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Milestones for Disposal of Radioactive Waste at the Waste Isolation Pilot Plant (WIPP) in the United States

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Abstract

Since its identification as a potential deep geologic repository in about 1973, the regulatory assessment process for the Waste Isolation Pilot Plant (WIPP) in New Mexico has developed over the past 25 years. (Concurrent in the 1980s, approximately 6 years were spent on construction.) National policy issues, negotiated agreements, and court settlements over the first half of the project had a strong influence on the amount and type of scientific data collected. Assessments and studies before the mid 1980s were undertaken primarily (1) to satisfy needs for environmental impact statements, (2) to develop general understanding of selected natural phenomena associated with nuclear waste disposal, or (3) to satisfy negotiated agreements with the State of New Mexico. In the last third of the project, federal compliance policy and actual regulations were sketched out, but continued to evolve until 1996. During this eight-year period, four preliminary performance assessments, one compliance performance assessment, and one verification performance assessment were performed.

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Preface

The milestones table for the Waste Isolation Pilot Plant (WIPP) Project was originally prepared as a section in the report, *An Introduction to the Mechanics of Performance Assessment Using Examples of Calculations Done for the Waste Isolation Pilot Plant Between 1990 and 1992*, SAND93-1378, by Rob P. Rechard. The milestones table, a particularly popular section, has been reproduced separately here and has been updated to include 1996 and 1997. As before, some text accompanies the milestone tables, but the emphasis remains on the tables because of their usefulness in providing a comprehensive but concise history of the WIPP. The usefulness of the milestones table is due in part to Anita Reiser and Wendell Weart, both of Sandia National Laboratories, who helped with verification of information; and Tech Reps, Inc., personnel, Carol Crawford, who verified references; Molly Minahan, who edited the text; and Kathy Best, who placed the text in tables.

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Milestones for Disposal of Radioactive Waste at the Waste Isolation Pilot Plant

New Mexico has a long history of involvement in nuclear phenomena: In 1942, the Manhattan Engineering District selected New Mexico for assembling the scientists, engineers, and technicians to develop the first atomic bomb and what was to become Los Alamos National Laboratory and Sandia National Laboratories (SNL). In 1945, the first atomic explosion occurred in the desert near Alamogordo, New Mexico. In 1961, the U.S. detonated a device to explore nonmilitary uses of nuclear explosives in bedded salt near Carlsbad, New Mexico (Gnome Project).^{T5} Since 1973, New Mexico has been a potential disposal site for waste contaminated with transuranic (TRU) nuclear elements created during the production of nuclear weapons.^{T22} A brief description of this latter aspect is presented below followed by a detailed tabulation of milestones of the Waste Isolation Pilot Plant (WIPP).

Early History of Nuclear Waste Disposal Related to the WIPP

Around 1944, the Manhattan Engineering District initially decided to bury solid nuclear waste in shallow trenches and augered holes at Los Alamos National Laboratory in New Mexico, and in railroad cars, trenches, and underground caissons at the Hanford Reservation in Washington. Liquid nuclear waste was stored in ponds at both sites. The Atomic Energy Commission (AEC), formed in 1946^{F1} and the precursor to the Department of Energy (DOE), continued the practices of the Manhattan Engineering District. The AEC also constructed storage tanks in the late 1940s at Hanford and completed a nuclear waste storage complex at Idaho National Engineering and Environmental Laboratory (INEEL) in 1952. The AEC spent the period from 1955 through the late 1960s exploring more permanent solutions for radioactive waste disposal in the United States. Studies of disposal options began in 1955 when the AEC asked the National Academy of Sciences (NAS) to examine the disposal issue.^{D2} In 1957, the NAS reported that while various options and disposal sites were feasible, disposal in salt beds was the most promising method to explore.^{T2} NAS reaffirmed that recommendation in 1961. Frustration at the lack of a formal waste policy at AEC caused the NAS to strongly criticize current AEC disposal practices in 1966.^{N2,T9,T22} In 1970, the Board of Radioactive Waste Management of the NAS concluded that bedded salt was satisfactory and was the safest choice now available for nuclear waste disposal.^{T3, T10, T11} From 1961 through the early 1970s, Oak Ridge National Laboratory (ORNL) conducted radioactive-waste disposal experiments, most notably Project Salt Vault in an abandoned salt mine near Lyons, Kansas from 1963 to 1967.^{T7,T8}

In June 1970, the AEC tentatively selected the Kansas mine as a repository.^{D6} Also in June 1970, the AEC told Idaho Senator Church that the waste stored in Idaho would be removed by 1980 and sent to the salt mine.^{D8} Later in 1970, a conceptual design was completed for a nuclear waste repository in salt. In 1971, the AEC directed that high-level waste (HLW) be solidified within five years, stored retrievably at all DOE facilities, and delivered to a federal repository within 10 years.^{D7} This directive also eventually affected transuranic nuclear waste, which was thereafter retrievably stored on the surface in Idaho and elsewhere rather than disposed of in trenches with low level waste. In the same year, a large number of drill holes and some solution mining were discovered at the proposed repository site near Lyons, Kansas.^{T12} Soon after, Congress directed the AEC to stop work on the Lyons project until safety was certified. In May of 1972, the AEC officially abandoned the Lyons project and announced plans for a Retrievable Surface Storage Facility (RSSF).^{D9} Anti-nuclear groups claimed that the RSSF proposed by the AEC to be de facto permanent disposal. This situation prompted the AEC to search again for a more suitable disposal site.^{T13-T20} Soon after, the AEC, ORNL, and the United States Geological Survey (USGS) recommended the extensive salt beds of southeastern New Mexico.^{T21}

Early Studies at the WIPP*

With the tacit approval of governor Bruce King of New Mexico, the AEC focused further attention on the Delaware Basin in New Mexico. After an initial investigation of existing information, a potential site near the edge of the basin was identified in 1973. The first large-scale field test was conducted in March 1974 when ORNL drilled AEC-7 and AEC-8.^{T89} Also, in 1974, ORNL conducted the first scenario development and deterministic analysis for the proposed repository.^{T22} In April 1975, SNL was chosen as the lead laboratory to (a) select and characterize,^{T24} (b) develop a conceptual design,^{T27} (c) draft an environmental impact statement (EIS)^{D20}, and (d) initiate scientific studies for the repository.^{T26} After some site characterization, SNL recommended locating the WIPP site nearer the basin center where the stratigraphy was more predictable.^{T12, T23, T24} (A minor repositioning of the disposal panels also occurred in 1982). That site was to become the current WIPP site, near Carlsbad, New Mexico.^{D10}

National policy issues, court settlements, and negotiated agreements have had a strong influence on the amount and type of scientific data collected during the early phase of the WIPP Project. The passage by Congress of the *National Environmental Policy Act of 1969*^{F3} established a broad national policy requiring an EIS on large federally funded projects. The EIS process exerted its influence during the 1970s as the AEC, which later became the Energy Research and Development Agency (ERDA) and later became the DOE,^{**} continued investigations on bedded salt in general and specifically, the salt deposit in New Mexico as a satisfactory medium for hosting a repository. SNL's support of the EIS consisted of (among other things) deterministic detailed computer modeling of diffusion through the salt of radioisotopes through human intrusion, release of radioactivity, and their potential transport of radioisotopes through the aquifer overlying the WIPP to the Pecos River over a 250,000-year time frame (~10 half-lives of ²³⁹Pu) followed by dose calculations to humans.

During 1978 and early 1979 and without consultation with the State of New Mexico, the mission of the WIPP oscillated between including and not including commercial spent nuclear fuel (SNF) and high-level waste (HLW) in addition to TRU wastes.^{D13, D18} Also, the new Carter administration required a fresh look at sites and options for nuclear waste disposal.^{D14, D15, D17} Because some of the options considered generated distrust of the intentions of the DOE within the state and were counter to the ideas of Congress, Congress firmly established the purpose of the WIPP Project as a research and development facility for storage and disposal of TRU waste only (i.e., not commercial or defense SNF nor HLW). Congress also specifically exempted regulation by the NRC and thus by default granted self-regulation to the DOE.^{***} National advisory groups, particularly the WIPP Panel, which was set up under the Board of Radioactive Waste Management of the NAS,^{D10, T85} and an independent state-selected evaluation group, the New Mexico Environmental Evaluation Group, were established on the initiative of the DOE to monitor its self-regulation.

After the final EIS^{D20} was published in 1980 and a record of decision published in January 1981,^{D22} the DOE proceeded to the preliminary design of the WIPP. Planning activities included a site and preliminary design validation (SPDV) phase, consisting of drilling two shafts in 1981 and 1982 and mining an

* Because the Waste Isolation Pilot Plant (WIPP) Project spans more than 25 years, more events and milestones have occurred than can easily be covered in a few pages; thus, the description is selective to those issues that do not require extensive explanations. However, the large influence of national and regional policy on the type and extent of scientific studies conducted at the site is still evident.

