Should WIPP Replace Yucca Mountain? - 11058

Christopher M. Timm, PE* and Jerry V. Fox, PhD, PE*
*PECOS Management Services, Inc.

ABSTRACT

The 2010 decision by the Department of Energy (DOE) to abandon the Yucca Mountain Repository for the disposal of high-level radioactive waste is still being played out as this abstract is written. Among the ideas floated to replace Yucca Mountain has been to expand the Waste Isolation Pilot Plant (WIPP) in New Mexico that is currently disposing of transuranic waste in a thick, geologically stable salt bed.

This paper will examine the scientific, engineering, health and safety, environmental, and management issues associated with the deep disposal of high-level radioactive waste on or near the WIPP site. Scientific issues will include criticality, heat impacts, and potential for transport of radionuclides to the accessible environment in the future. Engineering issues will include the stability of the existing WIPP repository for expansion, the availability of undisturbed salt formations in the USA, the suitability of the waste handling facilities to handle high-level waste (HLW) and spent nuclear fuel (SNF), and the potential for retrieval. The potential for the WIPP infrastructure to support the Yucca Mountain issue in terms of electrical power, potable water, waste treatment, and other services will also be examined. Health and safety issues will look at whether the existing WIPP facilities can safely handle HLW and, if not, what upgrades would be required. Environmental issues will examine the potential additional release mechanisms and the reliability and credibility of the performance assessments in terms of potential future releases. It will also look at the regulatory issues from the perspective of the regulating agency and requirements.

INTRODUCTION

WIPP is located in southeastern New Mexico near Carlsbad, NM. The disposal area of WIPP is situated approximately 655 meters (2150 ft) underground; mined into the middle of a 610 m (2000 ft) thick salt formation deposited 250 million years ago. The repository consists of surface facilities, the primary one being the Waste Handling Building, four vertical shafts drilled into the salt formation and a series of eight disposal areas called panels (Figure 1). In 1992, the Land Withdrawal Act (LWA) [1] established that the combined volume of contact handled and remote handled transuranic (TRU) waste allowed at WIPP must be less than or equal to 175,564 m^3 (6,200,000 ft^3)with a disposal limit for RH TRU waste of 7,080 m^3 with the remainder being CH TRU waste.

The Yucca Mountain repository is located in a volcanic tuff mountain in the southwestern Nevada desert about 161 km (100 mi) northwest of Las Vegas. It is the proposed disposal site for up to 77,000 metric tons of radioactive waste (primarily commercial and defense spent fuel and high-level radioactive waste) presently in storage nationwide at commercial reactors and DOE sites. The Yucca Mountain Project arose from the 1982 Nuclear Waste Policy Act [2] that required the DOE to construct a permanent underground nuclear-waste storage facility. The repository is located approximately 305 m (1,000 ft.) beneath the mountain and is accessed by a tunnel into the side of the mountain (Figure 2).

