Contamination [of the canisters] may have occurred during disassembly of the nested configuration due to contaminated hands and fingers [in the hot cell manipulation]. If the cans were known to be contaminated or if time was not allowed for decontamination, they were mummified before disposal."

Comment: This indicates that since the cans were hastily disposed of, they were not decontaminated and could be handled for placement in the MWL because the cans were mummified, i.e., placed in lead or plastic bags.

The memos of Cox on 3/20/1997 and 4/1/1997 indicate that hazardous constituents, i.e., Resource Conservation and Recovery Act ("RCRA") wastes could also be in the canisters:

> "Based on interviews with TA 5 personnel, there may be hazardous constituents in the canisters."

The 3/20/1997 Cox memo at page 3 describes Pit 35 as having a 35 mR/hr exposure rate at ground surface and Pit 36 at 6 mR/hr due to Co-60, Cs-137, and Na-22. Cox recommended backfilling the pits.
Comment: A 35 mR/hr dose at the ground surface would deliver a worker his annual exposure limit in three minutes!

It is also interesting to note the statement in the 3/20/97 Cox memo "The nested cans were then removed from the core and disassembled to study the source term of a simulated meltdown of oxide fuels." The high radiation readings near Pits 35 and 36 is additional evidence that some or all of the melted fuels were not removed from the canisters.

The April 1, 1997 Memorandum of Cox to Laskar reiterates that Pits 35 and 36 contain four stainless steel canisters 9 inches in diameter and 20 feet long used in TA 5 in the mid-1980s for experiments involving mixed oxide nuclear reactor fuels. It is claimed that the fuels were removed from the radioactive canisters before disposal at the MWL. Cox presents what is an extremely hot radiation field if the canisters were to be sampled for hazardous wastes:

> "Based on interviews with TA 5 personnel, there may be hazardous constituents in the canisters." "Handling and sampling of the canisters will be very difficult, resulting in unnecessary exposure to **radiation fields as high as 5 R/hr to sampling personnel."** (Emphasis supplied).

Radiation levels of 5 R/hr strongly suggest that at least some of the highly radioactive melted fuel, cladding, and debris is still contained within the now buried canisters located in the MWL. Also the canisters likely contain parts of the highly damaged fuel pins. The Peace 2/20/1997 memo states:

> "If the cans were known to be contaminated or if time was not allowed for decontamination, they were mummified before disposal. … One of the cans in Pit 36 is mummified, suggesting probable elevated levels of loose surface contamination."

The presence of sodium in the canisters would also be confirmation that the origin of the canisters was from the LMFBR tests and that the canisters were unopened and contained high level waste. The 3/20/97 Cox memo makes it obvious that the presence of sodium, in addition to high radiation levels, would make sampling the canisters for hazardous constituents "very difficult" and "very dangerous," and removal of the canisters would result in complicated waste management issues. The 3/20/1997 memo is further evidence that the canisters containing

sodium as a coolant in the experiments did not have the irradiated fuel removed, and were disposed of intact with the melted fuel still in the canisters when disposal took place in the MWL.

In the September 1997 Notice of Deficiency, the NMED Comment 7 stated [30]:

> Surface contact readings of 0.5, 50, and 6 mrem/hr were measured for Pits SP-4, SP-35 and SP-36, respectively. These levels of radioactivity are high enough to be a concern. For example, 0.5 mrem/hr is equivalent to 960 mrem/yr in the Albuquerque area. The surface contact readings must be reduced to background levels by additional shielding at Pits, SP-4, SP-35 and SP-36. Alternatively, the radioactive/mixed waste in these pits could be removed and disposed of elsewhere."

The disposal in Pits 35 and 36 and SP-4 and SP-5 that resulted in the high radiation readings at ground surface and the presence of Na-22 became a key waste management issue for Sandia.

The 3/20/97 memo of Cox to Laskar states Pits 35 and 36 contain 4 steel canisters, 9 inches in diameter and 20 feet long that were used for experiments involving oxide nuclear reactor fuels that were placed in the core of the ACRR. Cox raises several "key waste management issues" for why the canisters should be left in place at the MWL rather than excavated. Cox states:

> "The Mixed Waste Landfill has been proposed for No Further Action [NFA] under the SNL/NM *Hazardous and Solid Waste Amendment (HSWA)* permit process. Pits 35 and 36 need to be backfilled to move the HSWA process along towards completion. *The outstanding issue is whether or not the canisters should be removed from the waste pits and managed as waste. If the decision is made to require SNL to remove the canisters from the pit and manage them as waste* the following key waste management issues complicate the situation and need to be considered:" (Italics in original).

Cox cites high radiation levels and the presence of metallic sodium. Cox states four reasons why the canisters should be left in place at the MWL rather than excavated:

1. Canisters would need to be dismantled, sampled and analyzed for suspected hazardous contaminants that could include metallic sodium. "It will be very difficult to obtain representative samples for analysis. The required sampling of the canisters will be very difficult, and the necessary handling to obtain the sample will result in personnel radiation exposure to the sampling personnel, violating ALARA. "If metallic sodium is present, as suspected by TA 5 personnel, sampling could be very dangerous as a result of this metal's reactivity."
   Comment: It should be noted that ALARA is a standard for radiation exposure that does not apply to workers at nuclear weapons laboratories to the extent it applies to the public.
2. Upon removal from the pit a 90-day clock begins. The canisters would then have to be sampled. No currently available disposal option existed due to the "high concentration of radioactive material in the waste." There is little process knowledge and there have been no controls since the waste was generated. There would need to be thorough sampling and investigation to ensure that no hazardous material is present in the waste.
   (Comment: this is an indication the canisters were placed in the MWL unopened and without removal of the fuel contained inside the canisters.)
3. *Custom designed shielded storage containers would need to be developed and built* to safely contain the waste and maintain radiation levels at an acceptable level while in storage

awaiting disposal. *The design of such container would be expensive and time consuming.* (Emphasis in the original).

4. *Should the waste be found to be mixed waste and since* no viable disposal option is available and the waste would have to be added to the SNL/NM Site Treatment Plan. SNL is working diligently to avoid the very high costs associated with additions to the STP. *Waste of this type will result in continuation of a Site Treatment Plan for an indefinite time. Removal from the STP would only be accomplished if new disposal options became available in the future.* (Emphasis in original).
   Comment: Indicates that this is high-level mixed waste because low level mixed waste does have disposal pathways.

The consideration of removing the canisters, as suggested by the NMED, led ultimately to the Sandia management decision in 1998 to leave the HLW in place, cover the landfill with dirt and close the MWL site through "risk assessment, long-term monitoring and institutional controls."[31]

Owning up to the presence of high-level mixed waste disposed of in the MWL would have scuttled Sandia's plan to avoid the very high costs of excavation, treatment and storage.

Sandia decided to simply backfill the pits with dirt. This decision was based on the earlier February 20, 1997, March 20, 1997 and April 1, 1997 memos, and the November 20, 1998 Memorandum that John Gould wrote to Dick Fate and copied to Laskar KAO, Oms KAO, Bourne ERDA/DOE, Cox SNL, Nimick SNL, and Peace SNL. The Memorandum addressed the high radiation surface contact readings identified by NMED NOD Comment 7 for the MWL RCRA Facility Investigation [RFI]. Gould's 11/20/1998 Memorandum stated:

> "As we all realize, under current conditions, removal and off-site disposal of the pit contents is not feasible. As a result, we have selected the option of covering the landfill and closing the site through risk assessment, long-term monitoring and institutional controls."

The Memorandum states further that:

> The possibility exists that, at a future date when improved technology and a mixed waste disposal site are available, this site could be remediated by removal of all pit contents. If this remediation should occur, I recommend that we plan in advance for the problems those conducting this effort may face, and fill the pits in a manner that will not unnecessarily complicate removal of the fill material.

The September 11, 1997 Notice of Deficiency (NOD, Dr. Dinwiddie) also informed Sandia that the MWL was not a RCRA permitted unit, that the MWL is a "regulated unit" that received hazardous waste after July 26, 1982 [32] and thus the MWL required a closure and post-closure permit unless closure by removal was demonstrated.[33] No RCRA Subpart G closure or post-closure permits were obtained by Sandia. Sandia instead sought to continue the status of a Solid Waste Management Unit (SWMU) that had been designated by the EPA Region 6 in 1993.

After receiving the NOD, Sandia began to push hard to gain a no further action status for the MWL so that the MWL would not have to be clean closed. Sandia selected a dirt cover remedy for the MWL six years prior to the public hearing held for a RCRA permit modification that resulted in the May 26, 2005 Final Order that selected a corrective measure of a dirt cover. The public was not informed of Sandia's decision making process in 1998 or of the extensive

links of the MWL disposals to the meltdown experiments and presence of high-level mixed waste in the MWL.

Dr. Dinwiddie was threatened with termination unless he resigned as the NMED Hazardous Waste Bureau Chief. Thereafter, the MWL remained classified as a Solid Waste Management Unit (SWMU) despite the fact that it had received hazardous waste after July 26, 1982. Thus, Sandia was able to avoid the issues and problems that would arise from the necessity for clean closure and a post-closure plan for the MWL that contained HLW mixed waste that had no disposal pathway at the time. The MWL would not be subject to the Sandia Site Treatment Plan. Additionally, by virtue of the MWL being classified as a SWMU, Sandia was able to avoid the strict requirements in 40 CFR 264.90-100 for groundwater monitoring for the MWL as a "regulated unit." Groundwater monitoring was known to be defective shortly after the monitoring wells were installed in 1989.[34]

The administrative documents describing the various meltdown experiments lack any information referring to:

- The identification of the name(s), type(s), and number of experiment(s) that provided the source of the contents in the canisters placed in the MWL
- The actual dates of the disposal in Pits 35 and 36 and the additional disposal in holes at the bottom of the trenches
- The number and location of additional cans disposed of holes in the bottom of the MWL trenches
- Evidence of hot cell facility processes that could have been used to remove the melted high level waste from the canisters prior to disposal
- Records for the timing of removal of high level waste and the disposal pathway for the high level waste removed from the various canisters

Although there is a lack of knowledge for the above disposal issues, the known facts are that the mixed oxide meltdown experiments took place in the ACRR and generated several forms of high-level and hazardous waste along with sodium that was disposed of in the MWL:

a. Canisters were disposed of in small diameter holes drilled into the bottom of trenches in the MWL. Four unopened canisters containing sodium and high radiation levels. Intact but damaged fuel pins – cladding may have been ruptured and leaking
b. Radioactive with debris – stainless steel and zircaloy cladding puddled at the bottom, the oxide fuel partially melted, release of radioactive gas to the environment and plated to the canister.
c. Ancillary contaminated experimental equipment from the many various types of experiments. The experiments produced radioactive waste such as cameras, wires, cords, thermocouples, glass mirrors, and gloves that were put into the tops of the canisters.
d. The LMFBR experiments had the structures that the liquid sodium coolant went through, metal structures, deformed pins, sodium, beryllium, lead, and epoxied unit pieces left over from cutting. Pins assembled in a metal frame were covered in epoxy and then cut into "experimental samples" in the Hot Cell Facility to check the deformation of the fuel pins. The experimental samples were examined in hot cells with cameras that documented the damage to the fuel pin.
e. The 1997-98 memos show that Sandia management decided not to excavate the MWL due to concerns for the *very dangerous* reactivity of sodium, the very difficult task of characterizing the presence of hazardous waste, and the high radiation levels in the canisters disposed of in Pits 35 and 36. The canisters that were used for the

numerous source term studies for the Liquid Metal Fast Breeder Reactor ("LMFBR") tests experiments contained a sodium coolant.