** The Atomic Energy Commission (AEC) was formed by the *Atomic Energy Act of 1946*.^{F1} The Energy Research and Development Agency (ERDA) and the Nuclear Regulatory Commission (NRC) were formed by splitting the Atomic Energy Commission in the *1974 Energy Reorganization Act*.^{F7} ERDA became the Department of Energy (DOE) in 1977.^{F11}

*** Although regulation by the Nuclear Regulatory Commission (NRC) would have been possible, the NRC had been established to regulate primarily commercial nuclear reactors and waste. Also, Congress did not favor NRC oversight of defense-related activities.

experimental area. Full construction of the WIPP surface facility, an extensive underground experimental area, and one underground disposal panel began in 1983 after meeting the terms of the "Consultation and Cooperation Agreement" with the State of New Mexico and continued to completion over the next five years. Simultaneously with design and construction, SNL began fielding many in situ salt creep experiments to characterize the local disposal system.^{T43, T44, T45} Although, from a practical standpoint, the predicted and measured values of creep were close, the measured salt creep was nevertheless about three times greater than the predicted values and so by 1985 an alternate mathematical expression for the creep phenomenon was developed.^{T47, T48, T61} In addition to developing a general understanding of selected natural phenomena as deemed prudent by SNL scientists (working with peers in waste management) and/or scientists on the WIPP Panel of the NAS,^{D10, T85} many of the geotechnical experiments conducted during the 1980s were undertaken to satisfy agreements with the State of New Mexico. Specifically, in 1981 in response to a lawsuit, a "Stipulated Agreement" and "Consultation and Cooperation Agreement" as mentioned earlier were negotiated that defined the relationship of the WIPP Project with the State of New Mexico and listed required geotechnical experiments.^{N6} These requirements and early drafts of the Environmental Protection Agency (EPA) nuclear waste disposal regulation in Title 40 of the Code of Federal Regulations Part 191 (40 CFR 191) greatly influenced the type of in situ experiments and activities initially planned at the WIPP. For example, while deepening WIPP-12 as part of the negotiated settlement with the State of New Mexico, the project encountered a brine reservoir in 1981,^{T39} which resulted in moving the disposal region ~1800 m to the south in 1982. Also, Sandia and the U.S. Geological Survey explored and dismissed the possibility of extensive dissolution disrupting the repository.^{T40, T41}

The decision by Congress in 1987 to characterize only Yucca Mountain, Nevada, for the first commercial spent-fuel and high-level waste repository^{F28} caused the DOE to cancel many of the experiments being performed at the WIPP in support of a potential commercial repository elsewhere in bedded salt. The presence or absence of additional pockets of brine below the repository became of concern to the New Mexico Environmental Evaluation Group (EEG) in the early 1980s. Therefore, some studies were conducted to try to dismiss their presence.^{T42} Though strongly suggesting brine pockets were not present below the waste rooms in the anhydrite layer where other brine pockets had been found, the studies were unable to unequivocally show that brine pockets were not present in deeper anhydrite layers in the Castile Formation. Long-term slow seepage of brine trapped in the salt into the repository became a topic of great interest in 1988^{T54} and the full Board of Radioactive Waste Management of the NAS examined the issue. Members of the NAS concluded that the rapid salt creep combined with low permeability of the salt meant that the repository would be fairly well consolidated before much brine could enter the repository.^{T55}

In preparation for the WIPP's planned opening by the end of the 1980s, SNL summarized past work and data, and performed numerous bounding calculations to support a draft supplemental EIS in 1989.^{T59, D29} It identified gas generation—the gas being generated through anoxic corrosion of waste containers—as an important issue to study.^{T59} This issue had been identified in the mid 1970s, but it was dismissed based on the assumption that high salt permeability values obtained from measurement in boreholes drilled prior to excavating the repository would allow any gas generated to dissipate without producing large pressures. Studying gas generation became an important purpose of proposed tests using actual TRU waste within the repository during a monitored pilot phase after better in situ measurements of the salt permeability within the excavations in the mid 1980s suggested values three orders of magnitude less than those measured in the mid 1970s.^{T55} However Congress stipulated in 1992 that the waste could be brought to the WIPP only if the tests were necessary to show compliance. Although the tests would have been potentially reassuring as a demonstration, the monitored pilot phase was not necessary for compliance. Therefore, in October 1993, the NAS recommended^{T77} with DOE concurrence to eliminate the tests with actual waste at the WIPP (pilot phase) and to perform additional experiments in laboratories.^{D33} Without a pilot phase, the DOE decided to accelerate to the compliance phase for the WIPP and closed the in-situ experimental area in October 1995.

Compliance Setting for the WIPP

A major task of the second half of the WIPP project, which started near 1986, was spent developing evidence of compliance. The promulgation of 40 CFR 191 in 1985 established the primary probabilistic

regulation with which the WIPP would have to comply, yet a legal ruling in 1984^{F23} and regulations in 1986 and 1987^{D26} resulted in defining much of the waste destined for the WIPP as chemically hazardous. This legal ruling established another set of regulations that the WIPP also had to comply with—those for hazardous waste (40 CFR 260-270 and analogous New Mexico regulations) promulgated in response to the *Resource Conservation and Recovery Act (RCRA)*.^{F9} Then in 1992, Congress defined the process by which the WIPP compliance would have to be evaluated, transferred ownership of the WIPP site to the DOE, and designated the EPA (rather than the DOE) as the regulator of the WIPP (*Waste Isolation Pilot Plant Land Withdrawal Act*).^{F37} This act officially marked the transition from the construction and disposal-system-characterization phase to the compliance and testing phases. However, these latter phases began informally in 1985 and 1986 when the EPA issued 40 CFR 191^{F13} and its interpretation of mixed hazardous waste and in 1989 when SNL first assessed performance using the EPA standard.^{T63, T64} Finally, in 1996, the EPA promulgated 40 CFR 194, a regulation to implement its 40 CFR 191 standard, which imposed several new interpretations, such as expanded human intrusion activities (specifically, potash mining) and requirements such as peer review on waste characterization, engineered and natural barriers, and conceptual models.^{F45} Also in 1996, Congress removed one of the RCRA land disposal requirements (i.e., seeking a no-migration variance), which required similar calculations to that for 40 CFR 191.^{F46}

Development of Methodology for Assessing Compliance of the WIPP

The history of assessing performance of a geologic disposal system began formally in 1976 when the ERDA funded two conferences to bring engineers and geologists together to explore the modeling of geologic disposal systems. By 1977, demands for permanent solutions to nuclear waste provided an impetus for President Gerald Ford to request the EPA to more vigorously pursue applicable standards for proposed waste repositories.^{D11, D12}

During the EPA's development of 40 CFR 191 in the late 1970s and early 1980s, analysts at Sandia National Laboratories (SNL) were advocates for a thorough approach in evaluating the uncertainty caused by various parameters in models of the exposure pathways and uncertainty about various pathways as a way to gain insight about the behavior of a geologic waste repository. For example, analysis that SNL had conducted for the EIS had relied heavily on mathematical modeling. This position of SNL had developed indirectly from participation by a few Sandians on the 60-member team for the Nuclear Reactor Safety Study^{F51} and Sandia's direct involvement on several subsequent reactor accident studies for the NRC. In addition, SNL's advocacy for a probabilistic approach was influenced indirectly by its use in evaluating the reliability of weapons systems and externally by the growing acceptance for evaluating technological risks. During this period, the term performance assessment (PA) was adopted internationally to describe the process of evaluating whether a geologic disposal system complied with the regulatory criteria—criteria that were probabilistic in the United States and thus the assessment was similar to probabilistic risk assessments (PRA) for nuclear reactors.

Hence, in the United States, a performance assessment became a stochastic simulation of possible long-term behaviors of a real system with a computer-implemented mathematical model of that system. In this respect, performance assessment is similar to other large-scale simulations (such as PRAs) that have been used by federal agencies in the past to explore policy options and develop regulations. Performance assessments of systems for the disposal of radioactive wastes nevertheless differ from most simulations for policy analysis in two significant and related ways: the way results of a performance assessment are to be used and the nature of the real system that is being simulated. In contrast with simulations for policy analysis, the EPA chose to use PA results ultimately to test compliance of a real system with an existing environmental standard, not merely to gain insight into the behavior of the system. However, the fact that part of the disposal system is geologic introduces several differences with some types of risk assessments. For instance, the geologic portion of the disposal system introduces the necessity to characterize rather than design. In addition, both the engineered and geologic components of a waste disposal system are subject to natural processes over geologic time; hence, phenomenological models are needed in order to include geologic processes.

