

Robust Disposal Concept, Uniform Regulations, and Trust in the Messenger; Three Fundamental Building Blocks for Consent-Based HLW-Disposal Solutions in the USA - 15104

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ABSTRACT

Pending enabling legislation, the USA's HLW-disposal program had been held in political abeyance since 2009 at the crossroads to one or both of the Yucca Mountain candidate (since 1987) HLW-repository in Nevada and/or *the consent-based siting* of the new HLW-disposal and centralized HLW-storage facilities proposed in 2012; *a road not previously travelled*. The consent-based siting approach would require the following gap between the reality (A) and the requirement (B) for public trust, acceptance and sustained support (PASS) to be bridged:

- A. Less than 1% of the general public in any given country fully comprehends the scientific-underpinnings and the projected health risks imposed by a HLW repository.
- B. More than 50% of the general public in a given geographical area would have to accept to host it from start to end.

The following PASS-building blocks, successfully used at the WIPP-site in New Mexico and abroad to get from A to B during the past 30+ years, are thus highly recommended:

1. *Defining the consent footprint upon host-county/state boundaries and/or radiation/health-risks and/or to identify/designate the directly affected parties (DAPs).*
2. *Using databases and lessons-learned by other repository programs to advantage.*
3. *Presenting the information in terms and/or by examples more readily understood by laypeople, because both their acceptance and opposition/rejection are influenced by:*
 - a. The type, number, problems, and status of "similar" disposal concepts; and
 - b. The level of
 - i. Radiation protection provided by applicable regulations;
 - ii. Involvement and decision-making authority vested in the DAPs; and
 - iii. *Their trust in the "spokesperson/messenger".*

INTRODUCTION AND BACKGROUND

Despite more than 60 years of costly efforts to site and develop (S&D) deep geological disposal systems/solutions (DGDSs) for HLW [1], the USA had been on a new, aberrant, path since 2009 [2-5] to enact legislation enabling "*consent/consensual-based siting*" of new HLW-disposition (storage and disposal) facilities; *a road not previously travelled*. At that time, 71 breaches of "standard-contract" claims had been filed against the U.S. Department of Energy (DOE), resulting in approximately \$1.2 billion (B) in damages awarded thus far, and estimates for the total potential liability incurred by the DOE as a result of the Yucca Mountain (YM) litigation ranged as high as \$50 B [6].

Moreover, after decades of political, legal, administrative, and environmental delays, the Obama administration (OA), with the support of Congress, defunded the YM project for FY2010, and announced an intention to pursue other alternatives for the disposal of HLW. But, following a ruling by the U.S. Court of Appeals for the District of Columbia Circuit (the A Court) in August 2013 [7], the at the end of 2014 still pending legislation for the new strategy proposed by OA in January 2013 [4] and in the U.S. Senate Bill (S.1240-SI) proposed in June 2013 [5], also has to address the fate of the USA's only candidate HLW-repository since 1987 at the YM site in Nevada (NV) (Figures 1 and 2) [8,9], which the OA declared "not workable" in 2009 [2] and then did not fund, closed and aborted in 2010.

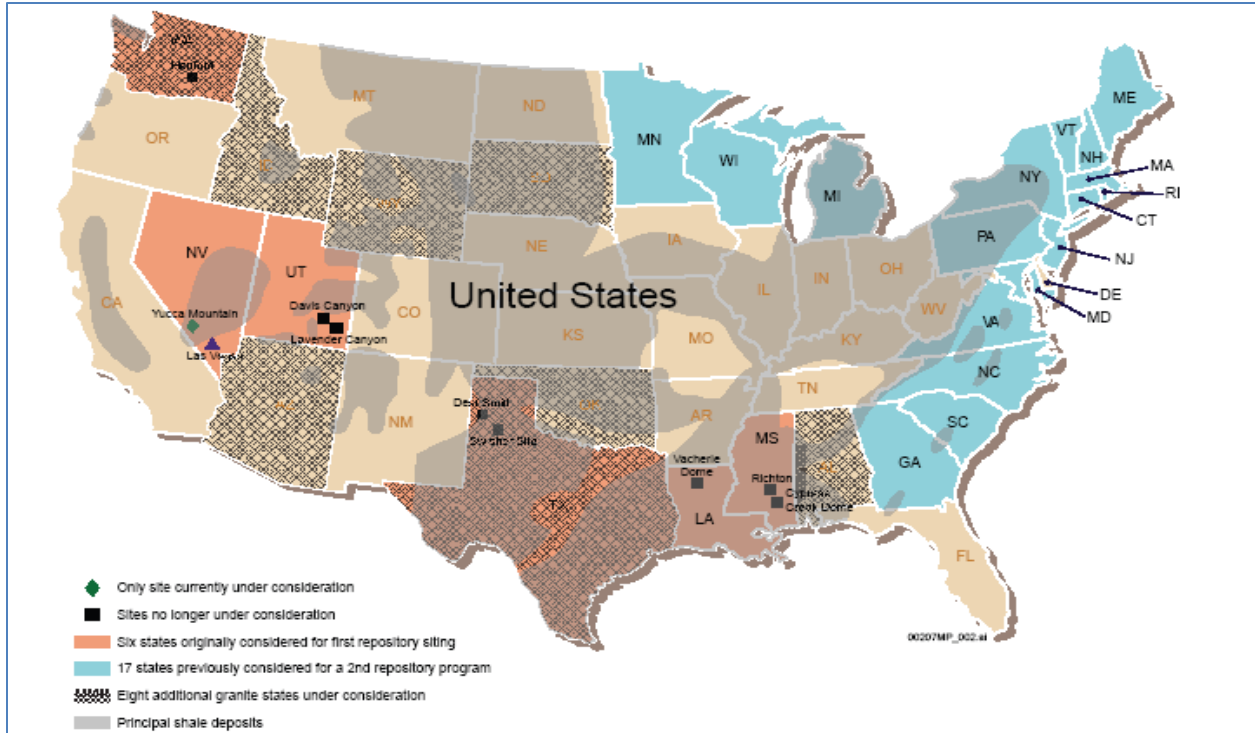


Fig. 1. Schematic illustration of regions, areas, site-locations and rock-types evaluated in the USA since 1982 for deep geological disposal of high-level radioactive waste.

