To: San Onofre Community Engagement Panel (CEP) and the Community

From: David G. Victor, CEP Chairman

Re: The process for setting outlier scenarios to be discussed at our May 28th meeting and beyond

Date: 18 May 2020

For the last seven years, since the creation of the CEP (see Appendix A for a list of current members), we have been exploring the issues surrounding safe long-term storage of spent nuclear fuel at the site. The so-called "ISFSI" (independent spent fuel storage installation) is designed to store the spent fuel used in the reactors, and the original plan was to permanently dispose of that fuel at Yucca Mountain in 1998. The federal government has failed to honor that plan—federal law, actually. A Blue Ribbon Commission on America's Nuclear Future explored various ideas for "interim" storage facilities and two now are taking shape but remain in the regulatory permitting phase. Many of us in the CEP have advocated heavily for needed changes in federal law and appropriations to help make interim storage viable. Southern California Edison's (SCE) leadership has done the same; so have many in the California Congressional delegation, including Representative Scott Peters, Senator Dianne Feinstein, and Representative Mike Levin.

We must prepare for the possibility that the spent fuel will be here for some time—maybe decades. In that context, the CEP has devoted at least one meeting per year to the topic of "defense-in-depth" at the ISFSI—to understand the layers of design, fabrication, monitoring, remediation/repair and other activities that, together, give confidence in the integrity and safety of the ISFSI. We have also been getting questions about what, even with robust defense-in-depth, are some of the worst things that might happen at the ISFSI? If they happen, what might be the consequences and responses? It is clear from massive technical analysis by the industry and by independent groups, notably at the US National Academies of Sciences, that if the spent fuel is stuck on site for now the best place for it is in a robust and passively cooled ISFSI. And it is clear from the decisions made around the expansion of the SONGS ISFSI that the system we have is extra-engineered, in particular to address seismic risks and the marine environment. Still, as Paul Wyatt, CEP Member and Dana Point Council Member, asked at a CEP meeting earlier this year: "If a member of the public wants to know what can go wrong, what do I tell them?"

On May 28th we will have a CEP meeting to address this question more fully. Not every event can be examined in full depth given time constraints and thus the May 28th meeting will be organized around a few scenarios of greatest consequence and interest. In addition to that public discussion of scenarios, along with response strategies, the CEP leadership and SCE are building a library of fact-based resources related to these scenarios, such as peer-reviewed papers and expert reports. That will provide a durable, evolving location for helpful resources

on these scenarios—even what might be "postulated" as going wrong even when there aren't particularly credible scenarios to end up at that outcome.

This memo is about how a long list of scenarios was created and the processes we organized to winnow that list to a small handful that will be the main focus of the May 28th meeting. It is also about how we have engaged with volunteer experts to help guide that process; some of those experts will also serve as guest speakers on May 28th. All of them have offered extraordinary insight and help with our process.

Developing a list of scenarios and a provisional agenda

In the fall of 2018, the CEP had a sustained discussion around the need for a public dialogue on possible outlier events at the SONGS ISFSI. For several years we had been discussing defense-in-depth and also the imperative of off-site storage or disposal to help move the spent fuel offsite. We also had, in March 2018, a petition brought forward by local activists asking for discussion of extreme events that might occur at the site (see Appendix B for the petition).

Based on these discussions, it was the sense of the CEP leadership that we should hold a meeting on the topic. SCE committed, as well, to support and hold a public meeting. The CEP leadership formed a Working Group to help with planning; that group met first on Oct. 12, 2018 and had a far-ranging conversation (see Appendix C for an agenda and presentation material). That Working Group included local activists who had been highly interested in this topic, CEP members, SCE leadership, and a representative from SCE's Expert Team that was advising on long-term management of spent fuel (Tom Isaacs). As chairman of that meeting it became clear that we needed help narrowing the large number of imagined possible natural and manmade events at the site (a total of 9 scenarios at that time), which ranged from meteor strikes to terrorism to shaking from demolition of the plant nearby) into a list that was both shorter and reflected plausible real-world outlier events. Just as a plan was emerging to engage a group of outside experts, the Working Group suspended while SCE focused on a more immediate and appropriate task of reworking its canister downloading procedures. After that was complete, around late summer 2019, the Working Group began preparations to meet again and reconvened on Nov. 22, 2019 (see Appendix D for the Nov. 22 agenda and Appendix E for a "status and next steps" document). We invited additional input into lists of scenarios. Discussions at that meeting resulted in the exclusion of some scenarios (e.g., meteor strikes) and added more discussion of sea level rise, possible terrorism scenarios and a variety of other concerns. Once again it was apparent that we needed some help to organize the lists of possible scenarios and some expert input on what was plausible.

Based on the discussions at the first two Working Group meetings, the CEP leadership asked SCE staff to compile a list of possible scenarios. To avoid tunnel vision, our request to SCE was to look not just at the scenarios that emerged from the Working Group (and thus reflected public comments and concerns) but also a wider array of "beyond design basis" events that were the normal part of risk analysis at a site like this. During a members-only meeting of the CEP on Jan. 9, 2020, some of the local elected officials who serve on the CEP expressed an

interest in being better equipped to address questions from their constituents regarding the risk and consequences of outlier scenarios—so that the CEP and SCE could offer more useful answers to members of the public who were wondering about the implications of being stuck with spent fuel onsite for a protracted period of time. Since dry storage of commercial nuclear fuel began in 1986, there has never been an instance of spent fuel in dry storage affecting the health of people or the environment. That is not widely known but perhaps it can be through the efforts of the CEP. To get a better sense of what potential concerns local officials are hearing from at least some people in the community, on Feb. 27, 2020, we began polling City Managers in several cities in south Orange County and north San Diego County for their perspectives (a sample letter to City Managers is at Appendix Q).

By the end of the second Working Group meeting it was also clear that the public event (at the time, we planned a workshop; now it is a full CEP meeting) would need to have at least two major segments: one focused on scenarios and the other focused on responses. With regard to the latter, we asked leadership from Orange County and San Diego County first responders, along with SCE's internal response team to plan commentary on the scenarios, their responses and the layers of resources available at the site, local, state and federal levels. That commentary—about existing plans to handle outlier events—would comprise the "response strategies" part of the CEP meeting.

Enlisting a group of experts

Through the Working Group brainstorming we complied a long list of possible experts, but we needed help identifying the nation's best team. The Working Group established the standard for choosing experts as "individuals with extensive, practical experience with design, engineering, regulation, and/or management of ISFSI systems." That standard (captured in Appendices E and G) was discussed at the second Working Group meeting on Nov. 22, 2019. Following that meeting, in early 2020 I asked the leadership of the Nuclear and Radiation Studies Board at the National Academies of Sciences—Board Director Charles Ferguson—for help identifying the right people. Through that process a list of nine leading experts emerged. On Jan. 16, 2020, I circulated that list to the entire Working Group for any comment, in advance of our third Working Group meeting on Feb. 13, 2020 (see Appendix F for an agenda and Appendix G for an updated "status and next steps" document prepared for that meeting). I then invited everyone on that list of nine people to join. The full list, their bios, and an example of my invitation letter is at Appendix H. Three declined for various reasons.

That yielded a list of six highly qualified experts from diverse backgrounds. It is extraordinary to see so many civil servants willing to devote so much time and attention to a public service like this. Let me underscore, as well, that what we have asked the experts to do is far outside the normal comfort zone for experts. We have asked them to help us make assessments around the plausibility and consequences of outlier events.

The expert-driven assessment process

As a reminder, the agenda and scenarios for our May 28th meeting are not only expert driven. They are also designed to look at concerns of broader public interest. The discussion in this section is about just the expert portion of that process.

We established a four-step process to gain expert review of these outlier scenarios.

Step 1: we invited the experts to a kickoff call and sent them the formal charge for the group, including the list of possible scenarios. The kickoff call held Feb. 24, 2020 (see Appendix I for the agenda) allowed them to ask any questions and make recommendations to revise the charge where needed (see Appendices J and K for a pair of emails that show, in part, how the charge evolved so that it would focus more on consequences and less on traditional risk assessment). Some experts asked for information about the specific design of the SONGS ISFSI—important for considerations of groundwater intrusion and sea level rise as well as seismic events and shaking from dismantlement work. Others asked for the petition.

Step 2: after that kickoff call, I clarified the charge to focus on consequences and SCE supplied any and all requested documentation. I asked each expert individually to report their assessment privately—to help avoid groupthink. Those individual assessments are attached as Appendix L.

Step 3: based on those individual assessments I compiled a short internal draft discussion memo (see Appendix M for the memo) that identified themes in the analyses and thus topics that would likely merit top attention at our CEP meeting. (At the time, we were planning this for the March CEP meeting. The complexity of planning made that timeline very challenging; the arrival of pandemic sealed its fate: the public meeting would be pushed to late May.)

That short memo became the basis for a second call with the experts on March 6, 2020. It was clear from that call that a set of very high priorities were emerging for the CEP meeting, with some fast-unfolding scenarios (versus those that emerge slowly over time), notably terrorism, that warranted being a focus of the meeting. Other topics elicited a range of views by the experts—for example, we included a "postulated undetected through-wall crack in a canister" as one of the scenarios because there had been a lot of discussion by activists around what might happen if a canister cracked without notice even as the most likely route to cracking (chloride-induced stress corrosion cracking, CISCC, had already been discussed extensively in CEP meetings, was the subject of an ongoing monitoring program, and was one of the scenarios already). Enough of the experts thought that canister degradation and related issues deserved attention that we included it on the agenda for the CEP meeting. Scenarios that were ranked of lesser importance for discussion at the CEP meeting would be addressed by posting relevant material online. During the expert calls it was repeatedly stressed that we needed to keep these online resources fresh and that a few slides would need to be included as part of the CEP meeting materials to draw attention to the available resources.

The focus on consequences and the speed at which response strategies could be developed helps to explain why none of the experts put topics such as sea level rise at the top of their list of concerns. That wasn't because those aren't serious issues—they are—but because they are slow to develop, and good monitoring and planning will readily mitigate them. Also ranked low were vibration from dismantlement work and intrusion of groundwater—not because vibration or groundwater flows are not possible but because the phenomena have been well-assessed and it does not pose a threat to the ISFSI.

The expert process urged that we focus on terrorism as the risk of greatest consequence. That risk, though extremely low, reflects a broad consensus of the expert team, but the variation in views is also important (see individual responses in Appendix L). In particular, I note that many experts did not see any of the outlier events as major reasons for concern. And one expert (Ed Lyman) has underscored the need to explore the role of "insiders" and it was agreed the topic would be included in the realm of terrorism. On the call on March 6, 2020 it was also agreed that SCE would include as part of the meeting materials some information (omitting classified "safeguards" information) about how it defends against attack and screens internal threats including controlling the flow of materials into the ISFSI. That internal security memo will be posted on the library for the May 28th meeting.

The terrorism issues are particularly difficult to handle in a non-classified setting. To that end, it became clear that one of our experts—Kevin Crowley—would be vitally important to engage for the public meeting because he served as the senior board director for the Nuclear and Radiation Studies Board at the National Academies that produced both classified and non-classified reports on terrorism in the context of commercial nuclear sites in the wake of the 9/11 attacks.

During the March 6, 2020 meeting, we also provided the experts with the results from the City Managers' survey (see Appendix R for the results).

Step 4: after the second experts call, I invited any final comments on the process and outcomes. On March 5, 2020, I sent an email (see Appendix M for the email) summarizing expert assessments of scenarios to the expert group. That email, which reflected the expert discussions, aimed to stratify the scenarios:

- Terrorism, including internal sabotage
- A second set of scenarios were viewed as potentially important to address at the CEP meeting: canister drop, canister degradation due to CISCC including a postulated undetected through-wall crack in a canister that allows water to enter with hydrogen production, and seismic / tsunami events
- A third set of scenarios were deemed as somewhat less important to address at the CEP meeting because robust response strategies are available to address them, and the events unfold slowly: vibration from dismantlement work and sea level rise
- A fourth category was down-weighted heavily because impacts are minimal and response strategies are robust: groundwater daylighting

In addition, some experts and City Managers added other outlier events to the list for consideration: risk of refined products/natural gas nearby generating an explosion, internal sabotage, aircraft impacts/jet fuel fire, and even potential staffing shortages due to the pandemic. (Per above, the matter of internal sabotage will be addressed as part of the topic of terrorism.) The other matters have been down-weighted. Fires, airplane crashes (including the prospect of jet fuel pooling and catching fire in the vertical ISFSI modules) all have been assessed in previous studies. (We have asked Kevin Crowley to include a brief discussion of this topic in his remarks on May 28th). With respect to nearby pipeline explosions, a full probabilistic analysis found "no undue risk to the plant and, subsequently, to the health and safety of the public exists" (refer to section 2.2.3.1.3 of Appendix N). On the matter of the coronavirus, a pandemic protocol is in place at SONGS (as well as other nuclear sites across the country) that is informed by guidance from a variety of sources including a protocol prepared by the Nuclear Energy Institute (the protocol is available at Appendix O).

We then hosted a call for the Working Group (the final meeting of that group), the full membership of the CEP, and the experts to allow a fuller conversation, held on March 19, 2020 (the agenda is available at Appendix P).

That meeting focused on terrorism, longer-term events including sea level rise and canister degradation over long periods, and seismic/tsunami events as key points of discussion for the CEP meeting. On that call it became clear that the public interest would be best served by focusing on topics that were new—seismic and tsunami were risks that had been analyzed extensively and the subject of several CEP meetings and thus materials from those public discussions would be added to the library and brief mention would be made of them in the agenda for the May 28th meeting. It also was emphasized by a member of the Working Group (and widely agreed) that the CEP meeting should include pre-circulation of materials well in advance so that the views of the experts could be understood. That would facilitate efforts to formulate questions and, perhaps, to elicit a robust list of questions in advance of the meeting. This memo is one contribution to that important role of transparency; advance materials for the May 28th meeting will be posted so that early engagement and question-asking can proceed. The CEP leadership envisions that we will put rosters of questions to the experts before the meeting so that they can adjust their comments to be responsive. In addition, the May 28th meeting will have a period of public comment devoted directly to the matters at hand for the meeting, along with a period that is not structured so that people can raise whatever issues may be on their mind and merit public comment.

That final Working Group meeting also identified the importance of making unclassified studies available in advance, providing a non-classified SCE summary of security, addressing how security will change after all fuel is in the ISFSI and the risk profile is reduced, as well as considering possible follow-up activities and address new, related questions. All of those materials will be part of the library.

Polling local cities

As noted above, the experts and the CEP members thought it would be useful to solicit input from City Managers. We already had a lot of input from CEP Meetings, from CEP Members (most of whom are local elected officials, for a current roster see Appendix A), and from the activist petition (Appendix B). But we did not know, systematically, the questions that elected governing bodies were getting from the public. The polling helped fill that gap.

SCE wrote the manager of every city in the broad SONGS area (from Solana Beach in the south to Laguna Beach in the north). We also included CEP members from those elected bodies in the query to help ensure a response and then followed up repeatedly (from the CEP, Jerry Kern was the key point of contact). Of nine cities polled, six responded. A sample of the letter to City Managers is available at Appendix Q and a summary of the responses is at Appendix R.

The results confirmed what we had heard at CEP meetings over time, but they also indicated a sense of priority. The top concerns among the neighboring cities were (1) terrorism, (2) seismic event/tsunami, and (3) a spent fuel handling incident. Sea level rise was not on that short list, but many other inputs had flagged this as a concern. Based on that information, I think it is important that we include a couple slides to summarize prior meetings and information about seismic and tsunami risk. And it is important that we have a slide pointing to library resources about a spent fuel handling incident. The expert analysis has looked at that as well and has concentrated less on the causation of damage to a canister and more to a crack that went undetected for a long period of time (allowing for postulated water intrusion) and progressed through the canister shell, regardless of the particular event (spent fuel handling, CISCC, something else) that caused the crack.

An integrated list of scenarios, plus focal scenarios for May 28th.

This whole process, then, has led to a long (and expanding) list of plausible scenarios. Topics such as insider sabotage, potential for nearby gas pipeline explosions, aircraft impacts and jet fuel fire, postulated zirconium fire and postulated staffing shortages due to COVID-19 were discussed with experts. That expanded list of 14 scenarios is reproduced in Table 1. In the preparations for the May 28th meeting, information about each of those scenarios and responses will be organized and posted to the library.

Table 1

Outlier Scenarios	Agenda Topic	Library
Fast-Occurring Events		
Terrorism	✓	✓
Insider sabotage	✓	✓
Seismic events	✓	✓
Tsunami	✓	✓
Canister drop		✓
Nearby pipeline explosion		✓
Aircraft impacts/jet fuel fire		✓
Slowly Emerging Events		
Canister degradation (CISCC)	✓	✓
Postulated water intrusion, hydrogen build-up, ignition	✓	✓
Postulated zirconium fire		✓
Sea-level rise		✓
Groundwater daylighting		✓
Vibration from dismantlement activities		✓
Postulated staffing shortage due to COVID-19		✓

Of that long list, the scenarios that have attracted systematically the most attention can be grouped into three main topics:

1. terrorism and insider sabotage;
2. seismic events and tsunamis; and
3. canister degradation including postulated undetected cracking, water intrusion resulting in a hydrogen explosion.