In August of 1986, SNL accepted DOE's formal request to take responsibility for showing compliance of the WIPP with 40 CFR 191. To gain proficiency and for the project to be able to adapt efforts to collect needed information on geologic processes, SNL conducted four preliminary performance assessments from 1989 through 1992, each one building upon the other.^{T63, T64, T68, T69, T72, T78} The use of mathematical models and the general long-term flow path for radioisotope release was similar to the initial EIS, but the simulations were stochastic and numerous complexities were added, such as human intrusion causing radioisotope releases from drill cuttings. Hence, between January 1988 and December 1991, much effort was expended developing a computational modeling system, CAMCON.^{T67, T90, T91, T92} Furthermore, vast amounts of records and documentation were produced to ensure that the reasoning behind choices for data and models was traceable and repeatable. In October 1996, the performance assessment for the Compliance Certification Application (CCA) was completed showing compliance with 40 CFR 191.^{T83, T84} While not responsible for evaluating compliance, the NAS also issued a report in October that noted the excellent features of the WIPP site for containing nuclear waste.^{T85, T86} These same conclusions were echoed in the 84,000 page second supplementary EIS issued in November.^{D37} Since 1995, significant effort has been made by the EPA and their contractors in evaluating the CCA and supporting documentation.^{F47} The Conceptual Model Peer Review Group (formed in response to requirements in 40 CFR 194) concluded in early 1997 that 22 of the 24 conceptual models were adequate. The panel thought that, though conservative, the model for spallings (particulates carried to the surface by pressurized gas and/or brine during a hypothetical drilling intrusion in the repository at a future time) lacked sufficient realism; hence, they required redevelopment. The panel also thought the description of the behavior of the magnesium oxide (MgO) backfill needed improvement.^{T87, T88} In addition, SNL, under the direction of the EPA, reran the PA calculations, using EPA-selected values and distributions for 26 parameters to help bolster EPA confidence in the results. Finally, in October 1997, the EPA published a draft rule proposing to approve the WIPP.^{F49, F50} This step initiated the 120-day public comment period.

Summary

The final decision about whether to open the Waste Isolation Pilot Plant is very near, the culmination of a regulatory assessment process that has thus far taken about 25 years. If the WIPP is opened, the regulatory process for the disposal facility will continue through its operational phase and final closure some 35 years later. National policy issues, negotiated agreements, and court settlements during the first 15 years of the project had a strong influence on the amount and type of scientific data collected up to this point. Assessment activities before the mid 1980s were undertaken primarily (1) to satisfy needs for environmental impact statements, (2) to satisfy negotiated agreements with the State of New Mexico, or (3) to develop general understanding of selected natural phenomena associated with nuclear waste disposal. In the last 10 years, federal compliance policy and actual regulations were sketched out, continuing to evolve until 1996. During this period, four preliminary performance assessments, one compliance performance assessment, and one verification performance assessment were performed. Thus, many activities performed throughout the history of the WIPP Project cannot be neatly categorized in terms of fulfilling the specific needs of the final compliance process established in 1996. In general, stochastic simulations were introduced as a tool for the assessment of the WIPP's performance only recently (~8 yr ago).

Detailed Tabulation of WIPP Milestones

In the following tabulation of WIPP milestones, the history of the WIPP is divided into four main categories. One category highlights technical milestones, and three categories highlight the major political events that have influenced the WIPP Project, as briefly summarized above. Noteworthy events from all four categories are also shown schematically. The tabulation also indicates two temporal categories of the WIPP Project—one used officially by the DOE for the project as a whole and one used informally by SNL to describe its various activities.

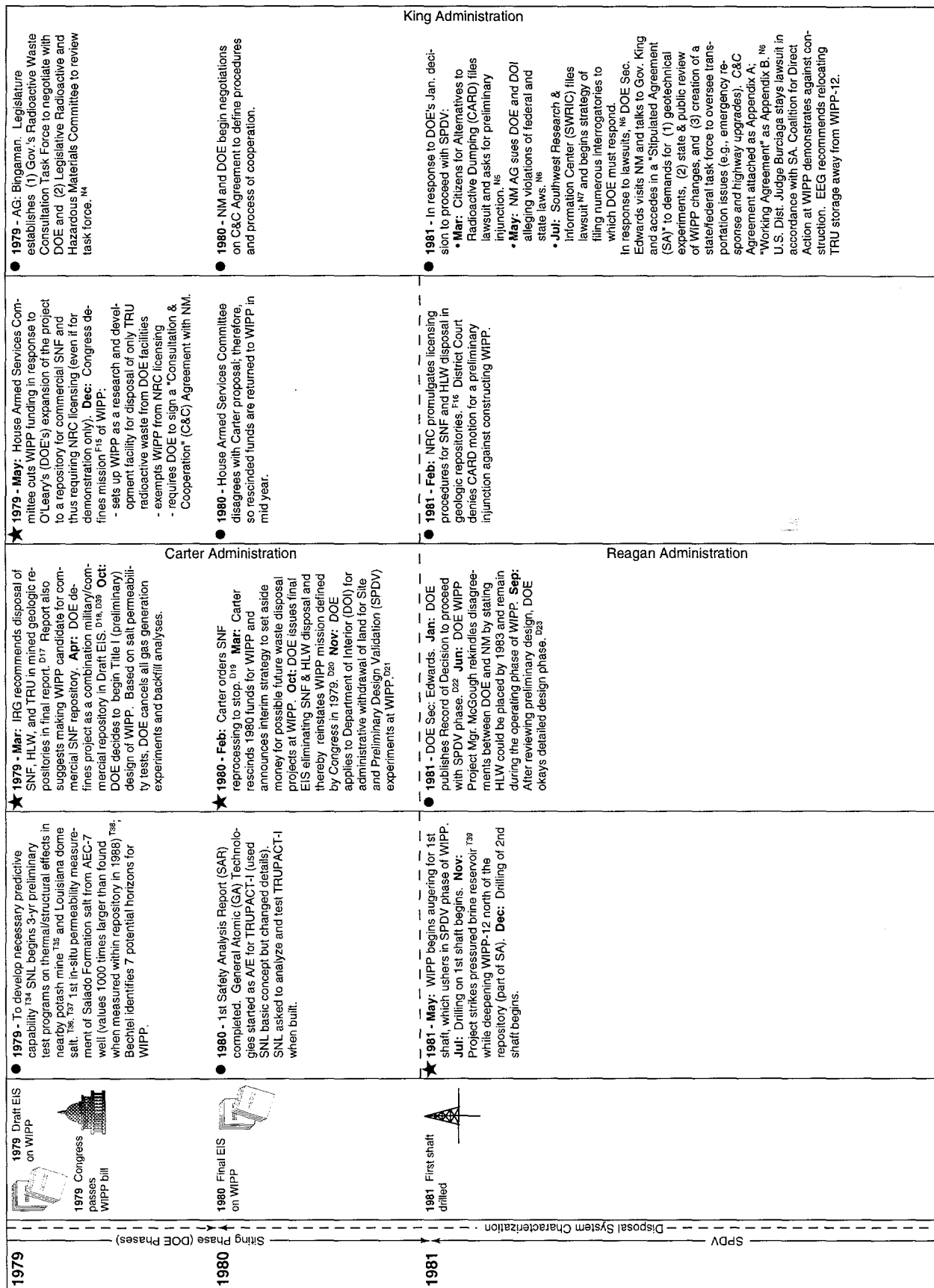
Milestones for Disposal of Radioactive Waste in the United States