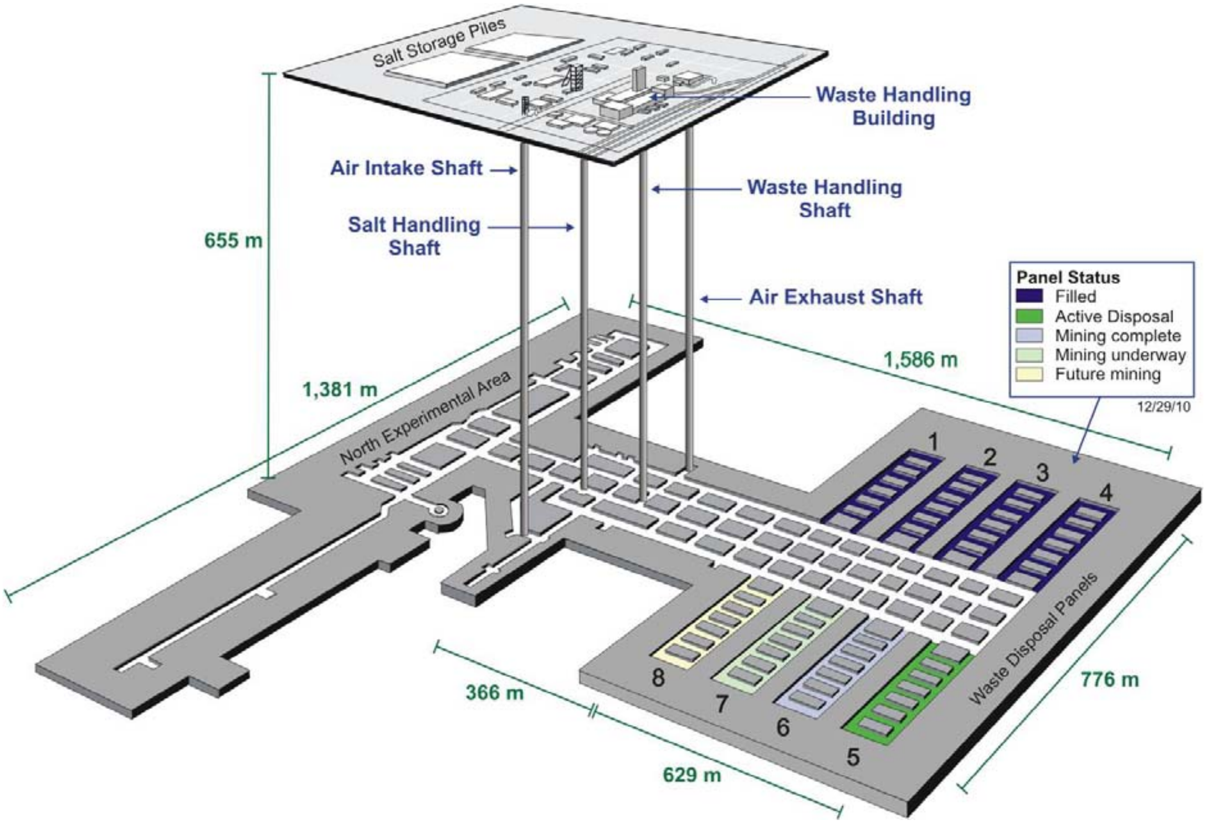

Figure 1 WIPP layout

The major difference between them is the geology. Salt is relatively plastic and will creep in to close any mined out openings relatively quickly, while openings in tuff will maintain their shape and volume much, much longer. As a result, retrieval of the radioactive waste is feasible from Yucca Mountain for hundreds of years, while at WIPP, retrieval of waste is only possible for a three to four years at best after placement in the WIPP repository.

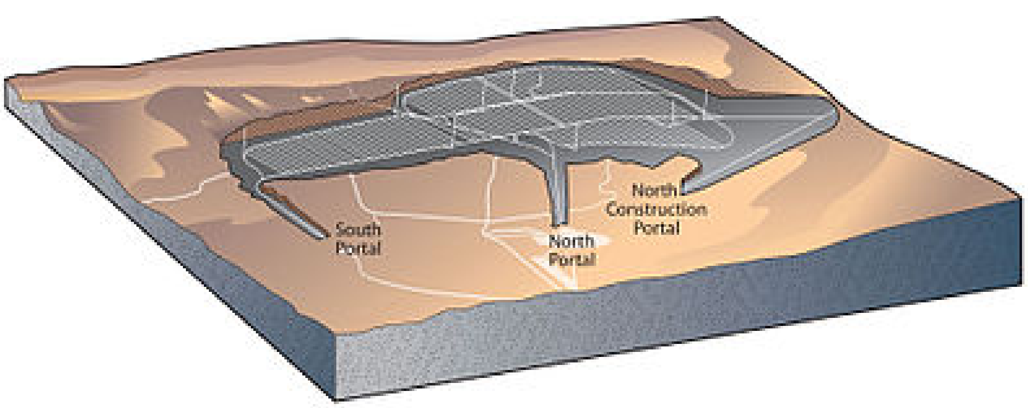

Figure 2 Yucca Mountain Repository

APPLICABLE HISTORY

The history of both WIPP and Yucca Mountain started in 1956, when the National Academy of Sciences recommended deep geological disposal of long-lived radioactive waste from nuclear reactors, suggesting that buried salt deposits and other rock types be investigated for permanent repositories [3].

The initial deep geological disposal site locations considered were the buried salt beds of the Salina Basin beneath Michigan and Ohio, which were investigated in the late 1950s and early 1960s by the U.S. Atomic Energy Commission (AEC), predecessor agency of the DOE. However, as an omen of what would plague both WIPP and Yucca Mountain, those studies were terminated because state and local officials as well as various concerned citizens groups objected.

In 1970, the AEC issued a report that indicated the primary choice for a deep geological disposal was salt beds [4]. Salt deposits were preferred for disposal of radioactive wastes based on a number of characteristics. First, salt deposits are wide spread and abundant in the USA, underlying about 500,000 square miles in portions of 24 states. Physically and geologically, the attractive properties of salt deposits include:

- Good structural properties, with a compressive strength and radiation-shielding properties similar to concrete,
- Bedded salt deposits are completely free of circulating ground waters and are isolated both above and below from underground aquifers by essentially impermeable rock formations, usually shale.
- Salt generally in areas of low seismicity,
- Any fractures that might develop are healed by plastic deformation and recrystallization of the salt
- Salt thermal properties are better than those of most other rock types, and
- Salt is relatively inexpensive to mine.