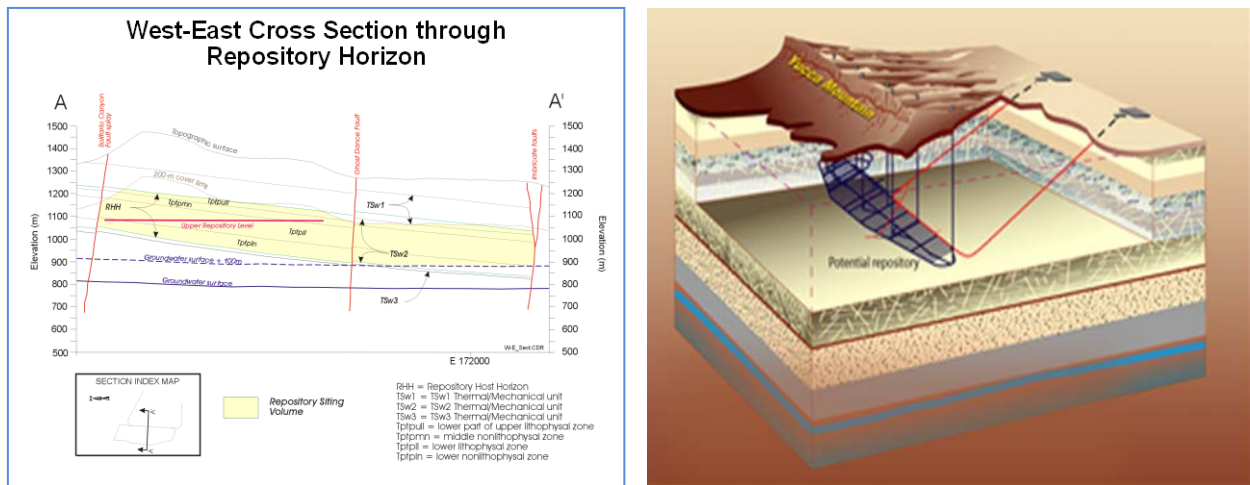


Fig. 2. Schematic cross section and stratigraphic column at the Yucca Mountain site (to the left), and schematic illustration (to the right) of the proposed layout of the HLW repository (in blue). The now closed underground Exploratory Studies Facility and its two access tunnels are shown in red.

The opinions, conclusions, and recommendations presented in this paper are based upon the lessons learned by the author from his active involvement in, monitoring of, and reporting on approaches to and features, events, and processes (FEPs) used in the USA and abroad for safe and secure management and disposition of long-lived radioisotopes (LL-RI) since 1978 [e.g.,10-28]. This paper highlights a set of FEPs used by mature programs for S&D of DGDSs for LL-RI in the USA and abroad during the past 30+ years. Clearly, consent-based siting is only one piece in the very complex, controversial, emotionally-

fraught, HLW-disposition puzzle that needs to be pieced together for timely and cost-effective progress in the USA. Another WM2015 paper, co-authored with G.E. Dials [28], focuses on another important piece of the same puzzle; namely, *promising options for safe and secure disposal of HLW in the USA earlier than “by 2048”* [4]. A WM2013 paper, co-authored with G.E. Dials and C.H. George [26], *elaborates upon potential definitions of consent-based for both new HLW-disposition facilities and their related transportation routes*. All data sources shown by bracketed Arabic numbers [1-41] are listed in the REFERENCE section at the end of the paper, and a few selected key acronyms and terms follow here:

C&C	Consulting and Cooperation
CHLW	Commercially-generated HLW
DGDS	Deep geologic disposal system/solution
DHLW	Defense/government-generated HLW
ER	Elected representative
HLW	Includes used nuclear fuel (UNF), spent nuclear fuel (SNF), and high-level radioactive waste
LL-RI	Covers all radioisotopes requiring deep geological disposal, including, but not limited to, HLW, long-lived ILW (LL-ILW), and long-lived transuranic radioactive waste (TRUW)
NWAA	Nuclear Waste Administration Act of 2013 (proposed June 2013 in Senate Bill S.1240-SI)
NWAB	Nuclear Waste Advisory Board (proposed in Senate Bill S.1240-SI)
PASS	Public acceptance and sustained support
RC	Root cause
S&D	Site and develop

The focus herein is on consent-based S&D of DGDSs for HLW, because the term “***consent***“, and its derivatives, are qualitative and their respective meanings are thus in the eyes of the beholder. They may therefore serve as a volatile fuel for pro-longed discussions and lawsuits, rather than as keys to progress, until they are defined in measurable terms [26-28]. For reasons concisely described in the subsequent text, the author’s assessment is that > 99% of the members of the general public in any given country, *including this author*, do not have the special education and expertise required for fully comprehending the underpinnings and the results of the post-closure performance/safety analyses for a DGDS for LL-RI and the related projected health risks. This population group is referred to herein as “***laypeople***”. Similar to this author, they may also benefit from a second opinion from a “***trusted messenger***”. Whereas the terms “***trusted***” and “***trust***” solely reflect the recipient’s perception, the term “***messenger***” is used herein for people, organizations, and institutions presenting an opinion, conclusion, ruling, or recommendation on DGDSs for LL-RIs. The terms “***directly-affected party***” (DAP) and “***interested party***” (IP) are used herein to distinguish between people, organizations, and institutions exposed to an apparent/real radiation-related health risk from a proposed LL-RI-disposition solution, and those who are not, respectively.