Sandia "classified" the records of the disposal in the MWL so that it was difficult for the NMED and the public to review records of the experiments in relation to the disposal at the MWL.[35] According to Sandia personnel, although the four canisters were placed in the 0.6 acre portion of the classified area of the MWL,[36] the reactor meltdown experiments were *not classified experiments* related to nuclear weapons. Rather, the many tests were authorized by the Nuclear Regulatory Commission and utilized commercial fuel, both fresh and irradiated, for the testing of severe accident conditions that could occur in commercial nuclear reactors -- Light Water Reactors (LWRs) and Boiling Water Reactors (BWRs). Extensive tests were made for Liquid Metal Fast Breeder Reactors (LMFBRs).

VII. The meltdown experiments conducted by Sandia

Shortly after the 1979 nuclear reactor accident at the Three Mile Island Unit 2, the United States Nuclear Regulatory Commission (NRC) initiated a severe accident research program, the general purpose of which was to develop a basis for evaluating reactor core melt progression and ultimately, for assessing the release of fission products from the plant site and the ensuing threat to public health.

During the 1970s, Sandia began to investigate individual fuel pins and fuel pin assemblies for severe accident meltdown. In the 1970s, the Nuclear Regulatory Commission initiated a series of real time in-pile experiments on "**Millisecond-Period Meltdown Experiments on Prompt-Burst Effects**," that were vapor explosions that took place from the sodium-oxide fuel interactions.[37] These experiments took place in the Annular Core Research Reactor ("ACRR," referred to at the time as the Annular Core Pulse Reactor "ACPR") located in Technical Area V. These experiments exhibited fuel vaporization (vapor explosions) that were related to the type of meltdowns that could occur in a Liquid Metal Fast Breeder Reactor (LMFBR). These experiments used both fresh and irradiated uranium and mixed oxide fuels with liquid sodium as a coolant. The fuel vaporization dispersed a relatively large amount of molten oxide fuel into the sodium. The LWR severe accident tests used water, but did not use sodium as coolant.

The Sandia Reactor Safety Research Semiannual Report January - June 1986 Volume 35, p. 21 states that[38]:

> The Advanced Reactor Accident Energetics Program was initiated in 1975 to address the important phenomenological uncertainties involved in LMFBR core disruptive accidents. The Accident Energetics Program consisted of 10 major in-pile experimental programs addressing all phases of in-core phenomenology. These programs drew significant international attention and were jointly funded and staffed by the German KFK, Japanese PNC, and the UKAEA. With the completion of the STAR-7 test in the Initiation Phase, the GAP-2 experiment in the Transition Phase, and the irradiated Equation-of-State experiments in the Disassembly Phase the major elements of the program have now been completed.
>
> …
>
> The purpose of the seventh and last experiment in the STAR program, STAR-7, was to investigate the upper bound loss-of-flow (LOF) accident scenario for the MONJU fast breeder reactor.

Sandia (Albuquerque, NM) performed numerous nuclear reactor meltdown studies following the Three Mile Island accident. Waste disposal sheets show some wastes from TMI were dumped in the MWL. The severe accident condition experiments conducted at Sandia had different names. The names of the experiments were listed in an August 3, 2001 *Description of SNL Materials Included in the Spent Fuel Data Base.*[39] The data base included fuel pins and materials that were used in experiments named: the Sandia Transient Axial Relocation ("STAR"), Fuel Disruption ("FD" or "DF"), Degraded Core Coolability ("DCC"), Source Term ("ST"), Effective Equation of State ("EEOS"), and Debris Bed.[40]

The Sandia LMFBR Debris Coolability Program, the "D series experiments," utilized fission heating of fully enriched UC^ [Uranium Carbide] particles in the ACRR to realistically simulate decay heat. Sodium was used as the coolant to study the effects of liquid subcooling with a high-conductivity fluid. http://www.osti.gov/scitech/servlets/purl/6112398 NUREG/CR-4055

SAND84-1144 R7 (1984) *The D10 Experiment: Coolability of UO2 Debris in Sodium With Downward Heat Removal.* See figures figures in Appendix II. And see the RTMD sheet that shows evidence of disposal of wastes from the Debris Coolability program in the MWL and the existence of a Uranium/Sodium loading facility for the experiments.

The Sandia document, *A Material Management and Disposition Plan for Excess Materials at Sandia National Laboratories* (July 2002, FOIA doc #1) discusses 18 different waste streams ("Bins") that require disposition pathways. **Bin 14** is Sodium-bonded Uranium Material. (P. 6). At p.16, **Sandia -15. Spent Fuel** describes spent fuel containing sodium:

> material stream [that] includes parts from 11 experiments, which contain particulate, dispersed, highly enriched (93%) UO2 surrounded by Na. Quantities of these materials range from 2-7 kg U and about 2 kg Na in each of the 11 items.

An Electro Metallurgical Treatment facility at Argonne National Laboratory (ANL/W) at INEEL is described as the only possible location for eventual disposition as HWL. "ANL/W would eventually disposition the material as HLW." In response to the Citizen Action FOIA, Sandia did not provide any record of having removed the sodium from the sodium-bonded uranium. Whether Sandia shipped the spent fuel containing the sodium to ANL/W is unknown to Citizen Action. Citizen Action raised the issue of the disposition of wastes during the 2014 Hazardous Waste Permit hearing for the Sandia facility.

SAND2011-3404 *The Development of a Realistic Source Term for Sodium-Cooled Fast Reactors: Assessment of Current Status and Future Needs,* Middleton, et. al., June 2011 describes that sodium coolant was used in debris bed coolability tests conducted in the ACRR:

> A significant amount of in-pile transient testing work was performed in the 1980s on both metal and oxide fuels and documented previously in this report. The work was performed at both the TREAT Facility at INL and the ACRR Facility at SNL. Fuel failure testing and debris bed coolability was performed with and without sodium coolant in order to better understand the failure mechanics associated with a [hypothetical core disruptive accident] HCDA.

The use of sodium as a coolant, the presence of Cesium-137 and the high radiation levels found at ground surface are important factors in recognizing that the four canisters in Pits 35 and 36 or the canisters vertically placed in the bottom of MWL trenches probably were associated with the LMFBR tests. The Source Term tests, ST-1 and ST-2 were conducted for the Light Water Reactors and did not use sodium coolant so were probably not the canisters located in Pits 35 and 36. The presence of sodium in Pits 35 and 36 would indicate that the canisters were not disassembled but were intact when placed in the pits. The ST tests are further described below.

The waste produced by the various severe accident tests met the legal definition for high-level waste because highly radioactive materials were produced "as a byproduct of the reactions that occurred inside nuclear reactors." Due to the high temperatures, the mixed oxide (MOX) fuel was melted completely or partially in all tests, regardless of whether the tests were the STAR, TRAN, FD, or EEOS tests. The test canisters could also be considered to contain source, special nuclear, or byproduct material radioactive waste for which the NRC required a licensed facility for disposal.

The two Source Term ("ST") tests included both the irradiated fuel from the BR-3 reactor (Mol, Belgium) and the fresh fuel that were placed into the ACRR as experimental packages. During the 2004 public hearing, the name of the specific "Source Term" tests, which referred to tests ST-1 and ST-2, became confused with the general meaning of "source term" that referred to the fission products release from the mixed oxide fuel under the severe accident conditions. The February 20, 1997 Peace memorandum referred generally to the source term tests from the simulated meltdown of oxide fuels and cited the presence of sodium in the canisters. The ST tests did not use metallic sodium that was a serious concern of Sandia if the canisters in Pits 35 and 36 were to be excavated. The specific ST-1 and ST-2 tests were related to Light Water Reactors[41]:

ABSTRACT

Two experiments (ST-1 and ST-2) have been performed in the Annular Core Research Reactor (ACRR) at Sandia National Laboratories (SNLA) to obtain time-resolved data on the release of fission products from irradiated fuels under light water reactor (LWR) severe accident conditions. Both experiments were conducted in a highly reducing environment at maximum fuel temperatures of greater than 2400 K. These experiments were designed specifically to investigate the effect of increased total pressure on fission product release; ST-1 was performed at approximately 0.15 MPa and ST-2 was run at 1.9 MPa, whereas other parameters were matched as closely as possible. Release rate data were measured for Cs, I, Ba, Sr, Eu, Te,and U. The release rates were higher than predicted by existing codes for Ba, Sr, Eu, and U. Te release was very low, but Te did not appear to be sequestered by the zircaloy cladding; it was evenly distributed in the fuel. In addition, in posttest analysis a unique fuel morphology (fuel swelling) was observed which may have enhanced fission product release, especially in the high pressure test (ST-2). These data are compared with analytical results from the CORSOR correlation and the VICTORIA computer model.

In the ST experiments the "Zircaloy cladding melted and relocated to the bottom of the fresh bundle. The irradiated fuel pellets that reached temperatures over 2200° K showed extensive fuel swelling."[42]

The August 3, 2001 Spent Fuel Database (FOIA doc # 157) was prepared to "consider what preparations (handling concerns, characterization, stabilization may be required for the following materials planned for shipment to the Idaho National Engineering and Environmental Laboratory ("INEEL")." The Database describes that the cladding associated with the MOX fuel used in both the STAR and FD projects was "melted in all tests":

> "In addition, the fuel was disrupted during the majority of the tests and a occasionally vaporized. As a result, the fuel materials no longer clad and may be spread (plated) inside the experiment capsules. Fuel that was disrupted, but not vaporized, melted and 'puddled' at the bottom of the experiment capsules."