In the early 1970s, the AEC announced that a salt mine in Lyons, KS would be developed as an HLW repository, and, in fact, conducted a number of tests and experiments related to the possible effects of the heat and radioactivity associated with radioactive waste in various levels and forms on the salt [5]. However, that salt mine was abandoned in 1972 after KS state geologists discovered the site to be riddled with abandoned and poorly closed oil and gas exploration boreholes. After that, the DOE began studying several other sites in various geologic media.

The histories of WIPP and Yucca Mountain diverge significantly at that point. In 1972, when it was learned that that the salt mine near Lyons, KS was no longer being considered, the local, state and federal politicians representing the Carlsbad, NM area all came forward to the AEC in favor of locating the disposal site in southeastern New Mexico, initially in an abandoned potash mine. The offer was accepted and DOE proceeded to investigate the area east of Carlsbad to determine whether the potash mines or underlying salt formations were suitable for location of a waste repository. The investigations determined that the Salado Formation in that area was sufficiently thick and geologically stable and had a sufficiently large horizontal area with undisturbed integrity (no boreholes puncturing the formation) to warrant the issuance of a draft environmental impact statement (EIS) in 1979. That EIS proposed that WIPP be considered for disposal of both defense related and commercial high-level waste and for storage of spent nuclear fuel [6]. However as a result of objections by the State of New Mexico and assorted citizen groups, the original mission of WIPP as authorized by Congress in 1979 was only as a research and development facility to study the feasibility of disposal of defense-related radioactive waste in salt beds. The Record of Decision for the EIS that was issued by the DOE, (the successor to the AEC) in 1981 concentrated on potential disposal of TRU radioactive waste but did also include an intent to conduct experiments with the disposal of defense generated HLW and the construction of WIPP proceeded.

In that same timeframe, the resistance to WIPP by other entities in New Mexico, in particular the anti-nuclear groups became very active. Somewhat surprisingly, the congressman representing the district that contained Los Alamos National Laboratory, and the state environmental department and attorney general were equally against the location of WIPP in New Mexico. As a result, several lawsuits were filed and an agreement was reached in 1981 that effectively limited WIPP to the disposal of defense-related TRU waste only. The construction of WIPP and the evaluation of its acceptability as a radioactive waste disposal facility continued despite continuous attempts by various opponents to stop the project. Those attempts plus some safety and environmental concerns led to a declaration by the Secretary of Energy in 1989 that the opening of WIPP would be delayed indefinitely [7]. The WIPP program was restructured and that declaration was withdrawn a few months later. This led to a subsequent lawsuit in 1991 by the State of New Mexico to stop shipments to WIPP. Nevertheless, Congress made the determination to proceed with WIPP via the Land Withdrawal Act of 1992, as amended [1]. This led to the certification of WIPP by the EPA in 1998, the disposal of the first TRU waste in WIPP in March 1999, and the subsequent issuance of a Hazardous Waste Facility permit (HWFP) by the State of New Mexico in May 1999, which allowed the disposal of mixed waste in WIPP.

Partly as a result of the limitations put on WIPP in 1979, Congress passed the Nuclear Waste Policy Act (NWPA) in 1982 that set in motion a nationwide search for a new site for the deep geologic disposal of high-level radioactive waste and spent nuclear fuel [2]. After approval of the NWPA in 1983, the DOE named nine previously screened potentially acceptable repository sites in six states, and in 1985, the DOE nominated five of these sites from the original nine. As a result of extensive public objections in the states in the eastern US that had candidate sites, the list was whittled down to the final three. The three sites ultimately chosen for characterization were in Deaf Smith County, in far western Texas (in salt, part of the huge Permian Basin that was the site of the 1970s effort in Kansas and that today is home to WIPP); in Richland, Wash. (in a basalt ridge on the Hanford Reservation); and in a volcanic tuff mountain formation on the edge of the Nevada Test Site in Nye County, Nevada.

Because of the concern about the cost of investigating three sites, Congress narrowed the investigation down to the Yucca Mountain site in 1987 through an amendment to the NWPA [8]. This decision was based more on politics than science. Investigation work began that year and culminated in the issuance of the NEPA ROD in 2002, the initiation of supplemental EIS' in 2006 and 2008 and then the submittal of the licensing application to the NRC in 2008. During that period of time, the residents and government of Nye County became proponents of the project recognizing it was safe and also an economic boon for the county. Unfortunately, the State of Nevada and the anti-nuclear groups based primarily in Clark County have been able to suspend if not end the Yucca Mountain Project through political means rather than any scientific or engineering justification.

For perspective, it took 27 years from the time that it was proposed to locate WIPP in southeastern New Mexico until it opened. Development of Yucca Mountain has been underway for 25 years and it might have actually opened in 27 years if it had not been put on hold by the Obama administration.

