EXHIBITS

SpentFUEL

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THE LATEST DEVELOPMENTS IN SPENT FUEL MANAGEMENT AND TRANSPORTATION

Holtec Submits Letter of Intent for New Mexico Storage Facility

On August 3, Holtec International submitted a Letter of Intent (LoI) to the NRC for a future license application for a Consolidated Interim Storage (CIS) facility "on an undeveloped and isolated patch of land" in southeast New Mexico. The land is currently owned by the Eddy-Lea Alliance (ELEA), which is an alliance of the New Mexico cities of Carlsbad and Hobbs, and the New Mexico counties of Eddy and Lea. Holtec said the facility "is envisaged to fulfill our national aspiration for an interim storage facility for used nuclear fuel as articulated in the Blue Ribbon Commission's report which was subsequently adopted by the DOE." Holtec pointed out that the prerequisites for a consent-based facility "are fully met by the proposed ELEA facility which enjoys overwhelming support of the local community and a strong endorsement" of New Mexico Governor Susana Martinez.

Holtec plans to deploy the HI-STORM UMAX (Underground, Maximum Capacity) system (CoC 1040) at the facility. As stated in the Final Safety Analysis Report (FSAR), the HI-STORM UMAX has been engineered to store "the entire complement of canisters currently deployed at ISFSIs around the country." All current Holtec clients will become eligible to ship their fuel to the ELEA storage facility, as will prospective clients who might not yet have established an on-site independent spent fuel storage installation (ISFSI). Holtec plans to expand the contents list of the HI-STORM UMAX CoC to incorporate NUHOMS canisters, and stated in the LoI they propose a license amendment application for the CIS that will add the NUHOMS dry shielded canisters (DSCs) that are presently in use at the San Onofre Nuclear Generating Station (SONGS) to the list of approved contents for the HI-STORM UMAX system. Southern California Edison, which currently employs the NUHOMS storage system, recently selected the HI-STORM UMAX to expand the SONGS ISFSI.

Holtec will further expand the HI-STORM UMAX contents to include all Holtec canisters, and all canisters from shutdown plants and near-term shutdown plants, regardless of the type of canister a particular site currently employs. At a later date, Holtec plans to submit another amendment to the HI-STORM UMAX CoC that will seek to include all canisters deployed at presently operating ISFSIs. The cask systems in use at these plants will be included in future amendments to the HI-STORM UMAX system so that eventually every reactor site in the US that has dry storage will be eligible to send spent fuel to the ELEA storage site.

The ELEA site-specific application will invoke the HI-STORM UMAX FSAR by reference. The proposed facility is being engineered to "facilitate convenient and low dose removal of the canisters for their eventual transport to the ultimate repository." Holtec will propose a 40-year license life for the ELEA facility.

Holtec will soon request a pre-application meeting with NRC staff, and expects that such a meeting can take place before the US Thanksgiving holiday.

Holtec first announced it was working with the ELEA to build a storage facility in New Mexico on April 29 (*SpentFUEL* May 1).

Last week, Holtec's Senior Vice President and Chief Nuclear Officer, Pierre Oneid, discussed Holtec's proposal in a webinar that was sponsored by Nuclear Energy Insider (NE Insider), in which over 400 people participated. Some information gleaned from that webinar follows.

Oneid reviewed the well-known reasons given for building a consolidated storage facility in the US. He noted six common reasons, and emphasized the money that is being disbursed from the US Treasury that is expected to reach $20 billion of taxpayer funds by 2020. He also emphasized that having such a facility "dispels the arguments that there are no solutions for spent nuclear fuel."

PENGAD-Bayonne, N. J. EXHIBIT 1

The map above shows the nuclear facilities that are already located in this area. ELEA owns about 1,000 acres in this corridor, and the CIS would require only about 60 acres. The map also shows the Waste Control Specialists (WCS) site in Texas (see next story).

Oneid touted Holtec's dry storage and transportation experience, noting that 101 plants worldwide are under contract for Holtec dry storage systems – 59 of these are in the US. Over 770 Holtec canisters have been loaded, and 70 to 90 canisters are loaded each year. He also pointed out that Ukraine has selected Holtec to build a storage facility.

Oneid explained some of the features of the HI-STORM UMAX system, which stores the fuel below grade in underground silos. The above ground height of the HI-STORM UMAX is below waist height, which makes the facility "visibly inconspicuous and provides a clear, unobstructed view of the entire facility from any location." From a radiation protection perspective, he said, this system is "superior."

The preliminary licensing and construction schedule calls for the following:

- December 1, 2015: Pre-application meeting with the NRC;
- June 1, 2016: Application submitted to the NRC;
- October 30, 2018: Safety Evaluation Report completed;
- January 30, 2019: License issued;
- April 1, 2019: Construction begins;
- April 1, 2020: Operations begin.

Holtec sees the facility as a benefit to New Mexico, which can be measured in expected revenue and new jobs. The company sees the CIS as a "staging facility" on the way to permanent storage – not as an impediment to a permanent repository.

As part of the webinar, NE Insider conducted two "instant polls" among the participants, which yielded some interesting results. The first question was: "What will be the biggest hurdle in bringing CISFs into operation?" The choices were the following: (1) NRC licensing procedures; (2) challenges from the federal government; (3) local stakeholders not providing consent; (4) inadequate technology; (5) used fuel transportation issues. Challenges from the federal government was selected by 37% of the participants as being the main hurdle, followed by used fuel transportation issues (28%), local stakeholders not providing consent (18%), NRC licensing procedures (15%), and inadequate technology (1%).

The second instant poll question was: "Will the construction and operation of CISFs in the US encourage new build?" Responses were split, with 52% of respondents said Yes, and 48% said No.

Oneid explained, in response to a question about who will hold title to the spent fuel, that the title issue needs to be worked out but Holtec's vision is that DOE would sign a contract with Holtec to be the customer, and thus DOE would take title to the fuel at the reactor site and be responsible for transporting it to the storage facility, just as it would if DOE were sending the spent fuel to a permanent repository. Holtec is working with DOE, in parallel to its licensing work, to start discussions with DOE about this issue.

The two New Mexico senators, Sen. Martin Heinrich (D) and Sen. Tom Udall (D), have stated publicly they will not support this facility, but Oneid said that shortly after he read of their opposition to the project, he visited both of them in their offices. "We are actively in the communication process with both senators and are formulating and will be implementing a plan to target communities with a communication and education process."

Interim storage and many other topics germane to spent fuel and decommissioning will be discussed at NE Insider's Nuclear Decommissioning and Used Fuel Strategy Summit in Charlotte, North Carolina on October 5-6. Quite a range of speakers and panelists from utilities, vendors, regulators, state and federal government (including Canada), and more are on the agenda. Details can be found at www.nuclearenergyinsider.com/nuclear-decommissioning-used-fuel

Top Story

SpentFUEL interview with WCS team – could be ready to accept waste by 2020

Texas-based Waste Control Specialists (WCS) has also announced plans to build a Consolidated Interim Storage Facility (CISF) in west Texas. WCS and its team, which includes AREVA TN and NAC International, already met with the NRC for the first pre-application meeting on June 16 (*SpentFUEL* June 19). WCS is seeking a site-specific 10 CFR Part 72 license from the NRC to build and operate a CISF to store up to 40,000 MTU of spent fuel and reactor-related greater-than-Class C (GTCC) waste. The Environmental Impact Statement (EIS) will encompass the full capacity, but

What Holtec Requires to Start Construction

HOLTEC INTERNATIONAL

- Holtec will initiate licensing process:
  - ✓ Requires federal funding to construct & operate CISF
- Legislation (S854 / HR 3643):
  - ✓ Allows portion of Nuclear Waste Fund to pay for interim storage services
  - ✓ Enables DOE to take title of SNF and transport to CISF

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PENGAD-Bayonne, N. J.
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Holtec to start regulatory process for New Mexico used fuel store soon

30 July 2015

Holtec International has unveiled the schedule for its proposed consolidated interim storage facility (CISF) for used nuclear fuel, with start-up slated for 2020. Holtec sees the facility, to be built in south-eastern New Mexico, as the only solution being put forward to deal with the USA's 70,000 tonnes of used nuclear fuel that is currently located in 35 states and at about 70 sites.

In April, Holtec and Eddy-Lea Energy Alliance (ELEA) announced the signing of a memorandum of agreement covering the design, licensing, construction and operation of the facility that is to be modelled on Holtec's HI-STORM UMAX dry storage system. ELEA will provide the land and local logistics support, including existing environmental characterization data.

In a webinar organized by *Nuclear Energy Insider* yesterday, Holtec International senior vice president and chief nuclear officer Pierre Oneid said the company would submit its letter of intent for the project to the Nuclear Regulatory Commission (NRC) next month.

Holtec will request that NRC's used fuel management office opens a Part 72 docket which, Oneid said, "will serve as a letter of intent that will make its way to NRC in August". Part 72 refers to licensing requirements for the independent storage of used nuclear fuel, high-level radioactive waste, and reactor-related greater than Class C waste.

That will mean a pre-application meeting with NRC can be expected by December and an application submittal to the agency by June 2016, Oneid said. "We expect, based on past experience and on our discussions with NRC, that it is reasonable to put a date like October 2018 for the safety evaluation report," he added.

The licence might then be issued in January 2019, with the first phase of construction starting in April 2019. Operation of the facility could then begin a year later.

Wise approach

Oneid said CISF is a "wiser approach" to dealing with the USA's commercial high-level nuclear waste, not least because some storage is currently in the most densely populated areas of the country. Twelve decontamination and decommissioning sites

in particular want to turn themselves back to greenfield land, but cannot until the high-level waste is moved, Oneid said.

Transportation of used nuclear fuel and high-level waste is "proven safe", he said, since thousands of tonnes of it have been transported around the USA for the past 40 years "without a single significant incident". In addition, radioactivity "decreases rapidly with time", with gamma and heat decay, he said.

The US government is legally responsible for developing a long-term disposal strategy for used nuclear fuel. From 1992 until 2009, that strategy had been the Yucca Mountain repository. The Department of Energy (DOE) announced a new waste disposal strategy in early 2013, envisaging a series of interim stores until a permanent underground disposal facility is ready for service around 2048.

Breach of contracts associated with termination of the Yucca Mountain project incurs a DOE settlement fund payment of $20 billion by 2020 from the US Treasury, Oneid said, with a further cost after that date of about $500 million per year until a CISF or repository is built.

US taxpayers are paying for the fact that "decisions have not been made" on dealing with used nuclear fuel, Oneid said, and "we want to dispel the argument that there are no solutions".

The 1000-acre (405-hectare) site, mid-way between Hobbs and Carlsbad, which ELEA originally purchased for the DOE's Global Nuclear Energy Partnership, is a remote, geologically stable, dry location with existing infrastructure, including rail. It also has a pre-existing and robust scientific and nuclear operations workforce, Oneid said, with the Waste Isolation Pilot Plant to the south and, to the east, International Isotopes Inc, Louisiana Energy Services and Waste Control Specialists.

"If there is a perfect place on earth for the CISF that would be it," Oneid said, adding that the facility would require just 60 of the site's 1000 acres.

Proven technology

Holtec is in the process of licensing its HI-STORM UMAX (Holtec International STORage Module Universal MAXimum security) technology to store not only its own canisters, Oneid said, "but any in use today" in the USA.

"We have more than seven dockets as Certificates of Compliance with NRC and also have certificates for transporting casks that exist today, so that if we as a country can get behind the solution we're offering, then we could start transportation immediately," he said.

In addition to the safety and security features of the CISF design using HI-STORM UMAX - for example, it is below waist height, making it inconspicuous and providing a clear view of the entire facility - it enables retrieval of the stored fuel within 4-8 hours.

"We are designing it to be able to retrieve at any point, whether one year or 50 years from now," Oneid said. The technology is also economically desirable since it has already been constructed, at Missouri's Callaway nuclear power plant. In

December, Southern California Edison selected HI-STORM UMAX for storing used nuclear fuel from the decommissioned San Onofre plant.