Time Line	Noteworthy Events	Technical Milestones Related to the WIPP	U.S. President and DOE: Regulatory Decisions	Federal Legislation, Judicial Decisions, and Regulatory Requirements Related to Nuclear Waste Disposal	New Mexico Administration, Regional Issues, and Legal Challenges
1942			★ 1942 - Manhattan Engineering District Corps of Engineers selects site for Los Alamos National Laboratory (LANL) to develop nuclear weapons.		Miles Admin.
1943		<ul style="list-style-type: none"> ● 1943 - Plutonium operations begin and disposal of nuclear waste begins on site at Oak Ridge National Lab (ORNL) in trenches. Water has saturated the bottoms of the trenches and migration of radioisotopes has been observed. 	<ul style="list-style-type: none"> ★ In 1940's - Atomic Energy Commission's (AEC's) earliest decision on managing waste: store high-level waste (HLW) as liquids in tanks and bury other waste (solid or liquid) in trenches.⁶¹ 		Dempsey Administration
1944		<ul style="list-style-type: none"> ● 1944 - Disposal of nuclear waste begins on site at LANL (using trenches, ponds, augered holes) and Hanford Reservation (using rail-road cars, trenches, ponds, tanks, underground caissons).¹¹ 			
1945		<ul style="list-style-type: none"> ★ 1945 - Atomic bomb exploded at Trinity Site near Alamogordo, NM. 			
1946			<ul style="list-style-type: none"> ● 1946 - AEC Chairman: Lillenthal (Director of Tennessee Valley Authority) 	<ul style="list-style-type: none"> ● 1946 - Atomic Energy Act (AEA) of 1946⁶²: <ul style="list-style-type: none"> - creates AEC - establishes government monopoly on atomic weapons and nuclear material 	Mabry Administration
1949			<ul style="list-style-type: none"> ● 1949 - Truman asks AT&T to manage the recently formed Sandia Laboratory. 		
1951					
1952		<ul style="list-style-type: none"> ● 1952 - Idaho National Engineering and Environmental Lab (INEEL) completes Radioactive Waste Management Complex (RWMC) for storing and burying waste; migration of radioisotopes downward into the alluvium has been observed. 			
1953		<ul style="list-style-type: none"> ● 1953 - Savannah River Plant (SRP) begins waste storage and disposal on site at "Old Burial Ground" water in trenches from precipitation has caused migration of radionuclides. 	<ul style="list-style-type: none"> ● 1953 - AEC Chairman: Strauss 		Mechem Administration
1955		<ul style="list-style-type: none"> ● 1954 - Rocky Flats Plant, CO begins shipping transuranic (TRU) waste to INEEL for disposal at RWMC. 	<ul style="list-style-type: none"> ● 1955 - AEC asks National Academy of Sciences (NAS) to examine issue of permanent disposal of radioactive wastes.⁶² 	<ul style="list-style-type: none"> ● 1954 - AEA of 1954⁶² seeks peaceful uses of atomic energy, thus allows regulated private atomic energy development. 	Simms Admin.
1957		<ul style="list-style-type: none"> ★ 1957 - NAS recommends radioisotope waste disposal in salt as most promising method.¹² ORNL begins research in salt (1957-61).¹³ 	<ul style="list-style-type: none"> ● 1957 - Plowshare program started to look at peaceful uses of nuclear explosives.⁶³ 		Mechem Admin.
1959		<ul style="list-style-type: none"> ● 1959 - NAS commission on oceanography reports on coastal disposal of low-level radioactive waste.¹⁴ 			Burroughs Admin.
1960					

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Milestones for Disposal of Radioactive Waste in the United States

Time Line	Noteworthy Events	Technical Milestones Related to the WIPP	U.S. President and DOE: Regulatory Decisions	Federal Legislation, Judicial Decisions, and Regulatory Requirements Related to Nuclear Waste Disposal	New Mexico Administration, Regional Issues, and Legal Challenges
1974		<ul style="list-style-type: none"> 1974 - ORNL conducts first scenario development and deterministic analysis for WIPP. ⁷²² Mar: ORNL begins field investigations by drilling AEC-7 and AEC-8. ¹⁸ 	<ul style="list-style-type: none"> 1974 - AEC promises Idaho that wastes will be shipped in the 1980's. May: WIPP work suspended until 1975 because AEC wished to emphasize HSPF and AEC Chairman Ray would not withdraw land from oil exploration because of oil embargo. ¹¹² 	<ul style="list-style-type: none"> 1974 - Energy Reorganization Act ⁷⁷ splits AEC into Nuclear Regulatory Commission (NRC) and Energy Research and Development Agency (ERDA). 	<ul style="list-style-type: none"> 1974 - Gov. King establishes Governor's Technical Excellence Committee; created WIPP oversight subcommittee.
1975	 <p>1975 WIPP moved toward basin center</p>	<ul style="list-style-type: none"> 1975 - Mar: SNL receives funding and starts four tasks: selecting site and characterizing, producing conceptual design, drafting EIS, initiating scientific studies. May: ERDA-6 drilled at NW corner of original ORNL site; encounters deformed salt beds and hits brine much deeper. ¹²⁴ SNL recommends relocation and project moves site ~11 km (7 mi) toward center of Delaware Basin to avoid deformed salt beds as indicated by oil well logs. ^{112, 724} 	<ul style="list-style-type: none"> 1975 - ERDA removes WIPP from commercial repository program. Jan: ERDA asks Sandia National Laboratories (SNL), located in NM, to oversee investigations rather than ORNL and suggests an opening date of 1982. 	<ul style="list-style-type: none"> 1975 - NRC promulgates "As Low As Reasonably Achievable" (ALARA) policy for limiting radiation exposure. ⁷⁸ Oct: NRC final PRA for Nuclear Reactors. ⁷⁸¹ 	<ul style="list-style-type: none"> 1975 - AG: Anaya.
1976	 <p>1976 ERDA-9 drilled at center of WIPP site</p>  <p>1976 Ford orders demonstration of nuclear waste disposal</p>	<ul style="list-style-type: none"> 1976 - SNL begins site characterization and engineering design program at new site; various natural backfills such as apatite or salt bentonite considered for use in repository. Apr: ERDA-9 drilled into Castile Formation near center of new site. Tests on TRU waste behavior and HLW packages initiated. ^{725, 728} 	<ul style="list-style-type: none"> 1976 - Jan: Project is officially named the "Waste Isolation Pilot Plant." ⁷³⁰ Oct: Ford orders major expansion of ERDA program to demonstrate permanent disposal for nuclear waste and orders EPA to develop generally applicable standards. ^{711, 712} 	<ul style="list-style-type: none"> 1976 - Resource Conservation and Recovery Act (RCRA) ⁷⁹ seeks to reduce or eliminate hazardous waste generation to minimize present and future threat to human health and environment. Dec: EPA announces intent to develop radiation protection standards for HLW disposal. ⁷¹⁰ 	<ul style="list-style-type: none"> 1977 - NM Hazardous Waste Act ⁷³ seeks to maintain environmental quality.
1977		<ul style="list-style-type: none"> 1977 - Jun: WIPP conceptual design report issued. ¹²⁷ SNL plugs ERDA-10 to test plugging boreholes in salt. ⁷²³ 	<ul style="list-style-type: none"> 1977 - DOE Sec. Schlesinger. Nov: DOE tells NRC it plans to seek license to build and operate WIPP. (WIPP returns to commercial waste repository program.) 	<ul style="list-style-type: none"> 1977 - Oct: DOE Organization Act ⁷¹¹ creates cabinet-level Department of Energy (DOE) from ERDA. Feb: In response to Ford's directive, EPA conducts 1st public workshop to understand public concerns and technical issues of waste disposal. ^{712, 713} 	
1978	 <p>1978 Oversight by WIPP panel of NAS and NM EEG begins</p>	<ul style="list-style-type: none"> 1978 - SNL begins design of the Transuranic Package Transport, design I (TRUPACT-I) using standard cargo box concept. ^{729, 730, 731} Bechtel National starts as WIPP Architect/Engineer (A/E). Westinghouse Electric Corp. starts as Tech Support Contractor. SNL raises concern about gas generation and Los Alamos begins tests. ⁷³² Jun: WIPP Panel of BRWM of NAS (component of outside oversight DOE setup that changed in 1982) holds first meeting. ⁷³³ SNL completes geologic characterization report ⁷²⁴ supporting Draft EIS on WIPP; hydrologic and radioisotope transport modeling for EIS is primarily regional and extends for 250,000 yr (10 half lives of ²³⁹Pu). 	<ul style="list-style-type: none"> 1978 - DOE Deputy Sec. Jerry O'Leary promises NM Congressional delegation "if NM did not wish to have the WIPP, then it could veto the plan." Both Comptroller Gen. and DOE Gen. Counsel state O'Leary powerless to grant "state veto." ⁷¹³ DOE conducts local hearings on proposed WIPP. Oct: Deutch (Massachusetts Institute of Technology [MIT] chem. prof.) report written for DOE recommends (1) disposing TRU waste at WIPP without planning for retrieval, and (2) demonstrating spent nuclear fuel (SNF), HLW, and TRU disposal at WIPP. ^{714, 715} DOE Deputy Sec. J. O'Leary presses on with 2nd recommendation until 1979 enabling law for WIPP as a way to satisfy California law banning nuclear power plants until SNF disposal demonstrated. ⁷¹⁶ Mar: President forms Interagency Review Group (IRG), in response to Deutch report to recommend type of nuclear waste disposal. 	<ul style="list-style-type: none"> 1978 - Jan: EPA announces public forum to develop protection criteria for radioactive wastes. ⁷¹⁷ Nov: EPA publishes "Criteria for Radioactive Wastes" as guidance for federal agencies and seeks comments. ⁷¹⁴ 	<ul style="list-style-type: none"> 1978 - DOE contracts with NM to establish Environmental Evaluation Group (EEG) to provide a full-time, independent assessment of WIPP and oversee environment, public health and safety. Although DOE-funded, EEG is initially made a part of the NM Health & Environment Department. The general understanding is neither DOE nor NM would attempt to bias or interfere in EEG's technical conclusions. EEG becomes second permanent outside oversight group set up by DOE (first was NAS WIPP Panel of BRWM). NM House almost passes ballot proposal for constitutional amendment to keep nuclear waste from NM.