RESEARCH AND DEVELOPMENT

Research and development (R&D) related to the disposal of all forms of radioactive waste in salt were initiated by the AEC in 1957. Oak Ridge National Laboratory (ORNL) was the initial focus of the R&D and conducted laboratory and field studies of the feasibility of using salt formations for radioactive waste disposal during 1957-1962. Further, from 1963-1967 ORNL performed extensive studies related to the disposal of high-level radioactive waste in the Carey Salt Company mine in Lyons, KS. These studies, designated Project Salt Vault [5], were accomplished by the emplacement of approximately 4 million curies of radioactive material in the form of spent nuclear fuel in experimental disposal holes in the mine. The first material was emplaced in 1965 and the last material was removed in 1967. The results of the experiments showed that the structural properties of salt were not significantly altered by the high doses and dose rates though some of the effects noted had not been anticipated, namely the speed of the transfer of thermal stresses and the great distance the transfer effects were noted. Also, there were inclusions (shale lenses) in the salt that had more of an impact than anticipated. These lessons learned were applied to the design of the WIPP.

During the period from 1975 to the submission of the certification application to the EPA in 1996, there was a continuing investigation and research and development program focused on the WIPP site [9]. The principal technical issues addressed by that program included:

- The interaction of TRU wastes with salt including the assessment of potential degradation mechanisms and the impact on the repository and radionuclide isolation.
- The interaction of thermal and radiation fields from heat producing wastes with the salt environment and the impact on the waste form encapsulating materials.
- Prediction of the response of the host rock to both the ambient conditions upon excavation and the enhanced deformation anticipated with heat-producing waste forms.
- Characterization of the potential for radionuclide migration in the WIPP environment.
- Characterization of the properties of the host rock for permeation of gases or liquids.
- Assessment of the potential for mobilization of natural fluids in the salt and the subsequent interaction with waste containers.
- Quantification of the technology for sealing man-made penetrations into or near the storage horizons.
- Demonstration and certification of safe operational techniques and appropriate design assumptions.

In addressing these technical issues in the initial site characterization and in situ testing programs at the WIPP site, the effects of both TRU waste and high-level waste were included in order to establish the radionuclide containment and isolation characteristics of the prevailing geology as they pertain to both TRU waste and HLW. Thus, the foundation for the effectiveness of disposal of HLW and spent nuclear fuel (SNF) at WIPP has already been established.

Subsequent to the opening of WIPP, investigative work has continued to improve the overall understanding of how salt reacts to the heat and radioactivity emitted from TRU wastes, affects of other emissions from the waste containers (volatile organic compounds, etc.) on the repository, the geotechnical impact of major openings on the salt formation, the performance assessment, and operational procedures. Suffice to say that if Yucca Mountain is 'the most studied real estate on the planet', as stated by a DOE representative at a Congress hearing [8]; WIPP is a very close second.

The other aspect of the R&D necessary for disposal of HLW and SNF is the waste packaging, transportation, and handling requirements. Those requirements have been extensively researched during the development of Yucca Mountain (16) and the appropriate systems, equipment and processes developed. Those systems, equipment and processes would serve as a more than adequate baseline for any modifications necessary for disposal in salt.

REQUIREMENTS FOR USE OF WIPP SITE

If it was scientifically and technically demonstrated that the WIPP site could be expanded for the disposal of HLW (and SNF if reprocessing is continued to be blocked in the USA) by use of the current facilities or by co-locating a new disposal facility in the land withdrawn for WIPP, the first step would be the Congressional action to either modify the LWA or pass new enabling legislation for the new repository. That legislation action would also have to clarify the whether EPA, who currently is the certifier for WIPP per the LWA, or the NRC, who is the licensing agency for HLW/SNF repositories would have the Federal regulatory lead. The roles and responsibilities of the State of New Mexico would also have to be addressed.

Licensing Agency. The two most likely options as the responsible licensing agency should WIPP be designated for high-level waste disposal are EPA and NRC. If the existing, surface facilities, shafts and a part of the underground work areas at WIPP were to be the basis for development of a high-level waste repository, then authorization could be accomplished by relatively minor modifications to the Land Withdrawal Act (recognizing that nothing related to nuclear waste disposal in the US that requires Congressional action is ever minor). That would leave EPA as the regulatory agency and 40CFR194 as the certifying process. However, should DOE opt to establish a new facility for disposal in salt (on or near WIPP), the licensing responsibility would remain with the NRC.