There are therefore no technological impediments, he said, to the proposed CISF, "which we see as a staging facility on the way to permanent storage".

Political hurdle

Asked what he saw then as the main challenges to the project, Oneid said "political support is going to be the number one hurdle", although local government backing in New Mexico is not seen as an issue.

That hurdle will be no surprise to anyone "who is no stranger to the Yucca Mountain situation", he said, noting that the US Senate is to hold a hearing on the storage of used nuclear fuel on 4 October.

On the question of whether the CISF could stimulate new reactor construction projects in the USA, Oneid said that Holtec is actively pursuing the small modular reactor program. He noted that one of the biggest hurdles for the four units under construction today in the country is the "contentious" issue of high-level waste storage.

For the CISF, Holtec could draw on its experience of private fuel storage, Oneid said. Without local support, any such project is "a futile exercise", he said. "We are actively trying to define what 'consent' is and pursuing that to a T." An "interesting block" on licensing, he said, was the effort Holtec had had to make to prove the safety of HI-STORM UMAX against an F-16 crash. Oneid was referring to Holtec's announcement in January 2013 that the USA's first NRC licensed CISF, planned for the Goshute reservation in Skull Valley, Utah, by Private Fuel Storage, had ceased due to opposition from the Department of Interior.

Asked who would ultimately own the fuel stored at the proposed CISF in New Mexico, Oneid said Holtec had started unofficial talks with the DOE. "We will surely soon have official talks with them on a contract whereby the DOE will hold the title to the fuel."

Researched and written by World Nuclear News

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LAND PURCHASE OPTION AGREEMENT

This Land Purchase Option Agreement (this "Agreement") is entered into this 5th day of February 2016 between Eddy-Lea Energy Alliance Limited Liability Company, a New Mexico limited liability company ("ELEA"), and Holtec International, a Delaware corporation ("Holtec").

RECITALS

A. ELEA is a New Mexico limited liability company organized under a joint powers agreement between Eddy County, Lea County, the City of Carlsbad and the City of Hobbs (collectively, the "Members") for the purpose of promoting energy-related economic development for the benefit of the residents of the Members.

B. Holtec has developed a system for monitored retrieval storage of spent nuclear fuel ("SNF") and high-level waste ("HLW"), which it calls the Holtec International Storage Module Underground Maximum Capacity, or "HI-STORM UMAX" system.

C. In 2009, ELEA purchased a parcel of undeveloped property in Lea County (the "Property") for $1 million with the intent of donating the Property to a private party, pursuant to the Local Economic Development Act, Sections 5-10-1 to 5-10-13 NMSA 1978 ("LEDA"), for use as a Global Nuclear Energy Partnership ("GNEP") facility. The Property comprises approximately 960 acres, and is more specifically described in Exhibit A hereto.

D. The GNEP program was subsequently cancelled, and ELEA has now determined that its economic development mission would be best served by selling the Property to Holtec for no less than fair market value, contingent upon Holtec achieving the Option Start Date (as defined below) or exercising the Early Option (as defined below) to purchase the Property.

E. It is Holtec's intend to obtain a license from the Nuclear Regulatory Commission (the "NRC") and upon successful completion of an agreement with the Department of Energy and/or one or more utility companies to store spent nuclear fuel, construct and operate the HI-STORM UMAX system on the Property (the "Project").

AGREEMENT

Section 1. Effective Date. This Agreement shall not be effective until, and shall be immediately effective upon, approval of this Agreement by the State Board of Finance pursuant to NMAC 1.5.23.9 and Holtec's satisfactorily completing due diligence with regard to any mineral rights owners of the Property. (the "Effective Date"). ELEA agrees to assist Holtec by providing sufficient information regarding the current mineral right owners of the Property.

Section 2. Licensing; Storage Contracts.

(a) Promptly following the Effective Date, Holtec shall commence preparation of a site-specific license application (the "NRC Application") under the provisions of the Code of Federal Regulations (CFR) Chapter 10, Part 72 for a license (the "License") to

EXHIBIT 4

operate the Property as an interim storage facility (the "Facility"), and to obtain a favorable draft Safety Evaluation Report pursuant to NRC regulations (the "Draft SER"). Holtec shall use best efforts to cause the NRC to expeditiously issue the Draft SER. No later than three years following the Effective Date, Holtec shall submit the NRC Application to the NRC, and shall thereafter use its best efforts to obtain issuance of the License.

(b) Holtec will use reasonable efforts to negotiate an agreement with the Department of Energy ("DOE") for the interim storage of HLW and/or SNF on the Property (the "DOE Agreement") and/or negotiate an agreement with one or more power utilities for the storage of HLW and/or SNF on the Project (the "Utility Agreement", and together with the DOE Agreement, the "Storage Agreements").

(c) The date on which Holtec has (i) obtained the License, (ii) entered into either the DOE Agreement or the Utility Agreement, and (iii) in Holtec's sole judgment, secured financing for the initial construction of the Project, shall be the "Option Start Date". Holtec shall cause the Option Start Date to occur not later than thirteen years after the Effective Date unless otherwise extended by the parties.

Section 3. Property Purchase Option. Upon the occurrence of the Option Start Date, Holtec shall have the option to purchase the Property. Holtec shall exercise the purchase option by delivering written notice thereof (the "Option Exercise Notice") to ELEA no later than 90 days after the Option Start Date.

Section 4. Property Purchase Price. Within 60 days after delivery of the Option Exercise Notice, ELEA and Holtec shall select an MAI appraiser and such appraiser shall determine the fair market value of the land portion of the Property, excluding the value of any improvements, including, but not limited to, the License, or alterations made by Holtec with the consent of ELEA (the "Land Value"). If ELEA and Holtec are unable to agree upon the appraiser, each will select its own MAI appraiser (who shall be paid by that party), and such appraisers shall each independently determine the Land Value. If the lower appraisal is at least 90% of the higher appraisal, the "Land Value" shall be the average of such two appraisals. If the lower appraisal is not at least 90% of the higher appraisal, the two appraisers shall select a third MIA appraiser, and the third appraiser shall determine the Land Value. The cost of either the agreed upon appraiser or the third appraiser shall be shared equally by the parties. The purchase price for the Property (the "Purchase Price") shall be the greater of (i) $1 million or (ii) the Land Value.

Section 5. Property Purchase Closing. The closing of the purchase of the Property (the "Closing") will occur within 90 days of the determination of the Purchase Price. The Purchase Price shall be paid at closing, in cash or a cash equivalent. ELEA shall convey the Property to Holtec by quitclaim deed.

Section 6. Early Purchase Option.

(a) Holtec shall have the option to purchase the Property at any time prior to the Option Start Date (the "Early Option") by delivering written notice thereof (the "Early Option Notice") to ELEA. Within 60 days after delivery of the Early Option Notice, the parties

shall proceed to have the Purchase Price determined using the procedure described in Section 4, and shall transfer the Property for the Purchase Price (the "Early Purchase") as provided in Section 5.

(b) If, following the Early Purchase, Holtec determines in its sole reasonable decision that completion of the Project is not feasible , then ELEA shall have the option of purchasing the Property, including all improvements thereon, for the Purchase Price that was paid by Holtec for the Early Purchase (the "Repurchase Price"), subject, however, to such environmental and other investigations as ELEA may reasonably require. The cost of such investigations may be deducted from the Repurchase Price.

Section 7. Cooperative Promotion of Facility.

(a) At Holtec's request, ELEA will take reasonable actions to support and promote the approval, licensing, construction and operations of the Facility, including the following:

(i) ELEA shall take all reasonable actions to persuade national, state and local governmental officials, the DOE, the NRC, the State of New Mexico, ELEA's Members, and the local communities to support the Facility and its licensing, including, without limitation, participating in meetings with governmental officials and the public. ELEA's support will continue so long as this Agreement is in force.

(ii) ELEA will assist Holtec in its efforts to petition and/or negotiate with the DOE (or any other potential utility customer) to store HLW and SNF at the Facility.

(iii) Holtec and ELEA will work together to expand the mission of the Facility to include interim storage of defense high-level waste.

(iv) ELEA will provide full support to Holtec in Holtec's efforts to secure partial federal support of the Facility to reduce the financing burden on Holtec.

(b) Neither Holtec nor ELEA will sponsor or promote the development of any competing central interim storage project for SNF or HLW in the State of New Mexico or in a state bordering the State of New Mexico.

(c) With regard to the performance by ELEA of its obligations under this Section 7, ELEA shall be responsible only for the in-state travel and office expenses of ELEA board members and employees. ELEA personnel shall not be obligated to travel outside of New Mexico, and ELEA shall not be obligated to incur other expenses of any description except as provided in the preceding sentence, absent reimbursement or, at ELEA's option, payment in advance, by Holtec of such expenses.

Section 8. Revenue Sharing. Holtec shall pay ELEA the rate of local government reimbursement negotiated in good faith with the DOE or utility, which rate shall not be less than 30% of gross revenues; provided, however, that ELEA may approve, in its sole discretion, a rate

less than 30%. Holtec will keep ELEA informed of all material issues relating to the negotiation of the local government reimbursement, and two of ELEA's board members shall be allowed full participation in the negotiation of the local government reimbursement. The reimbursement payments shall be made monthly, within 20 days after the end of each calendar month; provided that if Holtec does not receive a Storage Agreement payment in a given month, then the payment due to ELEA shall be paid within 20 days after Holtec receives such Storage Agreement payment. The parties anticipate that ELEA will be required to pay a percentage of each reimbursement payment to the State of New Mexico. After subtracting the portion that ELEA must pay to the State, the remainder of each payment under this Section 8 may be reduced by up to 50% (each, a "Reduction"), until the total of all such Reductions is an amount equal to the Purchase Price. (For example, if the first payment obligation is $500,000, and the State share is 60%, then Holtec may reduce the actual payment by $100,000 (i.e., ($500,000-$300,000)/2)). ELEA and its agents shall be provided such access to the Facility's records as is reasonably necessary to confirm the correct calculation of the revenue sharing payments. ELEA acknowledges ELEA shall be solely responsible for any and all fees paid to the State of New Mexico as a result of this Project and that Holtec shall have no obligation whatsoever to pay the State of New Mexico as a part of the revenue sharing of this Agreement.

Section 9. Termination.

(a) This Agreement shall automatically terminate if Holtec has not delivered the Option Exercise Notice no later than 90 days after the Option Start Date.

(b) Holtec may, by written notice to ELEA, terminate this Agreement at any time prior to Closing.

(c) Unless terminated as provided in Subsection 9(a) or Subsection 9(b), or terminated as the result of a breach, this Agreement shall continue so long as the Property is used for the Facility.

Section 10. Assignment. With the consent of ELEA (which consent shall not be unreasonably refused), Holtec may assign this Agreement to a third party.

Section 11. Industrial Revenue Bonds. The parties acknowledge that Holtec may request Lea County (the "County") to issue an industrial revenue bond (an "IRB") for the Facility, in which case Holtec will deed the Property to the County, and the County will immediately lease the Property back to Holtec under an IRB lease and purchase agreement. ELEA consents to such an IRB transaction; provided, however, such IRB transaction shall not effect ELEA's rights under Section 8 hereof.

Section 12. Amendments. This Agreement may be amended only by a written instrument signed by all the parties, and then only to the extent of such instrument. Any amendment affecting the terms of the transfer of the Property from ELEA to Holtec shall not be effective without the prior consent of the State Board of Finance.

Section 13. Binding Effect. This Agreement shall inure to the benefit of and shall be binding upon ELEA and Holtec, and their respective successors and assigns.

Section 14. Severability. In the event any provision of this Agreement shall be held invalid or unenforceable by any court of competent jurisdiction, such holding shall not invalidate or render unenforceable any other provision hereof; provided, however, that if enforcement of this Agreement absent such invalid or unenforceable provisions would destroy an essential purpose of this Agreement, then this Agreement shall be deemed modified to the extent necessary to make it valid or enforceable consistent with the true intent hereof.