Notwithstanding that both successes and failures provide valuable lessons learned in support of rational, informed, decision making, in the past, successful FEPs have been more readily shared with the general public than failure FEPs. In the opinion of this author, this “***see no evil, hear no evil, talk no evil***” ***practice/tenet is counter-productive to maintaining trust and majority public acceptance and sustained support (MPASS) of a given project in a democratic nation***. Based upon the forward-looking notion that it is less time-consuming and less costly to ensure a ship, before launch, is properly designed and has no apparent defects that might cause it to slow down, capsize, or sink when it is in the water, the following three documents, comprising the currently known justifications for the consent-based siting of a new HLW-repository, were evaluated and commented on in the spirit of how the “*Devil would read and comment on the bible*”:

1. The January 2012 Blue Ribbon Commission (BRC) Report [3].
2. The January 2013 Strategy for the Management and Disposal of Used Nuclear Fuel and High-level Radioactive Waste [4].

3. The Nuclear Waste Administration Act of 2013 (NWAA), as introduced (proposed) to the U.S. Senate on 27 June 2013 [5] and also referred to herein as S.1240-SI. (If there is a corresponding U.S. House of Representatives' Bill, it is not known to the author.)

Actually, the still pending enabling legislation for the NWAA could be a blessing in disguise, because:

- a. The YM HLW-repository had already been evaluated for 30+ years and it could offer significant time- (25+years?) and cost-savings relative to the HLW repository proposed in January 2013 [4], as well as relative to other HLW-disposition options; and
- b. S.1240-SI [5] failed to address major lessons-learned in the USA and abroad during the past 30+ years on how to gain and sustain MPASS of a DGDS for LL-RI [e.g.,16,18,19,22,23-28].

Following several failed S&D attempts, on 7 January 1983, the U.S. President signed Public Law 97-425 [8], also referred to as the Nuclear Waste Policy Act of 1982 (NWPAA). The NWPAA stated “*Federal efforts during the past 30 years to devise a permanent solution to the problems of civilian radioactive waste disposal have not been adequate*” and defined a new process, organizational structure, funding mechanism, and schedule for the S&D and staggered opening of two deep repositories for commercially-generated HLW (CHLW), also referred to as the first and second HLW-repository programs, respectively. The first HLW repository was to open no later than on 31 January 1998 and its capacity could not exceed 70,000 metric tons (MT) of heavy metals or an equivalent amount of uranium. The second HLW repository was to open no more than three years later. The NWPAA also directed the Secretary of Energy (the Secretary) to establish a dedicated federal office within the DOE to accomplish these objectives, the U.S. Nuclear Regulatory Commission (NRC) to develop, promulgate, and oversee compliance with the related licensing criteria, and the U.S. Environmental Protection Agency (EPA) to promulgate applicable environmental radiation protection standards. In response to their respective NWPAA mandate, the DOE established the Office of Civilian Radioactive Waste Management (OCRWM), the NRC promulgated licensing criteria for HLW-disposal under Title 10, Part 60 in the U.S. Code of Federal Regulations (10 CFR 60) [29] and the EPA promulgated the related environmental radiation protection standards under 40 CFR 191 [30]. In 2001, both of them were voided for the YM site by site-specific licensing criteria (10 CFR 63) [31] and environmental radiation protection standards (40 CFR 197) [32].

On 22 December 1987, the NWPAA [8] was amended by Public Law 100-203 [9], also referred to as the Nuclear Waste Policy Amendments Act of 1987 (NWPAA) and “*the screw Nevada Act*”, because it directed the Secretary to orderly phase out two of the then three *candidate* HLW-repository sites; the Hanford (basalt) site in the state of Washington (WA) and the Deaf Smith (rock salt) site in the state of Texas (TX) shown on Figure 1 within 90 days, and only continue the evaluation of the YM site shown on Figures 1 and 2. It also cancelled the second HLW-repository program. NV promptly vetoed the “premature” selection of the YM site, but the U.S. Congress overrode this veto in 2002, and the S&D of the YM site continued until the OA terminated all work on and funding of it in 2010, and transferred the OCRWM staff to other DOE offices; most of them to the Office of Nuclear Energy (NE).

In January 2012, the BRC submitted a report to the Secretary recommending ***prompt, consent-based***, S&D of both a consolidated HLW-storage facility (Key Element 5) and a HLW repository (Key Element 4) [3]. These recommendations were based on an 18-month-long evaluation of the USA's HLW- and other LL-RI-management policies and programs, i.e., the Waste Isolation Pilot Plant (WIPP) transuranic radioactive waste (TRUW) repository program (Figure 3), and a couple of mature European HLW-management programs employing consent-based S&D of their DGDSs for HLW/LL-RI. As illustrated on Figure 3, the WIPP TRUW repository is located in the lower half of a 250-million-year-old, ~ 600-m thick, virtually-impermeable, bedded-rock-salt formation. The current disposal capacity is 175,584 m³ of TRUW [12,16]. Although the WIPP repository cannot accommodate HLW-disposal at the end of 2014, it can be expanded [17,21,23] and embodies the following FEPs and lessons learned making it *the most applicable domestic example on MPASS-based siting of a DGDS for HLW in the USA*:

1. The WIPP repository has benefitted from local and state MPASS since early 1970.
2. The WIPP site was also evaluated for HLW disposal into the 1990s [e.g.,12,16,17,21,33,34].
3. The WIPP site is governed by the same environmental radiation protection standards [30] as all HLW-disposal sites outside of the YM site are, and it has already demonstrated compliance with these standards three times. As described and discussed in the subsequent text, to the best of the author's layman understanding, the WIPP standards [30] are also more compliance-point restrictive than their site-specific YM-site counterparts [31,32].