Based on all of the above, the May 28th meeting will include a slide or two that will set the scene for the long list of scenarios and provide a hyperlink to the online library with materials on each. Those setup slides will include a little more depth on scenarios that at least some people ranked as high concern for which extensive analysis and public discussion has already occurred—seismic, tsunami and sea level rise. A couple of slides will ask Tom Isaacs to comment on the long list in the framework of the speed with which the scenarios unfold and their consequences. After that, we will have a series of briefings by the other experts outlining the top few scenarios and their consequences in the context of spent fuel stored in the ISFSI. A draft agenda is shown in Table 2.

Table 2

Agenda Topic	Presenter
Overview of process and events in and out of scope	David Victor
Assessment methodology and top priorities	Tom Isaacs
Canister degradation, postulated undetected cracking / water intrusion / hydrogen build-up / ignition	Mike Corradini Ed Lyman
Terrorism	Kevin Crowley
Terrorism in the context of internal sabotage	Ed Lyman
SONGS ISFSI-only security posture and ISFSI design basis	Ross Quam (SCE)

The unusual nature of this meeting and the importance of an evergreen approach

A final note: I am struck that nothing like this assessment and CEP public meeting has ever happened in the industry to my knowledge. We need to make sure we stay tethered to facts and analysis while also being responsive to opinions. That is key to making this a public service.

The online library

The process for preparing this meeting has generated a HUGE amount of information of interest to the public, which tightly wants to know what life looks like if the spent fuel stays here at SONGS for a long period of time. Thus, in addition to the meeting itself Edison is putting together an organized evergreen library to offer a useful and lasting resource to the community.

Appendices

Appendix A	Community Engagement Panel – Current List of Members
Appendix B	Petition to CEP for a meeting devoted to Emergency Disaster Planning, March 3, 2018
Appendix C	CEP Workshop Scoping Session #1 - Agenda & Presentations, October 12, 2018
Appendix D	CEP Workshop Planning Meeting #2 – Agenda, November 22, 2019
Appendix E	CEP Workshop Planning Meeting - Status and Next Steps Document, November 15, 2019
Appendix F	CEP Workshop Planning Session #3 - Agenda, February 13, 2020
Appendix G	CEP Workshop Planning Meeting - Status and Next Steps Document, February 13, 2020
Appendix H	D. Victor's E-mail to Working Group; C. Ferguson Expert Recommendations, Jan. 16, 2020
Appendix I	CEP Workshop Planning Meeting with Experts - Agenda, February 24, 2020
Appendix J	D. Victor's Original Email Request to Experts for Assessments, February 18, 2020
Appendix K	D. Victor's Follow-up Email Request to Experts for Assessments, February 22, 2020
Appendix L	Assessment by Mike Corradini, February 28, 2020
Appendix L	Assessment by Kevin Crowley, March 2, 2020
Appendix L	Assessment by Tom Isaacs, February 28, 2020
Appendix L	Assessment by David Lochbaum, February 27, 2020
Appendix L	Assessment by Ed Lyman, March 5, 2020
Appendix L	Assessment by Arthur Motta, March 5, 2020
Appendix M	D. Victor Email Summary of Expert Assessments, March 5, 2020
Appendix N	SONGS ISFSI Final Safety Analysis Report
Appendix O	Nuclear Energy Institute Pandemic Protocol
Appendix P	CEP Outlier Topic Planning Update Meeting - Agenda, March 19, 2020
Appendix Q	Example Letter to City Managers Requesting Input, February 27, 2020
Appendix R	Local City Manager Response List for CEP Workshop, March 10, 2020

Community Engagement Panel Members

CEP Officers

Dr. David Victor - CEP Chairman

Professor and Director, Laboratory on International Law and Regulation

School of International Relations & Pacific Studies, UC San Diego

Dan Stetson - CEP Vice Chairman

Trustee and Executive Director, Nicholas Endowment

Jerry Kern - CEP Secretary

Representative of the City of Oceanside

Members

Honorable Lisa Bartlett - Supervisor, 5th District - County of Orange Board of Supervisors

Donna Boston - Director of Emergency Management, County of Orange Sheriff's Department and Operational Area

Garry Brown - President/CEO - Orange County Coastkeeper

Sam Jammal - Community Plans and Liaison Officer (CPLO), Marine Corps Base Camp Pendleton

Honorable John Taylor - San Juan Capistrano City Council Member, 4th District

Rich Haydon - South Sector Superintendent, California State Parks, Orange Coast District

Honorable Jim Desmond – Supervisor, 5th District - County of San Diego Board of Supervisors

Jim Leach

Val Macedo - Business Manager, Laborers International Union of North America, Local 89

Marni Magda - Sierra Club, Angeles Chapter

Honorable Martha McNicholas - Vice President, Capistrano Unified School District Board of Trustees

Ted Quinn - Past President - American Nuclear Society

Honorable Kathy Ward - San Clemente City Council Member

Mel Vernon - San Luis Rey Band of Mission Indians

Honorable Paul Wyatt - Mayor Pro Tem, Dana Point City Council

From: r johnson
Reply-To: r johnson
Date: Saturday, March 3, 2018 at 10:58 AM
To: "David G. Victor"
Subject: Petition for the CEP: Please circulate to panel members

To: Community Engagement Panel
From: Roger Johnson and 155 petitioners
Re: Petition for a future CEP meeting devoted to Emergency Disaster Planning
Date: March 2, 2018

To the CEP:

The country was shocked when terrorists attacked the World Trade Center with truck bombs in 1993 and again with airplanes in 2001. We were further shocked when the 9/11 commission later reported that the terrorists also considered attacking a nuclear power plant (NPP) instead. A NPP is a choice target because it is vulnerable and because it is a force-multiplier: every NPP already contains huge quantities of deadly highly-radioactive materials. When San Onofre was designed and built in the 1960s, little consideration was given to threats from terrorism, and much less was known about additional threats from earthquakes, tsunamis, missile attacks, and natural disasters. In addition, little consideration was given to the possibility that the thousands of tons of highly radioactive waste might remain on site for decades or centuries.

On-site storage of nuclear waste at San Onofre is already taking place. Hopes for a better solution are dim and everyone now knows that we must prepare for many years of living next to thousands of tons of uranium and plutonium. The CEP has been meeting since 2014, but the public has heard precious little of what it really needs to know in order to prepare for this very bad situation. The public wants to know about all of the dangers we might face and what we should do by way of disaster planning. A Petition is now presented to the CEP by way of chairman Professor Victor. The Petition and the names of 155 residents who signed on is presented below along with the names of the 27 cities and towns in Orange and San Diego Counties where they reside. The Petition requests a special future meeting of the CEP devoted to education about possible threats as well as planning for radiation emergencies. The petitioners wish to bring in expert speakers who can discuss all threats including worst case scenarios. They want to know (A) how the public will be informed and protected in the case of a radiation emergency; (B) what individuals, authorities, and entire communities should be doing now to learn more about the health hazards of radioactive contamination; (C) what everyone should do in the event of widespread radioactive fallout. The meeting should be held in San Clemente. The organizers of this special meeting will be Gary Headrick, Ace Hoffman, and Roger Johnson who will moderate the discussion portion of the meeting and select 2-3 outside experts to make presentations.

The situation we face today is much different from what the government and the nuclear industry promised almost a half-century ago. The public has witnessed accidents, safety violations, equipment malfunction, equipment design errors, human error, and even sabotage, radiation leaks, and acts of deception, all paid for by the ratepayers. The public has been exposed since 1968 to low-level radioactive releases in waters off our beaches and into the atmosphere we

breathe yet we do not know for sure whether these might be resulting in excess cases of cancer, especially in children. We were promised that the dangerous nuclear waste would be removed promptly but the government and the nuclear industry has failed on this promise. The government and the nuclear industry assure the country that nuclear waste will never be forced onto a community without consent (the President's Blue Ribbon Commission pledge to honor consent-based siting: https://www.energy.gov/sites/prod/files/2013/04/f0/brc_finalreport_jan2012.pdf), yet that is exactly what is happening. No one ever consented to storing nuclear waste indefinitely in this area of high population density (see end notes). Everyone is shocked that the best plan they can come up with is storing massive amounts of waste among millions of people in the middle of two major metropolitan areas. In short, the threat to the public has increased, the danger to the public has increased, and the possibility of removing the waste as promised has decreased.

The public also deplores the current strategy which is to make it sound as if a nuclear waste dump presents little danger. It is no longer acceptable to say that we don't have to do serious planning for radiation emergencies because these are events unlikely to happen at a closed plant. Let's face it, we are now the home of a dangerous nuclear waste dump for the indefinite future. A radiation catastrophe could render hundreds of square miles or more unlivable and worthless since no insurance covers radioactive contamination. Authorities have made few attempts to educate the public about what might happen and how the public should deal with a radiation emergency. In 2017, Orange County held a very large public fair to publicize emergency awareness. San Clemente also held its own emergency preparedness fair. Neither "fair" had a single document, a single booth, a single speaker about the worst possible emergency: a radiation emergency. Local, state, and federal government agencies as well as the nuclear industry are remiss in allowing this to happen. They are remiss in failing to inform the public about the threats and failing to inform us about what could happen to our homes and communities if we are inundated with radioactive contamination.

The increased awareness of the dangers of living near a nuclear power plant have made the public much more vocal, hence this petition. The CEP was founded in 2014 with the stated purpose to "encourage an open dialogue of issues of interest to the community." The very name "Community Engagement Panel" was chosen to emphasize the focus on community and its concerns. Edison's "Statement of Core Principles" (repeated at the beginning of every meeting) asserts its deeply held commitment to "Safety, Stewardship, and Engagement." While Edison has addressed some of these issues, it avoids others. Why does Edison avoid holding meetings in San Clemente, the closest town to the new waste dump and the one most impacted? (See the end notes of past meetings.) Why has the CEP avoided addressing some of the worst dangers the public may have to face? Why is there no discussion of disaster planning or worst case scenarios? This Petition seeks to address these shortcomings.

Today the dangers of nuclear power are much greater than we were promised in the last century. In addition to all the old dangers, we now also face new threats from missiles, drones, and truck bombs. The projections for large earthquakes in this area have increased. The technology for storing nuclear waste safely remains experimental rather than proven since it was never envisioned that we would have to store nuclear waste for long periods in thin temporary canisters. The world has suffered from numerous nuclear accidents and even some major

catastrophes (see the end notes) which prove that nuclear safety is not as good as we were led to believe.

In order to confront such criticism, the nuclear industry over the years has responded with probabilistic risk assessments seeking to sooth us with a perception of safety. Unfortunately, the risks have increased and public confidence in nuclear safety has decreased. A report by the Union of Concerned Scientists (https://www.ucsusa.org/sites/default/files/legacy/assets/documents/nuclear_power/nuc_risk.pdf) concluded that risk assessments are seriously flawed and the use of their results actually increases rather than decreases danger to the public (see end notes).

A few examples illustrate the risks of probabilistic risk assessment. One risk assessment demonstrated on paper that the simultaneous failure of both emergency shutdown systems in a reactor would happen only once every 17,000 years. It was of considerable embarrassment when a double emergency backup system failure actually happened twice within four days in 1983 at two reactors at the Salem, N.J. nuclear power plant. In another example, the large and unexpected 5.8 earthquake that hit Virginia in 2011 was supposed to occur only once every 1,000 years. And with regard to the safety of nuclear waste, former assistant secretary of energy Robert Alvarez noted (https://www.nytimes.com/2014/10/30/us/in-us-cleanup-efforts-accident-at-nuclear-site-points-to-cost-of-lapses.html?_r=1) that a risk analysis prepared for WIPP (Waste Isolation Pilot Plant near Carlsbad, NM) claimed there would be only one deflagration every 200,00 years. In 2014 (after only 15 years), fires, explosions, and radiation leaks closed the plant. It will not completely reopen until 2022 and costs are expected to reach $2 billion. Keep in mind that we are talking about some of the most deadly and dangerous elements known to science. Plutonium, for example, has a half-life of 24,000 years but it takes 10 half-lives for most of it to decay (think AD 242,018). It will be completely safe in 10 more half-lives, meaning in 2.4 million years. Lucky us: some day it will be safe.

In 2006, the Sandia National Labs published a study in the National Academy of Sciences Press entitled “Safety and Security of Commercial Nuclear Spent Fuel Storage” (http://www.nap.edu/openbook.php?record_id=11263&page=R9). They kept secret the classified report but released a public version. Noteworthy:

1. The committee noted that nuclear power plants have been designed for safety, not for security. They note that spent fuel storage facilities would be very attractive targets for terrorists. They noted that attacks from rented aircraft, particularly those larger than the small planes used in studies, are possible. They also noted the danger of sabotage and stated that large earthquakes are of major concern.
2. The committee noted that the position of the nuclear industry is that large scale threats to NPP are not their concern but rather the concern of other branches of government. The nuclear industry therefore ignores such concerns and focuses on minor concerns. (Important note: Large scale threats are of great concern of the public. The fact that the nuclear industry ignores them does NOT mean they are not concerns.)
3.. The committee stated that analyses carried out for the NRC do not consider maximum credible scenarios. Instead, they employ qualitative judgments and *reference* scenarios based on previous terrorist attacks. The committee of scientists who wrote the report instead recommended more study of worst case scenarios. They observed that terrorists who wanted to

attack hardened spent fuel storage facilities would choose weapons capable of producing maximum destruction.
4. The committee noted with some alarm that the NRC staff believes that terrorists attacks on spent fuel storage facilities are unlikely, would unfold slowly, produce minimum releases of radiation. They assume there would be weeks or months to mitigate any damage. The committee rejected this thinking and judged that the possibility of dangerous attacks cannot be dismissed.
5. The committee interviewed dry cask storage vendors and were told by the vendors that (A) Dry casks were designed for storage but were not designed to resist terrorist attacks; (B) customers (such as Edison) were more interested in the cost of the canisters than the design of the canisters. The committee concluded (details in the classified version) that there are scenarios where canisters could be breached and release off-site radiation into the community***. "The committee judges that no cask provides complete protection against all types of terrorist attacks."***
6. The committee visited Germany to study a fire test of a Castor cask. This thick-walled cask survived the test but the committee commented that these results do not apply to thin-walled canisters (such as the ones used by Edison).
7.. The committee noted that NRC regulations allowed lower levels of security for dry storage compared to wet storage. (Note: Edison has already applied for exemptions which would allow it to reduce their security force, eliminate their fire department, eliminate off-site radiation monitoring, eliminate off-site warning sirens, and reduce or eliminate response capability for terrorist attacks. Neither FEMA nor the California Office of Emergency Services will be called on to respond to a radiation emergency. Instead, this will become the responsibility of local cities and towns.)
8. The committee did <u>not</u> study all credible scenarios and instead focused mainly on airplane crashes and ground attacks by a small number of armed intruders. The committee did <u>not</u> study the dispersion of radioactivity from a breached dry cask. The committee did <u>not</u> study truck bombs, suicide attacks, mortar or rocket fire ,drone attacks, or missiles. (Note: It is understandable that the committee did not study drone or missile attacks since these threats have emerged only in the last few years. See endnotes for more discussion.)

The petition presented here is a follow-up of a letter to the CEP by Roger Johnson on Nov. 17 of last year which was critical that the CEP agenda proposed for 2018. Like the agendas of previous years, the meetings proposed for 2018 fail to address important issues of great concern to the public. The residents of southern California are now faced with decades or possibly centuries of "temporary" storage of 1,773 tons (1,609 metric tons) of highly radioactive uranium and plutonium waste. As the years pass, the likelihood a radiological event increases as does the threat to the health and safety and future of millions. Residents are now demanding to know what dangers we will be facing in the coming decades. Residents especially want to know about possible worst case scenarios, not just the ones that the nuclear industry likes to talk about. Residents want to know what to do if plumes of radiation sweep over this area with radioactive contamination that may last for months, years, decades, or centuries. After seven years, radiation levels are still dangerously high in Fukushima. Some estimate that it will not be safe to live there until the next century. The Chernobyl catastrophe happened in 1986 and some estimate that it will not be safe for 20,000 more years.

In short, the petitioners believe that the CEP has failed to achieve its stated mission. There is some evidence, however, that the CEP might be open to our suggestions. In his response to the Nov. 17 memo, chairperson David Victor replied on Nov. 23:

A. CEP agendas are not set in stone, topics are flexible, and topics already scheduled for 2018 are only drafts of possible meetings;
B. The CEP is open to suggestions not only from the panel but also from the public;
C. In keeping with the terms "community" and "engagement" the CEP wants to be responsive to topics and issues which are of concern to the public;
D. Chairman Victor expressed interest in covering security and “calamities” such as terrorist attacks.