Section 15. Recording. This Agreement and every assignment and modification hereof, or an appropriate and sufficient memorandum thereof, and each deed or instrument of conveyance contemplated hereunder, shall be recorded in the office of the County Clerk of Lea County, New Mexico.

Section 16. Execution in Counterparts. This Agreement may be executed in multiple counterparts, all of which taken together will constitute one instrument.

Section 17. Notices. All notices required under this Agreement shall be deemed to be properly sent if in writing, signed by the party or agent sending them, and (i) delivered personally, (ii) sent by registered or certified mail, or (iii) sent by a recognized overnight express courier service, addressed to ELEA or Holtec, as the case may be, at the following addresses, and such notices shall be effective on the date of receipt thereof:

If to ELEA:

Eddy-Lea Energy Alliance
c/o Lea County
100 N. Main
Lovington, NM 88260
Attn.: County Manager
Phone: (575) 396-8601
Fax: (575) 396-2093

with a copy to:

Rodey Law Firm
201 Third St., Suite 2200
Albuquerque, NM 87102
Attention: Alan Hall
Phone: (505) 768-7203
Fax: (505) 768-7395

If to Holtec:

Holtec International
1001 N US Highway 1
Jupiter, FL 33477
Attn.: Pierre Oneid
Phone: (561) 745-7772
Fax: (856) 797-0922

with a copy to:

Holtec International
One Holtec Drive
Marlton, NJ 08053
Attn.: Andrew R. Ryan, Esq.

Phone: (856) 797-0900
Fax: (856) 797-0922

Any party may, by notice to the other party, designate any further or different addresses to which subsequent notices, certificates or other communications are to be sent.

Section 18. Title; Headings. The title and headings of the articles, sections and subdivisions of this Agreement have been used for convenience only and will not modify or restrict any of the terms or provisions of this Agreement.

Section 19. Applicable Law. The validity, construction and effect of this Agreement will be governed by New Mexico law applicable to agreements made and to be performed in New Mexico, without regard or effect given to conflict of law principles or rules that would require the application of the laws of any other jurisdiction.

Section 20.Further Actions. At any time and from time to time, each party agrees, without further consideration, to take such actions and to execute and deliver such documents as may be reasonably necessary to effectuate the purposes of this Agreement. ELEA shall, upon the request of Holtec, execute and deliver such instruments as Holtec may reasonably request, including but not limited to amendments to this Agreement, to obtain or renew the License or any consent of any other governmental authority for the operation of the Facility, or to maintain Holtec's compliance with such government requirements or the DOE Agreement and/or the Utility Agreement; provided, however, that such instruments do not materially adversely affect ELEA's rights under this Agreement.

Section 21. Event of Default; Remedies. A failure by a party to perform any of its obligations under this Agreement for a period of 30 days after written notice, specifying such failure and requesting that it be remedied, is given to the breaching party by the non-breaching party, or, if such failure cannot reasonably be remedied within 30 days, failure by the breaching party to commence the remedy within such period and to pursue the same diligently to completion, shall constitute an "Event of Default". Upon the occurrence of an Event of Default, the non-breaching party may exercise any and all remedies available at law.

Section 22. No Pecuniary Liability of ELEA. Holtec shall bear all of the expense, direct, indirect and contingent, of the licensing, construction and operation of the Facility. Neither ELEA nor any of its Members shall have any liability for any costs or obligations pertaining to or arising out of the licensing, construction or operation of the Facility.

Section 23. Release and Indemnification.

(a) Holtec releases ELEA, ELEA's members, and all officials, officers, employees and agents of the ELEA and ELEA's members (collectively, the "Indemnitees") from, agrees that the Indemnitees will not be liable for, and agrees to indemnify and hold the Indemnitees harmless from and against any and all liabilities, claims, suits, costs and expenses that are or may be imposed upon, incurred or asserted against the Indemnitees on account of: (i) any loss or damage to property or injury to or death of or loss by any person caused by Holtec's

willful misconduct or negligence in investigating the Property prior to the Closing; (ii) any loss or damage to property or injury to or death of or loss by any person that may be occasioned by any cause whatsoever pertaining to the construction, maintenance, operation, use or demolition of the Facility (iii) any storage activities at, on, in, under or about the Property; (iii) any other loss, claim, damage, penalty, liability, disbursement, litigation expense, attorneys' fees, experts' fees or court costs arising out of or in any way relating to clauses (i) and (ii); and (iv) any claim, action or proceeding brought with respect to the matters set forth in clauses (i), (ii) and (iii) above.

(b) Holtec releases the Indemnitees from, agrees that the Indemnitees shall not be liable for, and agrees to indemnify and hold the Indemnitees harmless from and against any and all claims, suits, judgments, fines, penalties, assessments, natural resource damages, response costs (such as the cost of any testing, sampling, medical or other monitoring, cleanup, or other required response action), costs necessary to bring the Property or the Facility into compliance with Environmental Laws (as defined below) and other liabilities, together with attorneys' fees and experts' fees, costs and expenses which are or may be imposed upon, incurred by, or asserted against the Indemnitees resulting from or in any way connected with the use, handling, mixing, generation, storage, manufacture, refining, release, transportation, treatment, disposal or other release or presence, at, in, on, under or from the Property, of any Hazardous Material (as defined below), SNF, other radioactive substance, oils, asbestos in any form or conditions, or any pollutant or contaminant or hazardous, dangerous or toxic chemicals, materials or substances within the meaning of the Environmental Laws, or any other applicable federal, state or local law, regulation, ordinance or requirement relating to or imposing liability or standards of conduct concerning any Hazardous Material, hazardous, toxic or dangerous waste, substance or materials, all as now in effect or hereafter amended from time to time.

(c) As used in this Section 23, (i) "Environmental Laws" means any laws, statutes, regulations, orders or rules pertaining to health or the environment that are applicable from time to time to the Property or the Facility, and the construction, installation, operation, use and decommissioning of, and storage at, the Property or the Facility, including, without limitation, the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended ("CERCLA"), the Resource Conservation and Recovery Act of 1976 ("RCRA"), the National Environmental Policy Act, the Clean Air Act, the Clean Water Act, the Water Quality Act of 1987, the New Mexico Water Quality Act, the New Mexico Hazardous Waste Act, the New Mexico Air Quality Control Act and the New Mexico Radiation Protection Act, and (ii) "Hazardous Material" means (A) "hazardous materials," "hazardous substances," and "hazardous wastes" as defined in the Environmental Laws, and (B) any other material regulated under the Environmental Laws.

(d) If a claim is made or any action is brought against one or more of the Indemnitees based upon the matters described in Subsections 23(a) or (b) above and in respect of which indemnity is sought against Holtec pursuant to Subsections 23(a) or (b) above, the Indemnitee seeking indemnity shall, within ten days of being notified of an action against it, notify Holtec, in writing, and Holtec shall promptly assume or cause the assumption of the defense thereof, including the employment of counsel chosen by Holtec and approved in writing by the Indemnitee (provided that such approval by the Indemnitee shall not be unreasonably

withheld or delayed), the payment of the reasonable expenses of such counsel, and the right of the Indemnitee to participate in negotiations and to consent to settlement. If any Indemnitee is advised in a written opinion of independent counsel (i) that there may be legal defenses available to such Indemnitee that are adverse to or in conflict with those available to Holtec, or (ii) that the defense of such Indemnitee should be handled by separate counsel, Holtec shall not have the right to assume or cause the assumption of the defense of such Indemnitee, and Holtec shall be responsible for the reasonable fees and expenses of counsel retained by such Indemnitee, provided such counsel is approved in writing by Holtec (which approval shall not be unreasonably withheld or delayed), in assuming its own defense. If Holtec shall have failed to assume or cause the assumption of the defense of such action or to retain counsel reasonably satisfactory to the Indemnitee within a reasonable time after notice of the commencement of such action, the reasonable fees and expenses of counsel retained by the Indemnitee shall be paid by Holtec. Notwithstanding, and in addition to, any of the foregoing, any one or more of the Indemnitees shall have the right to employ separate counsel in any such action and to participate in the defense thereof, but the fees and expenses of such counsel shall be paid by such Indemnitee or Indemnitees unless the employment of such counsel has been specifically authorized in writing by Holtec. Holtec shall not be liable for any settlement of any such action effected without the written consent of Holtec, but if settled with the written consent of Holtec, or if there is a final judgment for the plaintiff in any such action with or without consent, and after all appeals have been taken and final orders or dismissals entered, Holtec agrees to indemnify and hold harmless the Indemnitees from and against any loss or liability by reason of such settlement or judgment.

(e) The indemnifications set forth in this Section 23 are intended to and will include the indemnification of all Indemnitees. The indemnification is intended to and will be enforceable by the Indemnitees to the full extent permitted by law.

(f) No release or indemnity is given under this Section 23 due to the exercise by any of ELEA's members of its police powers or in the performance of any essential governmental function; and provided further that there shall be excluded from the scope of this release and indemnity any liability, claims, costs and expenses imposed upon, incurred or asserted against an Indemnitee to the extent resulting from or arising out of the willful misconduct or negligence of the Indemnitee.

(g) If a court of competent jurisdiction determines that the provisions of Sections 56-7-1 or 56-7-2 NMSA 1978, as amended, are applicable to this Agreement or any claim arising under this Agreement, then any agreement in this Agreement to indemnify, hold harmless, insure, or defend another party will not extend to (i) liability, claims, damages, losses or expenses, including attorneys' fees, arising out of bodily injury to persons or damage to property caused by or resulting from, in whole or in part, the negligence, act or omission of the indemnitee, its officers, employees or agents. Notwithstanding anything in this Lease to the contrary, this Lease shall be subject to all other limitations of Sections 56-7-1 and 56-7-2 NMSA 1978.

Section 24. <u>Survivals</u>. Sections 6 through 24 of this Agreement shall survive the Closing. Sections 22 and 23 shall survive the termination of this Agreement.

IN WITNESS WHEREOF, ELEA and Holtec have executed this Agreement on the date stated above.

EDDY-LEA ENERGY ALLIANCE, LLC

By____________________________
Name: Monty D. Newman
Title: Chairman

HOLTEC INTERNATIONAL

By____________________________
Name:______________________
Title:______________________

State of New Mexico)
) ss.
County of Lea)

This instrument was acknowledged before me on February 5, 2016 by Monty D Newman as Chairman of Eddy-Lea Energy Alliance, LLC, a New Mexico limited liability company.

Linda Barrett
Notary Public

My commission expires:

Official Seal
Linda Bartlett
Notary Public
State of New Mexico
My Commission Expires 3/25/17

State of ______________)
) ss.
County of ____________)

This instrument was acknowledged before me on ____________, 20__ by __________________, as ____________________ of Holtec International, a Delaware corporation.

____
Notary Public

My commission expires:____________

Exhibit A

Legal Description of the Property

A. The surface estate only of Section 13, Township 20 South, Range 32 East, N.M.P.M.

B. Tract I: The surface estate only of a tract of land located in the Southwest Quarter of Section 17, Township 20 South, Range 33 East, N.M.P.M. and more particularly described as beginning at the Southwest corner of said Section 17, thence S89°59'E, 1322.50 feet; thence N0°3'W, 1320 feet; thence N89°59'W, 1322.50 feet; and thence S0°3'E, 1320 feet to the point of beginning; and

Tract II: The surface estate only of Lots 2, 3 and 4; the East Half of the West Half (E 1/2 W 1/2); and the South Half of the Southeast Quarter (S 1/2 SE 1/4), all in Section 18, Township 20 South, Range 33 East, N.M.P.M.