The 8/3/01 Spent Fuel Database document section, Main Sources of Fuel Pins, was written to give INEEL "introductory information concerning the SNL materials so that discussions concerning acceptance criteria and shipment schedules can be initiated."
1. Manufactured at Pacific northwest Laboratory -- MOX pins irradiated at EBR-II but not used at SNL, but in the SNL Spent Fuel database.
2. BR-3 Fuel manufactured in Mol, Belgium and irradiated in the BR-3
3. STAR experiments used pins cut from the PNL pins.
4. Fuel Disruption experiments used mostly PNL that was irradiated in EBR-II.
5. Source Term Material was from PNL (fresh fuel) and irradiated rods were from Mol, Belgium BR-3.
6. Effective Equation of State (EEOS) Material – MOX fuel manufactured by PNL and irradiated at EBR-II

The Database described the Source Term experiments as follows:

> **"Source Term (ST) Material** There were two ST experiments performed at Sandia, ST-1 and ST-2. The purpose of these experiments was to investigate fission product release under severe accident conditions. The fuel used in the ST-1 and ST-2 experiments was from two sources. The previously irradiated fuel rods were from the BR-3 reactor in Mol, Belgium and the fresh fuel was fabricated at Pacific Northwest Laboratories [PNL Battelle]. There are four containers of ST material in the Spent Fuel Database. All are shielded storage containers and the material is described as 'scrap' or 'scrap, fuel samples.'"

The 2001 Spent Fuel Database maintained that there were four containers of ST material remaining in the database that were maintained as "scrap" or "scrap, fuel samples" without disclosing any location for the four containers. If the four containers *were* disposed of in the MWL, there was no reason to list the four containers in the Spent Fuel Database.

However, the major concern for the canisters in Pits 35 and 36 was that it would be very dangerous for sampling to be made for hazardous sodium waste contained in the canisters placed in the MWL. The April 1, 1997 Cox memorandum to Laskar stated:

> "If metallic sodium is present, as suspected by TA 5 personnel, sampling could be very dangerous as a result of this metal's reactivity."

According to the November 10, 1987 Memorandum regarding the ST-2 Experiment Security, the ST-2 experiment contained pre-irradiated fuel and, therefore introduced some extraordinary potential for radiation exposure. The ST -2 experiment generated radiation levels as high as 100,000 milli/Remhour on close proximity to the package.

The DF (Damaged Fuel) experiments program conducted at Sandia National Laboratories (SNL) was a series of four in-pile fuel damage experiments carried out for LWRs in the Annular Core Research Reactor (ACRR) at SNL in the mid-1980s following the Three Mile Island accident. The DF-1 test assembly consisted of a nine-rod bundle that employed PWR-type fuel rods with a 0.5 m fissile length. The fuel rods were composed of 10% enriched UO2 pellets within a zircaloy cladding. Posttest cross sections show liquefaction losses of fuel in excess of 10 percent volume as well as large fractional losses of cladding material from the upper two-thirds of the bundle. The objectives were to reveal the dominating physical phenomena that participate in severe reactor core damage processes in LWRs and to measure the observed phenomena.

The cladding associated with the MOX fuel used in both the STAR and FD experiments was melted in all tests. The objectives were to reveal the dominating physical phenomena that participate in severe reactor core damage processes and to measure the observed phenomena.

The DF-4 experiment was designed to examine phenomena associated with the heat up, oxidation, and meltdown of a BWR fuel assembly.A7-1, A7-2 The experiment was conducted in the Annular Core Research Reactor (ACRR) at Sandia National Laboratories. The experimental bundle, designed to represent a small section of a General Electric D-lattice core, consisted of fourteen 0.5-m-long fuel rods, a Zircaloy channel box enclosing a representation of the tip region of a BWR control blade, and an insulated shroud consisting of porous ZrO2, which contained a fully dense, ceramic, ZrO2 tube.

A high-temperature oxidation transient was initiated by injecting superheated steam into the bundle. Fission product decay heat was simulated by fission heating of the 10% 235U-enriched fuel rods using the ACRR driver core to drive the heatup. [43]

The STAR program conducted additional experiments in the ACRR that were focused on the release of radioactive gases and materials following the partial melt down and rupture of fuel pins in LMFBRs. Information from these many experiments aided in the development and validation of state-of-the-art computer codes.

Additional experiments (under the STAR program) conducted in the ACRR focused on the release of radioactive gases and materials following the complete or partial melt down and rupture of fuel pins. The phenomena known to participate in the severe fuel damage process include rapid zircaloy oxidation with the associated chemical energy release, melting of cladding, UO2 attack and dissolution by molten zircaloy, relocation of liquefied fuel/cladding mixtures, vaporization and formation of blockage regions by the refreezing of previously molten components around intact fuel rods in cooler regions. Associated with these damage processes is the release of fission products and aerosol.

Sandia TA 5 personnel memoranda described how difficult it would be to dismantle, sample and analyze the canisters in Pits 35 and 36 from the perspective of radiation exposure to personnel and the *very dangerous* reactivity of metallic sodium. Thus, the suspected presence of metallic sodium could have precluded the full disassembly of the canisters in Pits 35 and 36 to remove the irradiated fuel prior to burial and disposal in the MWL. The cladding and fuel became molten and combined with the sodium while located in the ACRR core. Puddling at the bottom of the canisters and plating of the canisters occurred. The metal canisters may corrode over time and potentially release their highly radioactive and hazardous contents. An explosion under the dirt cover is possible if sodium contacts moisture.

The records for the various meltdown experiments do not describe the post-irradiation examination process in the hot cell facility nor the storage or the disposal pathway for the high level waste created by the experiments. It is obvious from the RTMDS records that the MWL was the dumping ground for wastes from the various meltdown experiments. The presence of Cesium-137 (Cs) associated with the irradiation of the oxide fuels and sodium (Na) leads to the conclusion that the canisters in Pits 35 and 36 contain at least some of the byproducts and high level waste produced during the series of LMFBR Prompt-Burst Experiments, Degraded Core Coolability, Debris Bed or other tests that used liquid sodium as a coolant.

VIII. The Waste from the Experiments and Presence of Sodium Na-22

The canisters disposed of in Pits 35 and 36 and elsewhere in the trenches were highly radioactive and contained some amount of high level waste from one or more of the different meltdown experiments conducted in the ACRR. Due to high radiation levels, the cans in Pits 35

and 36 or in the trenches needed to be "mummified" so that they could be safely handled and hurriedly disposed of at the MWL before its closure date in December 1988.[44]

As stated above, according to Sandia memoranda, at least four canisters or "cans" contaminated with high level waste were disposed of in the MWL in Pits 35 and 36 in the Classified area of the MWL. The memoranda describe that Sandia employees expressed concern that the canisters contained sodium that would have been used as a coolant. However, there is no indication that experiments other than the LMFBR experiments used liquid sodium as a coolant. The suspected presence of sodium in the canisters in Pits 35 and 36 requires that the source of the canisters would be from LMFBR tests.

SAND77-1778 *Status of the Design Concepts for a High Fluence Fast Pulse Reactor (HFFPR)*, J.S. Philbin, et.al., describes performance criteria as applied to PAHR reactor safety tests as being "an average radial energy deposition of 2599 j/gm into a 217-pin sodium cooled fuel bundle with a period of 1 msec." http://www.osti.gov/scitech/servlets/purl/6412926/

THE DESIGN AND PROPOSED UTILIZATION OF THE SANDIA ANNULAR CORE RESEARCH REACTOR (ACRR) http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/11/514/11514427.pdf describes "holograms producing pictures of fuel movement taking place in the sodium coolant behind 2.5 cm of reactor and experiment containment." The past use of use of sodium is set forth:

> In the past the emphasis has been on capsule tests of single pin UO2 and *WC* fuels with and without sodium. Supporting experiments to determine the equation-of-state of these fuels are carried out under different heating conditions. Future tests will include multipin geometries, irradiated fuel and flowing sodium as well as separate effects studies of fuel-coolant interactions and the hydro dynamics and thermodynamics of the expanding HCDA core vapor bubble.

Plans for future use of sodium in ACRR experiments are stated:

> Future experiments will involve single and multiple pin geometries with flowing sodium and will utilize the fuel motion detection system. LOF, TOP, and TUCOP heating conditions will be produced.

Table II of the ACRR Program Areas for the Debris Bed (PAHR) experiments states the scope/focus as being:

> Coolability of internal heated debris beds of UO2-steel particulate in sodium are examined over bed powers of interest.

That sodium was used in the experiments involving reactor fuel can be seen from the Radioactive and Toxic Material Disposal Sheets ("RTMDS". Prior to the mid-1970s there is little disposal of sodium seen in the RTMDS records. Disposal of sodium in the MWL took place. Na-22 is found present with multiple other fission products that would have come from ACRR reactor operations. RTMDS 8/5/82 shows there was a Uranium/Sodium loading facility for "Debris Bed" experiments located in 6505/III.

- Radioactive Material Disposal 3/31/64 Na, Be, Sr.
- RTMDS 9/15/71 5 pounds of NA-22 in a plastic bag, buried in Pit 25
- RTMDS 3/6/72 Radioactive waste from Activated Rabbit Na-24
- RTMDS 6/17/76 Na-22 disposed in Trench C
- RTMDS 2/1/77 Na-22,Ra-226, Ba-133, Co-60, Co-57, Mn-54, Pl-651,Pl - 696,Pl -887

- RTMDS 4/5/77 Na-22 1cu ft
- RTMDS 5/11/77 Na-22, Ge-68, Mn-54, Co-60, Fe-55
- RTMDS 9/19/77 Na-22 1cu ft
- RTMDS 12/14/77 Na-22 , H-3 Disposed in Trench C
- RTMDS 9/19/77 Na-22 disposed in Trench C
- RTMDS 11/29/78 Na-22, Ba-133, Sr-85, Pm-147, Cs-137, Ag-110m, Eu-152
- RTMDS 6/6/79 Tc-99, Na-22, Cs-137
- RTMDS 7/17/79 Na-22, Sr-90, Ba-133, Cs-137
- RTMDS 12/15/80 Cs-137, Eu-185m, Eu-155, Sr-85, Na-22
- RTMDS 8-4-81 Eu-155, Cs-137, Na-22
- RTMDS 1/26/82 Na-22, Technicium-99, Cs-137, Sr-85.
- RTMDS 11/3/82- I-125,Cs,-137, Na-22.
- RTMDS 6/23/84 Na-22, Ag-110, Ba-133,Bi-210,Cs-137, Eu-152, Eu-155, I-125, I-129, Pb-210, Pm-147, Ra-226, Ru-106, Sb-125, Sn-113, Sr-90, Tm-171, Tc-99.

Note: Tc-99 has a half-life of 213,000 years, is produced primarily as a fission product in nuclear fuel. Numerous studies have demonstrated that Tc-99 remains highly soluble and mobile in soil and groundwater.. http://pbadupws.nrc.gov/docs/ML0609/ML060930199.pdf , pp.2-1, 2-2. Numerous RTMDS show evidence of Tc-99 dsiposal in the MWL.