From these positive remarks, we look forward to engaging the engagement panel about future meetings.

For the petitioners,
Roger Johnson
San Clemente

END NOTES

History of CEP Meetings Of the 20 CEP meetings (including the one scheduled for March of 2018), there have been seven in Oceanside, six in San Juan Capistrano, four in Laguna Hills, two in Dana Point, and only one (March 25, 2014) in San Clemente. It is telling that the CEP has carefully avoided meeting in San Clemente in spite of the fact that it is the closest city to San Onofre and the community which is most in danger. The San Clemente Community Center holds 25% more people than the SJC Community Center which the CEP has used often. The proposed meeting on disaster planning (as well as many future meetings) should be held in San Clemente.

Population The San Onofre Nuclear waste dump is located about half way between the Los Angeles and San Diego metropolitan areas. The combined population of the greater Los Angeles and San Diego areas is about 22 million people. Los Angeles county has the largest population of any county in the United States (San Diego county ranks #5). After the Fukushima radiation disaster in 2011 the U.S. government recommended evacuation of everyone within 50 miles. About 8.7 million people live within 50 miles of San Onofre. This is possibly the worst possible place to locate a nuclear waste dump.

History of Radioactive Disasters While there has been much discussion at CEP about possible major or minor cracks in canisters, there has been no discussion of the kinds of catastrophes which are possible or have already occurred elsewhere. The IAEA (International Atomic Energy Agency) defines a nuclear and radiation accident as “an event that has led to significant consequences to people, the environment, or the facility.” Twenty-eight nuclear power incidents with multiple fatalities and more than $100 million in property damage are widely known (https://en.wikipedia.org/wiki/Nuclear_and_radiation_accidents_and_incidents). All told, there have been 100 serious nuclear power accidents. Most people remember only Three Mile Island, Chernobyl, and Fukushima. Few remember that one of the worst disasters (Mayak in the former Soviet Union) involved a storage facility, not an operating reactor. Storage tanks blew up and

contaminated hundreds of square miles with radioactive fallout which resulted widespread sickness and death from radiation poisoning. Many in California do not even remember the core meltdown and fuel processing fires at the Santa Susana Field Laboratory in Simi Valley. For a longer list of 67 radiation accidents up to 2014, visithttps://en.wikipedia.org/wiki/Nuclear_and_radiation_accidents_and_incidents. What these radioactive "accidents" have in common is that authorities usually covered up and concealed what happened and then lied to the public, sometimes for decades. It would be prudent to assume that authorities will also lie to the public here about any future accidents at San Onofre. It has been cited by the NRC for mismanagement of the steam generator project and it hid from the public for 17 days details about the radiation that leaked into the environment from the failed steam generator. The nuclear industry engages in considerable PR efforts to promote the perception that nuclear energy is completely safe. The facts are otherwise. Some would argue that these serious incidents are irrelevant because they are not directly comparable to San Onofre. The point is that there is a long history of accidents and even catastrophes at nuclear installations. Those of us who live nearby cannot dismiss these incidents and blindly accept the notion that there is very little risk.

Possibilities for Radiation Incidents The list is long including (in alphabetical order): Armed terrorist penetration, attacks from the air (missiles, drones, airplane crashes), attacks from ships at sea, attacks from land (truck bombs, rocket or mortar fire), canister failure, cyber attacks, earthquakes, equipment failure, fuel fires, human error, military conflict with other countries, sabotage, suicide attacks, tsunamis, water penetration, and wildfires.

Risk Assessment Risk assessments are seriously flawed and used inappropriately (https://www.ucsusa.org/sites/default/files/legacy/assets/documents/nuclear_power/nuc_risk.pdf) . According to this report: "• The risk assessments assume nuclear plants always conform with safety requirements, yet each year more than a thousand violations are reported. • Plants are assumed to have no design problems even though hundreds are reported every year. • Aging is assumed to result in no damage, despite evidence that aging materials killed four workers. • Reactor pressure vessels are assumed to be fail-proof, even though embrittlement forced the Yankee Rowe nuclear plant to shut down. • The risk assessments assume that plant workers are far less likely to make mistakes than actual operating experience demonstrates." Such factors are magnified at San Onofre because this plant has many more complaints from workers about safety violations than any other NPP in the country. According to the 1982 CRAC-II study (Calculation of Reactor Accident Consequences), nuclear accidents could cost $300 billion, injure 150,000, and kill 50,000. This study is now outdated and was applied mainly to operating reactors, but nevertheless it illustrates the dangers of nuclear power. A major flaw with all risk assessments is that they tend to count only immediate costs and seriously underestimate long range consequences such as cancer. For example, about 2,000 Japanese continue to die every year not from old age but from medical and cancer issues caused when they were irradiated as children living on the outskirts of Hiroshima or Nagasaki in 1945.

The Vulnerability of Nuclear Power Plants As mentioned above, the 9/11 attacks alerted the world to the alarming news that terrorists have already considered NPPs as choice targets for attack. This concern has been magnified by the of emergence of North Korea as a nuclear rogue nation with 3 stage solid fuel ICBMs which tests have shown to be able to reach anywhere in the United States with conventional warheads. It is expected that soon they will have nuclear

warheads, but nuclear warheads are unnecessary since San Onofre, for example, already has 1,773 tons of uranium and plutonium sitting at ground level. If enriched, this would be the equivalent of 20,000 Hiroshima-type bombs. North Korea has already conducted 150 missile tests including the Hwasong-15 (range 6700 km) and Taepondong-2 (range 10,000 km+). Another worry is IRBMs (Intermediate Range Ballistic Missiles) which can be launched from a mobile truck or concealed in a standard shipping container on any cargo ship. They were announced in 2006, offered for sale, and have been successfully tested. With a range of 250 miles, they can reach their target in 10 minutes (http://www.thedrive.com/the-war-zone/11723/israel-just-launched-a-containerized-ballistic-missile-from-the-deck-of-a-ship?iid=sr-link2). The U.S. Bureau of Transportation lists 2,937 container ships. Hundreds of cargo ships regularly visit California waters. There have already been 7 military attacks on nuclear sites (https://en.wikipedia.org/wiki/Vulnerability_of_nuclear_plants_to_attack). San Onofre has already had incidents of sabotage. Many countries have bunker buster bombs (technically called the MOP or Massive Ordinance Penetrator). The U.S. sells them to other countries. MOPs can penetrate 60 feet of reinforced concrete or 200 ft of earth.

As for truck bombs, the Three Mile Island Alert Security Report concluded: “Regrettably, the NRC has permitted conditions to exist where the setback distances and the lack of blast deflection shields have not precluded a deadly release of radiation due to a truck bomb. We have concluded that the vehicle barrier regulations are mostly "window dressing." To strengthen security from truck bombs, the U.S. military recommended that truck bomb setbacks be placed at least 400 ft. away from a nuclear facility. This is impossible at San Onofre because Old Pacific Highway (where anyone can drive or park) is far closer than this. At the public San Onofre State Park, there are hundreds of places in the campgrounds, along the road, on the beach, or in designated parking lots where any vehicle can park. This could include trucks or RVs with concealed weapons that could fire rockets or mortars. San Onofre State Park is open to the public and hosts 2.5 million visitors a year.

With regard to airplane crashes, the claims of the nuclear industry that nuclear power plants are safe from crashes are not true. According to the Sandia report, most studies are computer simulations with favorable assumptions. One experiment was done in which a small (compared to a large commercial airliner) F-4 Phantom fighter plane was slid on a rail at 480 mph into a moveable concrete wall. It damaged the wall and moved it several feet as expected. This test was never designed to test the strength of the wall but the nuclear industry continues to claim that this proved that their concrete cannot be penetrated by aircraft. The Sandia report concluded: “It is not possible to make any general statements about spent fuel storage facility vulnerabilities to air attacks that would apply to all U.S. commercial nuclear power plants.” The report further notes that U.S. commercial nuclear power plants are not required by the Nuclear Regulatory Commission to defend against air attacks. The nuclear industry frequently states that these kinds of attacks are not their concern with the implication that such concerns should be dismissed (they have never been discussed at any CEP meeting). While these are not concerns of the nuclear industry or the NRC, they are definitely major concerns of the public. Some of the research on missile and aircraft attacks is classified and cannot be discussed in public. But much is known and can be discussed. Above all, the NRC and the nuclear industry should never give the impression that such attacks are of no concern merely because details are classified.

Emergency Planning Although most cities and counties have emergency planning, almost all of it is directed at conventional emergencies. Plans for radiation emergencies range from inadequate to non-existent and some of it seems dedicated to white-washing the dangers. At the large and well-publicized emergency planning fairs held in 2017, both San Clemente and Orange County had no information of any kind about radiation emergencies. In the past, SCE has run an emergency planning partnership called the Interjurisdictional Planning Committee (IPC:http://www.songscommunity.com/partnerships.asp). The future of emergency planning is uncertain because Edison has asked for exemptions to be removed from emergency planning (for example to discontinue warning sirens, discontinue a fire department, discontinue off-site radiation monitoring, discontinue emergency coordination with cities, counties and federal agencies, and to reduce insurance coverage, and plant security). The IPC was formed by Edison 1982 and it included only the local communities of SanClemente, Dana Point, and San Juan Capistrano. It does not include any cities in San Diego Country except for Camp Pendleton. The IPC meetings are exempt from the Brown Act which requires transparency for government meetings. The IPC meetings are closed to the public and minutes/records are not accessible. Public information in San Clemente about a nuclear emergency is sketchy (http://www.san-clemente.org/government/city-departments/public-works/emergency-planning/nuclear-emergency) and makes heavy reference to Edison as the main resource. It tells us that radiation is everywhere and even our own bodies give off radiation. It includes Edison PR language which trivializes the amount of radiation that NPPs give off. For evacuation it instructs everyone to get on I-5 and drive north and assemble at the Orange County Fairgounds. Bring your own bedding. 3 days of toiletries, a flashlight and credit card, etc. Parents will not be allowed to pick up their own children at school because the plan calls for them to be evacuated by school buses for later reunion with their parents. For more information, people are supposed to listen to the radio and visit the SONGs website or call the Edison Community Relations Manager at 949-368-3365. This is hardly the kind of information that people need.

What might be helpful is a discussion of the different kinds of radiation. Alpha radiation, for example, cannot penetrate the skin but it can be deadly if it lands on your eyeball or is swallowed or inhaled in which case it becomes a deadly internal emitter. There is no protection from gamma radiation which can penetrate anything including lead and concrete. Exposure to such radiation can rearrange cell DNA and cause cancer. There should be warnings that women and children are far more vulnerable to radiation than the adult males that the nuclear industry uses to evaluate dosage tolerance (the human fetus is about 50 times more vulnerable). There should be a discussion of the important National Academy of Sciences BEIR-7 Report (Biological Effects of Ionizing Radiation: https://www.nap.edu/read/11340/chapter/2). This report concludes that radiation exposure is cumulative in its effects, there is no minimum threshold below which radiation has no effects, and the effects of radiation exposure are linear (the LNT or Linear No Threshold hypothesis now widely accepted by scientists).

It is not possible to summarize here the many different radiation emergency plans generated by the nuclear industry and by government agencies but suffice it to say that it is often confusing, conflicting, totally unrealistic, or non-existent. Here is some advice from the Center for Disease Control:https://emergency.cdc.gov/radiation/getinside.asp.

1. If you are outside, cover your face with a towel. Avoid being outside and get into a building right away. If possible, choose a brick building and go to the basement. Shut off all heat and air

conditioning regardless of temperature. Duct tape plastic sheets over all doors and windows. Stay away from walls.
2. Before you enter a building, strip off your clothing and shoes outside. Wash your body outside. All clothing worn outside has to be discarded after one exposure. Do not take contaminated clothing inside - have a plastic bag ready to discard clothing and shoes outside.
3. Avoid being in a car because it is not good protection from radiation. If you are in a car, do not open windows or turn on the heat or AC no matter what the temperature.

It is little wonder that emergency preparedness people do not want to publicize instructions like these. If being outside or in vehicles is dangerous, how can emergency responders function? If they all need hazmat suits, how many tens of thousands of these single-use suits can be made available within hours? Do hazmat suits come in children's sizes? Is it desirable to have kids exposed for many hours in school buses? Do the buses have food and water and bathrooms? Will bus drivers show up for work as usual? Will they be able to drive to work since all roads will be one way the other way? What will happen when all police cars, ambulances, and fire trucks are contaminated on the inside after one use and can no longer be entered? How will people get uncontaminated food and water? Why is it assumed that the radiation will last only 3 days? What if it continues for weeks, months, or years? These and hundreds of similar questions illustrate the fact that no one is prepared for a radiation emergency. Dedicating one public meeting to these issues would be a small start in the right direction.

PETITION FOR A CEP MEETING ON PREPARATION FOR A RADIATION EMERGENCY

Edison is now starting to move the remaining highly-radioactive uranium and plutonium nuclear waste from cooling pools into thin canisters to be stored at ground level near the beach in San Onofre. The 3.6 million pounds of deadly nuclear waste are an enormous threat to the 8.7 million people from San Diego to Los Angeles who live in the 50 mile radius (the recommended evacuation zone at Fukushima). Some of this waste will remain lethal for hundreds of thousands of years. When SONGS was built, promises were made that the dangerous nuclear waste would be safely removed. The current plan to store this waste in the middle of two metropolitan areas for the indefinite future is irresponsible.
Hopefully there will never be any radiation incidents but history teaches us otherwise. In addition to the usual threats of accidents, fuel fires, equipment malfunction, human error, and earthquakes, we also have the threat of terrorist attacks from missiles (launched from far away or from nearby cargo ships), drones, truck bombs, and aircraft crashes. There is very little public information about possible scenarios and dangers from radioactive fallout and long-term contamination. Since we all now live near a nuclear waste dump, the public is keenly interested in what this might mean for everyone's health and safety and the future of their communities. The public wants to know:
(1) What are the possible threats to this area, including worst case scenarios?
(2) How will the public learn about actual radiation levels in the event of an incident? What are the consequences of radiation exposure and radioactive contamination to life and property?
(3) In the event of a radiation emergency: (A) What will authorities do? (B) What can members of the community do to protect themselves from radiation? (C) How can the public be educated and be made aware of these serious issues?

The petitioners below request a full CEP meeting be devoted to these issues. Furthermore, the petitioners want the lead in organizing this presentation including the selection of a moderator and 2-3 expert speakers. The organizers representing the petitioners will be Gary Headrick, Ace Hoffman, and Roger Johnson.