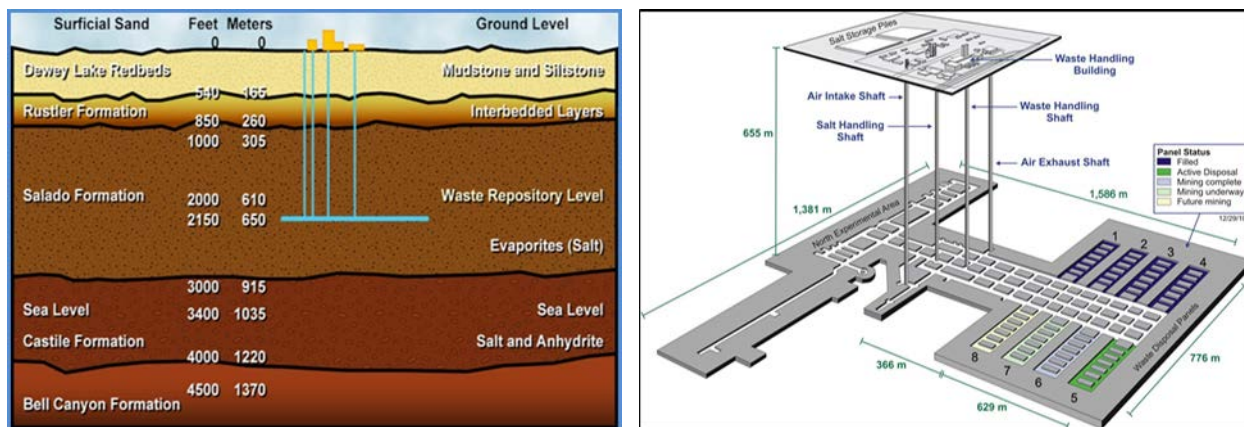


Fig. 3. Schematic illustrations of the cross section and stratigraphic column at the WIPP site (to the left), and (to the right) the layout of the WIPP TRUW-repository, the four shafts, and the North Experimental Area that hosted the underground in-situ-research laboratory.

Although the author harbors a long-standing bias in favor of rock salt being the most promising host-rock for long-term containment and isolation of gases, liquids, and long-lived radionuclides and heavy metals, he is also convinced other rock types can provide the required containment and isolation of LL-RI, *provided the disposal site is carefully selected and the disposal concept is robust and minimizes human-induced disturbances to the host rock* [12-14,17,20,24,25,35], as stated more eloquently in the following 1985 statement by Prof. Dr. Carl-Olof Morfeldt [35]:

“The art is not to overmaster nature by means of technology, but - with a deeper knowledge of geology - to adapt the engineering to nature.”

In January 2013, the Secretary/DOE purportedly responded to the 2012 BRC recommendations [3] with a new, 14-page, national HLW-management and -disposal strategy [4]. This strategy projected the USA's-first-of-its-kind, consent-based, yet-to-be-sited, HLW-storage and HLW-disposal facilities would open “by 2023” and “by 2048”, respectively, but also stated the new strategy could not be implemented until the enabling legislation was in place [4].

In June 2013, the NWAA/S.1240-SI was introduced to the U.S. Senate. It outlined a proposed path forward for HLW-disposition based upon the recommendations provided by the BRC in January 2012 [3], and the related new HLW-management and -disposal strategy proposed by the Secretary/OA in January 2013 [4]. Its main stated purposes were to:

- a. **Ensure adequate funding** for managing nuclear waste^a, and for other purposes;

^a. Although several laws cited in S.1240-SI refer to HLW, the author is not clear on the nuclear waste categories it could apply to, because the generic term “nuclear waste” is used more often in it than HLW is and some of the regulations evolving from these laws also apply to other radioactive waste categories than HLW.

- b. **Establish a new “nuclear waste management organization” ... “to discharge the responsibility of the Federal Government to provide for the permanent disposal of “nuclear waste”;**
- c. **Establish a new consensual process for the siting of nuclear-waste management facilities;** and
- d. **Provide for centralized storage of nuclear waste** pending the completion of a repository.

In August 2013, the A Court ruled that neither the U.S. President nor any federal agency could abandon a statutory program without the consent of the U.S. Congress [7]. This ruling revived the YM HLW repository that the OA had tried to abandon since 2009 [2], but it also left the U.S. Congress with the dilemma of having to re-consider and decide upon how to pursue future HLW-disposal solutions. At the end of 2014, the three main options were to cancel the YM HLW-repository or to develop it concurrent with or prior to the “consensual” siting of the new HLW-repository proposed in 2013 [4,5].

DESCRIPTIONS, DISCUSSIONS, COMMENTS, AND RECOMMENDATIONS

In January 1983, the USA was to open its and the world’s first HLW-repository no later than on 31 January 1998 [8]. In December 2008, it was projected to open at the YM site (Figures 1 and 2) no earlier than in 2017, but more likely in 2020 [36]. In January 2013, it was projected to open “by 2048” at a new site [4], which would be a 50-year delay in the opening of a HLW repository in the USA in 30 years. However, the January 2013 projection [4] did not account for the potential schedule- and cost impacts of the USA’s only *candidate* HLW-repository since 1987 at the YM site (Figures 1 and 2) [8,9], which was the sole basis for the 2008 projections [36]. Assuming that both the YM HLW repository and the S&D of new HLW repository start in 2017, it would add nine years to the 2017-2020 opening-range projected for the YM HLW repository in 2008 [36], and four years to the “by 2048” opening projected for the HLW repository envisioned in January 2013 [4]. For comparison, at the end of 2014, Finland was projected the open its HLW repository in 2023 (<http://www.posiva.fi>), France its in 2025 (<http://www.andra.fr>), and Sweden its in 2027 (<http://www.skb.se>); all being governed by consent-based-S&D. In addition, Canada and the United Kingdom (U.K.) were in the process of implementing consent-based S&D of their respective HLW-repository, whereas the USA was trying to define what consent-based S&D of HLW-DGDSs might involve and then decide on its implementation. As follows, the USA would no longer going to open the world’s first or perhaps not even one of its first three domestic HLW-repositories.