- RTMDS 2/19/79 Tc-99, Sr-85, Cs-137, Eu-152, Sr-90, Pm-147
- RTMDS 4/20/79 Tc-99, Sr-85, Cs-137, Eu-152
- RTMDS 6/6/79 Tc-99, Na-22, Cs-137

The July 11, 1977 ACPR Committee Meeting minutes describe a modification of the Power Burst Experiment [PBE] "for positioning the fuel pin … to reduce the sodium volume fraction.

The July 19, 1977 ACPR Committee Meeting minutes describe that all three of the tests for the PBE "will contain sodium and will be maximum pulses.

The April 28, 1980 ACRR Committee Meeting Minutes discuss the Debris Bed Experiment plans to consider retention of fission products in the fuel, liquid sodium, cover gas and on the vessel walls.

The August 31, 1981 ACRR Committee Meeting Minutes describe how disassembly and decontamination of the EOS-2 experimental package would be performed in a chemical hood. Dissolution of UO2 from selected sections of the "Tran" experiment was approved to be done in glove boxes.

Numerous ACRR Committee Meeting Minutes describe the STAR experiments that were performed using pre-irradiated fuel.packages in the ACRR

A 1984 Sandia report for Excess Nuclear Materials (FOIA # 38) considered special nuclear material (SNM) from experiments for reprocessing, disassembly, long term storage, and experiments and parts of experiments for burial. The report stated that large blocks of Hot Cell time were necessary for the disassembly of Degraded Core Coolability [DCC], Post-Accident Heat Removal [PAHR][45], GAP and Power Burst [PB] experiments and destruction of the metallic sodium in the PAHR and PB experiments.(At p. 3) The report estimated that "no more than 2 experiments/year could be disassembled and that the time would be need to be spread over several years (6-8).

The excess nuclear materials report prepared several numbered lists. List 18 included the EEOS, TRAN, DF, STAR, GAP and PB experiments:

p. 4 "List #18 – This is a list of material which was submitted to Gloria Millard for burial."

P. 74 “Basically it includes experiments and samples for which I believe the costs of recovery/reprocessing far exceeds the value of the material. DOE is trying to establish ‘Economic Discard Values’ but to my knowledge nothing has come down the pike.”

The Power Burst Experiments were described in list 18, p.76 as follows:

“These are mixed waste – each sample contained metallic sodium – however, over the storage life of – 8 years, I believe we now have a mix of sodium oxide, hydroxide and possibly some metallic sodium. Economics do not justify the expenditure of manpower to clean up the sodium and sodium compounds and/or the reclaim the SNM.” (Emphasis supplied).

The author stated for the Power Burst materials

“ I would prefer to bury these experiments ‘sans’ the shields. Economics do not justify the disassembly. These experiments would be mixed waste if buried intact.”

The excess materials for the TRAN experiments consisted of cut samples and contaminated hardware from the experiments all of which contained irradiated uranium oxide fuel impregnated with epoxy. Scrap cuttings left over from the DF and GAP experiments consisted of UO2 fine particulates mixed with stainless steel, epoxy, ThO2, some vermiculate, and paper for burial, if approved.

A March 27, 1998 interview with employee Fernando Dominguez, Bldg 882 described:

“Disposed of ‘cans’ in a hurry ‘cause landfill was closing soon. Area V got rid of its cans, hoods, etc. before landfill closed.”

A March 31,1998 interview with employee Max Morris described examples of disposal in the MWL:

“Sandia Engineering Reactor [SER] – 5 megawatt thermal reactor steady state, run 24 hours/day. When decommissioned, all disposable elements were taken apart and disposed of in pits, all fuel test components were disposed of in pits. On the order of 1000s of rem/hr on contact. Truckload after truckload was disposed of during decommissioning. Some elements of reactor exceeded 5000 rem/hr.

“ACRR – disposed of much material in pits ~ 100 rem/hr.

“All reactor materials are quite hot and should remain shielded in soil for decades.”

An interview with a 17 year employee Bob Schwing, who worked most of the time in TA-5 stated:

“Wastes disposed of in Pits from Nevada Test Site [NTS] and SP were examined then disposed of at theMWL.

“A Truck trailer is buried in Trench E or F. Truck trailer was slightly contaminated with Multiple Fission Products [MFP].

“TA-5 routinely sent Operations and Maintenance [O and M] waste to MWL in plastic rad bags, mostly Post-Irradiation Examination [PIE] and related material, from TA-5 reactor, hot cell, and IR facilities.”

The September 1987 CEARP Phase 1 assessment for the MWL did not describe the deposition of waste from any of the meltdown experiments but did state: “Certain pits were designated to contain wastes from special projects.”

A congressionally appointed commission called WERC [Waste Education and Research Consortium] investigated the MWL but was not provided information during the proceedings (2001-2003) regarding the role of the ACRR in relation to the meltdown tests and the disposal of canisters in the MWL classified and unclassified sections. Sandia did not provide the 1997-98 documents to the WERC or the information therein; thus, WERC had no awareness that nuclear fuel canisters came from the fuel meltdown experiments. The WERC Final Report[46] could only identify that:

> b) Location of many dangerous materials appears to be unknown, such as nuclear fuel canisters and possibly radioactive sealed sources.
> c) Amount of hazardous waste is not well understood. For instance, the inventory does not match the characterization of Pit 35, and Trenches B and C.

In December 2004, public hearings were held to consider a modification to the Sandia hazardous waste permit to select a corrective action remedy for the MWL -- installing a dirt cover over the MWL. After the public hearing, a NMED Final Order was issued in May 26, 2005 for the MWL.[47] There are conflicts in the testimony given at the 2004 public hearing for the MWL regarding which tests the canisters in Pits 35 and 36 came from. The 2004 public hearing testimony of Sandia’s witnesses Jerry Peace, Dick Fate and John Gould regarding the canisters at Pits 35 and 36 and elsewhere is at complete variance with their earlier 1997-98 written memoranda. In 2004 Peace, Fate and Gould claimed:

- the canisters are not the ones used in Three Mile Island tests that would have heated fuel until it vaporized;
- personnel familiar with the tests conducted in Area V denied disposals other than at Pits 35 and 36.
- it is not true that cans were placed in small, diameter holes drilled into the bottom of trenches.

The cross-contamination and surface contamination of the canisters was not addressed. The high radiation levels and presence of Cs-137 and other fission products was not addressed. The extreme heat from irradiation for all the experiments was not addressed. The need for mummification before disposal was not discussed. There was no mention of the employee concerns for the presence of sodium in the canisters

It is important to recognize that the change in the testimony by Sandia’s witnesses Peace, Fate and Gould about the canisters came only after Citizen Action had obtained their 1997-98 memoranda and a white paper that was written by Dr. Eric Nuttall about the meltdown experiments based on the memoranda and further research about the Three Mile Island experiments. Three Mile Island waste was disposed of in the MWL.[48] The Peace, Fate and Gould testimony is also in conflict with the RTMDS records.

Contentious issues at the public hearing were whether there was high level waste in the canisters from the experiments and what experiments had produced the canisters.

The hearing officer’s stated at page 41 that “there is a reasonably accurate and complete inventory for the landfill.” The statement grossly fails to identify the true nature and extent of high level waste or hazardous waste disposed of at the MWL. Sandia witnesses made

the unsupported assertion that the canisters that had been used for the mixed oxide tests were empty. The presence of sodium in the canisters would have shown that the canisters were not emptied. As explained above, Sandia's 1997-1998 memoranda described that four canisters were disposed of in Pits 35 and 36 and other canisters in the trenches at the MWL. The memoranda did not describe what specific experiment(s) the canisters came from -- just that the tests were to study the "source term." So confusion was created between the technical meaning for the "source term" and the Source Term experiments, St-1 and ST-2.

During the December 2004 public hearing held for the Sandia hazardous waste permit Class 3 modification for the MWL, Dr. Eric Nuttall, Professor of Chemical and Nuclear Engineering at the University of New Mexico, raised the issue that the canisters in Pits 35 and 36 contained HLW resulting from the severe accident research program. The white paper ("SNL/MWL Nuclear Spent Fuel Disposal," 5/12/03) prepared by Dr. Nuttall, was submitted to the NMED and the hearing officer regarding the HLW issue. Dr. Nuttall served as a panelist on the first WERC "Independent Peer Review of the MWL" (2001) and was responsible for reviewing the inventory of the MWL as a part of the Fate and Transport section on the MWL. Unfortunately, the WERC was not informed of the oxide tests in the ACRR, nor of the MWL disposal pathway.

Dr. Nuttall's research concluded that the high-level waste generated, as a result of the oxide reactor fuel experiments, *is* buried in the MWL and should be characterized as HLW. His report was submitted to the NMED prior to the announcement that Roger Kennett of the NMED/DOE Oversight Bureau would be completing a report on this issue. However, the conclusions reached by Dr. Nuttall were never addressed in Mr. Kennett's report nor were any of the references from Dr. Nuttall's report included in the Kennett report. The Kennett report concluded that only four canisters were disposed of in the MWL. Kennett's conclusion does not square with the statements that additional canisters were disposed of in vertical holes drilled in the bottom of trenches. Nor does the Kennett report address the issue that the canisters in Pits 35 and 36 contained sodium so that the canisters were from the LMFBR tests and could not have been from the ST tests that were made for the LWRs.

At the 2004 public hearing, Sandia claimed that the four canisters instead came from the Source Term ("ST") experiments, ST-1 and ST-2. If the inner and outer canisters were separated to make four canisters, the inner canisters could not have had high level waste removed from them because the molten fuel puddled at the bottom and/or plated the sides of the canisters. The radiation from ST-2 was extraordinarily high and the package contained spent fuel. Sandia claimed it removed the spent fuel from the disposed canisters, a statement that is not technically justifiable due to the plating of the inner canister with molten fuel and cross contamination that would have occurred if there were disassembly of the canisters in the hot cell.

Because the 1994 Class 3 permit modification was a RCRA proceeding, the NMED lacked jurisdiction to fully pursue anything other than the hazardous waste contained in the MWL. Sandia demanded high security clearance to review the records of disposal, stalling NMED personnel from reviewing the records. Thousands of pages of documents that would have taken weeks to examine were not checked out by the DOE Oversight Bureau. Only random disposal records were selected for review. The hearing officer stated at page 8 in the Findings of Fact:

> Richard Kilbury of NMED studied Sandia's inventory records for the landfill, and traced randomly-selected disposal records from the late 1950s to 1989 to the current unclassified waste disposal sheets. Mr. Kilbury was able to successfully trace all 36 records he targeted, gaining confidence in the published inventory and that all classified

> waste was in fact contained in the unclassified inventory (without specific names of the project names and places or weapon numbers). NMED Exhibit 15. On cross and redirect, Mssrs. Fate and Peace testified that several earlier memos Sandia had produced were incorrect, and that later data, interviews and NMED analysis all concluded that no high-level waste was placed in the landfill. TR 424-53. (Emphasis supplied).