155 Petitioners Residing in 27 Cities and Towns of Orange and San Diego Counties

Joy Adams, Patricia Borchmann, Susan Echevarria, Armida Brashears, Brett Blottiaux, Vik Gupta, Keston Baker, L.R.Hering, Julie Trager, Marilee Carroll, Judy Jones, Christina Lucey, Chuck Hackwith, William Alley, Denise Brown, Kanta Gupta, William Jordan, Patricia Barboni, Sally Campbell, George Courser, Gloria Glanville, Tamara Isaacs, Nina Babiarz, Iolee Chandraratna, Janette Dye, Jack Fox, Dana Baillie, Christine Collins, Torgen Johnson, Marcia Goldstein, Gary Headrick, Lauri Headrick, Mary Class, Leslie Zieminski, David Eisenstein, Dhana Lee, Barbara Wood, Christine Maclean, Patricia Hurley, Marilyn Caddy, Derek Casady, Roger Johnson, Ron Herbert, Natalie Conklin, Colein Baker, Rosemarie Auaire, Virginia Hayter, Louise Herbert, Celia McCarty, Jim Bunch, Ellen Erlinso, Barbara Helton, Rosh Chandraratna, BeverlyGrant, Joel Goldstein, David Slingluff, David Golman, Sanda Exelby, Charles Langley, Nancy Casady, Beth McConway, Bob Caddy, Rosemarie Alley, Joan Thompson, Ana Golan, Dianne Gooding, Jiffy Massey, Lyn Hall, Amy Lindsay, Jerry Davis, P.W. Henman, Lorene Laguna, Sharon Hoffman, Anne Farrell, Robert Hotto, Lori Johnson, Will Hershel, Evelyn Griffiths, Ellen Olshansky, Chris Hoover, Jane Magum, Mary Christine Moore, Michael Gordon, Linda McLaughlin, Grace Winchell, Donald Isaacs, Linda Hackwith, Ace Hoffman, Pam Patterson, Sharon Moriwaki, Kevin Kensinger, Ray Lutz, Nancy Kriz, Liz Myers-Chamberlin, Carole Kanode, Ron Rodarte, Eva Maier, Rita Macdonald, Anthony Hays, Dave Rice, Karen Reisdorf, Maureen Ohanstad, Kash Gupta, Diane Nied, Sandra Schulte, Janet Henry, Jahn Levitt, Rachael Mitchell, Les Miklosy, Patricia Santry, John Navaro, Charlotte O'Brien, Bart Zeigler, John Massey, Andrea Lex, Shelly Peterson, Rusty Maese, Barbara Slera, Lynne Talley, Robert Pope, Melvin Mitchell, Marilyn O'Brien, Chuck Zoltan, Ricardo Nicol, Noel Obrien, Kris Rice, Keiko Suenaga, Judy Stanford, Karel Tharp, Michelle Paolilli, Marjorie Sosa, Loraine Walsh, Pat O'Brien, Madge Torres, Edward Tharp, Dave Patterson, Marion Simon, Lauren Wade, Kay Zoltan, Anita Simons, Nany Winchers, Don Paolilli, Jerry Tilain, Leah Vasquez, Ray Swanson, Charlotte Puch, Petti Van Rekom, Arturo Torres, Sherry Reams, Roger Gloss, Lindi Siegel, Ronette Youman, Mark Smith, Scott Tree, Dawn Yates

Mission Viejo, Newport Beach, Tustin, Aliso Viejo, Ramona, Cardiff By the Sea, San Juan Capistrano, Oceanside, Fullerton, Dana Point, San Clemente, San Diego, Encinitas, Laguna Beach, Fountain Valley, Laguna Woods, Irvine, Rancho Santa Margarita, La Mesa, Long Beach, Laguna Hills, Solana Beach, Huntington Beach, Costa Mesa, El Cajon, Carlsbad, Chula Vista

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Decommissioning San Onofre Nuclear Generating Station

Scoping Session for CEP Workshop on Extreme Events

Friday, Oct. 12, 2018
9:00 am to Noon
Oceanside City Hall – Sisters City Room
3rd Floor of North Building – Adjacent to Parking Garage
300 North Coast Highway
Oceanside, CA 92054

Purpose:

- Obtain input on the scope of the CEP workshop
- Prioritize pre-read material to be shared in connection with workshop
- Discuss next steps including timing of workshop

AGENDA

Time	Topic	Who
9:00 – 9:05 am	Welcome	Jerry Kern
9:05 – 9:10 am	Review Agenda / Safety	Manuel Camargo
9:10 – 9:20 am	Introductions	David Victor
9:20 – 9:30	Purpose and Parameters • Addressing topics of interest to local communities • Focus is ISFSI-only site condition • Understanding risks and mitigations	David Victor
9:30 – 10:30 am	Scope Roundtable Discussion (~5 minutes per person) • **2-3 most important issues as it relates to extreme events and emergency preparedness**	Dan Stetson
10:30 – 10:45 am	Radiological Consequences • Radiation and contamination • Plausible releases from ISFSI • Radiation basics in or out of scope?	Randall Granaas
10:45 – 11:00 am	Emergency Preparedness (EP) Response to Extreme Events • Protocols for response to offsite release • On-site, local, and state resources • Scope of EP in workshop?	Steve Giannell
11:00 – 11:20 am	Draft Summary of Workshop Topics	Dan Stetson Manuel Camargo
11:20 – 11:35 am	Pre-Read Material for Workshop • Which papers to include?	Manuel Camargo
11:35 – 11:45 am	Guest Speakers and Workshop Timing • Submit speaker recommendations to Camargo by 10/26 • Workshop timing?	Manuel Camargo
11:45 am - Noon	Closing Comments	David Victor

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Decommissioning
San Onofre
Nuclear Generating Station

Radiological Consequences

Presented By:
Randall Granaas
SCE Nuclear Fuel/ISFSI Engineer

October 12, 2018

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Radiation vs. Contamination

- Imagine a freshly painted room. Now consider that the paint is radioactive. Light reflected off the painted walls is just like radiation from the radioactive paint. You can avoid being exposed to this radiation by simply walking out of the room.

- But, if you walk out of the room with paint on your shoes you take some of the radioactive paint with you. That's contamination. And if you're not careful, you can track it down the hallway on to your nice clean floors. This radioactive contamination can be cleaned up with soap and water but you've got paint in places you don't want it.

- Now if the painters were nuclear workers, each worker would be wearing a radiation detection device that measures how much radiation they receive while they're in the freshly painted room. The amount of exposure to the radioactive paint would be strictly controlled in accordance with federal regulations.

- The nuclear painters would also be wearing coveralls, boots and gloves. When they leave the room, they would remove their protective clothing so that any contamination on their clothes stays in the room.

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Radiation Basics—In Scope?

- Four types of ionizing radiation
  - Alpha particle
  - Beta particle
  - Gamma rays
  - Neutrons
- Shielding of ionizing radiation
- Biological hazards
- Normal background radiation

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Basic Fuel Design and Characteristics

- Ceramic uranium dioxide pellets sealed within zirconium alloy cladding
- Offsite releases at Chernobyl and Fukushima due to motive force associated with an operating reactor (heat and steam)
- SONGS reactors have been shutdown for nearly 7 years

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Basic Fuel Design and Characteristics

- No water within a dry storage canister, decay heat of hottest SONGS spent fuel assembly comparable to a hair dryer (~1500W)
- Cs-137 not volatile at dry storage temperatures
- Absent a motive force, radioactive contamination on the surface of the fuel, and fuel particulate, are not very mobile

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Vacuum Dryer Filter Replacement

- *Typical replacement of filter for vacuum drying system*
- *Vacuum drying can take several days*
- *Pump draws a deep vacuum on the storage canister*
- *Does not result in sucking significant quantities of radioactive material out of the canister, even when drying damaged fuel*
- *Filters are only mildly radioactive*



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Plausible Releases From an ISFSI

- Per NRC-approved Safety Analysis Report (SAR), no credible release mechanisms
- Accident analyses demonstrate that the functional integrity of the system is maintained by:
  - Maintaining sub-criticality
  - Maintaining confinement boundary integrity
  - Ensuring fuel retrievabilty
  - Maintaining doses within 10CFR 72.106 limits (<5 rem).

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Accidents Evaluated in the SARs

- Tornado and tornado missiles
- Flood/tsunami
- Fire/explosion
- Lightning
- Blockage of air vents

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Beyond Design Basis Accidents?

- Natural events of greater severity than analyzed in the SAR—e.g., earthquake exceeding 1.5g horizontal, or flood that exceeds 50’ above the storage canister (~80’ above sea level)
- Acts of aggression
- Other?

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Appendix/Backup Slides

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Radiation Basics—In Scope?

- Basic atomic structure
- Radiation measurement (units)
- Radiation units—U.S. or System International (SI)?
- What is an isotope?
- Radioactive decay
- Half-life
- Fission
- Other?

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Emergency Preparedness

Presented By:
Steve Giannell
Emergency Planning

October 12, 2018

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Postulated ISFSI Events with all Spent Fuel in Dry Storage

- No credible event can breach the canister Confinement Boundary
- NUREG-1140 states that the effective dose equivalent that would be received at 100 meters due to a canister Confinement Boundary breach is 3 millirem
- For comparison, 10 CFR 20 states that the total effective dose equivalent to individual members of the public from the licensed operation of the ISFSI cannot exceed 100 millirem

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Protocols for Response to Offsite Releases

- A significant event requires a radiological survey be performed
- If radiation levels exceed limits an Unusual Event is declared
- An additional survey determines if a radiological release is in progress
- SONGS notifies California Office of Emergency Services (OES), Orange County Sheriff Communications (Control One), San Diego OES, and Camp Pendleton:
  - **Electronic notification within 15 minutes**
  - **Verbal notification within 60 minutes including the notification to NRC**
    - Control One informs OC Emergency Management who, in turn, notifies cities and State Parks
    - San Clemente Emergency Management notifies Capistrano Unified School District

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Protocols for Response to Offsite Releases

- SONGS obtains support to determine whether there is indications of airborne radioactive contamination downwind
- Updated information is communicated to offsite agencies
- The local officials make all protective action decisions regarding evacuation, shelter-in-place or other actions deemed necessary to protect the public
- Counties and State perform radiological monitoring around the site for independent verification
- *Letters of Agreement are in place with Camp Pendleton Fire, State Parks, FBI, CHP, OC Sheriff, Mission Hospital, Tri-City Hospital, and others for emergency support capabilities*

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Onsite, Local and State Resources

- Onsite resources: initial radiation survey capability
  - Additional radiological technical support onsite within four hours
- Local offsite resources for detection and decontamination, if needed, provided by local government agencies still receiving funding for maintaining capability
- State resources deployed by Cal OES commensurate with event
  - Cal OES could request and coordinate federal resources to assist
  - California Department of Public Health provides radiological assessments

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Decommissioning San Onofre Nuclear Generating Station

Scope of EP in Workshop

- Understanding of the regulatory requirements for emergency preparedness at an ISFSI
- Knowledge of the regulatory commitments in the SONGS ISFSI-Only Emergency Plan, and implementing procedure
- Knowledge of onsite Emergency Response Organization (ERO) personnel training and qualifications that maintain ERO readiness
- Knowledge of the surveillance programs that maintain Emergency Response Facility and equipment readiness
- Knowledge of the Exercise and Drill program that maintains overall SCE readiness

Decommissioning San Onofre Nuclear Generating Station

CEP WORKSHOP PLANNING SESSION #2

"SONGS Dry Cask Storage: Design, Potential Events, & Remedies"

Friday, November 22, 2019

1:00 – 3:00 p.m. Pacific Time

Volare Hotel, San Clemente

SAN ONOFRE NUCLEAR GENERATING STATION
Purpose of Meeting: • To review the status of planning the workshop and solicit input from external stakeholders

AGENDA

Time	Topic	Who
1:00 - 1:05	Welcome and introductions	David Victor
1:05 - 1:15	Review the status of actions from previous meeting	Manuel Camargo
1:15 - 1:45	• Discuss CEP workshop scope and format • Discuss input on reviewers and expert panelists	David Victor
1:45 - 2:15	Facilitate a discussion of potential event scenarios, probability/ consequence, hazards, mitigations & emergency response	Manuel Camargo Randall Granaas Kelli Gallion
2:15 – 2:45	Open discussion	All
2:45 – 2:55	Review actions and next steps	Manuel Camargo
2:55 – 3:00	Closing remarks	David Victor

INVITEES:

- DAN STETSON – CEP VICE CHAIRMAN
- DAVID VICTOR – CEP CHAIRMAN
- DONNA BOSTON – COUNTY OF ORANGE EMERGENCY MANAGEMENT
- DOUG BAUDER – SCE VP & CHIEF NUCLEAR OFFICER
- GARY HEADRICK – SAN CLEMENTE GREEN
- JERRY KERN – CEP SECRETARY
- KATIE DAY – SURFRIDER FOUNDATION
- KELLI GALLION – SCE EMERGENCY PLANNING
- LORRAINE SANDSTROM – SCE STAKEHOLDER ENGAGEMENT
- MANUEL CAMARGO – SCE STRATEGIC PLANNING & STAKEHOLDER ENGAGEMENT
- RANDALL GRANAAS – SCE FUELS ENGINEERING
- ROGER JOHNSON – SAN CLEMENTE RESIDENT
- STEPHEN REA – COUNTY OF SAN DIEGO EMERGENCY MANAGEMENT
- TOM ISAACS – EXPERTS TEAM & INDEPENDENT STRATEGIC ADVISOR FOR NUCLEAR WASTE
- TORGEN JOHNSON – SAMUEL LAWRENCE FOUNDATION

CEP Workshop Status and Next Steps "SONGS Dry Cask Storage: Design, Potential Events, & Remedies"

Draft 11/15/19

Background

The SONGS Community Engagement Panel (CEP) was convened by the SONGS co-owners as a volunteer, non-regulatory body to enhance and foster open communication, public involvement, and education on SONGS decommissioning activities. This includes addressing matters of interest to area communities. SCE and the CEP leadership recognize demonstrated public interest in potential hazards represented to SONGS from various natural and manmade events, and emergency response or "remedies" to certain events.

Based on demonstrated public interest, SCE and the SONGS CEP are planning a science/fact-based CEP workshop titled **"SONGS Dry Cask Storage Design, Potential Events, & Remedies"** on March 26, 2020. A planning session was held in October 2018 with representatives from SCE, the CEP, and several external stakeholders to discuss the focus of the workshop and next steps. News stories and scientific studies regarding potential natural and man-made events were circulated among the interested parties in advance of the planning session.

Scope

During the initial planning meeting, participants decided that the SONGS site condition to be considered for the workshop will be after all spent nuclear fuel at SONGS has been transferred into passive dry cask storage – by mid-2020 – in the independent spent fuel storage installation (ISFSI) at SONGS. Questions to be addressed at the workshop may include:

1. What are the possible threats to the San Onofre area, including worst-case events?
2. In the unlikely event of an off-site release of radiation, how will the public be informed?
    a. Which local, state, and/or federal agencies would be engaged and what are their roles?
    b. Which agencies have the authority to issue protective actions?
3. What are the consequences of radiation exposure and radioactive contamination?

Actions and Status (stemming from October 2018 meeting)

#	Action	Status
1	Develop a list of event scenarios, including public exposure information	An Excel spreadsheet that outlines this information has been developed by SCE
2	Develop a list of third parties to review the event scenarios and provide feedback	SCE and CEP developing preliminary list of reviewers; input from external stakeholders will be considered
3	Select an event beyond current design basis and discuss the emergency response from SCE, city, county and state organizations	Meteor strikes and terrorism both are included in the Excel spreadsheet
4	Determine a procedure for selection of guest panelists	External stakeholders are welcome to submit recommendations for guest panelists; final makeup of the panel will be determined by SCE and the CEP leadership
5	Determine whether SCE will compensate third party experts for serving as panelists in the workshop	Guest panelists will be compensated, as needed, for their time and/or reimbursed for travel expenses

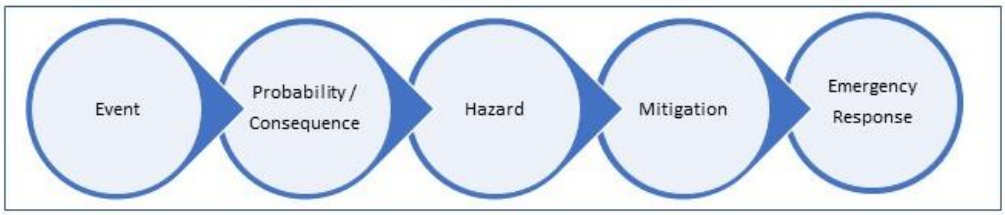
CEP Workshop Status and Next Steps "SONGS Dry Cask Storage: Design, Potential Events, & Remedies"

Draft 11/15/19

6	Determine the date of the workshop and secure a venue	Workshop is scheduled for March 26, 2020; venue is to be determined

Workshop format

1. Presentation of events, probability/consequence, hazards, mitigation and emergency response
    a. Expert panelists comment
    b. CEP and external stakeholders comment
2. Third party health physicist presents information regarding radiation and contamination
    a. Panelists comment
    b. CEP and external stakeholders comment
3. Public comment period (events and radiation/contamination)



Potential events (natural and manmade, from October 2018 meeting; alpha order)

1. Degraded canister (chloride-induced stress corrosion cracking)
2. Dismantlement (construction vibration)
3. Groundwater daylighting (intrusion from groundwater
4. Hydrogen build-up in canister (risk of an explosion with a cracked canister)
5. Meteorite strike
6. Seismic event
7. Terrorist attack
8. Tsunami/sea level rise (inundation/submersion of ISFSI by seawater overtopping seawall)

Prospective reviewers of event scenarios[1]

[To be developed]

Prospective expert panelists[1]

[To be developed]

Request for recommendations and next steps	Timing
1. Recommendations regarding potential reviewers due to SCE	Dec. 16
2. Recommendations regarding potential expert panelists due to SCE	Jan. 10
3. Third planning meeting to discuss panelists	Jan. (TBD)
4. Final set of panelists determined/recommendations dispositioned	Feb. 7
5. CEP workshop	March 26

[1] Emphasis will be placed on selecting individuals with extensive, practical experience with design, engineering, regulation, and/or management of ISFSI systems.