Regardless of the lead Federal agency, it appears that it would have to be demonstrated that the new disposal facility could meet the EPA disposal standards (40CFR191) [10]and certification requirements (40CFR194) [11] as well as receive a Resource Conservation and Recovery Act

(RCRA) [12] disposal permit modification or new permit from the New Mexico Environment Department

However, before the legislative and certification/permitting requirements could be addressed the suitability of the WIPP site with respect to the following issues would have to be addressed:

- Compliance with applicable environmental standards
- Sufficiency of Space (surface and underground) at WIPP
- Integrity of the Salado Formation
- Adequacy of Existing Facilities
- Recovery of Spent Nuclear Fuel
- Operational Health and Safety Differences
- Transportation

Compliance with Environmental Standards. The primary issue here is whether the EPA standards for WIPP (40CFR191) or for Yucca Mountain (40CFR197) would be applicable. There is a significant difference in that the EPA standards for WIPP require that the annual cumulative dose rate from any releases be less than 0.15 millisievert (mSv) per year for 10,000 years after closure while the Yucca Mountain standards have several added requirements including a dose limit of 1 mSv annual exposure per year between 10,000 years and 1 million years [13]. However, it is significant that 40CFR191 is applicable to any radioactive waste disposal facility other than Yucca Mountain that is operated by DOE while 40CFR197 is Yucca Mountain specific. Therefore, it can be argued that a decision to add a HLW/SNF facility at WIPP (within the designated land withdrawal area) would only require compliance with 40CFR191. If that were the case, the current performance assessment, which is essentially constructed such that an increase in the waste that is disposed in the salt formation results in a concurrent increase in the allowable integrated release of radionuclides, could be used and would be expected to continue to demonstrate compliance with 40CFR191[14].

The other EPA standards that may be at issue relate to RCRA. If the disposal would be in the current WIPP facilities, then a major modification to the WIPP HWFP issued by the New Mexico Environment Department would be required since the high-level waste would be disposed in different containers than currently identified in the HWFP and there may be hazardous materials in the high-level waste identified for disposal at Yucca Mountain other than those approved for disposal as mixed waste in WIPP. However, should a new disposal facility be proposed to be constructed and operated within the withdrawn land area (new waste handling building, shafts and underground workings) then it appears, based on the licensing history for Yucca Mountain, that only the NRC license would be required.

Sufficiency of Space at WIPP. The land withdrawal area for WIPP is a square measuring 6.44 km (4 mi.) on each side for a total area of 41.4 sq. km. (16 sq. mi.) and the active disposal area covers approximately 2.59 sq. km. (1 sq. mi.) in the middle of the withdrawn area with the surface facilities only covering approximately 0.13 km^2 (0.05 $mi.^2$) [15]. The area required for the same capacity for high-level waste and SNF disposal as was planned for Yucca Mountain is approximately 0.32 km^2 (0.125 $mi.^2$) for the surface facilities and 0.8 km^2 (0.3 $mi.^2$) of subsurface facilities [16]. The repository portion of Yucca Mountain is planned to include approximately 64.4 km (40 mi) of railroad lines [17]. However, it is doubtful whether the design of a HLW/SNF repository in salt would use the same disposal approach – rail lines – because of the difference in geological properties between salt and tuff.

Since the load bearing properties of salt are substantially less than those of tuff, the underground area for a HLW/SNF repository is salt would be substantially greater than the Yucca Mountain plan. Even so, there should be sufficient area to locate a separate HLW/SNF repository in the land withdrawal area of WIPP since the thickness of the Salado Formation would allow for more than one disposal level for HLW/SNF. The geological characterizations of the WIPP land withdrawal area and the surrounding area indicate that a location south or east of the current WIPP facility would be preferable both from the concern about a possible solution front that was identified early in the WIPP siting process and the near surface hydrogeology associated the possible release pathways to either potable water aquifers (there are none nearby) or to Nash Draw, an intermittent stream to the west of the WIPP site. A review of the current WIPP configuration (Figure 1), indicates that expansion to the east would be the easiest should a decision be made to use as much of the existing shaft and underground facilities as possible.

Also, should an increase of the capacity of the HLW/SNF repository be required above the 77,000 tons of nuclear waste currently authorized, as has been stated by DOE, the thickness of the Salado Formation would accommodate the construction of more than one disposal level in the repository – an option that had been explored earlier for WIPP [15].