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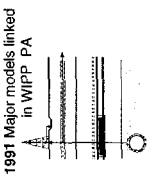
Milestones for Disposal of Radioactive Waste in the United States

Time Line	Noteworthy Events	Technical Milestones Related to the WIPP	U.S. President and DOE: Directives and Regulatory Decisions	Federal Legislation, Judicial Decisions, and Regulatory Requirements Related to Nuclear Waste Disposal	New Mexico Administration, Regional Issues, and Legal Challenges
1982	<p>1982 USGS dismisses concerns about Breccia pipes</p> 	<p>★ 1982 - 2nd shaft completed (~80m [270ft] of drilling fluid left in the shaft). Underground excavation started to connect the two shafts. Following evaluation of WIPP-12 TRU disposal area moved ~1800 m (6000 ft) farther south (experimental area left in original area). Dec: SNL completes interim report on dissolution of evaporates in and around the Delaware Basin^{14c} (part of SA). USGS completes breccia pipe report (part of SA) and dismisses concerns.^{14d}</p>	<p>U.S. President and DOE: Directives and Regulatory Decisions</p>	<p>1982 - Courts decline to relieve DOE from responding to numerous SWRIC interrogatories. Mar: DOI approves DOE's application for administrative withdrawal of 36 x 10⁶ m² (8960 ac) for conducting SPDV experiments for 8 yr.^{17r} Dec: Nuclear Waste Policy Act (NWPA) passed.¹⁸</p> <ul style="list-style-type: none"> - sets up trust fund, funded by utilities, to pay for SNF & HLW repository - requires NRC licensing of repository - sets acceptable risk of 1000 deaths/10,000 yr - states SNF & HLW from DOE facilities will go to repository unless President objects - suggests DOE build Monitored Retrievable Storage (MRS) <p>EPA publishes working draft 20 of environmental standards for radioactive waste management as proposed 40 CFR 191. F¹⁹</p>	<p>King Administration</p> <p>1982 - Dec: Supplemental SA signed (1) committing DOE to seek funds for upgrading highways in NM, (2) committing DOE to more geotechnical studies, and (3) making DOE liable for WIPP-related accidents.¹⁹</p>
1983	<p>1983 Full construction begins</p> 	<p>★ 1983 - Mar: SNL, USGS, and contractors complete most reports required by SA. Apr: WIPP Panel NAS tours WIPP underground to examine SPDV tests.^{14z} May: Repository level selected. Jun: Army Corps of Engineers assumes responsibility for all phases of construction management. Excavations connect the two existing shafts. Oct: Drilling of pilot hole for 3rd shaft begins.</p>	<p>Reagan Administration</p> <p>1983 - DOE Sec: Hodel. Mar: DOE gives SPDV reports to NM and allows 60 day comment period.^{12a} Jul: DOE announces decision to proceed with construction.^{12b} Sep: DOE sets Oct 1988 as WIPP opening date.</p>	<p>1983 - Congress allocates \$5.8 M for road improvement in NM. Jun: DOI approves land withdrawal for 8 years for a 36 x 10⁶ m² area to construct WIPP.^{12b} NRC promulgates technical criteria for waste disposal in geologic repositories and includes by reference the yet-to-be promulgated EPA standard on waste disposal.^{12c} Jan-Sep: EPA's Science Advisory Board (SAB) holds public meetings on 40 CFR 191.</p>	<p>1983 - AG: Bardacke. May: after reviewing results from SPDV program, EEG concludes that "...the Los Medanos site has been characterized in sufficient detail to warrant confidence in the validation of the site for permanent emplacement of approximately 6 million ft³ (1.75 x 10⁶ m³) of defense TRU waste." but also recommends additional studies to resolve outstanding geotechnical issues such as evaluation of potential for brine reservoirs.¹⁹ Aug: EEG issues report and Governor holds press conference on concern about potentially explosive hydrogen gas in TRUPACT-I.¹¹⁰ Sep: CARD and Sierra Club allege that DOE and EEG are collaborating to deceive NM about safety of WIPP; they also insist on NRC licensing of WIPP.</p>
1984	<p>1984 SNL begins fielding many underground experiments</p> 	<p>★ 1984 - SNL begins many thermal/structural and waste package (e.g., defense HLW) field tests defined in 1982, ushering in the system characterization phase of project.^{143,144,145} Pumping tests at DOE 2 suggest fracture flow in Culebra. General Atomic completes one TRUPACT-I container. SNL sends it to ORNL test facility because container exceeds SNL weight limit for 30 ft drop and puncture test, etc., required in 10 CFR 71.¹⁴⁶ container passes tests.</p>	<p>1984 - Mar: Manager of Albuquerque Operations Office (AL) moves WIPP Project Office (WPO) to Carlsbad.</p>	<p>1984 - Feb: SAB endorses probabilistic approach but states performance criteria too restrictive and recommends several changes.¹²² Apr: Legal Environmental Assistance Foundation (LEAF) vs. Hodel.¹²³ requires DOE to apply both the technical and procedural requirements of RCRA to DOE facilities even though AEA exempted DOE from many environmental and human health laws. Nov: Hazardous & Solid Waste Amendments (HSWA)¹²⁴ to RCRA ban land disposal of hazardous waste without treatment unless disposal site and generator demonstrate no migration of constituents for as long as waste remains hazardous.</p>	<p>Anaya Administration</p> <p>1984 - Nov: 1st modification to C&C Agreement limiting remote handled (RH) TRU waste amount to 5.1 x 10⁶ Ci.</p>