Decommissioning San Onofre Nuclear Generating Station

CEP WORKSHOP PLANNING SESSION #3

SONGS Community Engagement Panel - Outlier Events Meeting

Thursday, February 13, 2010

2:00 – 4:00 p.m. PDT

The Outlets at San Clemente - 101 West Avendia Hermosa, Suite 190 (Conference Room)

SAN ONOFRE NUCLEAR GENERATING STATION
Purpose of Meeting: • To review CEP workshop planning status and next steps

AGENDA		
Time	**Topic**	**Who**
2:00 – 2:10	Welcome and introductions	David Victor
2:10 - 2:40	Provide update on expert recommendations, invitations and responses • Experts to prioritize event scenarios • Schedule meeting with expert reviewers prior to CEP Workshop	David Victor
2:40 - 3:00	Discuss CEP workshop scope and format • Basics of Radiation • Event Scenarios • Emergency Preparedness	David Victor
3:00 – 3:45	Open discussion	All
3:45 – 3:50	Review actions and next steps	Lorraine Sandstrom
3:50 – 4:00	Closing remarks	David Victor

INVITEES:

- DOUG BAUDER – SCE VP & CHIEF NUCLEAR OFFICER
- DONNA BOSTON – COUNTY OF ORANGE EMERGENCY MANAGEMENT
- MANUEL CAMARGO – SCE STRATEGIC PLANNING & STAKEHOLDER ENGAGEMENT - ABSENT
- KATIE DAY – SURFRIDER FOUNDATION – ABSENT
- JOHN DOBKEN – SCE PUBLIC INFORMATION OFFICER
- KELLI GALLION – SCE EMERGENCY PLANNING
- RANDALL GRANAAS – SCE FUELS ENGINEERING
- GARY HEADRICK – SAN CLEMENTE GREEN
- ACE HOFFMAN – SAN CLEMENT RESIDENT - ABSENT
- TOM ISAACS – EXPERTS TEAM & INDEPENDENT STRATEGIC ADVISOR FOR NUCLEAR WASTE
- ROGER JOHNSON – SAN CLEMENTE RESIDENT
- TORGEN JOHNSON – SAMUEL LAWRENCE FOUNDATION
- JERRY KERN – CEP SECRETARY - ABSENT
- STEPHEN REA – COUNTY OF SAN DIEGO EMERGENCY MANAGEMENT - ABSENT
- LORRAINE SANDSTROM – SCE STAKEHOLDER ENGAGEMENT
- DAN STETSON – CEP VICE CHAIRMAN
- JERRY STEPHENSON – SCE MANAGER, ISFSI ENGINEERING
- DAVID VICTOR – CEP CHAIRMAN

CEP Workshop Status and Next Steps

2-13-20

SONGS Community Engagement Panel - Outlier Events Meeting

Background

The SONGS Community Engagement Panel (CEP) was convened by the SONGS co-owners as a volunteer, non-regulatory body to enhance and foster open communication, public involvement, and education on SONGS decommissioning activities. This includes addressing matters of interest to area communities. SCE and the CEP leadership recognize demonstrated public interest in potential hazards represented to SONGS from various outlier events, and emergency response or "remedies" to certain events.

Based on demonstrated public interest, SCE and the SONGS CEP are planning a science/fact-based CEP workshop titled **"SONGS Community Engagement Panel – Outlier Events Meeting"** on March 26, 2020. A planning session was held in October 2018 with representatives from SCE, the CEP, and several external stakeholders to discuss the focus of the workshop and next steps. News stories and scientific studies regarding potential natural and man-made events were circulated among the interested parties in advance of the planning session. A second planning meeting was held in November 2019 to discuss meeting scope and recommendations for expert reviewers and panelists.

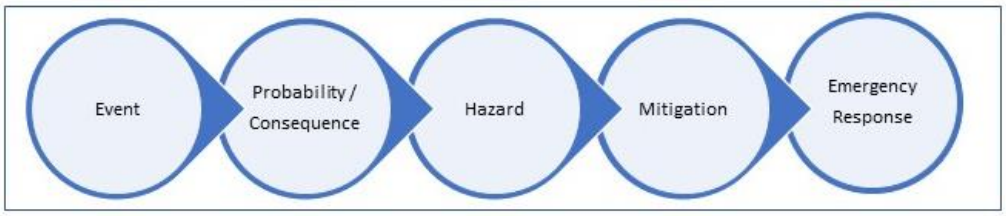
Scope

During the initial planning meeting, participants decided that the SONGS site condition to be considered for the workshop will be after all spent nuclear fuel at SONGS has been transferred into passive dry cask storage – by mid-2020 – in the independent spent fuel storage installation (ISFSI) at SONGS. Questions to be addressed at the workshop may include:

1. What are the possible threats to the San Onofre area, including worst-case events?
2. In the unlikely event of an off-site release of radiation, how will the public be informed?
    a. Which local, state, and/or federal agencies would be engaged and what are their roles?
    b. Which agencies have the authority to issue protective actions?
3. What is the difference between radiation and contamination?

Workshop format

1. Presentation of events, analysis of probability and consequence, hazards, mitigation and emergency response
    a. Expert panelists comment
2. Third party health physicist presents information regarding radiation and contamination
    a. Panelists comment
3. Public comment period (events and radiation/contamination)



Potential events (natural and manmade, from October 2018 meeting; alpha order)

1. Degraded canister (chloride-induced stress corrosion cracking)
2. Dismantlement (construction vibration)
3. Groundwater daylighting (intrusion from groundwater
4. Hydrogen build-up in canister (risk of an explosion with a cracked canister)
5. Seismic event

6. Terrorist attack
7. Tsunami/sea level rise (inundation/submersion of ISFSI by seawater overtopping seawall)

Prospective reviewers of event scenarios[1]

1. Michael (Mike) Corradini
2. Kevin D. Crowley, Ph.D.
3. Tom Isaacs
4. Dave Lochbaum
5. Ed Lyman
6. Richard (Dick) Meserve
7. Arthur Motta
8. Dr. Joseph Shepard
9. Elizabeth Ten Eyck

Prospective expert panelists[1]

Dr. Patrick Papin – SDSU Physics (Basics of Radiation Presentation)

Request for recommendations and next steps	Timing
1. Recommendations regarding potential reviewers due to SCE	Dec. 16 Complete
2. Recommendations regarding potential expert panelists due to SCE	Jan. 10 Complete
3. Third planning meeting to discuss panelists	Feb. 13 Complete
4. Final set of panelists determined/recommendations dispositioned	Feb. 13
5. CEP workshop	Mar. 26

6. Actions and Status (stemming from October 2018 meeting)

#	Action	Status
1	Develop a list of event scenarios, including public exposure information	**Complete** - An Excel spreadsheet that outlines this information has been developed by SCE
2	Develop a list of third parties to review the event scenarios and provide feedback	**Complete** - SCE and CEP developed a list of reviewers with input from external stakeholders
3	Select an outlier event and discuss the emergency response from SCE, city, county and state organizations	Experts will review the events and make recommendations on the scenarios to present during the CEP workshop (meteors were removed from the event list based on SCE, CEP and external input)
4	Determine a procedure for selection of guest panelists	**Complete** - External stakeholders submit recommendations for expert reviewers and guest panelists; final makeup of the panel will be determined by SCE and the CEP leadership

[1] Emphasis will be placed on selecting individuals with extensive, practical experience with design, engineering, regulation, and/or management of ISFSI systems.

CEP Workshop Status and Next Steps

2-13-20

SONGS Community Engagement Panel - Outlier Events Meeting

5	Determine whether SCE will compensate third party experts for serving as panelists in the workshop	**Complete** - Guest panelists will be compensated, as needed, for their time and/or reimbursed for travel expenses
6	Determine the date of the workshop and secure a venue	**Complete** - Workshop is scheduled for March 26, 2020 at the San Juan Capistrano Community Center

From: David G. Victor
Sent: Thursday, January 16, 2020 10:42 AM
To: Roger Johnson; Gary Headrick; Ace Hoffman; Jerry Kern; Daniel T. Stetson; Katie Day; Donna Boston; Tom Isaacs; Steve Carlson; RANDALL GRANAAS; Julie C Holt; Doug Bauder; KELLI GALLION; Manuel Camargo; Stephen Rea; Chris Thompson; Myrna Martinez; John Dobken; Liese Mosher; Lorraine Quinn Sandstrom; JERRY STEPHENSON
Subject: (External):panel of review experts

Dear Participants in the planning efforts for the CEP meeting on outlier events, risks and responses at the San Onofre ISFSI.

In December and earlier this month I have been working on the question of a panel of experts. To help, I spoke with Charles Ferguson and his staff at the National Academy of Sciences—Charles is an expert in the area (he can't serve on our panel because his Academy role) and also is key staff person for the Academy's Board that has done numerous studies on nuclear fuel and storage. He has his finger on the pulse of who has deep expertise and the perspective needed to help us evaluate scenarios to ensure that they, while extreme, are plausible.

Based on those conversations, plus the notes from our two planning meetings, below is the list of experts I will reach out to for assistance. Other than Tom I, who has been part of our meetings, I have not spoken with any of them directly about this yet. But in the coming few days I will do that and will also assemble a list of scenarios.

At present, our request to them is to review some documents, participate on a call or two, and offer their opinions on ranking and plausibility. IN a few cases, we may also ask them to be speakers.

All best
David

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Michael "Mike" Corradini. Michael L. Corradini, Ph.D., is a professor in the Department of Engineering Physics at the University of Wisconsin, Madison. Dr. Corradini's research focus is nuclear engineering and multiphase flow with specific interests that include light-water reactor safety, fusion reactor design and safety, waste management and disposal, vapor explosions research and molten core–concrete interaction research, and energy policy analysis. He received his B.S. in mechanical engineering from Marquette University and his M.S. and Ph.D. degrees in nuclear engineering from the Massachusetts Institute of Technology. He is a member of the American Institute of Chemical Engineers, the American Society of Engineering Education, and the American Society of Mechanical Engineers, and a Fellow of the American Nuclear Society. Dr. Corradini has received numerous awards including the National Science Foundation's Presidential Young Investigator Award, the American Nuclear Society reactor safety best paper award, and the University of Wisconsin, Madison, campus teaching award. He has served on various technical review committees, including the research review panel of the U.S. Nuclear Regulatory Commission. He currently serves on the U.S. Nuclear Regulatory Commission's Advisory Committee on

Reactor Safeguards and was president of the American Nuclear Society in 2013-2014. Dr. Corradini was elected to the National Academy of Engineering in 1998..

Kevin D. Crowley, Ph.D., has been an advisor to the NRSB since entering phased retirement in August 2017. His professional interests focus on the application of science and technology to improve societal well-being, advance public policy making, and enhance international cooperation, particularly with respect to the safety, security, and efficacy of nuclear and radiation-based technologies and applications. He previously held several positions at the National Academies, including senior board director of the NRSB (2005–2017), director of the Board on Radioactive Waste Management (1996–2005), and principal investigator for a long-standing cooperative agreement between the National Academy of Sciences and the Department of Energy to provide scientific support to the Radiation Effects Research Foundation in Hiroshima, Japan (2010–2017). Before joining the National Academies staff in 1993, Dr. Crowley held teaching and research positions at Miami University of Ohio, the University of Oklahoma, and the U.S. Geological Survey. He holds an M.A. and a Ph.D., both in geology, from Princeton University.

Tom Isaacs. Currently, advisor to Canadian Nuclear Waste Management Organization (NWMO) on management and storage of Canada's SNF, last 13 years. Mr. Isaacs is a well-recognized national and international leader in the field of nuclear energy, nuclear waste management, nuclear security, repository siting, and public trust and confidence. Recognized leader and frequent invited speaker both within the U.S. and around the world, including Canada, Japan, South Korea, Stanford, MIT, among many others on issues of nuclear waste management program strategy and implementation, fuel cycle, facility siting, public trust and confidence, and stakeholder engagement. Education includes a B.S. with honors in Chemical Engineering from the University of Pennsylvania (Tau Beta PI, Phi Lambda Upsilon honor societies) and a M.S. in Engineering and Applied Physics from Harvard University (while studying nuclear engineering at MIT). Mr. Isaacs has had significant leadership positions in the technical, strategic, programmatic, policy, siting, societal, engagement, and communications dimensions of nuclear waste management for over 30 years. He was instrumental in: the siting of the Yucca Mountain candidate repository Site; the passage of the Nuclear Waste Policy Amendments Act of 1987 that defined the U.S. waste program; the development of the Blue Ribbon Commission on America's Nuclear Future (BRC) report written at the direction of the President of the United States that recommended the path forward for the U.S. nuclear waste program; and the strategic approach currently being implemented by the Nuclear Waste Management Organization of Canada to manage and dispose of spent fuel. Director, Office of Policy within the U.S. DOE office responsible for spent fuel and high level radioactive waste (HLW) management and disposal (The DOE Office of Civilian Radioactive Waste Management). Responsible for the strategic direction of the national program to manage and dispose of spent nuclear fuel and high-level radioactive waste. Major responsibilities Included setting program directions, priorities, and policies for this $400 million per year program, leading policy and technical analyses, and managing a federal and contractor staff. Managed the comparative evaluation of candidate sites for the for the first U.S. repository program for the disposal of U.S. spent nuclear fuel and high-level radioactive (HLW).

David Lochbaum. Mr. Lochbaum received a BS in Nuclear Engineering from the University of Tennessee in 1979 and worked as a nuclear engineer in nuclear power plants for 17 years. In 1992, he and a colleague identified a safety problem in a plant where they were working. When their concerns were ignored by the plant manager, the utility, and the Nuclear Regulatory Commission (NRC), they took the issue to Congress. The problem was eventually corrected at the original plant and at plants across the country. Lochbaum joined UCS in 1996 to work on nuclear power safety. He spent a year in 2009-10

working at the NRC Training Center in Tennessee. He retired in 2018. Areas of expertise: Nuclear power safety, nuclear technology and plant design, regulatory oversight, plant license renewal and decommissioning .

Ed Lyman. Edwin Lyman is an internationally recognized expert on nuclear proliferation and nuclear terrorism as well as nuclear power safety and security. He is a member of the Institute of Nuclear Materials Management, and has testified numerous times before Congress and the Nuclear Regulatory Commission. Since joining UCS in 2003, he has published articles in a number of journals and magazines, including *Science, the Bulletin of the Atomic Scientists, Science and Global Security,* and *Arms Control Today,* and he has been cited in thousands of news stories, including articles in the *Boston Globe, Chicago Tribune, Los Angeles Times, New York Times, Wall Street Journal, Washington Post,* and *USA Today*, and in segments on ABC, CBS, CNN, C-SPAN, MSNBC, NBC, NPR and PBS. Dr. Lyman also co-authored the critically acclaimed book, *Fukushima: The Story of a Nuclear Disaster* (New Press), which was published in February 2014. In 2018, Dr. Lyman was awarded the 2018 Leo Szilard Lectureship Award from the American Physical Society.

Richard "Dick" Meserve, former Chairman of US NRC and current Chair of the IAEA's International Nuclear Safety Advisory Group. Dr. Richard A. Meserve, who served as Chairman of the United States Nuclear Regulatory Commission (NRC) from 1999 to 2003 following many years as a partner at Covington & Burling, is currently senior of counsel to the firm. Dr. Meserve is based in Covington's Washington office. With a Ph.D. in applied physics, Dr. Meserve has long concentrated his practice on issues at the intersections of law, regulation, science, and technology, with a special focus on recent years on nuclear matters. Dr. Meserve serves as President Emeritus of the Carnegie Institution for Science, a non-profit entity that undertakes fundamental research on the frontiers of biology, earth sciences, and astronomy. He assumed the presidency in April 2003, having been a member of Carnegie's board of trustees since 1992, retiring as President in 2014. Dr. Meserve served as Chairman of the NRC under Presidents Clinton and Bush. During his tenure from 1999 to 2003, he was the principal government official with responsibility for regulating nuclear power plants and the use of nuclear materials. In this role, he helped NRC and its licensees respond effectively to terrorist challenges; facilitated the continued production of safe nuclear power; prepared for the next generation of nuclear reactors; and made significant progress in establishing risk-informed regulation through the successful implementation of the reactor oversight process and through various regulatory changes. Dr. Meserve is currently chairman of the International Nuclear Safety Group chartered by the International Atomic Energy Agency. He has served on numerous legal and scientific committees over the years, including many chartered by the National Academies of Sciences, Engineering, and Medicine. Among other affiliations, he is a member of the American Philosophical Society and the National Academy of Engineering, and he is a fellow of the American Academy of Arts and Sciences, the American Association for the Advancement of Science, and the American Physical Society. Dr. Meserve served on the board of directors of PG&E Corporation and Duke Energy Corporation and is a member of the board of TAE Technologies, Inc. He is a former President of the Board of Overseers of Harvard University.

Arthur Motta. Arthur T. Motta, Ph.D., is Chair of the Nuclear Engineering Program and a professor of nuclear engineering and of materials science and engineering at Pennsylvania State University. His research focuses on the environmental degradation of materials in the reactor environment with specific emphasis on nuclear fuel cladding. His research interests include radiation damage, corrosion and hydrogen ingress, mechanical behavior of materials, and materials characterization. He holds a B.Sc. in mechanical engineering and an M.Sc. in nuclear engineering from the Federal University of Rio de Janeiro, Brazil, and a Ph.D. in nuclear engineering from the University of California, Berkeley. Before

coming to Penn State, he worked for the CEA at the Centre for Nuclear Studies in Grenoble, France, and for Atomic Energy of Canada Limited at the Chalk River Laboratories in Canada. He is a member of the editorial board of the *Journal of Nuclear Materials*. He received the Mishima Award from the American Nuclear Society for sustained contributions to nuclear fuel research and has just been awarded the Kroll Medal from ASTM for significant contributions to zirconium metallurgy.