Source:
http://www.nmenv.state.nm.us/HWB/SNL/MWL/Final_Decision/Hearing_Off_Rprt_Findings_Fact_Conclusion_Law_(05-20-2005).pdf

Without showing any real paper trail of proof, NMED and Sandia claimed that the spent fuel had been removed from the four canisters. At the 2004 public hearing, Sandia recanted the information contained in the 1997-98 memoranda. Sandia's testimony was that the earlier memos were incorrect. However, the memoranda were the compilation of what management had been informed by many employees and formed the basis for the 1997-98 decision to pursue the no-further-action strategy for the MWL. The assertion in the Sandia memos that the nuclear fuels were removed from the canisters prior to the disposal of the canisters in the MWL has no factual foundation and is contradicted by the contamination that would be present from the various stages of handling of the canisters after the experiments in the Hot Cell. There is no evidence that the canisters were decontaminated. In fact, Pit 36 showed high ground surface exposure rates for Co-60, Na-22 and Cs-137 which are indicative that the disposed canisters in the MWL contain spent fuel contamination from the experiments taking place in a reactor.

Sandia's denial that the 1997-98 memoranda were correct came only in 2004 after Dr. Eric Nuttall filed the white paper based on FOIA documents documenting the possibility that the sodium laced high level waste in Pit 35 and 36 came from the FD or STAR meltdown experiments. At the public hearing, it became necessary for Sandia's personnel to disavow the earlier memoranda that could have led to NMED's denial of the dirt cover remedy.

Without addressing the issue of the presence of sodium in the canisters, the hearing officer concluded dismissively that the Source Term (ST) tests and not the Disrupted Fuel (DF) or STAR tests were the source of the four canisters placed in the MWL. She also concluded that the canisters had been emptied so that high-level fuel did not remain in the canisters.

The hearing officer cited Dr. Nuttall's testimony regarding the lack of quantification and the danger for containers and canisters in the MWL at page12:

> "[Dr. Nuttall] pointed out that what has not been quantified is the status of the various containers and canisters in the landfill (plastic bags, 55-gallon drums), how they will decay and break down in the future, releasing radioactive and hazardous materials, and how those materials will behave and move in the subsurface. He emphasized that since the landfill site is not completely dry, anything placed in it could become mobile in the future once the container it is in is breached, as all containers will eventually. TR 158-71.

The hearing officer cited the testimony of Carolyn Cooper. Ms. Cooper was in no way an expert on the spent fuel or the reactor meltdown studies that had created the high level waste. Ms. Cooper had nothing more to go on than the limited studies that were conducted by Mr. Kilbury. The hearing officer stated at page 29:

> "Ms. Cooper also detailed the research NMED had performed that confirmed that high-level radioactive waste had not been buried at the landfill, and refuted concerns from Dr. Maurice Weisberg and Dr. Nuttall that fuels and wastes from particular experiments had been disposed of in the landfill. TR 912-18."

The hearing officer did however consider Dr. Eric Nuttall to be an expert and stated at page 40:

> "Dr. Nuttall's education, credentials and experience with a broad variety of nuclear and radioactive wastes at many sites give his testimony substantial weight, and the fact that he testified as an independent witness not aligned with any particular group or party increases his credibility."

The hearing officer conceded the lack of knowledge for issues about the tests, containers and their location at page 40:

> "Issues include whether waste from particular tests and projects went in, what sorts of containers were placed where, and how much liquid was placed in or on the landfill. (see Nuttall, Resnikoff and Robinson testimony, AR 03-034, AR 97-001)."

The hearing officer admitted she was "troubled" by the lack of knowledge in the small sampling of the Kilbury-Kennett study that would have taken months to study regarding the inventory of the MWL wastes (at page 41):

> "However, I was troubled by the Kilbury-Kennett study in July 2000, which acknowledged that only 3 hours were spent comparing and tracing 36 items in landfill records that otherwise would take months to study. From this small sampling of records, NMED concluded that the classified records were sound and Sandia knew how much of what went into the landfill over time. I was not convinced that enough was done in this area to verify these records and inventory, particularly given the significant amount of controversy surrounding the inventory raised by Citizen Action's witnesses, the WERC panel and the public. However, in spite of this, based on NMED's and Sandia's testimony, I had to agree that there is a reasonably accurate and complete inventory for the landfill, and that more is known about this landfill than about many other historic landfills." (Emphasis supplied).

Sandia's witnesses' perjury to disavow the 1997-98 memoranda, was an obvious ploy to gain NMED's acceptance of the dirt cover. NMED admitted in its August 2, 2005 response to public comments that sodium could be present in the canisters.[49] NMED provided no explanation of how it was possible to separate the canisters without cross-contamination of the inner and outer canisters with high level waste. NMED did not provide any explanation for why metallic sodium would be present in the canisters disposed of in the MWL or how the high level waste was removed in the presence of metallic sodium. NMED did not explain how the spent fuel could have been separated from the sodium in the canisters where the sodium and oxide fuel had melted together and puddled in the bottom of the canisters and plated onto the sides of the canisters. Worse, NMED made no provision for excavation and examination of the canisters for sodium waste.

The possibility that the canisters were from the Disrupted Fuel (DF) or the STAR tests, as suggested by Dr. Eric Nuttall, was dismissed by the hearing officer. The hearing officer dismissed the issue of disposal of HLW by insisting that the canisters disposed of in the MWL were from the specifically named "Source Term" (ST) experiments and not from the "Disrupted Fuel" (DF) tests.[50] Despite the absence of sodium in the ST tests, even if the ST experiments had been disposed of in Pits 35 and 36, there was no evidence, other than Sandia's self-serving testimony, that the canisters were not at least holding high-level waste from the ST experiments and were cross-contaminated from handling and needed mummification. But again, the great

concern of Sandia management for not removing the canisters from Pits 35 and 36 was that sodium that was present. The ST tests did not use sodium as a coolant. However, even assuming that the canisters were from the ST experiments, there were extremely high radiation readings at ground surface. That indicates that if the fuel had been removed, the canisters were cross-contaminated with HWL during disassembly and analysis in the Hot Cell Facility.

The hearing officer (paragraph 79) incorrectly stated that "the short duration of tests involving fresh nuclear fuel did not change the uranium or plutonium content inventory in the fresh or spent fuels and fresh fuels used in the tests did not become spent." Irradiation of UO2 fuel will always cause an increase in fission products such as plutonium and Cs-137. The fresh fuel in the tests was unusable after the tests because of the disruption and/or melting of the fuel. The fact is that pre-irradiated fuel was present in many of the experimental packages and the melting and/or vaporization of the fresh and pre-irradiated fuel made that fuel unusable.

The hearing officer's findings of fact and conclusions of law at paragraph 79 describes that "Four canisters from two ST experiments were placed in the MWL." The hearing officer concluded that the fuel used in the ST experiments would not create high-level waste. That flatly contradicts scientific reality. The fuel pins used in the ST-1 and ST-2 experiments included both fresh and previously irradiated fuel pins.[51] The ST-1 and ST-2 experiments were placed inside the core of the ACRR reactor and the test sections were fission heated until the test sections reached a temperature greater than 2400º Kelvin. Fission products were released and collected in the ST tests. These fission products included Cesium-137, Tellurium, Europium, radioactive Iodine, Barium, and Strontium. The previously irradiated fuel from the BR-3 reactor already contained a plutonium-239 and uranium-235 inventory. The irradiation of the ST packages in the core of the ACRR changed the inventory of both plutonium and uranium in the fresh fuel and the previously irradiated fuel as well as creating other fission products.

At the conclusion of the public hearings, the May 26, 2005 Final Order decided upon the corrective measure of a dirt cover for the MWL, with a review for the feasibility of excavation, fate and transport model, groundwater monitoring and effectiveness of the remedy to be performed every five years. A 2006 TechLaw, Inc. report contracted for by NMED considered the dirt cover to not be protective and found the dirt cover to have been improperly designed for monitoring for moisture beneath the cover.[52] NMED improperly withheld the TechLaw report by filing a lawsuit against Citizen Action. The lawsuit was dismissed and Citizen Action obtained the TechLaw report in November 2009 after the dirt cover had been installed at the MWL. Citizen Action had to sue the EPA Region 6 and the EPA Office of Inspector General to obtain a Region 6 technical report that showed concerns for groundwater monitoring and recommendations that the groundwater monitoring wells needed replacement.

Sandia continues to take the dishonest position that only low level mixed waste is present in the MWL despite the very high radiation levels that the NMED identified at ground surface of Pits SP-35 and SP-36 where the canisters from the severe accident tests were disposed, and at SP-4 where reactor vessel plates were buried and disposed. The presence of Na-22 along with Cs-137 at Pit 36, as described in the March 20, 1997 Cox Memo, is evidence of sodium irradiation in the ACRR. The nature and names of the experiments, the location of the disposal and the contents of the additional cans disposed of in the vertical holes drilled into the trenches of the MWL should be demanded by the NMED and revealed by Sandia.

IX. Defective groundwater monitoring practices at the MWL. Groundwater monitoring wells used for the data on which to base the dirt cover decision were defective and did not provide reliable and representative samples.

Groundwater monitoring wells were installed in the wrong locations at the MWL and were drilled with mud rotary techniques that hid evidence of contamination to the groundwater. Improper

sampling methods were in place. These problems were described extensively in NMED and EPA Region 6 documents throughout the 1990s. However, the bogus data from the monitoring wells was used to make the administrative decision to leave the MWL wastes under a dirt cover in the 2005 Final Order, conditioned upon the review of feasibility of the wastes "every five years." See http://www.radfreenm.org/images/PDF/MWL/MWL_exec_rpt_1-2011.pdf

No reliable groundwater monitoring network has ever been in place to monitor the groundwater beneath the dump. The New Mexico Environment Department, the Environmental Protection Agency and DOE/Sandia knew in the early 1990s that the groundwater monitoring wells were put in the *wrong locations* at the MWL dump. The agencies knew also that the wells had *corroded well screens,* were improperly sampled, had well screens cross-contaminating different strata of fine-grained sediments and the Ancient Rio Grande strata, and were *contaminated with Bentonite clay that hides evidence of contamination*. Shortly after four monitoring wells were installed, it was learned that the flow of groundwater was not to the northwest, but to the southwest. The monitoring wells were providing data that could not possibly be accurate. Nevertheless, the NMED accepted the erroneous data to make the decision in 2005 to leave the MWL dump wastes in place under a dirt cover.[53] In 2012, Sandia applied for the Long Term Monitoring and Maintenance Plan (LTMMP) with a knowingly defective groundwater monitoring network that will continue to hide evidence of contamination.