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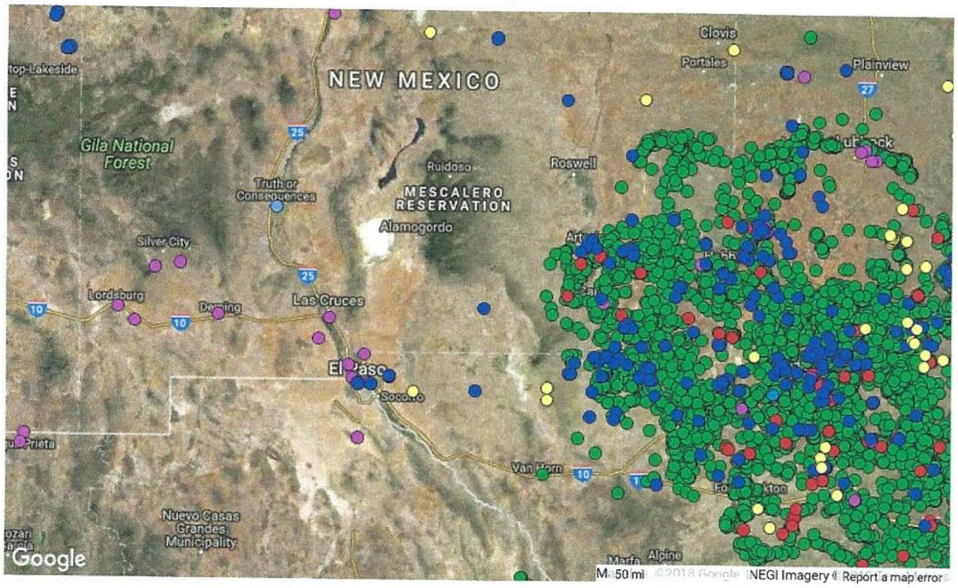

- Drilling

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PENGAD-Bayonne, N. J. EXHIBIT 5

Details Legend

Oil & Gas wells (4-20-2017)

Counties

Shale Plays

Shale Basins

State of stress in the Permian Basin, Texas and New Mexico: Implications for induced seismicity

Jens-Erik Lund Snee[1] and Mark D. Zoback[1]

Abstract

Since the 1960s, the Permian Basin of west Texas and southeast New Mexico has experienced earthquakes that were possibly triggered by oil and gas activities. In recent years, seismicity has been concentrated near Pecos, Texas; around the Dagger Draw Field, New Mexico; and near the Cogdell Field, Snyder, Texas. We have collected hundreds of measurements of stress orientation and relative magnitude to identify potentially active normal, normal/strike-slip, or strike-slip faults that might be susceptible to earthquake triggering in this region. In the Midland Basin and Central Basin Platform, the faulting regime is consistently normal/strike slip, and the direction of the maximum horizontal compressive stress (S_{Hmax}) is approximately east–west, although modest rotations of the S_{Hmax} direction are seen in some areas. Within the Delaware Basin, however, a large-magnitude clockwise rotation (~150°) of S_{Hmax} occurs progressively from being nearly north–south in the north to east-southeast–west-northwest in the south, including the western Val Verde Basin. A normal faulting stress field is observed throughout the Delaware Basin. We use these stress data to estimate the potential for slip on mapped faults across the Permian Basin in response to injection-related pressure changes at depth that might be associated with future oil and gas development activities in the region.

Introduction

The Permian Basin of west Texas and southeast New Mexico is one of the most important petroleum-producing regions in the United States, containing numerous vertically stacked producing intervals (Dutton et al., 2005). The basin is subdivided into several structural regions (Figure 1), including the prolific Midland and Delaware basins, which are separated by the Central Basin Platform, a crystalline-basement-involved structural high overlain by carbonate reef deposits and clastic rocks (Cartwright, 1930; Galley, 1958; Matchus and Jones, 1984).

Fluid injection and hydrocarbon production have been suspected as the triggering mechanisms for numerous earthquakes that have occurred in the Permian Basin since the 1960s (Rogers and Malkiel, 1979; Keller et al., 1981; Orr, 1984; Keller et al., 1987). The area is also naturally seismically active (Doser et al., 1991, 1992). Seismicity in the Permian Basin has historically occurred in several localized areas (Figure 1), including parts of the Central Basin Platform and around the Dagger Draw and Cogdell fields (Sanford et al., 2006; Gan and Frohlich, 2013; Pursley et al., 2013; Herzog, 2014; Frohlich et al., 2016). Since about 2009, seismicity has occurred in the southern Delaware Basin (Jing et al., 2017), an area where the USGS National Earthquake Information Center and Keller et al. (1987) report very little previous seismicity. Since the TexNet Seismological Network (Savvaidis et al., 2017) began recording earthquakes across Texas in January 2017, at least three groups of earthquakes, surrounded by more diffusely located events, have occurred in the southern Delaware Basin, near Pecos, Texas. A fourth group of events occurred mostly in mid-November 2017 farther to the west in northeastern Jeff Davis County. In addition, a group of mostly small ($M_L < 2$) earthquakes occurred between Midland and Odessa, in the Midland Basin.

As illustrated through recent studies of induced seismicity in Oklahoma (Walsh and Zoback, 2016), knowledge of the current state of stress is an essential component in estimating the pore-pressure perturbation needed to trigger an earthquake on a given fault. Such analyses enable both retrospective analyses of potential triggering conditions of past earthquakes as well as estimates of the likelihood of future slip on mapped faults due to fluid injection or extraction. As part of our work to map the state of stress in Texas, we (Lund Snee and Zoback, 2016) recently contributed more than 100 new, reliable (A–C-quality) maximum horizontal compressive stress (S_{Hmax}) orientations specifically within the Permian Basin, together with an interpolated map of the relative principal stresses expressed using the A_ϕ parameter (Simpson, 1997). In anticipation of fluid-injection activities associated with the thousands of wells to be drilled in the Permian Basin in the next few years, we report more than 100 additional S_{Hmax} orientations and a refined map of the relative stress magnitudes (Figure 1) to provide a comprehensive view of the state of stress in the Permian Basin and its relation to potential earthquake triggering on faults in the region.

In this paper, we first summarize the compilation of new stress measurements and provide an overview of relative stress magnitudes. We then discuss the stress field (especially in areas where it varies considerably, such as the Delaware Basin) and apply the new stress data to estimate the fault slip potential that would be expected due to fluid-pressure increases that might be associated with fluid injection at depth. This analysis will utilize FSP v.1.07, a freely available software tool developed by the Stanford Center for Induced and Triggered Seismicity in collaboration with ExxonMobil (Walsh et al., 2017). We use only publicly available information about faults in the region.

Methods

In the earth, a combination of tectonic driving forces and local factors such as density heterogeneities give rise to anisotropic principal stresses with consistent orientations and relative magnitudes throughout the brittle upper crust (Zoback and Zoback, 1980; Zoback, 1992). These principal stresses, which are continually replenished by tectonic activity, are modulated by the finite strength of the crust, which dissipates accumulated stresses through seismic and aseismic slip on faults. Consequently, most of the brittle crust is thought to be critically stressed, meaning

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that it is in a state of frictional equilibrium in which the faults best oriented for slip with respect to the principal stress directions are usually within one earthquake cycle of failure (Zoback et al., 2002). Thus, knowing the orientations of the principal stresses reveals the faults that are most likely to slip. Conveniently, one principal stress is usually vertical and the other two horizontal (Zoback and Zoback, 1980) because the earth's surface is an interface between a fluid (air or water) and rock, across which no shear tractions are transmitted. Knowing both the orientation of S_{Hmax} and the relative magnitudes of the principal stresses is therefore sufficient to predict the orientations (strike and dip) and type (normal, strike slip, and/or reverse) of faults most likely to slip.

Measuring the orientation and relative magnitudes of the principal stresses. (*Editor's note: Figures A1 and A2 and Tables A1–A5 are included as supplemental material to this paper in SEG's Digital Library at https://library.seg.org/doi/suppl/10.1190/tle37020127.1.*) The S_{Hmax} orientations shown in Figure 1 and reported in supplemental Tables A1 and A2 were mostly measured using well-established techniques. The vast majority of these orientations represent means of the azimuths of drilling-induced tensile fractures (DITF) or wellbore breakouts observed using image logs such as the fullbore formation microimager (FMI) and ultrasonic borehole imager. As reported in the supplemental material that accompanies this article, the quality of each measurement was assessed using Fisher et al. (1987) statistics where possible. Quality ratings were assigned to each measurement using criteria provided in Table A3, which now include criteria for aligned microseismic events that define the orientations of hydraulic fractures. Our criteria are based on those presented by Zoback and Zoback (1989), Zoback (2010), and Alt and Zoback (2017), who specify that only A–C-quality data are sufficiently robust to justify plotting on a map (D-quality measurements are reported in Tables A1 and A2 but are not mapped). These quality criteria were developed to ensure that each mapped S_{Hmax} orientation is well constrained and is based on a sufficient number and depth range of measured stress indicators.

Six orientations, previously reported by Lund Snee and Zoback (2016) and included in Figure 1, were measured by averaging the