Integrity of the Salado Formation. The integrity of the Salado Formation relates to the presence of oil or gas wells or other natural resource mining activities that may have resulted in breaches of the Salado Formation that could expedite or facilitate the entry of water or brine into the formation and consequent interaction with radioactive waste disposed therein. Since WIPP was initiated, there has been a substantial increase in the oil and gas exploration and extraction activities in the Delaware Basin where WIPP is located, so many of the previous nearby areas that were undisturbed now have been drilled through. This is reflected by the increased deep borehole drilling density reported in the 2009 recertification application to EPA [18], which is based on actual drilling records in the basin. However, the integrity of the Salado Formation under the 41.4 square kilometer (16 square miles) land withdrawal area has not changed since drilling is not allowed within that area. In fact, close surveillance is kept of any drilling within one mile of the WIPP boundaries so it would be relatively easy to expand the land withdrawal area up to 64.7 km^2 (25.mi. ^{2}) and maintain the formation integrity required. This is allowed by 40CFR191, which allows expansion of up to 100 km^2 (approximately 38.6 $mi.^2$) [14]. Of course, it would require an amendment of the Land Withdrawal Act (PL 97-102) [1].

Adequacy of Existing Facilities. There are two major issues with using the existing WIPP facilities to transfer and dispose of HLW/SNF. First, while the Waste Handling Building at WIPP is equipped with a hot cell, the handling plan for Yucca Mountain indicates as many as four hot cells would be needed since the radioactive waste would be received either already packaged into the approved disposal canisters (SNF) or other shipping containers. There are expected to be multiple forms and sizes of containers that would have to be transferred into approved canisters for disposal [16]. Therefore, it is probable that the WIPP hot cell does not have either the equipment or capacity or meet the current DOE safety requirements for the handling of HLW containers or SNF canisters. A second but equally critical issue is the ability of the Waste Shaft to handle the HLW/SNF waste packages. The WIPP waste shaft car is 9.1 m (30 ft) high by 3 m (10 ft) wide by 4.6 m (15 ft) deep and can carry a payload of 40.82 metric tons (45 tons) [15]. The proposed HLW/SNF waste package size is 3.7-5.5 m (12-18 ft) long by 1.5-1.8 m (5-6 ft) in diameter and the maximum weight of a waste package with a full load of either HLW or SNF is expected to be 54.25 tons [16]. A HLW/SNF waste package that is 5.5 m (18 ft) long would have to be lowered into the repository via the WIPP Waste Shaft in a vertical position, which would require special rigging for transfer into and out of the car. Also, the current waste shaft would not be able to transfer the heavier HLW/SNF waste packages, which are projected to be 90% of the HLW/SNF volume designated for Yucca Mountain.

In terms of basic utilities, the WIPP EIS [15] indicates that the electrical supply to the WIPP site is a 115 kilovolt transmission line provided by Southwestern Public Service Company. This is more than ample for the full WIPP operations and could be expanded as needed to meet the power requirements for a HLW/SNF facility in the land withdrawal area. Potable water is supplied to WIPP by the Double Eagle Water System, which consists of a series of wells about 56 km (35 mi.) north-northeast of the site. The system has a 2052 liter per minute (542-gpm) reserve pumping capacity and a storage capacity of 1272 kiloliters (336,000 gallons.) The actual water usage at WIPP has been approximately 13.2 megaliters/day (3.5 MGD), which indicates that there is a sufficient water supply to support installation of a HLW/SNF repository co-located with WIPP [19].

A separate but key consideration with respect to WIPP is the age of the WIPP infrastructure. Built in the 1980's, much of the WIPP infrastructure including the electrical distribution system, communications system, and underground wheeled equipment has reached or exceeding its design life, and, while well-maintained, is dated in terms of technology improvements and in some cases replacement parts are no longer being manufactured. In addition, despite extensive roof-bolting and other geo-technical reinforcements, the overhead in the tunnels and shafts are increasingly likely to collapse.

Recovery of Spent Nuclear Fuel. While the US currently does not have a SNF recycling program, that possibility is currently being re-considered by the Blue Ribbon Commission that was established by President Obama to recommend upgrades and redirections to this country's nuclear energy strategy. A major reason why the National Academy of Sciences recommended disposal in a salt formation as their first choice in the 1957 report and subsequent reports is that salt deforms or creeps with time under very low differential stresses. This property is beneficial in terms of efficiently closing openings in a salt formation and effectively encapsulating the emplaced radioactive waste. However, unless rigid structures are in place to forestall the salt creep, the period of physical access to the emplaced waste is limited. At WIPP, the estimate is that the salt will creep sufficiently in 5 to 6 years to prevent the safe retrieval of any emplaced TRU waste [20]. Furthermore, the research experiments conducted by DOE on salt creep revealed that the deformation/creep rate increases with increased thermal loading/rock temperature and depth/stress. It is expected that there would be a substantial increased in the thermal loading/rock temperatures associated with emplacement of SNF. Thus, if the intent is to be able to safely and easily retrieve SNF for future reprocessing, emplacement in a salt formation is not recommended. However, for disposal of the HLW resulting from the reprocessing of SNF, salt is a very viable option.