Dr. Joseph Shepherd, Chair of the Academies study on Lessons Learned from the Fukushima Nuclear Accident for Improving Safety and Security of U.S. Nuclear Plants, Phase 2. Joseph E. Shepherd, Ph.D., is the C. L. "Kelly" Johnson Professor of Aeronautics and Mechanical Engineering and vice president for student affairs at the California Institute of Technology (Caltech) in Pasadena. His research interests are fluid and solid dynamics, combustion chemistry, thermodynamics, and dynamic structural response with applications to explosions, propulsion, high-speed flight, and energy technology. Since 1980 he has carried out research on hydrogen combustion behavior during severe accidents in nuclear power plants as well as in nuclear material processing and storage facilities. He has worked with private industry, the U.S. Nuclear Regulatory Commission, the U.S. Department of Energy, U.S. National Laboratories, and international organizations to evaluate hydrogen control methodologies and assess potential hazards including the effects of explosions. Dr. Shepherd earned his Ph.D. in applied physics from Caltech in 1981. He served as a member of the technical staff at Sandia National Laboratories from 1980 to 1986. From 1986 to 1993 Dr. Shepherd was an assistant professor of mechanical engineering at Rensselaer Polytechnic Institute. He has been on the faculty at Caltech since 1993. Dr. Shepherd served on the National Research Council Committee on Determining Basic Research Needs to Interrupt the Improvised Explosive Device Delivery Chain.

Elizabeth Ten Eyck. Elizabeth Q. Ten Eyck is president of ETE Consulting, Inc. She is an expert in domestic and international nuclear safeguards and security for government-owned and -licensed commercial nuclear facilities and has participated in vulnerability assessments of U.S. critical infrastructure for the Department of Homeland Security. Ms. Ten Eyck received her B.S. in electrical engineering from the University of Maryland. She has more than 30 years of career federal service, first as a security engineer for the U.S. Secret Service, then as director of the Office of Safeguards and Security for the U.S. Department of Energy, and, until she retired in 2000, as director of the Division of Fuel Cycle Safety and Safeguards for the U.S. Nuclear Regulatory Commission (USNRC), where she managed the safety and safeguards regulatory program for commercial fuel-cycle facilities. During her career at the USNRC, she also managed transportation activities and the safeguards program for nuclear power reactors. Ms. Ten Eyck served on the National Research Council Committee on Transportation of Radioactive Waste.

Decommissioning San Onofre Nuclear Generating Station

CEP WORKSHOP PLANNING SESSION WITH EXPERTS

SONGS Community Engagement Panel - Outlier Events Meeting

Monday, February 24, 2020 (9:30 – 10:30 a.m. PDT)

Skype Meeting – Dial In 1-213-297-0156 Conference ID 240180462#

SAN ONOFRE NUCLEAR GENERATING STATION

Purpose of Meeting:

- To discuss approach to outlier events topic in a public setting

AGENDA

Time	Topic	Who
9:30 – 9:35	Welcome and introductions	David Victor
9:35 – 9:45	CEP Workshop Overview: ○ Module on nuclear material, radiation, and contamination basics ○ Module on outlier events and consequences ○ Module on emergency response resources (local, state, federal)	David Victor
9:45 – 10:20	Open discussion	All
10:20 - 10:25	Review actions and next steps	Lorraine Sandstrom
10:25 –10:30	Closing remarks	David Victor

INVITEES:

- **DOUG BAUDER** – SCE VP & CHIEF NUCLEAR OFFICER
- **MANUEL CAMARGO** – SCE STRATEGIC PLANNING & STAKEHOLDER ENGAGEMENT
- **JOHN DOBKEN** – SCE PUBLIC INFORMATION OFFICER
- **KELLI GALLION** – SCE EMERGENCY PLANNING
- **RANDALL GRANAAS** – SCE FUELS ENGINEERING
- **TOM ISAACS** – EXPERTS TEAM & SCE INDEPENDENT STRATEGIC ADVISOR FOR NUCLEAR WASTE
- **JERRY KERN** – CEP SECRETARY
- **LORRAINE SANDSTROM** – SCE STAKEHOLDER ENGAGEMENT
- **JERRY STEPHENSON** – SCE MANAGER, ISFSI ENGINEERING
- **DAN STETSON** – CEP VICE CHAIRMAN
- **DAVID VICTOR** – CEP CHAIRMAN

EXPERT REVIEWERS:

- **MICHAEL (MIKE) CORRADINI, PH.D**, - Professor for Dept. of Engineering Physics at the Univ. of Wiscons in Madison
- **KEVIN CROWLEY, PH.D.** - advisor to the NRSB since entering phased retirement in 2017
- **DAVID LOCHBAUM** - Former director, Nuclear Safety Project
- **ED LYMAN, PH.D.** - Director of Nuclear Power Safety Union of Concerned Scientists Washington, DC
- **ARTHUR MOTTA, PH.D.** - Professor of Nuclear Engineering and Materials Science and Engineering, Ken and Mary Alice Lindquist Department of Nuclear Engineering, Penn State University
- **DR. JOSEPH SHEPARD , Ph.D.** - C. L. "Kelly" Johnson Professor of Aeronautics and Mechanical Engineering and vice president for student affairs at Caltech

From: David G. Victor
Sent: Tuesday, February 18, 2020 8:55 AM
To: Ed Lyman; Joseph Shepherd; Mike Corradini; Kevin Crowley; Tom Isaacs; David Lochbaum; Arthur Motta
Cc: Daniel T. Stetson; Jerry Kern; Manuel Camargo; Lorraine Quinn Sandstrom; Steve Carlson
Subject: (External):Expert review panel: SONGS meeting on outlier events

CAUTION EXTERNAL EMAIL
Dear Experts

This is a terrific panel, and I thank you very much for your help as we prepare a meeting in late March on outlier events at the SONGS ISFSI.

As I mentioned in my original invitation letter, we need your help ranking possible "worst case" scenarios that might involve the ISFSI. Through community meetings and reviews of technical analysis of the ISFSI we have identified 9 possible scenarios that, we think, reflect clusters of "outlier hazards" that might affect the ISFSI. We have excluded scenarios that we have judged as completely implausible (eg, meteorite strike). We are mindful that many of these scenarios involve actions that are often considered beyond design basis—or even way beyond design basis. However, we have assembled this list because we are getting many questions from the local communities about what is the worst that could happen at the ISFSI. Those questions are taking on greater urgency given the ongoing stalemate in DC with regard to spent fuel policy.

The list is:

1. Tsunami
2. Sea Level Rise
3. Ground Water daylighting
4. Seismic events
5. Vibration from decontamination and dismantlement activities
6. Canister drop
7. Corrosion and/or cracking of a canister due to CISCC
8. Postulated crack allows water to enter canister, allowing for H2 buildup and explosion
9. Terrorist attack

Attached is an event matrix that covers these 9. (Note that the first two hazards are treated as one on the hazard matrix. And on the hazard matrix there is a 9th hazard—complete removal of the lid—that is included for reference purposes. We are not asking you to evaluate it.)

We are not asking for a full blown detailed assessment. Instead, we are seeking your expert intuition and assessment of four things:

A. Your assessment of the plausibility of each of the 9 outlier event scenarios. Rank the most plausible as 100. Consider completely implausible to be 0. What number would you assign each scenario? If you want additional information let me and the folks from Edison know what you need but please go ahead and make a preliminary rating. **These assessments of plausibility will be used to identify 2-3 most plausible scenarios that will be the subject of a special meeting about SONGS outlier events.**
B. Your assessment of the practicality of discussing each scenario and its consequences in a public, non-classified format. Just a sentence or two per scenario, if that. We assume this relates

centrally to scenario 9, and any advice on how to handle that in a non-classified setting is welcome.

C. Your assessment, based on what you know (no additional research needed), of the severity of impacts of the hazard to the local community. In this case, rank the most harmful scenario to the community "100"; zero danger is 0. And assign a score to each. Again, we are interested in your intuition; at our meeting we will be presenting systematic information based in risk assessments.
D. What is missing from our list, if anything?

We hope you can do a preliminary assessment on all these questions before we have the first group call—so that we can get your independent views before the team talks as a group.

Please note that we are exploring the ISFSI-only site condition; as of this coming summer, there will be no fuel in spent fuel pools. Moreover, the SONGS ISFSIs may be the most robust in the country at 1.5g peak ground acceleration (lateral) because they were designed and constructed when a blind-thrust fault was hypothesized in the area. (Subsequent research has found that such a blind-thrust fault is highly implausible.)

I note that some members of the community have rejected this risk-based framework and want, instead, to posit that a criticality event and explosion of the fuel can occur—and they want to analyze the consequences after such an event. I have resisted that approach because i don't see how we can have a fact-based, informative meeting without some careful analysis of what, really, can go wrong. And for an ISFSI-only site the risks are radically different from an operational reactor. I fear that if the process concludes that nothing "really bad" can happen at the ISFSI that some community members will brand that outcome as a whitewash over some lurking risk that everyone is hiding. One group already has a "study" published on its website that calculates the cost of southern California becomes uninhabitable because of a Chernobyl-like event at the ISFSI. If you have advice on how this should be handled I would welcome that, but I don't want to belabor your work with those larger political questions.

Over the next 2-3 weeks I would like to do three things: a) talk with each of you individually for 15 minutes about the charge and any questions you may have—as soon as possible; b) schedule a group meeting (one hour, max) to discuss your rankings; and c) schedule a second and final group meeting to discuss any further reactions after the first meeting (one hour max). The final call will include an opportunity for members of the planning team for our meeting to join and ask questions. Lorraine from Edison will be sending you a doodle for the two group calls.

Thanks again for your help. All of us really appreciate it.

My direct private cell phone is below in case you ever need to reach me.

All best
David
Chairman, SONGS Community Engagement Panel

David G Victor
Center for Global Transformation Professor in Innovation and Public Policy, UCSD School of Global Policy and Strategy
Professor of Climate, Atmospheric Sciences and Physical Oceanography (adjunct), Scripps Institution of Oceanography
Professor of Mechanical and Aerospace Engineering (by courtesy)
Co-Director, Laboratory on International Law & Regulation
Co-Director, UCSD Deep Decarbonization Initiative
Senior Fellow, The Brookings Instiutution
UC San Diego, 9500 Gilman Drive #0519
La Jolla, CA 92093-0519 USA

Michael "Mike" Corradini. Michael L. Corradini, Ph.D., is a professor in the Department of Engineering Physics at the University of Wisconsin, Madison. Dr. Corradini's research focus is nuclear engineering and multiphase flow with specific interests that include light-water reactor safety, fusion reactor design and safety, waste management and disposal, vapor explosions research and molten core–concrete interaction research, and energy policy analysis. He received his B.S. in mechanical engineering from Marquette University and his M.S. and Ph.D. degrees in nuclear engineering from the Massachusetts Institute of Technology. He is a member of the American Institute of Chemical Engineers, the American Society of Engineering Education, and the American Society of Mechanical Engineers, and a Fellow of the American Nuclear Society. Dr. Corradini has received numerous awards including the National Science Foundation's Presidential Young Investigator Award, the American Nuclear Society reactor safety best paper award, and the University of Wisconsin, Madison, campus teaching award. He has served on various technical review committees, including the research review panel of the U.S. Nuclear Regulatory Commission. He currently serves on the U.S. Nuclear Regulatory Commission's Advisory Committee on Reactor Safeguards and was president of the American Nuclear Society in 2013-2014. Dr. Corradini was elected to the National Academy of Engineering in 1998..

Kevin D. Crowley, Ph.D., has been an advisor to the NRSB since entering phased retirement in August 2017. His professional interests focus on the application of science and technology to improve societal well-being, advance public policy making, and enhance international cooperation, particularly with respect to the safety, security, and efficacy of nuclear and radiation-based technologies and applications. He previously held several positions at the National Academies, including senior board director of the NRSB (2005–2017), director of the Board on Radioactive Waste Management (1996–2005), and principal investigator for a longstanding
cooperative agreement between the National Academy of Sciences and the Department of Energy to provide scientific support to the Radiation Effects Research Foundation in Hiroshima, Japan (2010–2017). Before joining the National Academies staff in 1993, Dr. Crowley held teaching and research positions at Miami University of Ohio, the University of Oklahoma, and the U.S. Geological Survey. He holds an M.A. and a Ph.D., both in geology, from Princeton University.

Tom Isaacs. Currently, advisor to Canadian Nuclear Waste Management Organization (NWMO) on management and storage of Canada's SNF, last 13 years. Mr. Isaacs is a well-recognized national and international leader in the field of nuclear energy, nuclear waste management, nuclear security, repository siting, and public trust and confidence. Recognized leader and frequent invited speaker both within the U.S. and around the world, including Canada, Japan, South Korea, Stanford, MIT, among many others on issues of nuclear waste management program strategy and implementation, fuel cycle, facility siting, public trust and confidence, and stakeholder engagement. Education includes a B.S. with honors in Chemical Engineering from the University of Pennsylvania (Tau Beta PI, Phi Lambda Upsilon honor societies) and a M.S. in Engineering and Applied Physics from Harvard University (while studying nuclear engineering at MIT). Mr. Isaacs has had significant leadership positions in the technical, strategic, programmatic, policy, siting, societal, engagement, and communications dimensions of nuclear waste management for over 30 years. He was instrumental in: the siting of the Yucca Mountain candidate repository Site; the passage of the Nuclear Waste Policy Amendments Act of 1987 that defined the U.S. waste program; the development of the Blue Ribbon Commission on America's Nuclear Future (BRC) report written at the direction of the President of the United States that recommended the path forward for the U.S. nuclear waste program; and the strategic approach currently being implemented by the Nuclear Waste Management Organization of Canada to manage and dispose of spent fuel. Director, Office of Policy within the U.S. DOE office responsible for spent fuel and high level radioactive waste (HLW) management and disposal (The DOE Office of Civilian Radioactive Waste Management). Responsible for the strategic direction of the national program to manage and dispose of spent nuclear fuel and high-level radioactive waste. Major responsibilities Included setting program directions, priorities, and policies for this $400 million per year program, leading policy and technical analyses, and managing a federal and contractor staff. Managed the comparative evaluation of candidate sites for the for the first U.S. repository program for the disposal of U.S. spent nuclear fuel and high-level radioactive (HLW).

David Lochbaum. Mr. Lochbaum received a BS in Nuclear Engineering from the University of Tennessee in 1979 and worked as a nuclear engineer in nuclear power plants for 17 years. In 1992, he and a colleague identified a safety problem in a plant where they were working. When their concerns were ignored by the plant manager, the utility, and the Nuclear Regulatory Commission (NRC), they took the issue to Congress. The problem was eventually corrected at the original plant and at plants across the country. Lochbaum joined UCS in 1996 to work on nuclear power safety. He spent a year in 2009-10 working at the NRC Training Center in Tennessee. He retired in 2018. Areas of expertise: Nuclear power safety, nuclear technology and plant design, regulatory oversight, plant license renewal and decommissioning .

Ed Lyman. Edwin Lyman is an internationally recognized expert on nuclear proliferation and nuclear terrorism as well as nuclear power safety and security. He is a member of the Institute of Nuclear Materials Management, and has testified numerous times before Congress and the Nuclear Regulatory Commission. Since joining UCS in 2003, he has published articles in a number of journals and magazines, including *Science*, *the Bulletin of the Atomic Scientists*,

Science and Global Security, and *Arms Control Today*, and he has been cited in thousands of news stories, including articles in the *Boston Globe*, *Chicago Tribune*, *Los Angeles Times*, *New York Times*, *Wall Street Journal*, *Washington Post*, and *USA Today*, and in segments on ABC, CBS, CNN, C-SPAN, MSNBC, NBC, NPR and PBS. Dr. Lyman also co-authored the critically acclaimed book, *Fukushima: The Story of a Nuclear Disaster* (New Press), which was published in February 2014. In 2018, Dr. Lyman was awarded the 2018 Leo Szilard Lectureship Award from the American Physical Society.

Arthur Motta. Arthur T. Motta, Ph.D., is Chair of the Nuclear Engineering Program and a professor of nuclear engineering and of materials science and engineering at Pennsylvania State University. His research focuses on the environmental degradation of materials in the reactor environment with specific emphasis on nuclear fuel cladding. His research interests include radiation damage, corrosion and hydrogen ingress, mechanical behavior of materials, and materials characterization. He holds a B.Sc. in mechanical engineering and an M.Sc. in nuclear engineering from the Federal University of Rio de Janeiro, Brazil, and a Ph.D. in nuclear engineering from the University of California, Berkeley. Before coming to Penn State, he worked for the CEA at the Centre for Nuclear Studies in Grenoble, France, and for Atomic Energy of Canada Limited at the Chalk River Laboratories in Canada. He is a member of the editorial board of the *Journal of Nuclear Materials*. He received the Mishima Award from the American Nuclear Society for sustained contributions to nuclear fuel research and has just been awarded the Kroll Medal from ASTM for significant contributions to zirconium metallurgy.