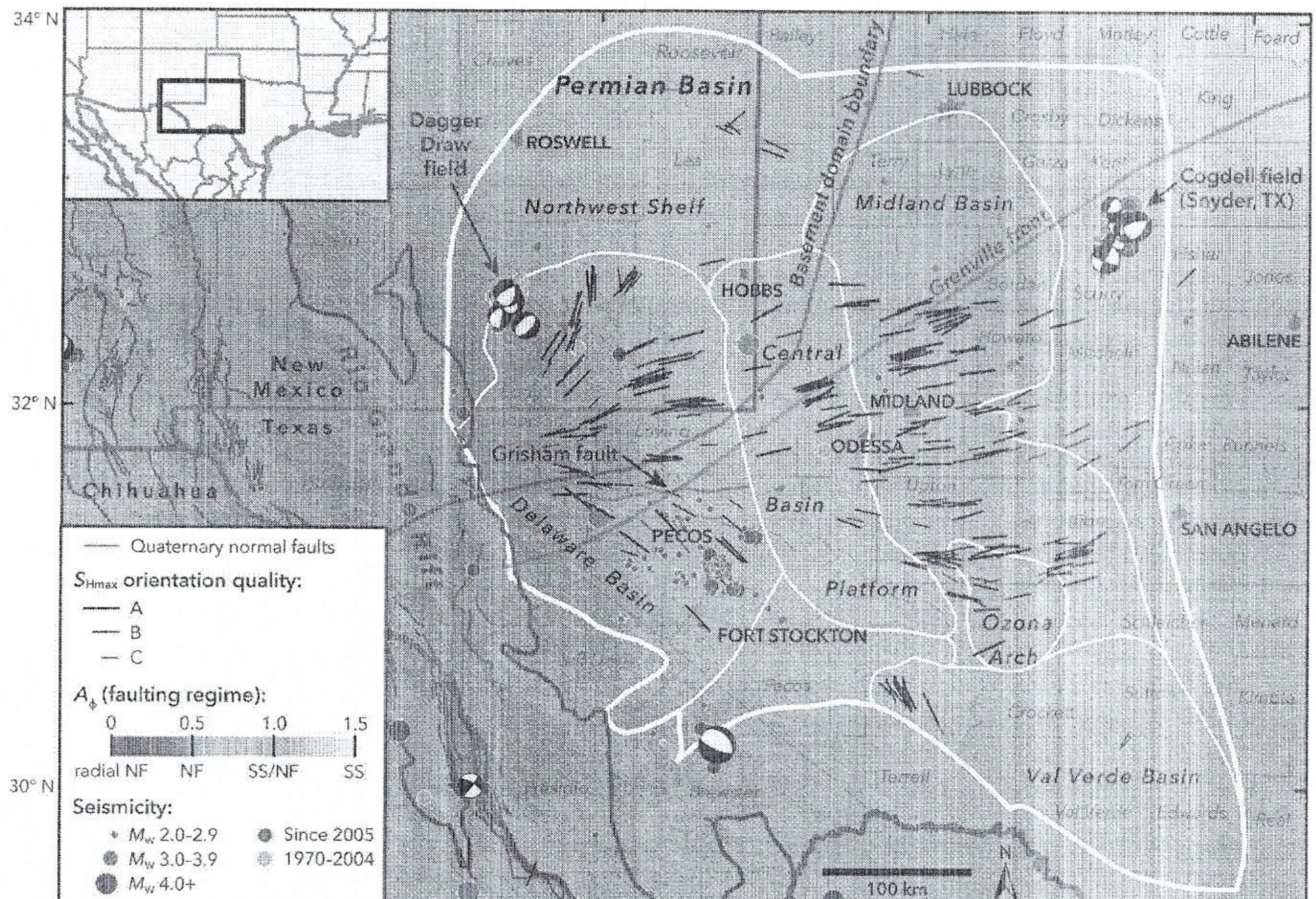

Figure 1. State of stress in the Permian Basin, Texas and New Mexico. Black lines are the measured orientations of S_{Hmax}, with line length scaled by data quality. The colored background is an interpolation of measured relative principal stress magnitudes (faulting regime) expressed using the A_ϕ parameter (see text for details) of Simpson (1997). Blue lines are fault traces known to have experienced normal-sense offset within the past 1.6 Ma, from the USGS Quaternary Faults and Folds Database (Crone and Wheeler, 2000). The boundary between the Shawnee and Mazatzal basement domains is from Lund et al. (2015), and the Precambrian Grenville Front is from Thomas (2006). The Permian Basin boundary is from the U.S. Energy Information Administration, and the subbasin boundaries are from the Texas Bureau of Economic Geology Permian Basin Geological Synthesis Project. Earthquakes are from the USGS National Earthquake Information Center, the TexNet Seismic Monitoring Program, and Gan and Frohlich (2013). Focal mechanisms are from Saint Louis University (Herrmann et al., 2011).

horizontal azimuth of the fastest shear-wave propagation in subvertical wells using measurements from crossed-dipole sonic logs. We also include several new S_{Hmax} orientations that were obtained from formal inversions of focal mechanisms from microseismic events detected during hydraulic fracturing operations. Several other S_{Hmax} orientations were obtained by measuring the orientations of aligned microseismic events thought to represent propagating hydraulic fractures. When collecting stress measurements from microseismic data, we do not account for the possibility of localized changes of stress orientations that might develop as a result of fracturing and proppant emplacement. It is unlikely that stimulation-induced changes in stress orientation would occur except in areas of very low stress anisotropy (which we demonstrate are rare). In such areas, there would not be consistent microseismic alignments orthogonal to the least principal stress that would satisfy the quality-control criterion for reliable stress orientations that we have developed (Table A3).

In addition to our new data, Figure 1 also includes previously published S_{Hmax} orientations from the Permian Basin area that we consider reliable. The 2016 release of the World Stress Map (Heidbach et al., 2016) included only a handful of S_{Hmax} orientations in the Permian Basin. We have downgraded the quality ratings for two older measurements that we suspect were made on the basis of mistaken interpretations. A large collection of S_{Hmax} orientations published by Tingay et al. (2006) and included in the World Stress Map Database were given D-quality ratings due to the lack of sufficient quality information (e.g., depth ranges, number of fractures, or standard deviations of fracture orientations), although many are in agreement with high-quality nearby measurements we utilize. Previously unpublished information contributed by R. Cornell (personal communication) is reported in Table A1, but there is not sufficient quality information to upgrade any of his measurements to C quality and be included in Figure 1. We also include S_{Hmax} orientations recently published by Forand et al. (2017), who report S_{Hmax} patterns consistent with the variations shown by Lund Snee and Zoback (2016). Although Forand et al. (2017) do not list the number and depth intervals for the stress indicators that they present, this information is included in their map because the distributions of fracture orientations shown in their rose diagrams allow us to interpret means, standard deviations, and the minimum number of fractures.

We interpolate the relative principal stress magnitudes across this area (colored background in Figure 1) using measurements reported in Table A4. We choose to represent the relative magnitudes of the three principal stresses (S_V, S_{Hmax}, and S_{hmin}) using the A_ϕ parameter (Simpson, 1997). The A_ϕ parameter (explained graphically in Figure A1) conveniently describes the ratio between the principal stress magnitudes using a single, readily interpolated value that ranges smoothly from 0 (the most extensional possible condition of radial normal faulting) to 3 (the most compressive possible condition of radial reverse faulting). The parameter is defined mathematically by

$$A_\phi = (n+0.5)+(-1)^n(\phi-0.5), \quad (1)$$

where

$$\phi = \frac{S_2 - S_3}{S_1 - S_3}. \quad (2)$$

S_1, S_2, and S_3 are the magnitudes of the maximum, intermediate, and minimum principal stresses, respectively, and n is 0 for normal faulting, 1 for strike-slip faulting, and 2 for reverse faulting.

Probabilistic analysis of fault slip potential. As mentioned earlier, we utilize FSP v.1.07 (Walsh et al., 2017) to estimate the slip potential on faults throughout the Permian Basin. The FSP tool allows operators to estimate the potential that planar fault segments will be critically stressed within a local stress field. Critically stressed conditions occur when the ratio of resolved shear stress to normal stress reaches a failure criterion, in this case the linearized Mohr-Coulomb failure envelope. The FSP program allows for either deterministic or probabilistic geomechanical analysis of the fault slip potential, the former of which treats each input as a discrete value with no uncertainty range. The probabilistic geomechanics function estimates the FSP on each fault segment using Monte Carlo-type analysis to randomly sample specified, uniform uncertainty distributions for input parameters including the fault strike and dip, ambient stress field, rock properties, and initial fluid pressure.

We conducted our analysis on fault traces compiled from Ewing et al. (1990), Green and Jones (1997), Ruppel et al. (2005), and the USGS Quaternary Faults and Folds Database (Crone and Wheeler, 2000). Most of these databases do not specify fault dips, so we make the conservative assumption that, within the generally normal and normal/strike-slip faulting environment of the Permian Basin, all potentially active faults dip in the range of 50° to 90°. This assumption implies that all fault segments could be ideally oriented for slip in either normal or strike-slip faulting environments at reasonable coefficients of friction, depending on the alignment of their strike with respect to S_{Hmax} (Figure A1).

Here we apply the probabilistic geomechanics function of the FSP tool. We apply reasonable stress values and uncertainty ranges based on the variability of the stress field we observe within 16 study areas (listed in Table A5). The study areas were selected to represent fairly uniform A_ϕ values and S_{Hmax} orientations (Figure 2) to minimize spatial variations of stress field in any given study area. As an example, Figure A2 shows input parameter distributions sampled during FSP analysis for a random fault within Area 10.

For the purposes of this demonstration, we do not hydrologically model the pressure changes associated with any known injection scenario; we instead estimate the fault slip potential in response to an increase in the fluid-pressure gradient corresponding to a 4% increase relative to hydrostatic (0.4 MPa/km or 0.018 psi/ft) to evaluate the potential for relatively modest pressure changes in crystalline basement (2 MPa [300 psi] at 5 km [16,400 ft]) associated with produced water disposal. This is the same gradient of pore-pressure perturbation applied by Walsh and Zoback (2016) for FSP analysis in north-central Oklahoma. The eventual pore-pressure increase that will occur in the uppermost parts of the crystalline basement due to injection in this area is of course unknown, and it is important to note that *relative* differences in slip potential between differently oriented faults will remain the

same regardless of the magnitude of uniform pressure increase (although the absolute fault slip potential will vary). Operators interested in screening potential sites for wastewater injection wells, for example, might alternatively use the software to test specific scenarios of pore-pressure evolution with time due to injection from wells in a localized area. Although large portions of the Permian Basin are known to be overpressured and underpressured at certain stratigraphic intervals (e.g., Orr, 1984; Doser et al., 1992; Rittenhouse et al., 2016), for the sake of simplicity in this whole-basin demonstration, we initially assume hydrostatic conditions (P_P = 9.8 MPa/km ≈ 0.43 psi/ft). In general, hypocentral depths for potentially damaging injection-triggered earthquakes are within the upper crystalline basement (e.g., Zhang et al., 2013; Walsh and Zoback, 2015), for which little pore-pressure information is available but for which hydrostatic values are reasonable (Townend and Zoback, 2000).

State of stress in the Permian Basin

Figure 1 shows all reliable S_{Hmax} orientations and an interpolated view of the A_ϕ parameter across the Permian Basin. Throughout the Midland Basin, the eastern part of the Permian Basin, the stress field is remarkably consistent, with S_{Hmax} oriented ~east–west (with modest rotations of S_{Hmax} in some areas) and $A_\phi \approx 1.0$ (indicative of normal/strike-slip faulting). The stress field is more extensional in the Val Verde Basin to the south, with $A_\phi \approx 0.7$. Few S_{Hmax} orientations are presently available in that subbasin, but S_{Hmax} is northwest–southest in the western part of the basin and appears to be ~northeast–southwest in the central part of the basin. This is similar to the stress state seen farther to the southeast, where S_{Hmax} follows the trend of the growth faults that strike subparallel to the Gulf of Mexico coastline (Lund Snee and Zoback, 2016). Along the Central Basin Platform, S_{Hmax} is generally ~east–west but rotates slightly clockwise from east to west, with A_ϕ ~ 0.8–1.0. In the Delaware Basin, the stress field is locally coherent but rotates dramatically by ~150° clockwise from north to south across the basin. In the western part of Eddy County, New Mexico, S_{Hmax} is ~north–south (consistent with the state of stress in the Rio Grande Rift; Zoback and Zoback, 1980) but rotates to ~east-northeast–west-southwest in southern Lea County, New Mexico, and the northernmost parts of Culberson and Reeves counties, Texas. It should be noted that where rapid stress rotations are observed in the Delaware Basin are areas with low values of A_ϕ (indicative of relatively small differences between the horizontal stresses) and elevated pore pressure (Rittenhouse et al., 2016), making it possible for relatively minor stress perturbations to cause significant changes in stress orientation (e.g., Moos and Zoback, 1993).

S_{Hmax} continues to rotate clockwise southward in the Delaware Basin to become ~N155°E in western Pecos County, westernmost Val Verde Basin, and northern Mexico (Suter, 1991; Lund Snee and Zoback, 2016). On the Northwest Shelf, A_ϕ varies from ~0.5 (normal faulting) in north Eddy County to ~0.9 (normal and strike-slip faulting) further east. S_{Hmax} rotates significantly across the Northwest Shelf as well, from ~north–south in northwest Eddy County to ~east-southeast–west-northwest in northern Lea and Yoakum counties.

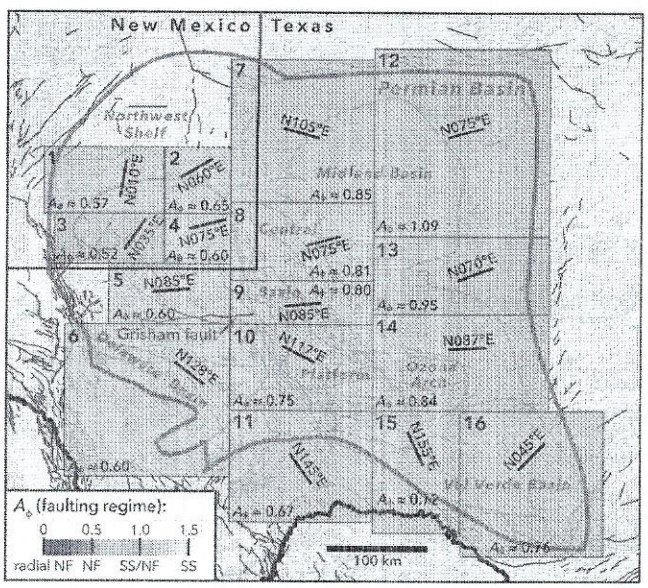

Figure 2. Map of study areas chosen for FSP analysis on the basis of broadly similar stress conditions. Text annotations indicate representative S_{Hmax} orientation and relative principal stress magnitudes (A_ϕ parameter) for each study area based on the data presented in Figure 1. Gray lines in the background indicate fault traces compiled from Ewing et al. (1990), Green and Jones (1997), Ruppel et al. (2005), and the USGS *Quaternary Faults and Folds Database* (Crone and Wheeler, 2000), to which we apply FSP analysis.