The aforementioned six national programs have experienced multi-year delays of different duration and for different reasons. For example, during the past 30+ years, the USA’s HLW-disposal programs have suffered from a broad range of political interferences that have caused significant program delays (> 25 years hitherto) and cost increases in excess of \$500 million per year (M/a) that could increase to > \$1B/a contingent upon when the DOE takes title to CHLW. The combination of delays and their common overlay of political actions and inactions have caused concerns and loss of public and international confidence in the pursued HLW-disposal concepts, the implementing organizations, the political will of the U.S. Congress [24,37], and the OA [7,38]. As a firm believer that “*time is money*”, “*the past holds the key to the future*”, and “*there is none so blind as the one who doesn’t want to see*” themes are very relevant to the S&D of both new and existing HLW-repositories, the subsequent text focuses on:

1. Five long-standing root causes (RCs) to the USA’s repeated spirals of failure during the past 30+ years to open a DGDS for HLW, because they are deemed to also affect and perhaps even increase in importance for future DGDSs for HLW based upon MPASS.
2. The June 2013 S.1240-SI, because it is the only visible, potential, political action/key in the USA at the end of 2014 to the S&D of a new, consent-based, HLW-repository and it needs additional U.S. Senate and U.S. Congress attention to facilitate MPASS and programmatic progress.

Root Cause 1

The primary radionuclide containment and isolation components of all DGDSs for LL-RI are:

1. The Natural System (NS), i.e., the host rock and its inherent characteristics; and
2. The Engineered Barriers System (EBS).

The combined performance of these two systems in response to a wide set of envisioned, time-dependent, FEPs, some with distinct anisotropic spatial variations and including human-induced FEPs, e.g., construction-induced NS damages, are analyzed to indicate the post-closure performance of the DGDS and the related radiation/health risks to a member of the general public located at a given distance from the perimeter of the disposed LL-RI who behaves in a given way during a given time-period. But, again, *< 1% of the members of the general public and their elected representatives (ERs) in any given municipality, county, state, country or sovereign nation (Indian Tribe) have the education and experience required to fully grasp the complexities of the following sub-components of all DGDSs for LL-RI:*

- *The huge spatial and temporal scales;*
- *The state-of-the-art scientific and technological/engineering concepts;*
- *The codes, models, and other analytical methodologies used; and*
- *The health risk(s) posed, including the units used.*

Consequently, > 99% of all *individuals presented with the option of hosting or rejecting a DGDS for LL-RI in their backyard* face one or more of the following repository-sciences/engineering and personal-risk and benefit FEPs that she/he:

- | | |
|---------------------------------------|---|
| a). Knows she/he knows. | f). Knows she/he knows, but doesn't. |
| b). Thinks she/he knows. | g). Thinks she/he knows, but doesn't. |
| c). Knows she/he doesn't know. | h). Knows are true or false, but reject. |
| d). Thinks she/he doesn't know. | i). Thinks are true or false, but reject. |
| e). Doesn't know she/he doesn't know. | j). Has been told by a "trusted" source. |

The end result is therefore often fear-based, negative responses, because it is much easier to say no to something perceived as potentially-risky and thus get rid of it, than it is to invest a lot of time trying to understand it. A related negative domino effect in the USA is the wide-spread reluctance among ERs to support the S&D of a new HLW repository due to the related "job-security/re-election" risks. However, this political trend/stigma/tenet could and should change when the majority of the DAPs support the hosting of a HLW-repository, because it would then be counterproductive to both the election of new and the re-election of ERs to oppose it. It is thus deemed imperative for obtaining the MPASS by the DAPs that the proponent's messengers have the requisite credentials, reputation, and credibility/serenity to be trusted on issues beyond the comprehension of the recipient, and also are able and willing to present the information in contexts and terms understood by laypeople. At WIPP, a set of reference cases were developed to FEPs that were familiar to laypeople, e.g., the projected dose was compared to x-ray doses.

For those of us who are unable to fully comprehend the state-of-the-art concepts and analytical methods and processes involved, the evolution of the initially-envisioned disposal concept and the EBS provide more-readily-comprehended yardsticks on the radionuclide containment and isolation provided by the NS. For example, the KBS-3 disposal concept employed in Finland and Sweden has gradually reduced the wall thickness of the HLW-container from 10 cm to 5 cm, which conveys a strong message to laypeople that the igneous/crystalline NS at the three candidate HLW-repository sites performed better than initially expected. At the YM site, the initially-envisioned disposal concept has repeatedly increased its reliance upon the EBS. For example, surface water reached the repository level in less than 40 years, which resulted in the design of a state-of-the-art ~ \$16 B drip shield that conveyed a very strong message to laypeople that the NS at the YM site "underperformed" relative to the initial expectations [39].