The inadequate condition of the pits and the poor control of water entering the buried wastes at the MWL dump is illustrated by a memorandum dated November 20, 1996 from Sandia staff person Mr. Jerry Peace to DOE staff person Mr. John Gould. Gould stated:

> "Pit caps in the classified area [of the MWL dump] are in serious need of repair. Many concrete caps have collapsed under their own weight because they were not formed, reinforced, or finished when poured. Plywood caps need immediate attention because they are rotting and slumping into the pits. **These collapsed pit caps act as funnels, channeling precipitation into buried waste [Emphasis supplied].** These caps have collapsed because backfilled soils have settled over time, leaving a void directly beneath the concrete or plywood cap (p.2)."

Source: *Defective Groundwater Practices at the MWL Dump*, Gilkeson (2011) at section 1.3.[54]

The poorly managed disposal and maintenance practices at the Sandia MWL allowed a large amount of water to enter the buried wastes. For example, 270,000 gallons of reactor waste water from the ACRR was disposed of in the MWL's Trench D. A uranium chip fire in the MWL had to be extinguished with 5,000 gallons of water. The precipitation and uncontrolled surface water flows onto the MWL dump introduced a large and unknown amount of water into the buried wastes increasing the likelihood of contaminant transport to the groundwater. There was poor control of precipitation and surface water run-in to the wastes dumped into the unlined trenches and pits 1). during the 30 years of disposal operations from March 1959 through December 1988 and 2). during the 18 years from 1989 to 2006. The annual amount of precipitation that fell on the MWL dump was 8.5 inches.[55] Berms around the MWL were washed away during powerful storms in 2006-2007 with pooling of water. Water that may enter the MWL through the dirt cover can pool in the underlying trenches in a sort of "bathtub" effect. According to Hakonson[56]:

> D 6.1.2 Subsurface Processes- Depending on climate, geology and soil conditions, water that infiltrates into and through the cap on old landfills can accumulate in the trench (bathtub effect) and/or percolate with solutes into groundwater. Percolation can also increase subsidence of the cap as a result of enhanced decomposition of bulky

waste in the trench. Subsidence may occur some variable time after closure of the land disposal unit and after final placement of the cover.

The stainless steel canisters, polyethylene bags, wooden crates and other containers are all subject to corrosion and potential release of their contents. No risk assessment was performed for the release of the total contents of the MWL.

The risk assessment for the MWL did not consider there to be a pathway to the groundwater. Soil vapor data clearly shows the contrary to be true. The presence of nickel, nitrates, chromium and nitrates in older groundwater monitoring wells also shows that the MWL wastes can and are reaching the groundwater. Soil vapor data from 2014 shows TCE and PCE have migrated from the MWL to more than 400 ft below ground surface. Earlier tritium isopleths showed that tritium had moved outside the downgradient boundary of the MWL. In 2007 the EPA Region 6 informed the NMED by email report to William Moats of the need for additional monitoring wells to be placed in both the northern and southern sections of the MWL. The EPA email report pointed to the flaws of all the existing monitoring wells at the MWL. NMED did not order the monitoring wells in those locations. MW-1 to the north of the MWL had shown excessively high levels of nickel. An acid pit in the southern portion of the MWL was routinely used for disposal and has never been monitored.

The MWL was misclassified as a Solid Waste Management Unit (SWMU). Because the MWL received hazardous wastes after July 26, 1982, the MWL is a "regulated unit."

Because there is significant statistical evidence that release of contaminants has occurred from the MWL, Sandia is required to immediately sample for the full list of groundwater monitoring constituents in 40 CFR Part 264, Appendix IX Groundwater monitoring appropriate to a regulated unit has not been imposed at the MWL.

Sandia is required to submit a ***permit modification*** to establish a compliance monitoring program within 90 days. Instead Sandia has submitted a request for a Certification of Completeness for Corrective Action despite the fact that releases of contamination in excess of limits are in evidence.

Sandia employees expressed concerns memorialized in memoranda written by Sandia managers that the canisters disposed of in Pits 35 and 36 were suspected to contain sodium, which is extremely reactive if exposed to air and would make excavation, characterization and disposal of the contents of the canisters exceedingly difficult.[57] An explosion of such wastes in the MWL could cause further release of contamination from the MWL to the vadose zone and create a fractured pathway for contamination to move to groundwater.

X. Presence of Nickel in Groundwater Monitoring Wells MW-1 and MW-3.

RCRA criteria identify that the nickel contamination measured in the ground-water samples collected from the Sandia MWL dump monitoring wells MWL-MW1 and -MW3 are from the nickel wastes buried in the Sandia MWL dump. The 1998 NMED Notice of Deficiency (NOD) Report 10 determined that the nickel wastes buried in the MWL dump were responsible for the high concentrations of nickel that were measured in the groundwater samples collected from monitoring wells MWL-MW1 and -MW3.

The concentrations of Nickel in MW-1 exceeded the EPA MCL for drinking water standards. Sandia and NMED claimed at the December 2004 Public Hearing that the high levels of nickel were from well screen corrosion of the monitoring wells but no isotopic analysis for nickel was ever performed. See http://www.radfreenm.org/images/PDF/MWL/MWL_exec_rpt_1-2011.pdf Pp. 101-106.

The RTMDS record proves conclusively that Nickel-63 was disposed of in the MWL over many years:

- Radioactive Material Disposal (RMD) 5/10/65 Ni-63 disposed of in Trench A
- Report of Expended SS Material 3/31/66 Al and Nickel Plated Assembly deposited with 12 kgs of Du-238 in Hole #16
- RMD 1/15/65 5 Nickel batteries
- RMD 8/25/67 and 8/27/67 Ni-63 disposed of in classified hole
- Report of Expended SS Material 5/29/69 Nickel Plate Coupon
- RTMDS 1/22/71 Scrap Nickel, Reactor Material Plastic Bag in Hole No. 25.
- RTMDS 1/15/73 Ni-63 Trench B
- RTMDS 2/1/78 Ni-63 250 tubes 2 cu ft
- RTMDS 3/8/78 Ni-63 2.5 cu ft
- RTMDS 8/16/79 Ni-63

XI. A short list of other RCRA wastes buried in the MWL

- RTMDS 7/2/74 75 pounds of Mercury
- 6/9/78 Lithium wastes
- PCBs, VOCs, SVOCs
- RTMDS 8/2/79 Lithium
- Extremely "hot" ends from fuel elements in the Sandia Engineering Reactor (SER) were deposited in the MWL in Classified Area Hole #25. 1/21/70, 1/15/71, 2/18/71
- Numerous RTMDS exist for Pu-239, -238, DU-238, UO2-235, Thorium, Radium, Ra-226, Beryllium, Lead, Mercury, Tritiated water (H3), fission products, etc.
- An entire fire engine, semi-trailer, spent fuel cask, Plutonium Arc Tunnel, Beryllium Catcher, missile parts, nuclear weapons debris

XII. Disposal of the HLW waste from the experiments is illegal and violates the public trust

At least 30 nuclear fuel meltdown experiments were performed. Single and multiple fuel pin assemblies were used. Such a large toxic inventory with so much ambiguity in its description, lack of certainty in the locations and depth of drilling requires excavation, retrieval and safe storage to protect the public from the long term danger. There is not an adequate record for Sandia to leave mixed hazardous, TRU, HLW and LLW in the unlined pits and trenches of the MWL above Albuquerque's drinking water resource.

Compare the Waste Isolation Pilot Project (WIPP) facility with the MWL. WIPP is a $6 Billion dollar facility, constructed one-half mile deep in a salt mine with highly engineered tunnels, rooms, filter systems, alarms and 24-hour monitoring, and waste acceptance criteria. Nevertheless, WIPP LEAKED PLUTONIUM into the environment from an explosion in Room 7 Panel 7. What would be the cosequences for Albuquerque if an explosion from canisters containing sodium and spent fuel took place in the MWL? What then is to be expected from the MWL over time and what problems will be present for clean up? The MWL already shows evidence of contamination of the groundwater from nickel, cadmium, nitrates, TCE and tritium more than 120 ft below the MWL.

By its actions at the MWL, DOE/Sandia have violated the public trust and committed criminal acts against the environment:

- The disposal of high level wastes containing extremely reactive sodium in the MWL, while lacking a license for the land disposal of high-level mixed waste or an exemption for the disposal from the NRC;
- Sandia's deliberate omission of facts about the location, nature and extent of the high level mixed waste;
- the deliberate destruction and alteration of the records of disposal;
- the failure to keep an accurate inventory for the high level waste;
- the use of a RCRA proceeding to gain no further action by omission of substantive facts and knowingly providing incorrect information and omitting substantial information about the high-level waste during the administrative hearing for the MWL;
- disposing high level waste with a defective groundwater monitoring network and beneath a dirt cover that cannot be protective for 1,000 years let alone 10,000 years;
- allowing the escape of tritium, nickel, cadmium, beryllium, TCE, PCE and nitrates from the pits and trenches to the vadose zone and the groundwater;
- the failure to perform the May 26, 2005 Final Order requirement for an excavation review every five years.

As governmental agencies charged with protection of the public's environmental assets, DOE/Sandia, the NRC, and the NMED have violated the public trust for present and future generations by allowing the MWL to contaminate the groundwater, soil and air. The Constitution of the State of New Mexico expressly declares that water belongs to the public.[58] There is violation of the precautionary principle to take protective action against known hazards before harm occurs. There is the violation of sustainable development in that DOE/SNL have contaminated, and the NRC and NMED have allowed and caused the public land resource to become unusable and a threat to public health and safety for millennia to come. These governmental agencies have failed to implement the necessary safeguards to ensure publicly accessible natural resources which are necessary for public welfare and survival. The agencies have failed to provide a plan that can restore the resource assets to usable condition. These agencies have failed to act as governmental trustees in a fiduciary capacity to manage the resources that are in the corpus of the trust as a long-term steward for the benefit of both present and future generations.

The unwillingness of DOE/Sandia to protect the public and environment is unmistakable in the 1997-98 memoranda. Cox describes the opposition of Sandia to examine the canisters for suspected hazardous contaminants that could contain metallic sodium. Sampling "could be "very difficult" and "very dangerous" and result in personnel radiation exposure, violating ALARA. Sandia knew the possibility existed for cross contamination from mixed hazardous waste in the landfill. Sandia failed to design and develop the custom shielded storage containers necessary to safely contain the waste and maintain radiation levels at an acceptable level while in storage awaiting disposal.