Slip potential on mapped faults

Figure 3 shows the results of our fault slip potential analysis for all study areas across the Permian Basin. We selected a color scale in which dark green lines represent faults with ≤5% probability of being critically stressed at the specified pore-pressure increase; dark red indicates faults with ≥45% fault slip potential; and yellow, orange, and light red represent intermediate values. The results shown in Figure 3 indicate that high fault slip potential is expected for dramatically different fault orientations across the basin, reflecting the varying stress field. In the northern Delaware Basin and much of the Central Basin Platform, for example, faults striking ~east–west are the most likely to slip in response to a fluid-pressure increase. However, farther south in the southern Delaware Basin, faults striking northwest–southeast are the most likely to slip, and ~east–west-striking faults have relatively low slip potential. Notably, we find high slip potential for large fault traces mapped across the southern Delaware Basin and Central Basin Platform, and along the Matador Arch. Figure 3 also indicates the faults that are *unlikely* to slip in response to a modest fluid-pressure increase. We find that large groups of mostly north–south-striking faults, predominantly located along the Central Basin Platform, the western Delaware Basin, and large parts of the Northwest Shelf have low fault slip potential at the modeled fluid-pressure perturbation. Knowing the orientations of faults that are unlikely to slip at a given fluid-pressure perturbation can be of great value because it provides operators with practical options for injection sites. Probabilistic geomechanical analysis of the type enabled by the FSP software is especially useful in areas with complex fault patterns. Figure 4 shows a larger-scale view of Area 10, an area of particularly dense faults. In Figure 4, it is clear that even

seemingly minor variations in fault strike can significantly change the fault slip potential.

Figures 3 and 4 illustrate the locations of earthquakes that have been recorded since 1970 in relation to the mapped faults. It is noteworthy that many earthquakes have occurred away from faults mapped at this regional scale, with the most obvious examples being groups of events described earlier, near the Dagger Draw Field (southeast New Mexico); the Cogdell Field (near Snyder, Texas); a group around the town of Pecos, Texas; and a recent group of mostly M < 2 events between the towns of Midland and Odessa, Texas. As the earthquakes undoubtedly occurred on faults, this observation underscores the necessity of developing improved subsurface fault maps, particularly for use in areas that might experience injection-related pore-pressure increases. Nevertheless, Figures 3 and 4 also show a number of earthquakes that may have occurred on mapped faults for which we estimate elevated fault slip potential. Of particular note are the recent (2009–2017) earthquakes in southeastern Reeves and northwestern Pecos counties, Texas, of which an appreciable number occurred on or near yellow or orange faults. Potentially active faults are identified near some towns in the Permian Basin, including Odessa (Figure 3) and Fort Stockton, Texas (Figure 4). In some areas, such as northern Brewster County, Texas, and parts of the northern Central Basin Platform, earthquakes occurred on or near orange or red faults that have relatively short along-strike lengths, making the faults appear fairly insignificant at this scale. In the area of active seismicity in Pecos and Reeves counties, we estimate relatively high slip potential for several significantly larger faults (>20 km along-strike length) on which few or no earthquakes have been recorded thus far (Figures 3 and 4). Larger faults are of particular concern for seismic hazard because they are more likely to extend into basement and, therefore, to potentially be associated with larger magnitude earthquakes.

As labeled in Figure 3, a number of regional-scale faults are known to exist in this area (Walper, 1977; Shumaker, 1992; Yang and Dorobek, 1995). The Permian Basin overlies a major boundary separating Precambrian-age lithospheric basement domains (Lund et al., 2015), and its crystalline "basement" hosts numerous major

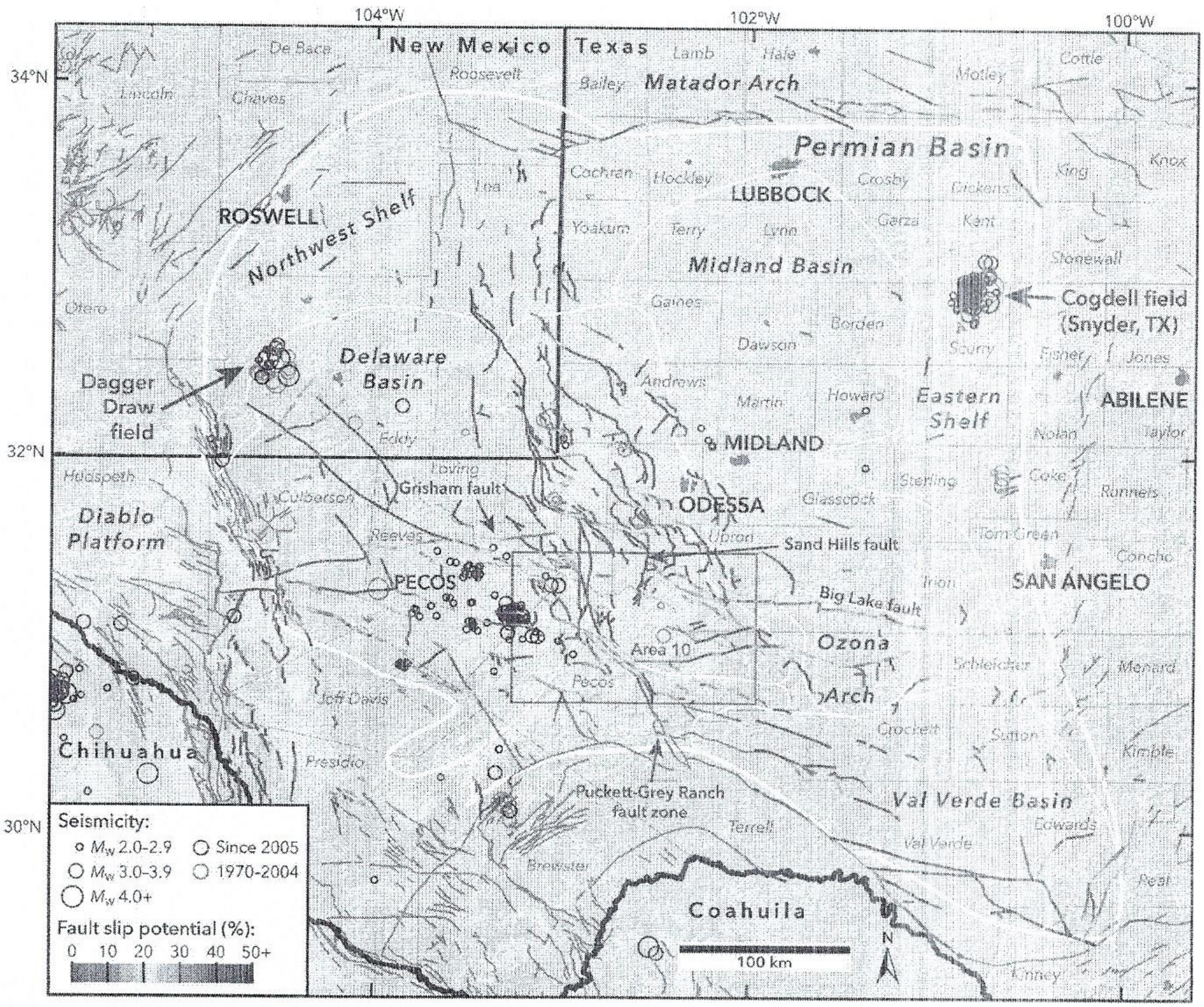

Figure 3. Results of our probabilistic FSP analysis across the Permian Basin. Data sources are as in Figures 1 and 2.

structures that have been repeatedly activated during subsequent plate collisions and rifting events (Kluth and Coney, 1981; Thomas, 2006). One notable example is the east–west-striking Grisham Fault (also referred to as the Mid-Basin Fault), which is between the rift margin of the Rodinia supercontinent and the boundary between the Shawnee and Mazatzal basement domains. The Grisham Fault is of particular importance for understanding the potential for induced seismicity in the Permian Basin because it is laterally extensive, offsets basement, and may have high slip potential. The upper part of Figure 5 (and Figure 3) shows a scenario in which the stresses resolved on the Grisham Fault are representative of Area 5, with S_{Hmax} oriented N085°E. However, the measured stress field changes dramatically from north to south across the Grisham Fault (Figures 1 and 2), presenting uncertainty about the stresses resolved upon the fault, reflected by its close proximity to Area 6, with a generalized S_{Hmax} orientation of N128°E. The lower part of Figure 5 shows the Grisham Fault in detail if the stress field shown in Area 6, just to the south, was appropriate. Needless to say, in the stress field represented by Area 5, fault segments oriented east–west are expected to have high probability of being critically stressed in response to a pore-pressure increase, but nearby west-northwest–east-southeast-striking faults

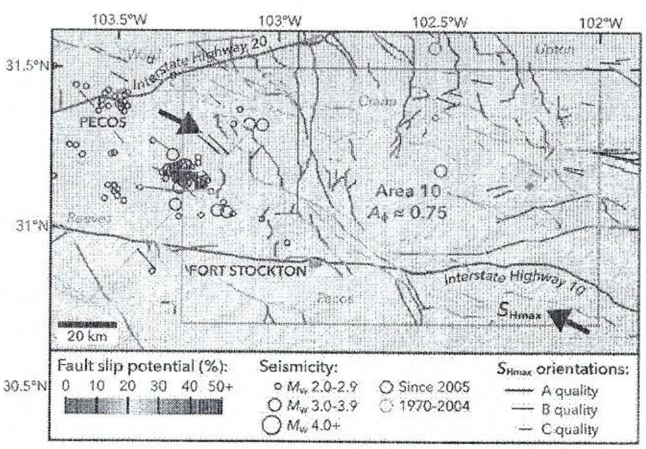

Figure 4. Large-scale view of the results of FSP analysis in Area 10 (location shown in Figures 2 and 3). Data sources are as in Figures 1 and 3.

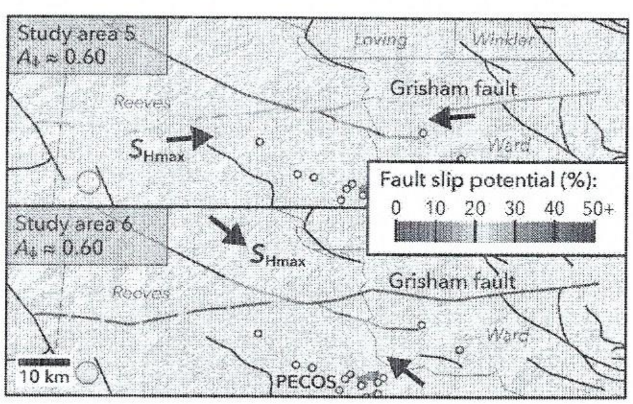

Figure 5. Map comparing the results of fault slip potential analysis on the Grisham (Mid-Basin) fault and selected nearby structures (locations shown in Figure 3) for stress conditions of Area 5 (S_{Hmax} N085°E ± 8°; top panel) and Area 6 (S_{Hmax} N128°E ± 15°; bottom panel). Symbols as in Figures 3 and 4.

have relatively low fault slip potential. In contrast, inclusion within the Area 6 stress field would result in low expected fault slip potential on the east–west segments but high values on the west-northwest–east-southeast-striking segments.