The 2001 promulgation of site-specific regulations [31,32] for the YM site 25 years into the S&D process exacerbated rather than mitigated DAP, IP, and other laypeople concerns, because they, inter alia,

extended the distance to the post-closure compliance point. In the 1983 nation-wide regulations, the maximum distance between the compliance point and the boundary of the disposed LL-RI was 5 km [29,30], whereas it became > 16 km (10 mi) at the YM site [31,32]. Actually, it was only 2.4 km (1.5 mi) at WIPP when it complied with the nation-wide standards [30] in 1998. Another change was the extension of the minimum post-closure period for which repository performance and safety assessments had to be conducted. At WIPP, it was and still is 10,000 years, whereas it is now 1,000,000 years at the YM site. However, among us laypeople already harboring concerns about the ability to credibly project the performance of any DGDS for LL-RI even 10,000 years with a high-degree (90+%) of statistical confidence (whatever that means), the 990,000-year time extension was nonsensical rather than comforting, because the relevance of the post-closure repository performance assessment and public-health risk analyses results for a DGDS for LL-RI are:

- A. Always anisotropic-host-rock, construction-methodology, radionuclide-inventory, temperature, and time dependent.
- B. Governed by:
 - a. The assumptions made;
 - b. The boundary conditions used; and
 - c. The degree to which the used algorithms, codes and models “mimic” the actual prevailing NS and EBS conditions from the outset and then through the regulatory post-closure period, because *garbage in results in garbage out regardless of the number of decimals*.
- C. Likely to include more than one irrelevant number. In particular, when people responsible for item B lack or are short on relevant, hands-on, site-characterization, underground-in-situ-testing, design and construction experience.

Second opinions and feedback from sources deemed qualified by the members of the general public and the ERs have played and are deemed to continue to play an important role in clarifying otherwise incomprehensible repository-sciences, -engineering, and -radiation risks to laypeople. Whereas both the already existing Nuclear Waste Technical Review Board (NWTRB) and the Nuclear Waste Oversight Board (NWOB) proposed in S.1240-SI with their politically-selected and -appointed members serve the members of the U.S. Congress in this capacity, there is no in-state advisory group available to the DAPs as it was for the WIPP TRUW repository in New Mexico (NM).

Based on the author’s active involvement in and the related lessons learned since 1993 in connection with the consent-based S&D, the 1988 certification, the 1999 opening, and the subsequent operation of the WIPP TRUW repository (Figure 3) [e.g.,16-19,21,22,25], augmented by four independent-expert reviews of the consent-based Swedish HLW-repository program between 1978 and 2010 [e.g.,24], an independent oversight entity in states considered for hosting one or both of the pending HLW-disposition solutions with a charter and *populated by professionals with excellent subject-matter relevant education and experiences at the top without term limits*, similar to those of the (now dissolved) Environmental Evaluation Group (EEG) in NM, could conceivably serve this currently missing DAP, IP, and other laypeople need very well [e.g., 16,18,19,25,26]. However, although the financial resources required for a potential host state to partake in the S&D process are available in S.1240-SI, it is only incumbent upon the proposed new S&D implementer, *the Nuclear Waste Administrator* (Administrator), to have the related Consulting and Cooperation (C&C) Agreement in place at the time a potentially-suitable site has been identified by the Administrator in a given state. The onus in S.1240-SI is thus on the potential host states to pursue a C&C Agreement if they want financial support to partake and have early/timely access to an independent advisory group before the S&D process has already reached a critical decision point.

Root Cause 2

As mentioned in the preceding text, *current licensing regulations and environmental radiation protection standards for HLW-disposal are not uniform across the USA*. One set of regulations applies to the YM

site only [31,32] and the other set applies to the remainder of the USA [29,30], which conveys the following two MPASS-counterproductive “generic/universal” messages:

- A given site cannot meet an existing regulation/standard; and
- All population groups and demographics do not deserve the same radiation-protection.

One set of the aforementioned regulations may thus justifiably be considered arbitrary, capricious, and societally-unjust [26], which, conceivably, will adversely affect public trust in it and the related regulator(s). Fortunately, the mitigation of RC2 is simple; one nationally-uniform set of HLW-disposal regulations and standards.

Root Cause 3

In the past, *no distinction/priority has been given to whether or not the messenger, might by be a DAP or an IP* [24,26]. During the past 30+ years RC3 has thus allowed IPs to skew, misrepresent, and overshadow the opinions and issues of concern to the DAPs. As suggested in 2013 [26], this long-standing societal inequity should and could be mitigated by a distinction in priority between opinions and issues expressed by the DAPs and the IPs, respectively. In addition to serving as a trusted messenger, based on experiences in Sweden [14], the independent NM-state group EEG mentioned in connection with RC1 could also serve as a bulwark against the implementer having to waste energy, time and money on ideologically- and/or interest-group-motivated issues and topics raised by the IPs, because the IPs will always be in majority and be greatly cause- and/or financially-motivated.

Root Cause 4

Proponents of LL-RI disposition (and HLW storages) had to present extensive documentation supporting their cases, whereas the opponents generally only had to raise an issue, which then became the “property” of the proponents to subsequently prove or disprove. However, RC4 is difficult to resolve due to the specific subject-matter expertise and large amount of money typically needed to address non-existent and very-low-probability performance/safety issues over their related period of potential health impact. One time- and cost-saving approach to addressing new HLW-repository performance/safety issues would be to resolve them by conducting probability-based scoping analyses for a variety of conservatively-selected parameter values using top-down models, e.g., GoldSim and/or its sibling Predicus, rather than time-consuming, bottoms-up, first-principle models and their underlying, quality-assured, data bases. Another is the independent host-state-advisory organization mentioned in RC1.

Root Cause 5

In the past, the DAPs and their ERs in the communities and states considered for hosting a HLW-repository have had virtually no say in either how to design or conduct the S&D program or in the related decision-making process, which, unfortunately, and perhaps unnecessarily, only left them with legal options to ensure that their concerns were seriously considered. Typically, the related legal processes resulted in multi-year project delays. For example, the legal challenges filed in 2010 by DAPs and IPs against the Secretary’s 2010 motion to the NRC for withdrawal of the 2008 construction license application (CLA) for the YM HLW repository were not resolved until August 2013 [7]. In the meantime, the implementing organization for the U.S. HLW-disposition program; the OCRWM, had been de-staffed and de-funded by the OA.