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1985	Disposal System Characterization	Compliance Evaluation	Full Construction Phase	
<p>1985 EPA promulgates 40 CFR 191</p> 	<p>1985 - Jan: Pillar creep test begins in room H. General Atomic disassembles TRUPACT-I and cuts in half; half with door rebuilt; while rebuilding, puncture damage replicated to match damage in original TRUPACT-I. With the definition of a 5-km boundary to the disposal system in 40 CFR 191, project begins to focus more on near-field hydrologic modeling rather than regional modeling. SNL observes discrepancy between measured and predicted salt creep.^{147, 148}</p> <p>1986 - Feb: TRUPACT-I passes fire test at SNL.^{146, 150} Aug: SNL accepts task of assessing performance of WIPP against 40 CFR 191 criteria (Performance Assessment [PA]).</p> <p>1987 - SNL finds possibility of a pressurized brine reservoir below the TRU disposal area cannot be ruled out.^{142, 151} Lack of double containment in TRUPACT-I becomes major issue.^{152, 153} Oct: Nuclear Packaging becomes A/E for the Transuranic Package Transport, design II (TRUPACT-II); SNL again selected as DOE technical advisor. Dec: Environmental groups raise concern of brine seepage into repository.¹⁵⁴</p>	<p>1985 - DOE Sec. Harrington. President approves the 3 repository candidates as recommended by DOE for SNF and HLW. President concurs with DOE recommendation that defense SNF and HLW be disposed of in commercial repository.</p> <p>1987 - May: DOE redefines "by-product material" to exclude everything except radionuclides, and thereby TRU waste is subject to RCRA (40 CFR 261).¹⁵⁵ Jul: Agreement between Department of Labor (DOL) and DOE on mine inspections.¹⁵⁷ Oct: DOE selects Nuclear Packaging conceptual design for TRUPACT-II.</p> <p>1988 - Sep: DOE announces that WIPP won't open as scheduled in Oct. DOE abruptly cancels SNF and HLW experiments because of NWPAA (no funds available to remove disposal containers).</p> <p>1989 - Jan & Feb: Redesign seals of TRUPACT-II pass engulfing fire test.¹⁵⁶ SNL completes documentation to support Draft Supplemental EIS; report identifies generation of gases as containers and waste corrode as issue (see 1978) because salt permeability lower than thought in 1979. 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<p>1985 - EEG notifies DOE that the single-shelled, vented rectangular transportation container for TRU waste, TRUPACT-I, is unacceptable for NM.¹¹¹ Jan: NM receives EPA authorization to regulate hazardous wastes.¹¹² Feb: Natural Resources Defense Council (NRDC) sues EPA to issue 40 CFR 191 as mandated in NWPA of 1982.¹¹³</p> <p>1986 - Mar: NRDC and others sue EPA over groundwater and individual protection standards in 40 CFR 191.</p> <p>1987 - AG: Stratton. Anticipating conflicts between radioactive & hazardous waste regulations, NM legislature exempts WIPP from hazardous waste regulations. Aug: 2nd modification to C&C Agreement committing DOE to comply with all applicable laws & regulations and discourage WIPP compliance by way of grandfathering, variance, exemption, or waiver; and use 40 CFR 191 as 1st issued for evaluating WIPP compliance until reissued by EPA. NRC and Department of Transportation (DOT) regs apply to WIPP transport.</p> <p>1988 - Jan: EEG issues report on potential brine reservoirs under WIPP. Oct: ID Gov. Andrus bans shipments of radioactive waste into state because WIPP not open. Dec: ID Gov. Andrus, CO Gov. Romer, and NM Gov. Caruthers meet in Salt Lake City to discuss WIPP and options to avert shutdown of DOE Rocky Flats Plant from lack of authorized storage imposed by CO, and inability to ship to ID because of imposed ban by Gov. Andrus. DOE agrees to vigorously pursue both administrative and legislative land withdrawal for WIPP.¹¹⁴</p> <p>1989 - Legislature unanimously removes "WIPP exemption" in hazardous waste laws so EPA will grant authority to regulate radioactive mixed waste. Nov: Berlin Wall falls signaling the end of the Cold War and greatly changing future demands for nuclear weapon material and thus type of waste going to WIPP.</p>	<p>1985 - Office of Technology Assessment (OTA), an agency of Congress, concludes no insurmountable technical obstacles for geologic repositories.¹²⁵ Sep: EPA promulgates 40 CFR 191 for disposal of SNF, HLW, and TRU in a geologic repository. Uses 1000 deaths/10,000-yr criterion from NWPA of 1982; promulgation begins the transition of the WIPP to compliance phase.</p> <p>1986 - EPA states that mixed waste (radioactive waste also meeting hazardous waste definition) is subject to RCRA and hazardous waste regulations.¹²⁶ NRC promulgates probabilistic safety goals for nuclear reactors that are similar to 40 CFR 191.¹²⁷</p> <p>1987 - Jul: In response to legal challenges to individual and groundwater protection requirements in support B; Court of Appeals for 1st Circuit in Boston vacates and remands all of 40 CFR 191 to EPA.¹²⁷ Sep: Court reinstates Subpart A of 40 CFR 191 in response to EPA request. Dec: Nuclear Waste Policy Amendment Act (NWPAA)¹²⁸ selects Yucca Mt., NV, to undergo site characterization for potential SNF and HLW disposal; because bedded salt not being considered, SNF and HLW tests at WIPP unnecessary.</p> <p>1988 - NM Congressmen ask NAS BRWM to study brine inflow controversy. With continued technical problems (e.g., TRUPACT-II not yet licensed), NM Congressional delegation cannot get consensus among themselves and WIPP Land Withdrawal legislation dies. NM Congressmen get Congress to reassign EEG to the New Mexico Institute of Mining and Technology in Socorro in Sep. because of conflicts between NM state government and EEG.¹²⁹</p> <p>1989 - Aug: NRC approves the pressurized transportation container for shipping contact-handled (CH) TRU to TRUPACT-II.</p>	<p>1985 - DOE Sec. Harrington. President approves the 3 repository candidates as recommended by DOE for SNF and HLW. President concurs with DOE recommendation that defense SNF and HLW be disposed of in commercial repository.</p> <p>1987 - May: DOE redefines "by-product material" to exclude everything except radionuclides, and thereby TRU waste is subject to RCRA (40 CFR 261).¹⁵⁵ Jul: Agreement between Department of Labor (DOL) and DOE on mine inspections.¹⁵⁷ Oct: DOE selects Nuclear Packaging conceptual design for TRUPACT-II.</p> <p>1988 - Sep: DOE announces that WIPP won't open as scheduled in Oct. DOE abruptly cancels SNF and HLW experiments because of NWPAA (no funds available to remove disposal containers).</p> <p>1989 - Jan & Feb: Redesign seals of TRUPACT-II pass engulfing fire test.¹⁵⁶ SNL completes documentation to support Draft Supplemental EIS; report identifies generation of gases as containers and waste corrode as issue (see 1978) because salt permeability lower than thought in 1979. 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1990	<p>1990 First full PA of WIPP (1989 PA was demo)</p> <p>1990 Supplemental EIS</p> <p>1990 Construction officially complete</p> 	<p>1990 - SNL and Westinghouse complete report on the pilot test phase of WIPP¹⁶⁵ suggesting that a waste amount equal to 0.5% of capacity be brought to WIPP for gas generation experiments. May: "Final" Safety Analysis Report Completed. Dec: SNL issues 2nd PA (1st full PA) highlighting use of modeling system. ^{167, 168, 169}</p>	<p>1990 - Jan: DOE issues Final Supplemental EIS. ¹⁶³ Jun: DOE issues "Record of Decision" on WIPP Final Supplemental EIS stating construction is officially complete, testing phase (-5yr) should proceed, and then another Supplemental EIS should be prepared before going to full operation. ¹³²</p>	<p>1990 - Oct: EPA issues no-migration variance for test phase of WIPP. ¹³⁰</p>	<p>1990 - Jul: NM granted authority by EPA to regulate radioactive mixed waste and thus WIPP waste becomes subject to NM regulations. ¹¹⁶ NM Environmental Improvement Division requests submittal of Parts A & B of RCRA permit. Oct: NM designates "preferred route" for waste transport from northern border to WIPP.</p>
1991	<p>1991 Major models linked in WIPP PA</p> 	<p>1991 - Westinghouse completes Parts A & B of RCRA permit application. ^{170, 171} Apr: Aug, Sep: To extend life of room 1, panel 1 for gas generation tests, internal and external panels meet to recommend roof support. Dec: SNL issues 3rd PA highlighting major components of the PA process and documents. ¹⁷² Westinghouse completes construction of roof support. ^{173, 174}</p>	<p>1991 - In response to audit, AL manager creates WIPP Integration Office (WPIO) in Albuquerque over WFO in Carlsbad.</p>	<p>1991 - Jan: DOI modifies administrative land withdrawal order to allow test phase of WIPP. ^{131, 132, 133} Mar: House Interior Committee adopts NM Congressman Richardson's resolution to nullify DOI-modified land withdrawal order (action allowed under Federal Land Policy & Management Act [FLPMA]). ¹³⁴ Sep: 9th Circuit Court of Appeals rules state ban on radioactive waste shipments imposed by Gov. Andrus of Idaho is illegal. ¹³⁵ Oct: DOI again grants administrative land withdrawal after Watkins certifies all environmental permitting requirements have been met. ¹³⁶</p>	<p>1991 - AG: Udall. Oct: AG Udall files 1000-page lawsuit in U.S. District Court for the District of Columbia to delay start of test phase at WIPP by challenging the administrative land withdrawal. ¹¹⁶</p>
1992	<p>1992 Refinements to models (e.g., transmissivity fields) in WIPP PA</p> <p>1992 Congress passes Land Withdrawal Act</p> 	<p>1992 - SNL & Westinghouse complete work necessary to modify Test Phase Plan. ¹⁷⁵ Westinghouse completes work necessary for modifying Waste Retrieval Plan. ¹⁷⁶ Jun: NAS WIPP Panel sends letter to DOE questioning scientific need for in-situ waste tests at WIPP. ¹⁷⁷ Dec: SNL issues 4th PA refining models and data used in the PA. ¹⁷⁸</p>	<p>1992 - Aug: DOE submits application to New Mexico Environment Department (NMED) for RCRA permit for test phase.</p>	<p>1992 - Oct: WIPP Land Withdrawal Act (LWA). ¹³⁷</p> <ul style="list-style-type: none"> - transfers land from DOI to DOE - establishes EPA as regulator for WIPP (removing self regulation by DOE); compliance requirements (different than WIPP Panel or EEG) to be set in 40 CFR 194 - requires recertifying site every 5 yr - reinstates Subpart B of 40 CFR 191 except disputed aspects of individual and groundwater protection requirements - requires DOE cooperation and consultation with EEG <p>Energy Policy Act ¹³⁸ asks NAS to recommend disposal criteria for Yucca Mt. . .</p> <ul style="list-style-type: none"> - requires EPA & NRC to reevaluate their disposal criteria for Yucca Mt. Federal Facility Compliance Act ¹³⁹. - waives federal sovereign immunity for civil and criminal liability for RCRA violations and thus brings DOE facilities under jurisdiction of states but exempts mixed waste stored by DOE. - Washington DC District Court Judge Penn grants preliminary injunction to stop testing with TRU waste at WIPP. Penn rules WIPP does not qualify for interim status under RCRA, thus must get permits before rather than during operation. 	<p>1992 - Environmental Defense Fund (EDF) and NRDC join the NM lawsuit and seek to make RCRA issues more important (e.g., interim status of WIPP). ¹¹⁷</p>