Operational Health and Safety Differences. There are major operational health and safety differences between WIPP and Yucca Mountain, primarily derived from the larger diversity of the radioactive waste types to be managed at Yucca Mountain versus WIPP. WIPP basically had four waste forms – contact handled TRU and TRU mixed waste and remote handled TRU and TRU mixed waste [15]. Those four waste forms are characterized and containerized at the generator sites and are prepared for disposal in one waste handling building. Further, while there are a number of containers used for the contact handled TRU and TRU mixed waste, there is only one container type that is used for the remote handled TRU and TRU mixed waste. The waste handling process for WIPP is shown below in Figure 3.

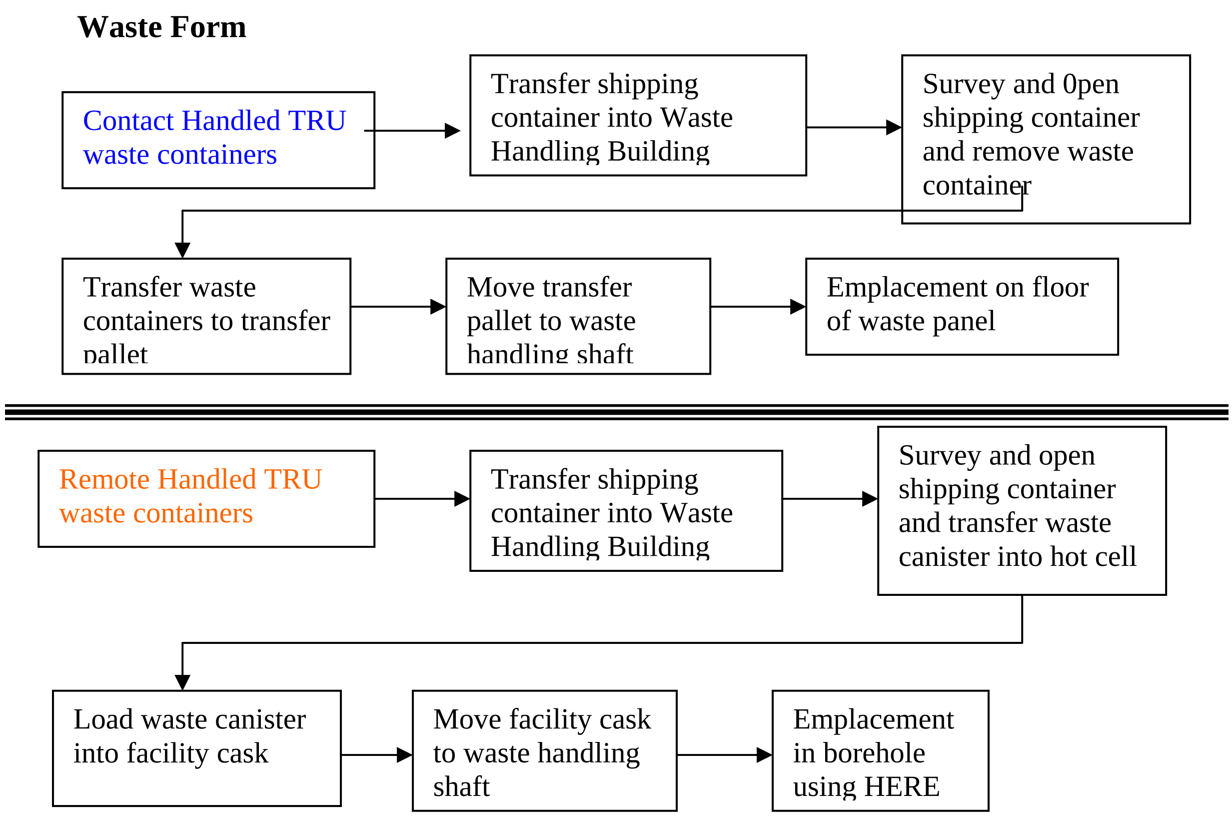

Figure 3 WIPP Waste Handling Process

For Yucca Mountain, the operational plan is to receive six waste streams in different forms as shown in Figure 4 below. To prepare those waste streams for disposal in the appropriate containers (the Transportation, Aging and Disposal Containers) will require eight separate facilities, most of which are planned for remote handling of the waste – effectively large hot cells. The HLW and SNF will be transferred into waste packages, which are essentially 1.5-1.8 m (5-6 ft) diameter cylinders ranging from 3-6 m (10-20 ft) long and weighing up to 50 tons for final emplacement. The surface temperature of the waste packages will range from 60 degrees Celsius to 200 degrees Celsius. However, the surface dose rate of the waste packages will be at or below the contact handled limit [21].