The critical importance of mitigating RC5 in future consent-based S&Ds of DGDSs for LL-RI in the USA is also very-clearly demonstrated by the long-standing string of negative host-state reactions and actions in NV that followed the U.S. Congress’ selection of the YM site in 1987 as the nation’s only candidate HLW-repository site and its 2002 override of NV’s related veto.

U.S. Senate Bill S.1240-SI

As currently understood by the author, S.1240-SI will adversely affect and might even be terminal to obtaining the MPASS from the DAPs that will be required for finding a voluntary site and then to make progress. As elaborated upon in the subsequent text, S.1240-SI contains FEPs that fail to ensure public transparency and timely, active/meaningful, participation by the DAPs in siting and decision-making processes. It may thus exacerbate rather than mitigate the current prevalent distrust of the U.S. government among the members of the general public and further delay the opening of new HLW-storage and –disposal solutions, unless several amendments are made in the enacted and enabled version of S.1240-SI. Following are the author’s current concerns and preliminary observations, comments, and recommendations on S.1240-SI.

Based upon the global historical record at the end of 2014, three fundamental generic building blocks for consensual siting of a DGDS for LL-RI in *a democratic country* are:

1. A robust LL-RI-disposal concept that meets all applicable regulations and standards.
2. Sufficient MPASS (50%+?) by the DAPs.
3. Sufficient national political will (makes or breaks building blocks 1 and 2).

There were also abundant examples in the USA and abroad, e.g., Finland, France, and Sweden that sufficient MPASS is attainable locally when the DAPs:

- A. Have a definitive say throughout the site selection/qualification/development process.
- B. Consider the disposal concept “safe/robust”.
- C. Trust the messenger(s).
- D. Perceive that the proposed solution provides some kind of near-term and/or long-term benefit(s), which, with the potential exception of the ERs, does not necessarily have to be to the individual/DAP.

In the context of these observations, it is not clear to the author how the organizational structure and decision-making processes outlined in S.1240-SI would improve public confidence in the new organizations (the Administrator) or make a positive change to the schedule and cost of future HLW-disposition solutions relative to those available under the existing legal framework [8,9]. S.1240-SI outlines two new “nuclear waste” management entities; the Administrator and the NWOB populated by seven Principal Officers with varying term limits “*appointed by the U.S. President, by and with the advice and consent of the U.S. Senate*” [5]. In addition, the Administrator will have a likewise appointed Inspector General without term limit. As follows, the proposed organizational structure would be both more politically-remote-controlled by the U.S. Congress than the OCRWM ever was, and also be more unstable by imposing unprecedented statutory term limits on the two Principal Officers of the Administrator and all five mandatory members of the NWOB that could compromise and even jeopardize the acquisition and retention of qualified candidates and institutional memory. Also, whereas S.1240-SI defined some of the DAPs and how they would be *asked for recommendations* during the siting processes for pending “**nuclear waste**”-storage and -disposal solutions, it did not:

- a.) Define the term “consensual” in terms that could be tracked and/or measured.
- b.) Include continuous active/meaningful participation of the DAPs in the planning and implementation of the siting processes or the related decision-making processes. As currently written, the Administrator would only have to interact/communicate with the municipalities, counties, and Indian Tribes in states considered and selected by the Administrator to host a potential HLW-disposition site and then again before initiating the on-site evaluation program, having the related jurisdictional authority. Although, the Administrator also has to establish a C&C Agreement with these parties including financial support, the decision-making was

exclusively assigned to the Administrator. The treatment of NV's veto on the conjectural selection of the YM site in 1987 left a legacy of distrust of the political will and political process in many quarters [24,37,38] that very-likely will adversely affect their interest and willingness to host a DGDS for LL-RI unless they also have the final say in this matter. Simply stated, why should they, because their involvement outlined in S.1240-SI does not convey a political interest in making them active participants in either the siting or the decision-making processes? Further diluting confidence and trust in the proposed organizational structure are the short, staggered, term limits imposed on the five members of the NWOB, i.e., 1, 2, 3, 4, and 5 years, respectively. These as well as the 6-year-maximum, term limits, imposed on the two upper managers of the Administrator organization will not necessarily prevent, but they will very-likely, complicate and compromise the acquisition, build-up and retention of relevant expertise and institutional memory. It also makes the proposed organizational structure vulnerable to changes in the political fabric of the U.S. Congress. As demonstrated by the November 2014 elections, the political fabric of the U.S. Congress can change every other year.

Based on the author's observations on and the feedback received in the USA during the past 30+ years, a large portion of the general public do not readily trust politicians or federal/state agencies. The two 2013 A Court rulings [7,38] exacerbated this distrust. They also affected public confidence in the law abidance of the Executive Office. *One of the lessons learned during the past 30+ years is that, in the USA, the S&D process needs to be protected and insulated from time- and ideological-dependent, unpredictable and uncontrollable, often self-serving interferences from politicians and IPs to minimize time-consuming and costly delays and, instead, actively and meaningfully engage the DAPs from the outset in both of them to gain the critical MPASS by the DAPs required for progress, which was done and still is being done successfully at the WIPP site (Figure 3).*

- c.) Address the relationship between the NWOB and the existing NWTRB that already served the U.S. Congress in a similar position since late 1980, as well as that of the long-standing National Research Council's Board on Radioactive Waste Management (BRWM). Otherwise, the NWOB could be perceived by the general public to be another FEP devised by the U.S. Congress to remain the sole co-driver of the new S&D organization/process.