Sandia failed to add the MWL to the SNL/NM Site Treatment Plan. Sandia only considered and worked "diligently to avoid the very high costs associated with additions to the STP." Sandia determined to leave the high-level wastes in shallow pits and trenches beneath a dirt cover that is not protective of the aquifer.

Federal regulations are clear that HLW cannot be disposed of in shallow pits and trenches such as those at the MWL. Sandia knew it violated the federal requirements for disposal of high-level wastes in deep repositories. Leaving the canisters in the ground provided SNL a streamlined and inexpensive disposal process even though it violated federal law and the public trust.

DOE/Sandia and NMED have failed to provide justifiable and transparent decision making for the MWL to protect the public health and safety and water resource.

APPENDIX 1

Incorrect statements made in the Conclusions and Recommendations of the Hearing Officer for the MWL Class 3 Permit Modification.

Paragraph 76 -- "The SNL memoranda stated that the nuclear fuels were removed from the canisters prior to the disposal of the canisters in the MWL."

February 20, 1997 Peace memo – "Contamination [of the primary and secondary cans] may have occurred during disassembly of the nested configuration due to contaminated hands and fingers [in the hot cell gloves]."

Moreover Paragraph 76 does not address the additional cans that were not inventoried and were disposed of in holes drilled in the bottom of trench. In addition, the fuel was "disrupted during the majority of the tests and occasionally vaporized.

Paragraph 77 – "Experiments using fresh fuel were also conducted in the ACRR, but the short duration of these tests did not cause the fuel to become spent."

The August 3, 2001 Database of spent fuel states that "The cladding associated with the MOX fuel used in both [the STAR and FD projects] was melted in all tests."

Paragraph 80 -- NMED's research determined that the four canisters described in the two 1997 SNL memoranda were from a different experimental series, the ST, and not from the DF experiments as Dr. Nuttall had thought.

Comment: The 2001 Spent Fuel Database states:

> "There were two ST experiments performed at SNL, ST-1 and ST-2. … The fuel used in the ST-1 and ST-2 experiments was from two sources. The previously irradiated fuel rods were from the BR-3 reactor in Mol, Belgium and the fresh fuel was fabricated at PNL. There are four containers of ST material in the Spent Fuel Database. All are shielded containers and the material is described as 'scrap' or 'scrap fuel samples.' Current exposure rates are not available for these ST containers, but the rates are expected to be high because previously irradiated fuel was used in each test."

Comment: The containers of scrap described by the Spent Fuel Database as remaining after the ST experiments are inconsistent with the canisters (cans) that were described as being 9 inches wide and 16 to 20 feet long that were placed in the MWL. Assuming that the ST canisters were those that were placed in the MWL, the ST canisters would nevertheless contain high levels of radiation from previously irradiated spent fuel and fresh fuel that had been tested under severe accident conditions. The disposal of ST storage containers would have been nonetheless in violation of federal law for disposal of HLW in shallow pits and trenches in the MWL.

Paragraph 82 – NMED's research concluded that the STAR canisters were not opened after the experiments.

Comment: The canisters were clearly disassembled according to the February 20, 1997 Peace memorandum that states:

> "The primary can, with fuel in place, was slipped inside a secondary can of slightly larger diameter. This nested configuration was then lowered through a hole in the floor and placed next to the core of the ACRR for approximately one hour. The core generated temperatures of 2500º K which vaporized or melted the fuels in the primary can. <u>The nested cans were then removed from the core and disassembled to study the source term of a simulated meltdown of oxide fuels.</u>"

[1] http://www.nmenv.state.nm.us/HWB/SNL/CMS/App_G_Tech_Approach_&_Cost_Estimate.pdf
Appendix G **Technical Approach and Cost Estimate for Excavation of the Classified Area Using Robotics**

1.2.3 Historical Radioactive and Mixed Waste Disposal Request Validation and Disposal Project (HDRV), Sandia National Laboratories, Albuquerque, New Mexico

A remote robotic system was developed, deployed, and operated to perform drilling, cutting, and manipulation tasks on 34 unknown radioactive contaminated cylindrical objects. A fully integrated robotic system was developed and deployed. The system consisted of robot manipulator, a tool rack, and a workbench. Site operations were conducted for approximately 11 days, followed by removal of the system over a two-day period.

During site operations, individual cylindrical objects were robotically retrieved and placed in the vise. A hole was drilled into the end of the object, and Tritium, O2, and lower explosive level (LEL) sensors were utilized by the robotic system to characterize the contents. In Addition, the robotic system was used to consolidate the contents of the cylinders into a single 5-gallon container.

[2] http://www.epa.gov/region6/6pd/rcra_c/pd-o/session7-groundwater-monitoring.pdf

[3] http://www.zerowasteamerica.org/LandfillsFedRegEPA.htm

[4] The Atomic Energy Act, as revised in 1978 and in 2005 by the Energy Policy Act, defines byproduct material in Section 11e.(1) as radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or using special nuclear material.

"Special nuclear material" (SNM) is defined by Title I of the Atomic Energy Act of 1954 as plutonium, uranium-233, or uranium enriched in the isotopes uranium-233 or uranium-235. The definition includes any other material that the Commission determines to be special nuclear material, but does not include source material. The NRC has not declared any other material as SNM.

In general terms, "source material" means either the element thorium or the element uranium, provided that the uranium has not been enriched in the isotope uranium-235. Source material also includes any combination of thorium and uranium, in any physical or chemical form, or ores that contain by weight one-twentieth of one percent (0.05 percent) or more of uranium, thorium, or any combination thereof. Depleted uranium (left over from uranium enrichment) is considered source material.

[5] Notes taken of interviews with Frank Stazula at Area V from November to December 1984 by G.C. Millard (FOIA #58)

[6] http://www.nrc.gov/waste/high-level-waste.html

[7] 40 CFR §§ 270.30 (l)(11) and 20.4.1.900 NMAC require that NMED and DOE/Sandia have a duty to verify whether information is incorrect and to promptly submit correct information. Where the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Director, it shall promptly submit such facts or information.

40 CFR §§ 270.41-270.43, 270.43(2) The permittee's failure to fully disclose all relevant facts in the application or during the permit issuance process, or the permittee's misrepresentation of any relevant facts *at any time* can be grounds for the termination, modification, revocation or reissuance of a RCRA permit.

[8] 40 CFR § 61.3 License required.

(a) No person may receive, possess, and dispose of radioactive waste containing source, special nuclear, or byproduct material at a land disposal facility unless authorized by a license issued by the Commission pursuant to this part, or unless exemption has been granted by the Commission under § 61.6 of this part.

(b) Each person shall file an application with the Commission and obtain a license as provided in this part before commencing construction of a land disposal facility. Failure to comply with this requirement may be grounds for denial of a license.

[9] 40 CFR 270.1 (c) Owners and operators of hazardous waste management units must have permits during the active life (including the closure period) of the unit. Owners and operators of surface impoundments, landfills, land treatment units, and waste pile units that received waste after July 26, 1982, or that certified closure (according to § 265.115 of this chapter) after January 26, 1983, must have post-closure permits, unless they demonstrate closure by removal or decontamination as provided under § 270.1(c)(5) and (6), or obtain an enforceable document in lieu of a post-closure permit, as provided under paragraph (c)(7) of this section. If a post-closure permit is required, the permit must address applicable 40 CFR part 264 groundwater monitoring, unsaturated zone monitoring, corrective action, and post-closure care requirements of this chapter. The denial of a permit for the active life of a hazardous waste management facility or unit does not affect the requirement to obtain a post-closure permit under this section.

[10] May 26,2005 Compliance Order on Consent Condition #5 at pg. 5:

5. Sandia shall prepare a report every 5 years, re-evaluating the feasibility of excavation and analyzing the continued effectiveness of the selected remedy. The report shall include a review of the documents, monitoring reports and any other pertinent data, and anything additional required by NMED. In each 5-year report, Sandia shall update the fate and transport model for the site with current data, and re-evaluate any likelihood of contaminants reaching groundwater. Additionally, the report shall detail all efforts to ensure any future releases or movement of contaminants are detected and addressed well before any effect on groundwater or increased risk to public health or the environment. Sandia shall make the report and supporting information readily available to the public, before it is approved by NMED. NMED shall provide a process whereby members of the public may comment on the report and its conclusions, and shall respond to those comments in its final approval of the report.
http://www.nmenv.state.nm.us/hwb/SNL/MWL/Final_Decision/Final_Order_(05-26-2005).pdf
[11] http://www.epa.gov/oig/reports/2010/20100414-10-P-0100.pdf *Region 6 Needs to Improve Oversight Practices*
Auditor interviews with EPA Region 6 technical staff show that incorrect data from the known defective groundwater monitoring network was used to make the decision to leave the hazardous wastes in place at the MWL.
[12] http://www.abqjournal.com/scitech/596965nm09-24-07.htm N.M. Fights to Keep Landfill Report a Secret http://www.abqjournal.com/news/state/604899nm10-24-07.htm NMED Sues to Keep Report Closed
http://www.radfreenm.org/old_web/pages/PressReleases/20091111PressReleaseNmedObeysCourtOrderToReleaseTechLaw.pdf -- New Mexico Environment Department Obeys Court Order

to Release Secret TechLaw Report to Citizen Action http://www.firstamendmentcenter.org/n-m-judge-agrees-report-on-sandia-landfill-is-public-record http://www.radfreenm.org/old_web/pages/Legal/lg-2008oct08a.pdf 1st Judicial District Court Decision

[13] http://www.dnfsb.gov/sites/default/files/Board%20Activities/Reports/Staff%20Issue%20Reports/Sandia%20National%20Laboratories/2012/sir_2012228_18581_115.pdf

Adequacy of Safe Harbor Methodology. During this review, the Board's staff determined that NUREG-1537, *Guidelines for Preparing and Reviewing Applications for the Licensing ofNon-Power Reactors* (1996), may be a more appropriate safe harbor for test reactors such as the ACRR. NRC regulators use NUREG-1537 for licensing of new non-power reactors. Although the Nuclear Safety Management Rule (Title 10, Code of Federal Regulations, Part 830) provides the option of using a "successor document" to Regulatory Guide 1.70, the contractor did not exercise this option. Several of the issues related to the DSA for the ACRR could have been avoided if NUREG-1537 had been consulted at the time the DSA was developed. Given that SNL personnel have now committed to completing a review of the accident analyses and perhaps a significant revision of the DSA, it would be prudent for them to consider using NUREG-1537 as the safe harbor approach. The Board's staff suggests it might be prudent for DOE to consider providing additional guidance to its contractors to use NUREG-1537 as the safe harbor for research and test reactors.