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1993	1994	1995	1996	1997
<p>1993 DOE decides not to test waste at WIPP.</p>  <p>1993 EPA promulgates 40 CFR 191</p> 	<p>1993 DOE Sec. Hazel O'Leary. Oct: DOE concurs with NAS and decides not to emplace waste in a pilot phase at WIPP - lab tests instead. ¹¹⁸ DOE decides to make draft application to EPA. Dec: O'Leary disbands WPIO in Albuquerque and selects new personnel for Carlsbad Area Office (CAO) (old WPO with new functions) and direct report to Undersecretary T. Grumbly. ¹¹⁸</p> <p>1994 - Aug: SNL seeks permits to drill new wells for tracer test in Culebra.</p> <p>1995 - Feb: Drilling of wells for tracer tests begin. Oct: IT Corp. completes cost/benefit study of engineered barrier alternatives suggested by 40 CFR 194. ⁷⁹ Dec: DOE publishes updated revision of WIPP inventory. ¹²⁰</p> <p>1996 - Apr: Completed tracer test in Culebra; decided dual porosity model reasonable and single porosity transport alternative model could be ruled out. ¹²¹ ¹²² Oct: SNL completes PA for Compliance Certification Application (CCA) of WIPP that includes MgO backfill mining scenario, and greater intrusion rate; except for few vectors, drill cuttings only release pathway. ¹²³ ¹²⁴ Calculation was run 3 times with 100 samples each and took 35,500 CPU hrs on 20 DEC alphas and created 100 GBytes of data in 165,000 files. Nov: NAS reports that WIPP site "excellent choice" geologically. ¹²⁵ ¹²⁶</p> <p>1996 SNL completes PA for WIPP certification; moving van required to send copies to EPA</p>  <p>1996 EPA promulgates 40 CFR 194</p> 	<p>1993 - Feb: EPA announces intent to promulgate 40 CFR 194 to specify requirements for implementing 40 CFR 191 at WIPP. ¹⁴⁰ Dec: In response to court remand and WIPP LWA, EPA recomulgates 40 CFR 191 to address individual and groundwater protection requirements, and makes other changes - no influential changes for WIPP. ¹⁴¹</p> <p>1994 - Congress authorizes funding for EEG for additional 5 yr. ¹⁴²</p> <p>1995 - Jan: EPA proposes compliance criteria for WIPP in 40 CFR 194. ¹⁴³ May: DOE comments that 40 CFR 194 exceeds scope of 40 CFR 191. Oct: EPA issues draft of non-binding Compliance Application Guide (CAG). ¹⁴⁴</p> <p>1996 - Feb: EPA promulgates final 40 CFR 194; directs DOE to consider additional criteria in assessing system performance. ¹⁴⁵</p> <ul style="list-style-type: none"> - requires waste characterization analysis and engineered barrier evaluation - requires a monitoring system - specifies requirements on quality assurance (QA), peer review, and expert judgment - requires peer review on waste characterization, engineered and natural barriers, and conceptual models - expands human activities (e.g., potash mining) to consider in performance assessment <p>Sep: Congress amends WIPP LWA and relieves WIPP of need to comply with land disposal restrictions of RCRA, but other requirements of RCRA still apply. ¹⁴⁶ Dec: EPA begins detailed evaluation of CCA and supporting information at SNL and elsewhere including SNL PA conceptual models, computer codes, model parameters, QA records, and specific technical issues (e.g. MgO backfill and passive institutional control). ¹⁴⁷</p> <p>1997 - May: In letter to DOE secretary, EPA Administrator Browner decrees DOE application "complete"; this starts the 1yr clock for review of CCA. Jun: Appeals Court in Washington rules meetings between EPA and DOE proper when one agency proposes regulations for another agency as required by executive order and says NM and TX AG law-suit is without basis. ¹⁴⁸ Oct: EPA issues draft rule to approve WIPP with conditions: requires use of panel seals used in PA; design requires QA for waste generators; lists requirements for using process knowledge to characterize wastes; requires schedule for installing passive controls; denies any protective credit for passive controls; and 120-day public comment period begins.</p> <p>1997 - DOE Secretary: Pena. Jan: DOE holds hearings on 2nd supplemental draft EIS for WIPP in Carlsbad, Albuquerque, and Santa Fe, New Mexico. ¹⁴⁹</p> <p>1997 - Jan: Conceptual Model Peer Review Group (formed in response to 40 CFR 194) concludes 22 of 24 conceptual models adequate. Spallings model must be redone and MgO backfill description improved. Mar: SNL conducts mini PA for EPA to do parametric sensitivity analysis of PA model parameters lacking "iron-clad" defense. Apr: Conceptual Model Peer Review Group reports that with additional information provided by SNL, they are satisfied that the new model of Spallings ¹⁵¹ and the model of the MgO backfill are adequate. ¹⁵² May: As part of EPA evaluation of CCA, SNL runs EPA - mandated PA calculations using EPA-selected values for 26 parameters and EPA selected model assumptions based on results from parameter review team comments in December and sensitivity analysis in March.</p>	<p>1993 - May: Mayor Forrest of Carlsbad demands more economic benefits accrue to city of Carlsbad from WIPP. ¹¹⁸ ¹¹⁹ NMED issues Draft RCRA permit for test phase. ¹²⁰</p> <p>1996 - Apr: NM AG Udall sues EPA alleging improper meetings were held between EPA and DOE about requirements in proposed 40 CFR 194 regulation. ¹²¹</p>	<p>King Admin.</p> <p>Johnson Administration</p> <p>Clinton Administration</p>

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Acronyms/Initialisms

A/E –	architect/engineering firm.
AEA –	<i>Atomic Energy Act</i> , either 1946 (Pub. L. 585) or 1954 (Pub. L. 703).
AEC –	Atomic Energy Commission, the forerunner of the DOE that was formed in 1946 (August 1, 1946, 60 Stat. 755).
AG –	attorney general.
AL –	Albuquerque Operations Office, DOE.
ALARA –	As low as reasonably achievable with costs and benefits taken into account; a basic NRC policy of radiation protection initially promulgated in 1975.
BRWM –	Board of Radioactive Waste Management, a permanent Board formed in 1968 in the National Research Council, the principal operating agency of the U.S. National Academy of Sciences (NAS).
C&C –	Consultation and Cooperation Agreement Between the State of New Mexico and the DOE.
CAG –	Compliance Application Guide, a non-binding guidance document developed by the EPA to supplement the 40 CFR 194 implementing regulation.
CAMCON –	Compliance Assessment Methodology CONTroller, computational system for assessing the performance of a disposal system (usually for nuclear wastes). This complex information management system provides for (1) the interfacing of individual computer codes of the WIPP PA modeling system, and (2) quality assurance.
CAO –	Carlsbad Area Office, DOE office for managing WIPP Project, formed in 1993 to replace the WIPP Integration Office (WPIO) that had been established in 1991, and the WIPP Project Office (WPO), which had been created in the 1980s, moving to Carlsbad, NM, in 1984.
CARD –	Citizens Against Radioactive Dumping, New Mexico special interest group.
CCA –	Title 40 CFR Part 191 Compliance Certification Application for the Waste Isolation Pilot Plant, coordinated by Westinghouse for the DOE with input from Sandia National Laboratories, sole author on Chapter 6 and numerous appendices.
CH-TRU–	contact-handled TransUranic waste, packaged TRU waste whose external surface dose rate does not exceed 200 mrem per hour.
DCCA –	Draft Compliance Certification Application prepared in 1995.
DHLW –	Defense high-level waste, that is, high-level waste (HLW) that has been generated by the DOE in reprocessing spent nuclear fuel from experimental and military reactors. Because the possibility of commercial reprocessing was stopped under the Carter Administration in 1980 and never initiated thereafter, only about 72 MTHM equivalents from the West Valley Demonstration Project in New York or 0.75% is commercial HLW in the United States. Hence, the distinction between defense and commercial HLW is usually unimportant except when highlighting the source of HLW or when discussing reprocessing and disposal plans for HLW in the United States prior to 1980.
DOE –	U.S. Department of Energy, formed by <i>DOE Organization Act</i> (Public Law 95-91, 91 Stat. 565), which replaced the Energy Research and Development Agency (ERDA). ERDA was formed by the 1974 <i>Energy Reorganization Act</i> (Public Law 93-438) and replaced the Atomic Energy Commission (AEC), which was formed in 1946 (August 1, 1946, 60 Stat. 755).