Following are the main conclusions on or directly-related to the initial version of S.1240-SI:

1. The proposed organizational structure and decision-making process will not receive MPASS outside of the U.S. Congress and its dependents.
2. If enabled as currently written, it will delay the opening dates for the HLW-storage and -disposal facilities proposed in the 2013 strategy [4].
3. The content of the final NWAA will provide a very-strong indication on whether or not:
 - a. The term "consensual" is quantitatively defined;
 - b. It recognizes the value of lessons learned and ensures that the DAPs are active participants throughout the S&D and the ultimate decision-makers; and
 - c. The opening of the USA's first HLW-disposal solution is considered a national priority and an imminent threat to Homeland Security.
4. If the YM HLW repository does not survive the pending legislation, or ongoing and future NRC reviews, or future lawsuits, the opening of the USA's first repository would be delayed at least another 35 years [4]. It would also extend the duration and amount of the current penalties the DOE is obliged to pay for its failure hitherto to comply with the terms of the post NWA Standard Contracts it signed with the nuclear utilities in the 1980s that might amount to \$1 B per year until the U.S. government takes title to the CHLW. One option for the DOE to reduce these payments and also benefit from the > \$10B already invested in the YM site [6,36] would be to negotiate a compromise with NV to use the YM site for other utilizations than CHLW disposal, such as e.g., long-term storage of CHLW and/or disposal of DHLW [23,27,28].

SUMMARY

At the end of 2014, the opening of the world's first HLW-disposal solution in Finland was at least nine years away, and the opening of the USA's first HLW repository was at least 9, but more likely 14 years away, and it could be more than 35 years away contingent upon the content of the pending enabling legislation for one or both of the following two HLW-disposal options:

1. Its only legal candidate HLW-repository since 1987 at the YM site in NV [8,9].
2. The hypothetical HLW-repository proposed by the OA in January 2013 [4].

However, the NWAA/S.1240-SI proposed in June 2013 [5] did not include the YM HLW repository, which was revived by the August 2013 A Court ruling [7]. It also failed to take advantage of several lessons-learned during the past 30+ years of consent-based S&D of DGDSs for LL-RI in the USA and abroad. Indeed, three potentially-terminal shortcomings were:

- A. It failed to engage/involve the DAPs as active participants in the siting process.
- B. It excluded the DAPs from the decision-making process.
- C. It outlined a revolving-door, key-personnel, organizational structure that was both more remote-controlled by the U.S. Congress than its 1983-2011 predecessor, the DOE OCRWM, and more adverse to gaining and maintaining relevant subject-matter experts and institutional memory.

The author's main related conclusions at the end of 2014 were as follows:

1. S.1240-SI will delay the opening of the USA's first consent-based HLW repository, unless the DAPs are given more active roles throughout the S&D and decision-making processes from the outset/get go in the pending enabled version.
2. S.1240-SI will not increase:
 - Public confidence in DGD of LL-RI;
 - Public trust in a new implementing organization because it is even more bureaucratic, politically-remote-controlled and susceptible to be side tracked by the U.S. Congress than the DOE OCRWM ever was;
 - Public willingness to host a HLW-disposition solution in one's backyard; or
 - The USA's credibility and standing in the international radioactive waste management community.
3. Due to the very-long, post-closure, liability period, the ultimate responsibility for the safe and secure disposal of LL-RI must remain with the U.S. Congress at all times; but, by definition, consent-based S&D of HLW- and LL-RI-disposition solutions require continuous active involvement by both the HLW-generators and the DAPs.
4. The CHLW generators have an apparent conflict of interest in the opening of a centralized HLW-storage facility due to the breach of the standard contract compensation they receive until the DOE takes title of their HLW. They should thus not be in a position affecting the schedule.
5. DAPs not locked into ideological or other positions will likely consider and be affected by:
 - a. The robustness of the disposal concept;
 - b. The level of radiation protection they are provided relative to other domestic regulations and, perhaps, abroad, and last but not least; and/or
 - c. Their trust in the messenger(s), which includes the implementing organization(s), involved regulatory agencies, and independent advisory groups.
6. The YM HLW repository offers by far the least time-consuming HLW-disposal solution.
7. A large government-owned and -operated, storage facility for CHLW is still the most expedient disposition solution for the DOE to take title to CHLW and reduce future penalties being paid to the utilities, *but it is not a final solution for HLW disposition.*

8. Premature selection of a single candidate HLW-disposal site could result in more than 35 years of delay to the opening of a replacement HLW-repository.

The author's main recommendations were:

1. Revise S.1240-SI as needed to ensure continuous active and meaningful involvement by the DAPs in the S&D processes and a joint say in the related decision-making portion.
2. Staff the S&D organization with professionals having relevant subject-matter education and hands-on experience unencumbered by term limits, as done in Finland and Sweden.
3. Shield the S&D organization and process from extraneous political and IP interferences.
4. Relax the current commingling requirement for CHLW and defense-generated HLW (DHLW) [40,41], and then consider disposing of:
 - a. Commingled CHLW and DHLW, or only DHLW, at the YM site [23,24,27,28];
 - b. DHLW at or adjacent to the WIPP site and/or in deep boreholes at or adjacent to current HLW-storage and/or HLW-generator sites benefitting from MPASS; and
 - c. CHLW at the YM site, in a new repository in rock salt, and/or in deep boreholes.
5. Pursue at least two HLW-disposal solutions until one of them has been licensed, because it provides a potential 35-year-plus, time-loss, insurance. It also facilitates the option of staged openings of two sizeable HLW repositories, ensuring the timely and adequate availability of domestic HLW-disposal capacity for another 50 years or longer.
6. Co-locate the HLW-storage and -disposal facilities whenever possible, because it reduces HLW-transportation and -handling risks to workers and members of the general public, and costs [23,28].

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