The results shown in Figures 3–5 are not intended to provide a definitive view of the fault slip potential across this complex basin, nor do they constitute a seismic hazard map. While the stress field is complicated in this area, the changes in the stress field are coherent and mappable. We consider the greatest uncertainties in the map to be the lack of knowledge of subsurface faults and the magnitude and extent of potential pore-pressure changes in areas where increased wastewater injection may occur in the future, especially wastewater injection that might change pore pressure on basement faults. Operators wishing to use the FSP tool to screen sites for fluid injection should use detailed fault maps that are specific to the injection interval, the underlying basement, and any intervening units, which take into account geometric uncertainties.

Conclusions

As part of our stress mapping across the U.S. midcontinent, we have collected hundreds of S_{Hmax} orientations within the Permian Basin, and we also map the faulting regime across the region. Our new data reveal dramatic rotations of S_{Hmax} within the Delaware Basin and Northwest Shelf but relatively consistent stress orientations elsewhere. The rapid stress rotations in the Delaware Basin are observed in areas with relatively small differences between the horizontal stresses and with elevated pore pressure, making it easier for stress perturbations to cause significant changes in the stress field.

We show how the FSP software package can be used as a quantitative screening tool to estimate the fault slip potential in a region with large variations of the stress field, and accounting for uncertainties in stress measurements, rock properties, fault orientations, and fluid pressure. Although many historical earthquakes have occurred away from mapped faults in this area, we find that a number of earthquakes have occurred on or near faults for which there is high fault slip potential under the modeled conditions. TLE

Acknowledgments

The authors are grateful to Apache Corporation, Devon Energy, MicroSeismic Inc., and Pioneer Natural Resources, and to R. Cornell, for contributing new data. The authors also wish to thank F. R. Walsh III for providing scripts to assist with data handling and for helpful discussions. The authors appreciate thoughtful comments by B. Birkelo and prompt editorial assistance by J. Shemeta. This work was supported by the Stanford Center for Induced and Triggered Seismicity industrial affiliates program.

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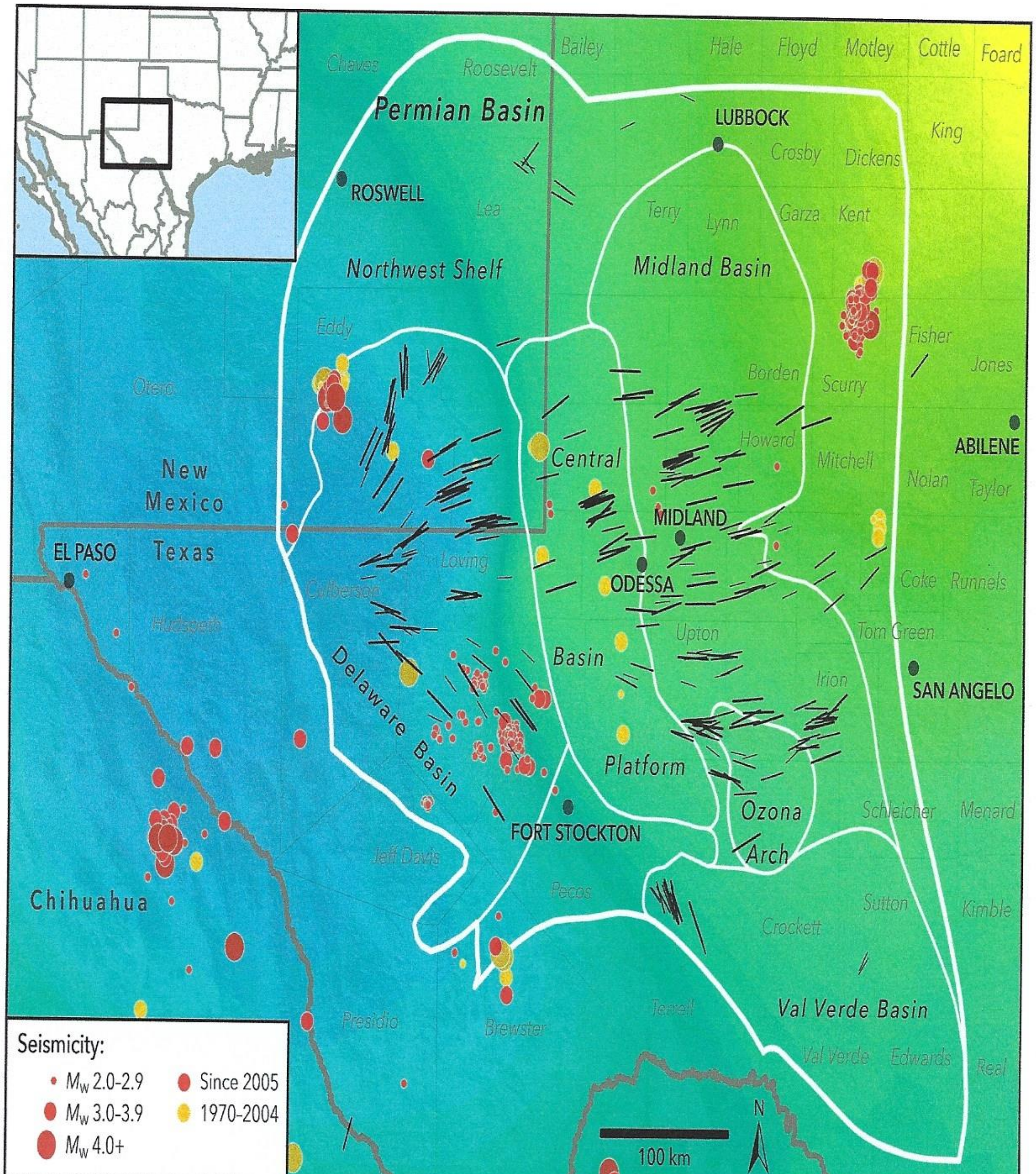
Cartwright, L. D. Jr., 1930, Transverse section of Permian Basin, west Texas and southeast New Mexico: AAPG Bulletin, **14**, 969–981.


Permian Basin
Northwest Shelf
Midland Basin
Central Basin Platform
Delaware Basin
Ozona Arch
Val Verde Basin
New Mexico
Texas
Chihuahua
LUBBOCK
ROSWELL
ABILENE
MIDLAND
ODESSA
EL PASO
SAN ANGELO
FORT STOCKTON
Seismicity:
Mw 2.0-2.9
Mw 3.0-3.9
Mw 4.0+
Since 2005
1970-2004
100 km
N

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(432) 687-1777

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Template = ADM-013
E-RIDS=ADM-03
ADD= Antoinette Walker-Smith, Jill Caverly (JSC1)

COMMENT (282)
PUBLICATION DATE: 3/30/2018
CITATION # 83 FR 13802

July 30, 2018

Mr. Michael Layton, Director
Division of Spent Fuel Management
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Re: USNRC Docket No. 72-1051 and 72-1052
Proposed Holtec High Level Nuclear Waste Storage Facility
Lea and Eddy County, NM

Dear Mr. Layton:

Please consider this as the formal opposition of Fasken Oil and Ranch, Ltd., ("Fasken") and PBLRO Coalition ("PBLRO") against the Eddy Lea Energy Alliance and Holtec International High Level Nuclear Waste Storage Facility ("Holtec") to be located in Southeast New Mexico. Fasken is both a landowner and oil and gas operator with interests adjacent to the Holtec site. The PBLRO is a coalition of landowners, ranchers and oil and gas operators from throughout Texas, New Mexico and the Permian Basin, which formed as a result of the proposed situating of interim high-level nuclear waste facilities within the Permian Basin.

The proposed Holtec site is to be located in the Permian Basin, which is the second largest oil and gas shale producer in the world. Fifty-five counties in West Texas and southern New Mexico make up the Permian Basin region, which is producing between 3.26 and 3.3 million barrels of oil per day (Dallas Fed Reserve, June 2018) and is forecast to reach production of 6 million barrels per day by the year 2025.

According to the Robert Strauss Center for International Security and Law, income from new technologies in oil and gas "offers a straightforward benefit to the United States, and such economic growth benefits U.S. national security for two reasons: first, under traditional definitions, one of the core national interests is in prosperity for Americans, and second, greater national wealth reduces the burden of protecting the nation through defense spending."

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At a time when our nation has ramped up domestic oil production, thus creating prosperity for our citizens and reducing our dependence upon foreign oil, it is illogical to fathom jeopardizing this means of economic prosperity and energy security. Ground zero for North American energy dominance should not be put at risk to accommodate the Holtec or any other similar project.

Now, I understand that Holtec International believes that they have a very rigorous containment system and that the NRC is actively seeking out a permanent solution for the containment of nuclear waste, however, without zero risk of exposure, the Federal government simply cannot allow the Permian Basin to be considered. Exposure due to human error or malfeasance during either transportation or storage would not only create a natural disaster but would also create economic harm. At this time, our nation is taking steps to protect our country's energy grid against cyber-attacks, while paradoxically putting our greatest energy resource in harm's way.

The proposed site sits on top of and adjacent to oil and gas minerals to be developed by means of fracture stimulation techniques. Currently, drilling techniques used to extract minerals in the Permian Basin involve drilling horizontally into deep underground formations up to two miles beneath the earth's surface. High pressure fluids are pumped into the wells, in some cases exceeding twelve thousand pounds per square inch. This pressure is power enough to fracture the surrounding rock thus releasing the oil and gas. The pressure create's fissures and cracks beneath the surface. And, at this time, there are oil and gas operators testing a new technique of simultaneously drilling and fracturing up to 49 horizontal wellbores in a single section of land. Either the traditional or new and unproven drilling technique, involving more than 20,000,000 bbls of water and sand, could conceivably be utilized to inject into and withdraw from the rock formation beneath and surrounding the Holtec site. Hydraulic fracturing beneath and around Holtec should give the NRC pause and is sufficient reason not to proceed.

In addition to those risks, any analysis as to the pros and cons of Holtec must also consider the nation's public policy of promoting the development of oil and gas. The U.S. has long afforded the industry the ability to exploit our country's mineral resources. To impede upon the ability to recover minerals is not only detrimental to our nation's economy and security but consider that the loss is an actionable interference with property rights as well.

Lastly, a comprehensive study of the infrastructure and means of transportation of the storage casks is either lacking or inadequate. The oil field traffic in the region has caused grid lock and many of the existing roads are in a state of disrepair. The State of Texas as well as New Mexico have been struggling to keep up with the infrastructure necessary for the resurgence of the oil industry. Train derailments are a frequent occurrence and have increased due to the unprecedented growth in the Permian Basin with several of the train derailments occurring within highly populated areas.

On behalf of Fasken and of the PBLRO, I appreciate your consideration of our concerns, including those attached, and respectfully request that Holtec's application for a high-level nuclear waste storage facility in the Permian Basin be denied.

Sincerely,

Fasken Oil and Ranch, Ltd.
PBLRO

Tommy E. Taylor
Director of Oil and Gas Development
PBLRO Coalition Member

Additional Comments for Holtec Storage Site in Eddy and Lea County, NM

1. The Holtec Proposal Is Contrary to Current Law.
   Current law only allows the U.S. Department of Energy to take title to commercial spent fuel "following commencement of operation of a repository" or at a DOE-owner and operated monitored retrievable storage facility. The Holtec site meets neither requirement, as it is a private facility.

2. Holtec Must Remove Copyrights and All Redactions in the Environmental Report.
   NRC must require Holtec to produce an Environmental Report (ER) that has no such copyright restrictions and has no redactions.

3. The Impacts of Permanent Storage Must Be Analyzed.
   The ER is inadequate and incomplete because it does not analyze the impacts of the spent fuel being left at the Holtec site indefinitely.

4. More Alternatives Must Be Analyzed.
   Keeping the spent fuel casks in some form of Hardened on Site Storage (HOSS) on the reactor sites must be analyzed. The alternative of consolidated storage being done at an existing licensed Independent Spent Fuel Storage Facility (ISFSI) must also be analyzed.