Dr. Joseph Shepherd, Chair of the Academies study on Lessons Learned from the Fukushima Nuclear Accident for Improving Safety and Security of U.S. Nuclear Plants, Phase 2. Joseph E. Shepherd, Ph.D., is the C. L. “Kelly” Johnson Professor of Aeronautics and Mechanical Engineering and vice president for student affairs at the California Institute of Technology (Caltech) in Pasadena. His research interests are fluid and solid dynamics, combustion chemistry, thermodynamics, and dynamic structural response with applications to explosions, propulsion, high-speed flight, and energy technology. Since 1980 he has carried out research on hydrogen combustion behavior during severe accidents in nuclear power plants as well as in nuclear material processing and storage facilities. He has worked with private industry, the U.S. Nuclear Regulatory Commission, the U.S. Department of Energy, U.S. National Laboratories, and international organizations to evaluate hydrogen control methodologies and assess potential hazards including the effects of explosions. Dr. Shepherd earned his Ph.D. in applied physics from Caltech in 1981. He served as a member of the technical staff at Sandia National Laboratories from 1980 to 1986. From 1986 to 1993 Dr. Shepherd was an assistant professor of mechanical engineering at Rensselaer Polytechnic Institute. He has been on the faculty at Caltech since 1993. Dr. Shepherd served on the National Research Council Committee on Determining Basic Research Needs to Interrupt the Improvised Explosive Device Delivery Chain.

From: David G. Victor
Sent: Saturday, February 22, 2020 8:07 AM
To: Tom Isaacs; David Lochbaum
Cc: Ed Lyman; Joseph Shepherd; Mike Corradini; Kevin Crowley; Arthur Motta; Daniel T. Stetson; Jerry Kern; Manuel Camargo; Lorraine Quinn Sandstrom; Steve Carlson
Subject: (External):Re: expert review panel: SONGS meeting on outlier events

CAUTION EXTERNAL EMAIL
Dear All

Thanks so much for your thoughtful discussion of these issues. Picking up on Tom's email, let me summarize and propose a way forward.

First, I will document more fully the broader process that has led to the 9 scenarios that we put together—in particular, the many inputs from the community, in addition to the petition. Thanks to Kevin for teeing that up.

Second, yesterday I initiated a process of writing to all the city managers from the towns and cities near the plant to get them to articulate the concerns they have heard about the dangers of long-term storage of the canisters at the ISFSI. Each of those towns and cities has an elected official on our CEP so I suspect we will get heavy or complete overlap in information, but this process will formalize and systematize that input. As we gather that info we will add it to the documentation about the concerns that the public has been raising about the site. Jerry Kern, who is part of the CEP leadership, will follow up to get replies from the City Managers—he used to be mayor of Oceanside.

Third, further to comments by Ed that many people have supported, lets simplify the evaluation we are asking from you, the team of experts. Let's focus just on consequences and your intuition of which consequences are most severe. If you want to rank them that is great; if you want to offer a qualitative assessment of which matter most that is fine as well. As a starting point, Tom has suggested a 2x2 matrix in his email and has suggested four scenarios that should command greater concern:

- Terrorist attack
- Seismic event followed by a tsunami
- Sea level rise
- Degradation of the canisters, followed by water intrusion (and hydrogen generation)

But we want the full panel's views, using whatever system of categorization makes sense to you, about which kinds of scenarios would be most consequential.

Fourth, as Dave L has suggested, there may be other scenarios. If so, please tell us about them—as Dave has done. And if they rank high in consequences in your view, please tell us that too.

Fifth, the public meeting we host will look at a combination of the most consequential concerns (aided by you) and those of greatest public concern (as revealed by our broader public process). I see that meeting giving some attention to topics that are addressed easily and then more detailed attention to the topics that are harder to parse yet really important—for example, terrorist attack. What is clear from the email threads, however, is that we need to make sure there are answers available for all the major scenarios of concern (ie, the 9 scenarios we have outlined, plus any others—such as wayward ships). I don't yet know how we will provide information about the scenarios beyond those that get focal attention at our meeting, but at minimum I will make sure that the relevant technical information

for each of those scenarios, along with responses, is assembled in plain English and in one place—so that people can see the full set of concerns, the full evaluations of consequences and responses. That is what we are hearing, from elected officials, is needed—and would be highly responsible for our CEP and for SCE.

On the call Monday we would like to hear any additional views you have on this process, questions, and also any requests for information. Again, we are not asking for a full blown risk analysis but your intuition as experts. But we fully appreciate that intuition is guided by information.

All best
David

From: Tom Isaacs
Date: Friday, February 21, 2020 at 3:08 PM
To: David Lochbaum
Cc: David G. Victor, Ed Lyman; Joseph Shepherd; Mike Corradini; Kevin Crowley; Arthur Motta; Daniel T. Stetson; Jerry Kern; Manuel Camargo; Lorraine Quinn Sandstrom; Steve Carlson
Subject: Re: expert review panel: SONGS meeting on outlier events

Dear all,

Thanks for the perceptive input. I would like to add some of my perspectives.

First let me mention that I currently serve as the chair of (another) Experts Team formed by San Onofre (SONGS) to advise them on exploring options for moving the spent fuel off-site. I also serve as the Independent Strategic Advisor to Southern California Edison, the parent company of SONGS, on nuclear waste issues. I mention this only to inform you of the affiliation as we hopefully work as a group to assist David and the CEP.

First as Kevin has already mentioned, I think it is important for David to explain the context for the proposed meeting. Namely there are several groups and individuals that express interest and concern to David and the CEP, and to SONGS, about what could possibly happen at SONGS, how extensive consequences might be, and how emergency response would work in the event of a serious incident. The petition is important and should be addressed as one of several inputs.

I am not a great fan of postulating "what if" scenarios in general. While they can serve a possible useful purpose in benchmarking, one can always construct yet more extreme scenarios. I think it would make sense to focus on scenarios that could be rather extreme and might lead to off-site emissions, but should be balanced against both plausibility and stakeholder interest,

In the roles I mentioned earlier, I have attended previous CEP meetings and had numerous interactions with the petitioners, other engaged individuals, and affected organizations. As I see it, the concerns regarding scenarios have tended to fit into what I think of as a two-by-two matrix: They want to look at events that are initiated by nature and those that that would be initiated by people. On the other axis of the matrix, they are interested in events that occur relatively rapidly such as a terrorist attack or a seismic event that could be followed by a tsunami, and they are interested in slower emerging

circumstances such as sea level rise inundating the storage system and/or the degradation of the storage containers, leading to radiation leakage and possibly compounded by water intrusion.

Those scenarios are a good starting point from my point of view.

I suggest that working to find the right balance is an important objective. Scenarios that test the limits of the system with regard to public health and safety and protection of the environment should be fully examined and balanced against causing undue anxiety or dread in the community which can also lead to bad decision making.

I look forward to our discussions.

Best,

Tom

DEPARTMENT of ENGINEERING PHYSICS
College of Engineering, University of Wisconsin-Madison

Nuclear Engineering **Engineering Physics** **Engineering Mechanics** **Astronautics**

February 28, 2020

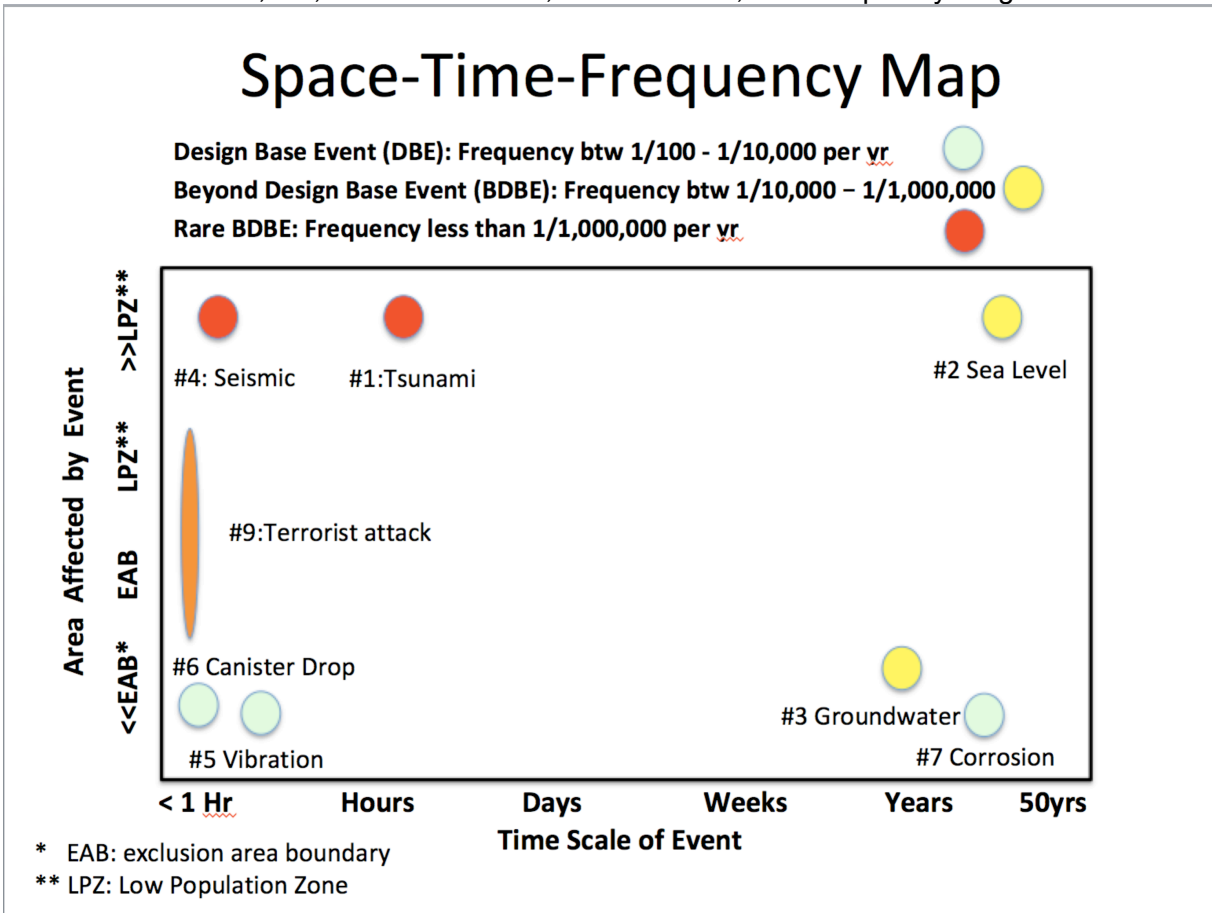
To: Prof. David Victor, UCSD

From: Prof. Mike Corradini, UW

RE: Comments on SONGS ISFSI Outlier Events

As requested, these are my comments on the postulated outlier events for the SONGS ISFSI. As I had noted in initial email, I was concerned about how these events were determined and you did help explain the evolution as to how these arose. I was also concerned that many of these events go beyond the regulatory design base. SONGS, as owned and managed by Southern California Edison (SCE), has historically shown that it has operated safely and it has provided adequate protection to the public with significant margin. The plant was built and operated in accordance with all requirements of the NRC license. And based on the FSAR for the ISFSI, that continues to the present time and into the future. In my view, all discussions about how to manage the ISFSI should be conducted in terms of compliance with applicable regulatory requirements. I appreciate some members of the public being concerned about the ISFSI operation, but this exercise should be viewed as showing how much margin exists beyond what is required for adequate protection.

In that context, I developed figure (below) in order to communicate the three attributes of any of these outlier events; i.e., Event time scale, Area affected, and Frequency range of the event.



Any of these events have a time scale over which the event occurs that could be less than an hour to many hours, days, weeks or even years. Also, these events could occur over a wide range of areas; i.e., within the SONGS site and what is controlled by SCE (EAB – exclusion area boundary) or within the near low population zone (LPZ) surrounding the site or over an area that could reach to the metropolitan areas of Los Angeles or San Diego. This is important since, while the radiological consequence of the event may be limited in area, the event itself and its non-radioactive consequence could be significant and could extend for tens of miles. In this case, this should be of equal or greater concern to the citizens of the region. Finally, the frequency of the event occurrence needs to be considered; i.e., within the design base events (DBE) of the ISFSI or beyond design basis events (BDBE) or rare events that go well beyond DBEs. In my judgment, I have placed all the postulated events within the figure above and provided my estimate of the three attributes.

1] Tsunami: I assumed this meant a large seismic event that occurs away from the region but the resulting tsunami impacts this region. Based on external flooding analyses, this is a rare event that affects a large region with minimal radiological consequences, but with significant other damage.

2] Sea Level Rise: This would be a slow process (decades) and compensatory actions could be taken by SCE if the pre-cursors suggest it would occur.

3] Groundwater Daylighting: I assumed this meant an unforeseen redirection of groundwater and intrusion into the ISFSI. This would also be a slow process (decades) and compensatory actions could be taken by SCE. I would judge this to be low likelihood too.

4] Seismic Event: This is a seismic event in the vicinity of the site. Based on past analyses and the robust ISFSI canister seismic design, this is likely a rare event that would affect a large region with minimal radiological consequences, but likely significant other damage to a large region of CA.

5] Vibration from on-site activities: This event should be within the design base and such an occurrence would have no radiological consequences based on the canister design for accidents.

6] Canister drop: This event is within the design base and such an occurrence would have no radiological consequences based on canister design for accidents. Testing has demonstrated this.

7] Corrosion due CISCC: This event is within the design base and such an occurrence would have no radiological consequences based on canister design; i.e., a slow event that can be monitored.

8] Postulated-crack/water-intrusion/H2-explosion: This event evolution is not specified but I assume it requires corrosion and crack of the canister, water intrusion, combustible gas production by radiolysis, and then combustion of the gases with enough severity to fail fuel with radiological material release. I would judge the scenario **incredible** given the sequence of physics required. First it would be a long time process (like #7) that monitoring would reveal and compensatory action taken. Second, temperatures would be low and radiolysis slow enough again monitoring would reveal an issue. Third, even if the first two events occur the canister is robust in design.

9] Terrorist attack: This event could occur over a relatively short time scale and likely localized to the site. Based on regulatory analyses, the radiological consequences may be beyond the site but the magnitude would be small. This event has significant uncertainty, but it is my judgment there are many more targets that could generate significant consequences to the health and safety of the public in larger population areas.

Department of Engineering Physics *1500 Engineering Drive* *Madison WI 53706*
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Assessments/Recommendations on CEP Workshop Scenarios

KD Crowley

March 2, 2020

1. It isn't feasible to risk-rank the scenarios because (1) the panelists haven't conducted a technical analysis of the scenarios; and (2) most of the scenarios have highly uncertain likelihoods of occurrence.

2. Discussing the scenarios in terms of absolute or relative risks is not likely to satisfy members of the public who are skeptical/dismissive of risk assessment. I think it is better to start with a discussion of potential consequences (characterized, for example, as "low", "medium", or "high") and then discuss likelihoods of occurrence. This approach will make risk experts uncomfortable but would likely be more meaningful to members of the public who care primarily about consequences regardless of likelihoods.

3. Here are three examples showing how the scenarios could be addressed; these brief responses would need to be fleshed out by the panelists having appropriate expertise:
    a. Tsunami: Low potential consequences because MPCs would protect the spent fuel from water ingress, casks would protect the MPCs from damage, and flooding would enhance heat removal from the stored spent fuel. Floodwater could be pumped out of the casks and air cooling restored following the tsunami.
    b. Sea level rise: Low potential consequences because changes in sea level sufficient to flood the ISFSI would occur over a period of decades, enough time for protective actions to be taken or for the ISFSI to be relocated to higher ground on the SONGS site (for example to the current location of Units 2 & 3; moving the ISFSI to higher ground on the SONGS site was explicitly mentioned in the CCC permit for the SONGS ISFSI) if an offsite storage location were not readily available.
    c. Ground water daylighting. Low potential consequences. As noted in (a) above, flooding would not damage the ISFSI. Additionally, pumps could be installed around the ISFSI to lower groundwater levels, or the ISFSI could be relocated to higher ground as noted in (b) above.

4. Terrorist attack. I probably have more exposure than any of the other panelists to the classified literature on spent fuel sabotage and can take the lead if desired to flesh out the response for this scenario, being very careful not to divulge classified/sensitive information. Here's an outline of a possible response:
    a. One needs to answer the following three questions to understand ISFSI sabotage risks: (1) Is the ISFSI an attractive target to terrorists? (2) Would a terrorist attack on the ISFSI likely succeed? (3) If an attack were successful, what would be the potential consequences? I would answer these questions in reverse order as discussed briefly in (b)-(d) below.
    b. Potential consequences of an attack: Low-medium: An attack that successfully breached an MPC containing spent fuel could result in the release of radioactive noble gases (e.g., Kr, Xe) and particulate materials to the environment. The noble gases would be diluted and transported in the atmosphere and particulates

would be dispersed on the ground downwind of the MPC. SONGS personnel and members of the public close to the ISFSI could receive radiation doses from these releases depending on atmospheric conditions, but received doses, if any, could be reduced through protective actions.

c. Likelihood of a successful attack: Low if "success" is defined as the release of radioactive materials to the environment because of (1) the inaccessibility of the ISFSI; (2) security posture at the SONGS site (vehicle barriers, fences, and guards with guns); and (3) robust construction of the ISFSI with multiple barriers to radioactive material releases (cask, MPC, and spent fuel cladding).
d. ISFSI attractiveness: Low. An ISFSI is a hardened target and would not be attractive to terrorists whose objectives are to kill large numbers of people and destroy/damage large amounts of property.