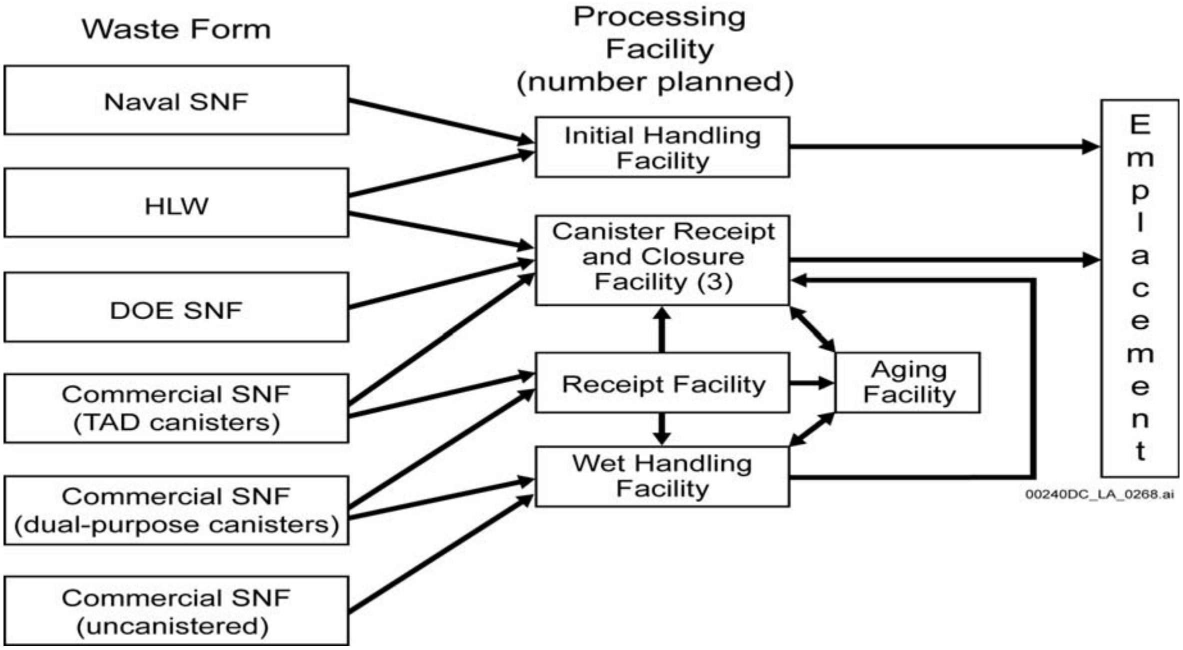

Figure 4 Yucca Mountain Waste Handling Process

Thus, the major health and safety differences are the greater number of waste forms and the heat and radiation levels of those waste forms. While the WIPP waste handling building was designed to handle some forms of HLW, it was not designed to handle the variety that Yucca Mountain is designed to manage.

Transportation. The major transportation routes to WIPP have already been established as shown in Figure 5 [15].

If a HLW/SNF repository was co-located at the WIPP site, additional truck transportation routes would be required to serve the commercial nuclear facilities located in south Texas, Florida, the upper Midwest and along the eastern seaboard. These potential routes had already been identified in the Yucca Mountain NEPA documents Transport by rail to the WIPP site would use much of the basic rail network proposed for Yucca Mountain via the Texas-Pacific and BNSF railroads with the addition of BNSF routes from the Midwest and Union Pacific routes through Texas to that network. Additionally, rail transport to the WIPP site would require the restoration of the rail spur line that extended from the mainline of the BNSF near Loving, TX to the WIPP site during the period of construction of WIPP [15].

Figure 5 WIPP Truck Transportation Routes.

CONCLUSIONS

A review of the scientific, engineering, and operational factors associated with the development and management of a HLW/SNF repository on or in the vicinity of WIPP leads to the following conclusions:

1. The Salado Formation that contains the WIPP repository is equally suited for disposal of HLW and for SNF (if reprocessing is not planned) in terms of geology, hydrogeology, and physical, chemical and radiological interactions with the HLW/SNF waste packages. It is not recommended for storage of SNF that is planned to be reprocessed.
2. A separate HLW/SNF disposal facility would be required to be constructed to accommodate the diversity of the HLW/SNF waste forms, the increased handling requirements, and the size and weight of the HLW/SNF waste packages (which precludes the use of the existing underground repository for the disposal of those waste packages).
3. There is sufficient space within the land withdrawn for WIPP (41.4 sq. km) to co-locate a HLW/SNF repository with WIPP. In fact, many of the WIPP surface facilities and infrastructure could be shared with the HLW/SNF disposal facility.
4. The preferred location for the HLW/SNF underground repository would be to the south or to the east of the WIPP repository.
5. Transportation of HLW/SNF to the WIPP site would be facilitated in that the basic network of rail and truck routes is already established and the rail spur that served WIPP during construction could be restored.

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