5. The Environmental Report inadequately discusses the Transportation Risks.
   The ER must include all transportation routes and the potential impacts of accidents or terrorism incidents on public health and safety along all the routes. The ER is inadequate and incomplete because it does not discuss how rail shipments from reactors with rail access would be accomplished and the risks and impacts of such shipments.

6. The Consequences to an Accident-Exposed Individual Must Be Analyzed.
   Terms like "collective dose risk" and "person-rem" are used to ignore the potential impacts to a single individual.

7. Cracked and Leaking Casks Must be Addressed
   The ER does not analyze exactly how radioactive waste from a cracked and leaking canister would be handled, since there is no wet pool or hot cell at the site.

8. More Cumulative Impacts Must Be Analyzed
   The ER mentions WIPP but does not analyze the impacts of a radiologic release from WIPP on the proposed CIS site.

9. Impacts of Future Railroads and Electric Lines Must be Analyzed
   The railroads and electric lines are not in place but must be analyzed.

10. Seismic Impacts on Stored Casks Must be Stated
    Although the ER gives a statement on recent seismic activity in the area, there is no analysis of what impacts many 3.0-4.0 earthquakes will have on the buried casks.

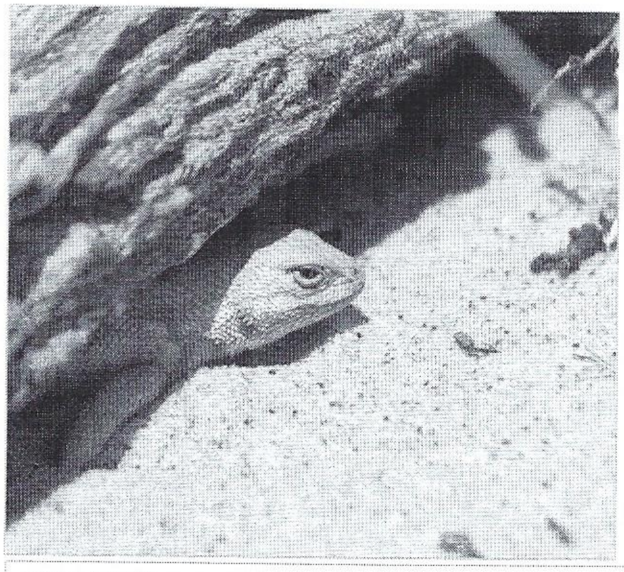


*Figure 1. The dunes sagebrush lizard (***Sceloporus arenicolus***) is endemic to shinnery oak sand dunes of eastern New Mexico and West Texas, where it is threatened by a variety of factors.*
Credit: Mark L. Watson / Flickr / CC BY-NC-ND

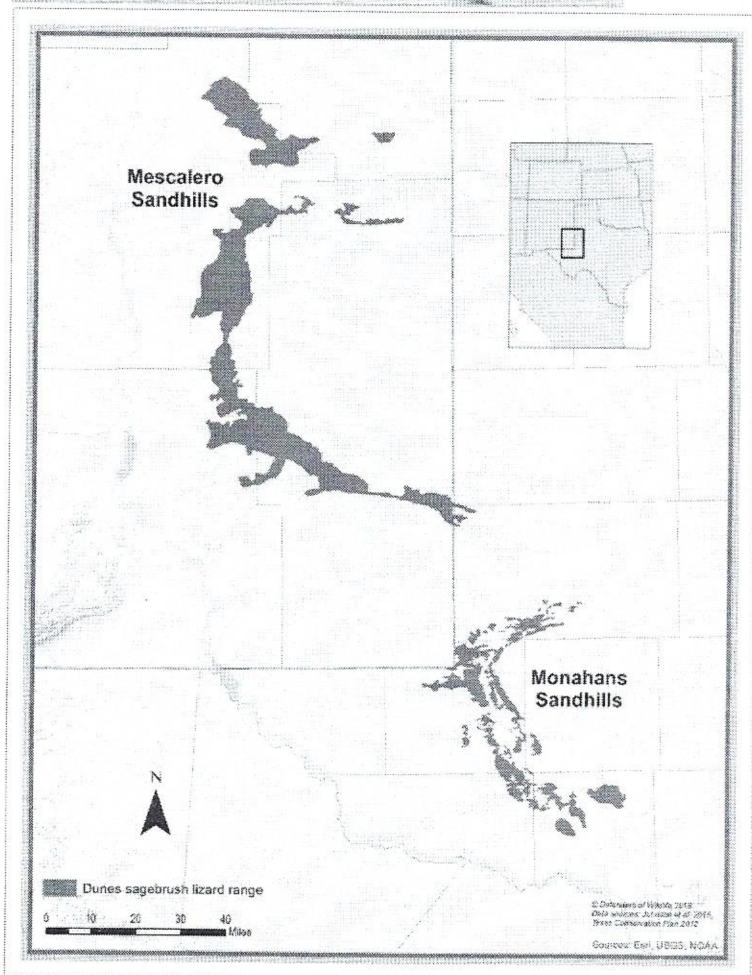
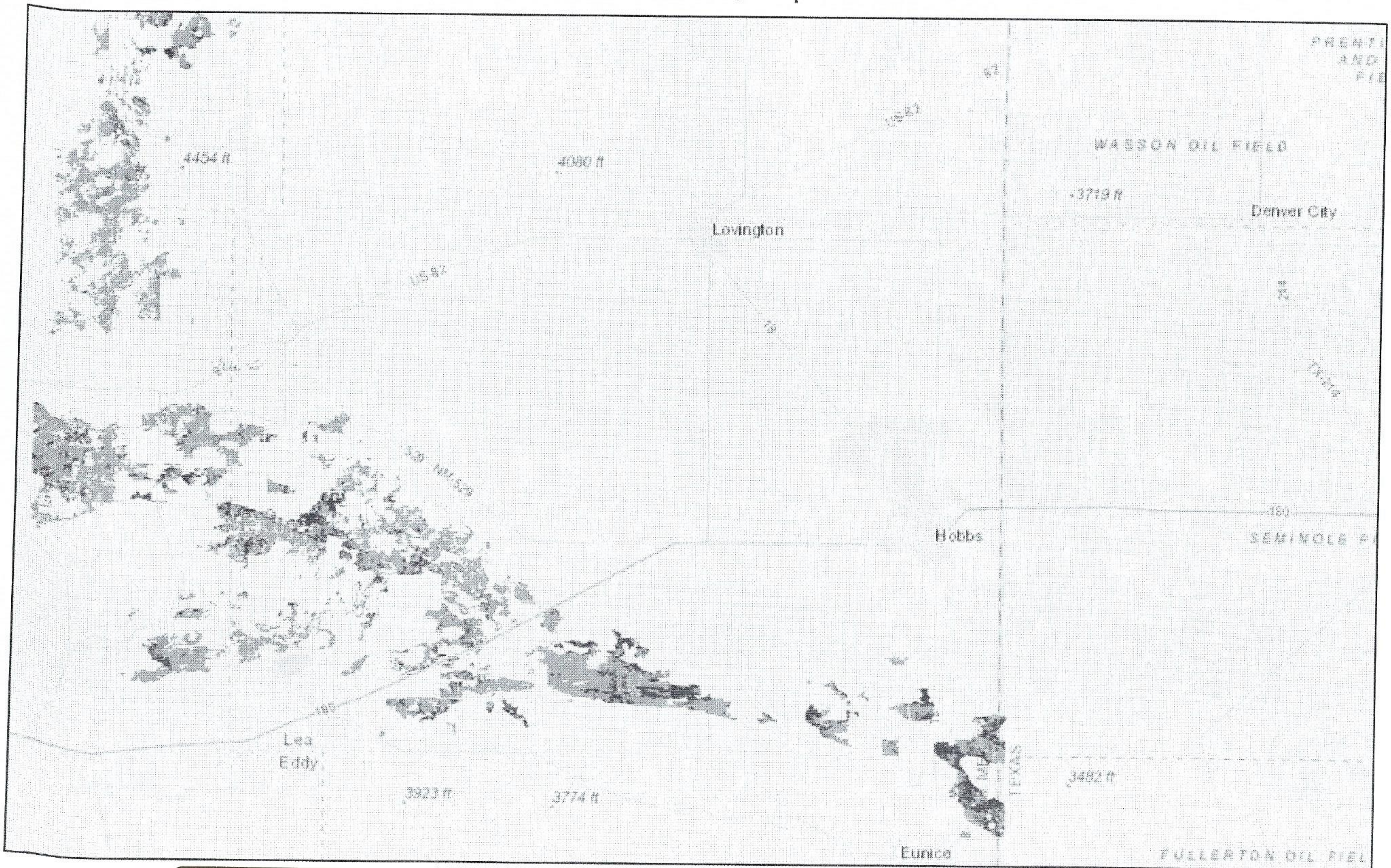


Figure 2. The dunes sagebrush lizard is a habitat specialist restricted to a shinnery oak sand dune habitats in the Mescalero Sandhills of eastern New Mexico and the Monahans Sandhills of West Texas. If the lizard is lost from either of these two areas, it will have lost essential representation and cannot be considered conserved.

DSL Suitable Habitat; Expanded Area



May 11, 2018

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Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri

DECLARATION OF STEVEN J. CASTLEMAN

1. My name is Steven J. Castleman. I am an attorney licensed to practice law in the State of California. Together with my co-counsel, David Anton, I represent Greenaction for Health and Environmental Justice in this action and a Petition seeking to revoke the federal Materials License of Tetra Tech, EC, Inc. ("Tetra Tech"), License number 29-31396-01, issued by Nuclear Regulatory Commission ("NRC"). The Petition is pending before the Executive Director for Operations of the NRC. That Petition (Exhibit 1 to this action), supported by statements under penalty of perjury, demonstrates Tetra Tech engaged in widespread fraud, including reporting fraudulent sampling and scanning data, which has compromised the remediation of radioactive contamination at the Hunters Point Naval Shipyard in San Francisco, California ("Shipyard").
2. The U.S. Navy hired contractors to review the data reported by Tetra Tech in an attempt to ascertain which, if any, of those data are reliable. One or more of those contractors wrote the reports entitled *Draft Radiological Data Evaluation Findings Report for Parcels B and G Soil*, dated September 2017, which is attached to the Supplemental Filing as Exhibit 1 and *Draft Radiological Data Evaluation Findings Report for Parcels C and E Soil*, dated December 2017, which is attached to the Supplemental Filing as Exhibit 1. It supplements the evidence of fraud and was not known at the time of the filing of the Petition.
3. On January 12, 2018, I had a telephone conversation with Dr. Kathryn A. Higley, a Professor and Head of the School of Nuclear Science and Engineering in the College of

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Engineering at Oregon State University. She has been hired by the U.S. Navy to act as a Community Technical Liaison for the radiation cleanup at the Shipyard.

4. During our phone conversation, Dr. Higley told me that the Navy has concluded, after data reviews including the one represented by Exhibit 1, that virtually all of the data reported by Tetra Tech is suspect. Later in our conversation she qualified what she said, saying a substantial but undefined proportion of Tetra Tech's data was "to a large extent useless." She also informed me that substantial re-sampling and re-scanning will be required to determine the full impact of Tetra Tech's fraud on the cleanup and the planning process for that project is currently under way.

5. On January 31, 2018, I attended a Community Open House meeting hosted by the Navy concerning the Hunters Point Shipyard radiological cleanup. Prior to the meeting I had a conversation with Derek Robinson, of the Navy's Base Realignment and Closure Program Management Office West ("BRAC PMO West"). He is the person in charge of the cleanup of the shipyard on behalf of the Navy. During our conversation, Mr. Robinson confirmed what Dr. Higley told me; the Navy had lost confidence in the Tetra Tech data. Mr. Robinson also said that the Navy was going to treat all Tetra Tech's data as unreliable and resample all locations where Tetra Tech did radiological work.

6. I declare under penalty of perjury that the foregoing is true and correct.

[signature]

Steven J. Castleman
Attorney at Law

June 26, 2018
Date