See also, http://www.radfreenm.org/index.php/sandia-s-unsafe-reactor

See also, regarding Sandia's Auxiliary Hot Cell Facility -- http://www.radfreenm.org/images/PDF/DNFSB/DNFSB-Letter_To_L_Brooks_9-27-2004.pdf "The methodology used to develop and present the hazard and accident analysis was inconsistent with the approved standard for the development of DSAs. Discussions with site personnel indicated that the underlying weaknesses are not limited to this single DSA, but reflect fundamental problems in the approach used to analyze Technical Area (TA)-V nuclear facilities at SNL. **Conclusion.** The DSA for the AHCF does not appear to be consistent with the safe harbor methodologies of the Nuclear Safety Management Rule, and does not provide an adequate assurance that the operational hazards have been identified through a comprehensive hazard and accident analysis."

[14] SNL Consent Order, p. 11 ¶ 56. http://www.nmenv.state.nm.us/HWB/SNL/Order_on_Consent/final/SNL_CONSENT_ORDER_April-29-2004_FINAL.pdf

[15] May 26, 2005 Final Order, paragraph 5.

[16] http://alibi.com/news/13096/Covering-Our-Tracks.html -- "Dick Fate, environmental restoration manager for project closure with Sandia, said the site will also remain closely monitored, and will be re-evaluated every five years to see if there are any signs that it should be excavated."

[17] http://pbadupws.nrc.gov/docs/ML0624/ML062440075.pdf p. 4

[18] NUREG-1465, Page 1

[19] http://www.inl.gov/technicalpublications/Documents/3634258.pdf *Long-Term Corrosion of Underground Stainless Steels* -- A growing environmental concern is the contamination of soil and groundwater by radionuclides and hazardous chemicals released from corroding metal waste forms and containers. Corrosion causes release of contamination in two ways: (1) via leaks from aging tanks or waste containers, where contaminants become readily available for

transport; and (2) via the corrosion process itself, where the contamination becomes available for transport as the surface of the buried contaminated bulk metal waste is reduced by chemical and physical attacks. The natural processes that release these contaminants to the environment and the rates at which the releases occur are poorly understood and inadequately defined. Understanding the corrosion, release, and transport processes is critical to predicting soil and groundwater contamination.

[20] WASH-1400 (NUREG 751014) The Reactor Safety Study "An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants," Professor Norman C. Rasmussen (January 19, 1975).
See also, SAND94-2157 *A COMPARISON OF WORLD-WIDE USES OF SEVERE REACTOR ACCIDENT SOURCE TERMS* (September 1994) p. 1. http://www.laka.org/docu/boeken/pdf/6-01-3-90-48.pdf -- "The formulae used for the calculation of the dilution and deposition of radioactive materials release from a reactor included a term that described the magnitude and the duration of radioactive material release from the reactor. This term, usually designated by the symbol **S** or in the equations, became known as the "source term." It has come to include a description of the physical and chemical forms of the released materials as well as the magnitude and duration of the release. … The technical understanding of radionuclide release and behavior has advanced greatly and the source terms are now much more complicated. A persistent confusion exists concerning 'source terms to the containment' and 'source terms to the environment.'"

[21] February 20, 1997 Memorandum of Jerry Peace to Mark Jackson and John Gould, Subject: Mixed Waste Landfill Classified Area Pit Contents

[22] *Mixed Waste Landfill Classified Area Pit Contents,* memorandum from Jerry Peace to Mark Jackson and John Gould, February 20, 1997

[23] DiNunno, J. J., *et al*., March 1962, "Calculation of Distance Factors for Power and Test Reactor Sites," Technical Information Document (TID)-14844, U.S. Atomic Energy Commission. http://pbadupws.nrc.gov/docs/ML0217/ML021750625.pdf -- for review and analysis of the probability and consequences of potential accidents in applications for siting nuclear reactors.

[24] SANDIA REPORT SAND2011-3404 *The Development of a Realistic Source Term for Sodium-Cooled Fast Reactors: Assessment of Current Status and Future Needs* (June 2011) Pages 17-18. And see TID-14844 and NUREG-1465 http://prod.sandia.gov/techlib/access-control.cgi/2011/113404.pdf

[25] http://www.radfreenm.org/old_web/pages/secretDocuments.htm

[26] The MWL does not meet the requirements of the Resource Conservation and Recovery Act (RCRA) to qualify as a landfill because it has no liners, leachate detection or leachate recovery systems in place.

[27] ERDA document 1977

[28] The DF-4 Fuel Damage Experiment in ACRR with a BWR Control Blade and Channel Box, NUREG/CR-4671, SAND86-1443, November 1989. p. xv
http://babel.hathitrust.org/cgi/pt?id=mdp.39015038146505;view=1up;seq=3

[29] A May 15, 1995 Memo from Sandia's Manager for Material Systems and Security Audits (name deleted) to Idaho National Laboratory regarding Sandia Spent Fuel indicates the practice of disposal of irradiated reactor waste from the experiments. The Memo stated in pertinent part:

> "Enclosed a summary of Sandia's spent nuclear fuel based on the INEL definition of spent fuel which states, "Fuel withdrawn from a reactor following irradiation to the point where it cannot be contact handled and the constituent components have not been removed or separated by reprocessing." This information does not include those reactor

irradiated nuclear materials (RINM) that were used in experiments. It is intended that the RINM will be disposed of as waste from the experiment processes. …"

[30] 9-11-1997 NMED - Denial-Report on MWL Phase 2 RFI see Comment 7 http://hwbdocuments.env.nm.gov/hwbdocs/HWB/snl/Mixed_waste_landfill/SNL_MWL_Records/9-11-1997%20NMED%20-%20Denial-Report%20on%20MWL%20Phase%202%20RFI.pdf

[31] Memorandum John Gould to Dick Fate, November 20, 1998.

[32] 40 CFR 264.90(a)(2) defines a regulated unit and provides special groundwater monitoring requirements under 40 CFR 264.90-100 that differ from those for a SWMU.

[33] 40 CFR 270.1(c) Owners and operators of surface impoundments, landfills, land treatment units, and waste pile units that received waste after July 26, 1982, or that certified closure (according to §265.115 of this chapter) after January 26, 1983, must have post-closure permits, unless they demonstrate closure by removal or decontamination as provided under §270.1(c)(5) and (6), or obtain an enforceable document in lieu of a post-closure permit, as provided under paragraph (c)(7) of this section.

[34] http://radfreenm.org/images/PDF/MWL/MWL_exec_rpt_1-2011.pdf

[35] Documents obtained by Citizen Action were the result of a Freedom of Information Act lawsuit

[36] The total acreage of the MWL is 2.6 acres.

[37] https://inis.iaea.org/search/search.aspx?orig_q=RN:8343982 *Millisecond-period meltdown experiments on prompt-burst effects and molten-tin-water dropping experiments*

"The U.S. Nuclear Regulatory Commission has initiated a program of confirmatory research for the safety assessment of LMFBR plants. In the sodium-fuel interactions area, this research includes a series of real-time in-pile experiments on the pressure and work potential of prompt-burst excursions as well as laboratory dropping experiments with molten tin and water. The in-pile experiments are performed by Sandia Laboratories in the Annular Core Pulse Reactor (ACPR), which has a minimum period of 1.3 milliseconds. These single-pin experiments are performed in a piston-loaded, stagnent-sodium autoclave, that is conceptually similar to the one used in the S-11 TREAT test. Unlike the S-11 test, however, realistic radial temperature profiles are obtained in the fuel, the cladding, and the sodium by pre-pulsing the reactor about 1/2 second before the main pulse."

[38] NUREG/CR-4805 (1 Of 2) SAND86-2752 (1 Of 2) R3, R5, R7 May 1987 **Reactor Safety Research Semiannual Report January - June 1986 Volume 35**
http://prod.sandia.gov/techlib/access-control.cgi/1986/862752-1.pdf
See also, **Reactor Safety Research Semiannual Report July - December 1986 Volume 36**
http://prod.sandia.gov/techlib/access-control.cgi/1986/862752-2.pdf

[39] Document 157 describing the spent fuel database was obtained by Citizen Action from a Freedom of Information Act request.

[40] The August 3, 2001 Memorandum regarding the Spent Fuel Database discusses the form of the canisters and how they will ship them to Idaho National Laboratory. The data base was written to consider offsite shipment from Sandia. It is unknown if the waste in the database was shipped offsite.

[41] SAND—88-0597C DE88 015694 ACRR FISSION PRODUCT RELEASE TESTS: ST-1 AND ST-2, M. D. Allen, H. W. Stockman, K. O. Reil, A. J. Grimley, and W. J. Camp (August 1988)

[42] Id., Fig. 5 at page 214-6

[43] http://pbadupws.nrc.gov/docs/ML0103/ML010310397.pdf Appendix A 7-1

[44] Memorandum Jerry Peace to Mark Jackson and John Gould, subject: Mixed Waste Landfill Classified Area Pit Contents (February 20, 1997).

[45] http://www.osti.gov/scitech/servlets/purl/6412926 p,21

[46] Final WERC Peer Review Report 1-31-03 http://www.ieenmsu.com/wp-content/uploads/2011/07/finalreport.pdf
[47] http://www.nmenv.state.nm.us/HWB/SNL/MWL/Final_Decision/Final_Order_(05-26-2005).pdf

[49] NMED Responses to Public Comments on the Sandia National Laboratories' Mixed Waste Landfill Permit Modification for Corrective Measures August 2, 2005, See NMED Response R1 http://www.nmenv.state.nm.us/HWB/SNL/MWL/Final_Decision/Response_to_Comments_(08-02-2005).pdf
[50] Transcript
[51] ACRR Fission Produce Release Tests: ST-1 and ST-2, M.D. Allen, et al., Sandia National Laboratories (August 1988) SAND –88-0597c, DE 88 015694
[52] http://www.radfreenm.org/old_web/pages/SecretDocuments/sd-2006jan31a.pdf
[53] August 2007 email to NMED William Moats from Rich Mayer EPA Region 6 and attached technical draft. And see, http://www.radfreenm.org/old_web/pages/GroundWater.htm
[54] http://www.radfreenm.org/old_web/pages/GroundWater.htm
[55] 2. Ho, C.H., T.J. Goering, J.L. Peace, M.L. Miller, January 2007. "Probabilistic Performance-Assessment Modeling of the Mixed Waste Landfill at Sandia National Laboratories (2nd Edition)," Sandia Report SAND2007-0170, Sandia National Laboratories, Albuquerque, New Mexico. <http://www.sandia.gov/caps/SAND2007-0170.pdf>
[56] http://www.radfreenm.org/old_web/pages/hakonson_full.htm

[58] The New Mexico State Constitution Article XVI Section 2. http://lawschool.unm.edu/nrj/volumes/32/3/05_ingram_public.pdf The Public Trust Doctrine and Community Values In Water at page 528