DOI –	U.S. Department of Interior.
DOL –	U.S. Department of Labor.
DOT –	U.S. Department of Transportation.
EEG –	Environmental Evaluation Group, formed in 1978 by New Mexico from funds provided by the DOE to conduct independent technical evaluation of the WIPP. <i>The National Defense Authorization Act, Fiscal Year 1989</i> , Public Law 100-456, Section 1433 assigned administrative oversight of EEG to the New Mexico Institute of Mining and Technology.
EIS –	Environmental Impact Statement, environmental documentation required by federal law (NEPA) for large, federally-funded programs.
EPA –	U.S. Environmental Protection Agency, formed by Congress on December 2, 1970, in Reorganization Plan No. 3 of 1970 (5 U.S.C. 903, n 19; 40 CFR 1). In this act, Congress transferred to EPA the tasks of monitoring research, setting standards, and performing enforcement activities related to pollution abatement and control that allow the environment to be considered as a single, interrelated system.
ERDA –	Energy Research and Development Agency, a forerunner of the DOE that was formed in 1974 (Pub. L. 93-438).
FLPMA –	Public Law 94-579. 1976. <i>Federal Land Policy and Management Act of 1976</i> (43 U.S.C. 1701 et seq.; 90 Stat. 2743).
GA –	General Atomic, Inc.
HLW –	High level (radioactive) waste, ". . . the highly radioactive material [fission products and some actinides,] resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations . . ." (NWPA, 1982, §2[12]) ^{F18} . Although not used in this manner in this report, general articles regarding radioactive waste use the term high level waste to imply any combination of spent nuclear fuel and HLW (and sometimes transuranic [TRU] waste) that requires disposal in a deep, geologic repository. 10 CFR 60, which was promulgated by the NRC prior to NWPA, also includes spent nuclear fuel in its definition of high level waste.
HSWA –	Hazardous and Solid Waste Amendments of 1984 (Pub. L. 98-616) (see also RCRA).
INEEL –	Idaho National Engineering and Environmental Laboratory, a multiprogram laboratory in Idaho Falls, Idaho, furnishing engineering services and products on primarily nuclear energy and related technologies. The Idaho Chemical Processing Plant (ICPP) at the Idaho site processes highly enriched uranium fuel from spent nuclear fuel stored at the site. In addition to receiving spent nuclear fuel from throughout the DOE defense complex, it stores a large volume of TRU waste from Rocky Flats destined for the WIPP. Prior to 1970, it buried this TRU waste, but now stores it on the surface.
IRG –	Interagency Review Group on Nuclear Waste Management; The Carter Administration formed this group on the recommendation of Secretary of Energy, Schlesinger. The group consisted of the DOE and eight other agencies together with several entities within the Executive Branch, including the Council on Environmental Quality.
LANL –	Los Alamos National Laboratory, a multiprogram laboratory in Los Alamos, NM, conducting research and development on all facets of nuclear weapon design and basic research in a variety of areas. A large volume of TRU waste stored on site is destined for the WIPP.
LEAF –	Legal Environmental Assistance Foundation.
MIT –	Massachusetts Institute of Technology.

- MRS** – monitored retrievable storage facility for spent fuel from commercial power reactors, proposed in 1982 in NWPA and 1987 in NWPA (see also RSSF).
- NAS** – National Academy of Sciences, is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research. The Academy was chartered by Congress in 1863 with the mandate to advise the federal government on scientific and technical matters.
- NEPA** – *National Environmental Policy Act of 1969*, federal law that sets environmental policy by requiring an environmental impact statement on all major federal projects; Public Law No. 91-190, 83 Stat. 852.
- NMED** – New Mexico Environment Department.
- NRC** – Nuclear Regulatory Commission, formed by the 1974 *Energy Reorganization Act* (Public Law 93-438) from the Atomic Energy Commission.
- NRDC** – National Resources Defense Council, U.S. environmental special interest group.
- NWPA** – *Nuclear Waste Policy Act of 1982*, provides a national policy for the interim storage, monitored retrievable storage, and eventual disposal of radioactive waste.
- NWPA** – *Nuclear Waste Policy Amendments Act of 1987*, amendments to the *Nuclear Waste Policy Act of 1982* specifying that only one repository site at Yucca Mountain was to be characterized by the DOE and placing less emphasis on the monitored retrievable storage option.
- ORNL** – Oak Ridge National Laboratory, Y-12 Plant, Oak Ridge Reservation, Oak Ridge, TN. A large volume of TRU waste in storage is destined for the WIPP.
- OTA** – Office of Technology Assessment, U.S. Congress.
- PA** – Performance assessment, the *process* of assessing whether a *system* meets a set of *performance criteria*. For the WIPP PA, the *process* is a stochastic simulation. The *system* is a deep geologic repository disposal system (in salt) for DOE TRU waste. The *performance criteria* are various long-term environmental metrics in U.S. government regulations (not short-term operational safety issues).
- PRA** – Probabilistic risk assessment, the process of assessing, through a stochastic simulation, the risks from a system. In theory, a PRA is identical to a performance assessment (PA) in the United States. In practice, the two differ because a PRA usually connotes (a) a system composed solely of human-engineered components, and (b) performance criteria that include risk to health over a short time (e.g., human lifetime) relative to geologic time. A PA usually connotes a system composed of both natural and human-engineered components over geologic time. Because the time frame is different, many phenomena for a PRA can be termed events (short-term phenomena); because the components are all human engineered, measured failure rates of components are often available. The modeling tools in a PRA can include elaborate event and fault trees and can substitute empirical data for mechanistic models. For a WIPP PA, the event trees are simpler, fault trees are not used, and mechanistic models are used directly.
- QA** – quality assurance, all those planned and systemic actions necessary to provide adequate confidence that a structure, system, or component will perform satisfactorily in service. Quality assurance for a product is ensuring that the product does what it is supposed to do to meet the specifications of the customer. The customer expectation, as related to a performance assessment, is that the analysis results present an adequate view (from a legal standpoint) of the WIPP performance based on currently available data and information.
- RCRA** – *Resource Conservation and Recovery Act of 1976* (Public Law 94-580) and, as used herein, subsequent amendments (e.g., HSWA, *Hazardous and Solid Waste Amendments of 1984*, Public Law 98-616). RCRA establishes a procedure to track and control

hazardous wastes from time of generation to disposal. Regulations in 40 CFR Parts 260-281 implement RCRA with respect to hazardous waste and hazardous waste treatment.

- RH-TRU** – remotely-handled Transuranic waste, packaged TRU waste whose external surface dose rate exceeds 200 mrem per hour, but not greater than 1000 rem per hour.
- RSSF** – Retrievable surface storage facility for spent nuclear fuel and high-level waste proposed in 1972 by the AEC.
- RWMC** – Radioactive Waste Management Complex, a nuclear waste storage facility for the DOE complex that has been at Idaho National Engineering and Environmental Laboratory (INEEL) since it was first built in 1952.
- SA** – Stipulated Agreement between the State of New Mexico and the DOE.
- SAB** – EPA's Science Advisory Board
- SAR** – Safety Analysis Report.
- SNF** – spent nuclear fuel, ". . . fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing" (NWPA, 1982)^{F18}. Spent fuel can include intact and failed fuel assemblies, consolidated fuel rods, non-fuel components that are a part of a fuel assembly (such as neutron sources, instrumentation, and fuel channels). Although spent nuclear fuel has fissionable ²³⁵U, it contains too many radionuclides (primarily short-lived) that adsorb neutrons from the fission process for it to be usefully left in the reactor. Because of spent nuclear fuel's high value, some countries choose to recycle it (recycling becomes more attractive after the short-lived fission products have decayed away). It is also designated separately from other high-level and transuranic wastes in the U.S. Environmental Protection Agency's standard on disposal of radioactive wastes, 40 CFR 191.
- SNL** – Sandia National Laboratories, a multiprogram laboratory located in Albuquerque, NM, and Livermore, CA. SNL is operated and managed for the DOE by the Sandia Corporation. From 1949 until October 1993, Sandia Corporation was a wholly owned subsidiary of AT&T. Sandia Corporation is currently a wholly owned subsidiary of Lockheed-Martin Corp.
- SPDV** – Site and preliminary design validation phase performed by Bechtel National.
- SRP** – Savannah River Plant Laboratory Production Reactors Defense Waste Processing Facility, located southeast of Augusta, Georgia. A large volume of TRU waste produced and stored on site is destined for the WIPP.
- SWCF** – Sandia WIPP Central Files.
- SWRIC** – Southwest Research and Information Center.
- TRU** – TRansUranic, all elements of the periodic table having atomic numbers greater than 92.
- TRUPACT-I** – Transuranic Package Transport design I, designed to be a vented package in the same shape and size as standard shipping containers to facilitate shipment. The EEG objected to a vented container; so the package was completely redesigned (see TRUPACT-II).
- TRUPACT-II** – Transuranic Package Transport design II, designed to be a pressurized hemispherical package for use on flatbed trucks.
- USGS** – U.S. Geological Survey, Department of Interior (DOI).
- WIPP** – Waste Isolation Pilot Plant, a full-scale research and development repository for transuranic wastes near Carlsbad, NM; authorized in 1979 (Pub. L. 96-164) for the management, storage, and eventual disposal of waste generated by DOE defense programs that is contaminated with transuranic radionuclides and some RCRA hazardous chemicals.

- WIPP LWA** – Public Law 102-579. 1992. *Waste Isolation Pilot Plant Land Withdrawal Act* (106 Stat. 4777).
- WPIO** – WIPP Project Integration Office, formed in 1989, forerunner of the Carlsbad Area Office (CAO).
- WPO** – WIPP Project office, forerunner of the Carlsbad Area Office (CAO).

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