5. Other suggestions for the workshop:
    a. Discuss the main features of the ISFSI and the multiple barriers to radioactive material releases.
    b. Discuss the role of regulators for the SONGS ISFSI. This would include the NRC, which licenses and regulates both the safety and security of ISFSIs in the United States, as well as the CCC, which issues permits for coastal development. Note that the CCC permit for the SONGS ISFSI specifically authorizes its operation only for a period of 20 years (until 2035) and requires SCE to obtain a permit amendment to retain, relocate, or remove the facility, supported by an analysis of coastal hazards, information about the physical condition of the casks, and information about the ISFSI maintenance and monitoring program. This is an important feedback loop that will help ensure that any changes in coastal hazards or condition of the facility can be dealt with in a timely manner.
    c. Answer representative questions about the ISFSI posed by members of the public, for example from the petition you provided previously, that are not captured by your scenarios.

<End>

From: Tom Isaacs
Date: Friday, February 28, 2020 at 8:56 AM
To: "David G. Victor"
Subject: Assessment of scenarios

HI David,

Hope all is well as it seems to me the world is turning faster with each day.

As to the scenarios, you have most of my thinking already in the piece where I described the 2x2 matrix as a way of thinking about the landscape of possible events.

The four postulated events that came out of that description still seem to me to be appropriate ones to consider as part of the CEP agenda. I realize four may be a lot to cover.

Of the four, in my judgment I would say sea level rise would be the one most subject to removal from the list as it should be slow moving enough to allow for sufficient time for appropriate action to mitigate. And I agree with some of the others that contemplating an act of terrorism might be at the top of my list. So I would rank them in order for coverage by the CEP - namely a qualitative judgment of plausibility, consequence, and interest:

Terrorism
Canister degradation with potential water intrusion
Seismic event followed by tsunami
Sea level rise and inundation

Part of the challenge or balancing act, as you know, will be between covering credible events and the petitioners' desire for "what's the worst that could happen" essentially independent of causation. The latter is not where most scientists live.

Let me know if you need anything else and feel free to contact me for further discussion.

Best,

Tom

>>

From: Tom Isaacs
Date: Friday, February 21, 2020 at 3:08 PM
To: David Lochbaum
Cc: David G. Victor, Ed Lyman; Joseph Shepard; Mike Corradini; Kevin Crowley; Arthur Motta; Dan Stetson; Jerry Kern; Manuel Camargo; Lorraine Quinn Sandstrom; Steve Carlson

Subject: Re: expert review panel: SONGS meeting on outlier events

Dear all,

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I look forward to our discussions.

Best,

Tom

Evaluation by Dave Lochbaum

	Event	Plausibility (100 high, 0 low)	Reason for Plausibility Assessment	Consequence (100 high, 0 low)	Reason for Consequence Assessment	Risk
1	Tsunami	20	Despite hindsight causing apprehension that a similarly low plausibility would have been assigned for Fukushima on March 10, 2011, this black swan seems less likely than other events.	5	There were 408 spent fuel assemblies loaded into 9 dry canisters at Fukushima when the tsunami arrived. The dry storage facility was submerged for awhile. Inspections about one week later and more thorough examinations about 10 weeks later found no evidence of damage or degradation - hence, this low consequence value. Tempering this low value is the fact that the event represents a common-cause hazard that could adversely affect multiple canisters. Yet, the low value remains.	1.0
2	Sea Level Rise	30	This event only has consequences if the ISFSI remains in place to become submerged by the rising tide. Given the relatively slow rising trend, human intervention would have to be slower for the event to happen. The plausibility reflects hope that intervention will be successful, dampened by less than complete faith.	5	There were 408 spent fuel assemblies loaded into 9 dry canisters at Fukushima when the tsunami arrived. The dry storage facility was submerged for awhile. Inspections about one week later and more thorough examinations about 10 weeks later found no evidence of damage or degradation - hence, this low consequence value. Tempering this low value is the fact that the event represents a common-cause hazard that could adversely affect multiple canisters. Yet, the low value remains.	1.5
3	Gound Water Daylighting	40	Not sure that is meant by "ground water daylighting," but I took it to mean instrusion of water into vault(s) to block cooling air flow and/or accelerate degradation mechanisms. Groundwater has made its way through concrete at Seabrook and the pathways for cooling air flow through the vaults can be used for water to get in. So, moisture seems plausible to visit vault(s).	10	While similar to the tsunami and sea level rise events in exposing canisters to water, the consequence value for this event is greater because of the potential for the water to remain undetected for longer periods, resulting in more degradation.	4.0
4	Seismic Events	70	California has higher seismic hazards than Kansas or Florida. The nuclear facilities in California consequently have more robust earthquake protections than nuclear facilities in Kansas or Georgia. The plausibility reflects a mix of required protections being defective and an earthquake's magnitude exceeding the design basis level (and protection).	25	The consequence value is based on the earthquake exploiting defective/inadequate seismic protection or being of a larger magnitude than designed for, resulting in canister(s) breach. The consequence value would be greater if the breach was believed to more likely than not result in a zirconium fire.	17.5
5	Vibration from Decontamination and Dismantlement Activities	50	The drop of a heavy component being removed could cause ground motion approaching that from a design basis earthquake. The modules being lifted into place at the new reactors (Vogtle Units 3 and 4) were evaluated for seismic-like impacts (no pun intended) with results showing the operating reactors next door would not experience motion exceeding design basis protection levels. But it's far from certain that decommissioning activites will be similarly analyzed.	25	The consequence value is linked to that for the seismic event. Deficient seismic protection or ground motion greater than designed against was considered to have the same potential consequence.	12.5
6	Canister Drop	60	Given the number of canisters to be moved and the multiple times each canister gets moved, anything shy fo 100% reliability means one or more canisters is dropped. Perfection is an elusive objective.	15	The consequence value evaluation considered that a drop could expose inadequate assembly or involve larger forces than designed for, similar to conditions factored into the seismic and vibration events consequences. But a lower consequence value was assigned to this event because the potential damage is limited to a single cask and the other events could potentially compromise multiple canisters.	9.0
7	Corrosion and/or cracking of a canister due to CISCC	90	Corrosion happens. The issue is whether corrosion proceeds to the point that integrity is breached or handling of the canister is impacted. Given the federal government's "progress" providing a repository, the canisters will potentially be around long enough for even a dead tortoise to win the slowest corrosion race.	30	This consequence value is based on an assumption that the corrosion is not detected and addressed before causing significant degradation. In June 1995, a spent fuel assembly being moved in the spent fuel pool at Oyster Creek broke apart with 41 fuel rods falling to the floor and 8 fuel rods along with a piece of the assembly still latched to the refueling crane. The spent fuel assembly has been in the pool for about 15 years and its degradation over that period was not detected until literally "the bottom fell out." A canister disintegating while being lifted from a vault could be worse, much worse.	27.0

8	Postulated crack allows water intrusion, H2 building, and explosion	10	Too many things have to happen for this event to progress to hydrogen detonation for it to warrant a higher plausibility factor.	70	The consequence value is significantly greater than the value given to the corrison/cracking event because this event assumes water intrusion, hydrogen generation and detonation - steps that are not inherent with a canister breach due to corrosion cracking.	7.0
9	Terrorist Attack	80	9/11, the Boston Marathon bombings, and mass shootings indicate that acts of malice are not speculative. After 9/11, the NRC upped physcial protection of operating reactors to include force-on-force security testing at least once every three years. Once permanently shut down, the NRC scales back physical protection and reduces the frequency of force-on-force security testing to NEVER. Hazardous targets and lessened security seems to invite attempted sabotage of an ISFSI. The plausibility value is also based on potential insider sabotage. On May 7, 1979, 62 of 64 new fuel assemblies at the Surry nuclear plant in Virginia were discovered to have had sodium hydroxide poured onto them (NRC Info Notice 79-12).	90	It's hard to recall a video of the World Trade Center towers collapsing or the damage to the Murray Federal Building in Oklahoma City and conclude that sabateurs would be unable to wreak havoc if given a chance. The high consequence value assumes that the sabotage is conducted as planned (i.e., intervention fails).	72.0

From: Edwin Lyman
Date: Thursday, March 5, 2020 at 2:33 PM
To: David G. Victor
Subject: RE: let me try this...here is the email forwarded as an email, not attachment.....

Hi David,

I'm finding it very difficult to do this subject any justice at this level of detail. I can't provide any real answers without a much deeper investigation, including reviewing the FSAR, etc. But let me offer some thoughts about the framework about how I would think about this problem:

Different ways the radiological consequences of accidents/terrorist attacks affecting a fully loaded ISFSI can be grouped into several categories (from most to least severe):

Individual dose-based criteria:

1. Atmospheric radiological releases off-site requiring near-term evacuation (EPA PAG: greater than 1 rem exposure in 96 hours)
2. Atmospheric radiological releases off-site requiring long-term population relocation (EPA PAG: greater than 2 rem exposure in the first year)
3. Atmospheric radiological releases requiring site decontamination but no recommended off-site emergency measures
4. Marine releases resulting in off-site shore/water restrictions, seafood interdiction (short-term due to storm/tsunami or long-term due to permanent inundation)

Collective dose/societal impact criteria;

1. Atmospheric radiological releases resulting in latent cancer fatalities > XX
2. Atmospheric radiological releases resulting in numbers of evacuees or relocated indivduals > YY
3. Atmospheric radiological releases resulting in economic consequences > ZZ
4. Marine releases resulting in dose/economic consequences > AA

Then there are a range of other considerations for the future if/when the spent fuel in the ISFSI needs to be unloaded and relocated or repackaged for off-site transport. Assembly drop, especially if there is corroded and damaged fuel, could dominate the consequences at that time.

So what scenarios are capable of resulting in these consequence classes? For the most severe, the most plausible events are those capable of breaching the casks, generating a large, dispersible source term as well as a driving force for expulsion of radioactive aerosols and gases.

1. Sabotage attacks capable of causing a self-sustaining zirconium fire, resulting in widespread cladding failure, fuel melt, and overpressure: requires cask breach, introduction of a sustained heat source into the cask and sufficient oxygen ingress
2. Sabotage attacks capable of damaging multiple casks at once. --e.g. multiple shaped charge attacks that would multiply the relatively small source terms from each cask
3. Aircraft crash resulting in engulfing, long-duration pool fire

If widespread fuel melt does not occur – which would be the outcome of a simple shaped charge attack -- the source term is limited to the radionuclides in the cask atmosphere resulting from CRUD and any failed fuel rods, additional gap fission product fraction from fuel rods breached by the attack, and particulate aerosol generated by mechanical damage and short-term heating from the shaped charge jet. But even a single shaped charge attack could conceivably lead to off-site doses requiring evacuation, especially for the narrow San Onofre site. See https://www.nrc.gov/docs/ML1329/ML13297A320.pdf

I would need to do more research to offer any insight regarding releases that could occur from long-term cask and fuel degradation. But again, the key factors are the likelihood of a breach, the extent of cladding damage, and the potential for a driving force. Residual hydrogen or additional generation from moisture infiltration could increase internal pressure but I would need to check whether deflagration/detonation would even be possible. That would require significant oxygen ingress.

With regard to marine releases, only sustained submersion would be likely to result in the conditions for significant radionuclide release. I did some work a long time ago regarding marine releases of spent fuel casks lost at sea. Dose rates over time to critical groups (e.g. seaweed/shellfish consumers) can be significant depending on the depth. I would think allowing the ISFSI to become permanently submerged could be a long-term radiological hazard – but is that a credible scenario unless there is no longer any maintenance or regulation of the site?

David, I hope this is helpful, but it is the best I can do in the available time!

Best,

Ed

PennState

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Prof. David G. Victor
David G Victor
UC San Diego, 9500 Gilman Drive #0519

March 5, 2020

David

Thank you for your patience and for speaking with me last week. I received your summary and decided instead to rewrite my response it in my own words, also after talking with Joe Shepherd, Kevin Crowley and Mike Corradini. This is a quick response to the 9 scenarios you had considered. Note that these are based only on a quick evaluation of the scenarios considered. Much more detail about the exact scenarios and a much more detailed technical evaluation would be needed for a quantitative assessment.

I share the concern that others have that if one focuses only on consequences, one would develop a very skewed notion of risk, similar to the example I gave on the phone of how many people can die in a plane crash? Well if two full 747s collide in midair and fall on a stadium where the Super Bowl is being played…, etc.

My overall comment is to agree with Kevin Crowley that absent a detailed technical evaluation one cannot credibly ranks risks.

Here are my off the cuff reactions to the scenarios proposed, keeping in mind that no quantitative evaluation was done:

1. Tsunami: I have no direct expertise. I understood, however, that the plates near California do not move in such a way as to produce a tsunami. And although tsunamis can originate elsewhere in the Pacific, they do diminish with distance.
2. Sea Level Rise; This is a very slow process, and as Mike Corradini says can be monitored over time. Kevin Crowley let me know that the ISFSI facility at San Onofre is a little elevated which gives it additional time for mitigating action. We should note if climate change indeed makes sea water rise to get to the ISFSI we have >much< bigger problems.
3. Ground Water daylighting: Kevin tells me this is the rise of the groundwater table so that it intersects the ISFSI; this would be a very slow process that could be monitored so at first sight it does not appear to be a major concern.
4. Seismic events: I have no expertise as to the likelihood of the event. As to the effect of ground shaking it could be similar to a canister drop see below.
5. Vibration from decontamination and dismantlement activities. From Kevin: this refers (I think) to ground shaking caused by demolition activities during SONGS decommissioning. This shaking would be substantially less severe than the design basis earthquake for the SONGS ISFSI.
6. Canister drop: The removal of canisters for final disposal or other purposes will be done very carefully, but accidents can happen, and a canister could be dropped. There is evidence that a 25 ft drop causes little canister damage. However, even if the canister is not damaged the fuel inside could be. In that case, although no release would happen if the canister is not damaged, the fuel inside could be broken and not retrievable. One strategy at that point is to further encapsulate the dropped canister to

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ensure no release. Since the canister drop should be a relatively unlikely event, such a mitigation strategy should make this cause be at little risk of release.

7. Corrosion and/or cracking of a canister due to CISCC. Out of an abundance of caution the possibility of stress corrosion cracks developing near marine environments enhanced by salt has been considered by the NRC. However, stress corrosion crack is a well-known process that develops slowly and can be monitored. The cracks produced by such a process would be likely closed (or be very small width) cracks that would allow little ingress of water into the canister.

8. Postulated crack allows water to enter canister, allowing for H2 buildup and explosion. The reason there were explosions at Fukushima is that the decay heat from the fuel was quite high and in the absence of forced cooling the fuel rod temperatures quickly rose to high levels. In contrast, by definition, fuel that is in dry storage has had to sit in a pool for 5 years or so, during which period the decay heat falls by a factor of 500-1000, so that natural convection can keep the nuclear fuel cool by itself (no forced cooling, no power needed). In order for there to be enough hydrogen generated that could cause an explosion the fuel would have to attain very high temperatures, on the order of 1200°C, as chemical reactions increase exponentially with temperature. I don't see a credible scenario for this to occur.

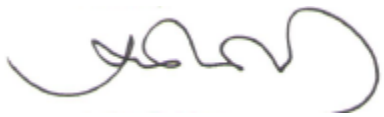
In speaking with Joe Shepherd he alerted me to another possible mechanism for achieving flammable mixture within the canister. This involves about a liter of water somehow getting into the canister, and over the years the water being dissociated by radiolysis into oxygen and hydrogen. Assuming no recombination or absorption of hydrogen anywhere and no leakage of hydrogen over the years (even though in this scenario significant water has come in to the canister so there would have to be an opening to the outside), there is a possibility of achieving a flammable mixture at some point in the canister's life. However, even in that case the radiological consequences are likely not much, because evaluations have been done that the canister can withstand such a conflagration without losing integrity.

The detailed quantitative evaluation of such a scenario is quite complicated: one would need to know what reasonable gamma and neutron fluxes (and resulting dose rates) are as a function of time, the rate of water ingress, the size of the hole that would allow water to get in but not allow hydrogen to get out, the availability of a spark within the canister, etc.

=> This clearly illustrates what Kevin mentioned, i.e. absent a detailed technical evaluation of the scenarios it is not really possible to risk-rank these scenarios.

9. Terrorist attack no idea what the likelihood is, but surely there are much softer targets with much larger consequences.

I would like to ask to review any public documents that use these opinions before they are published.
Please let me know if any questions.



Arthur T. Motta
Professor of Nuclear Engineering and Materials Science and Engineering

From: David G. Victor
Sent: Thursday, March 05, 2020 7:49 PM
To: Lorraine Quinn Sandstrom; Mike Corradinia; Kevin Crowley; Tom Isaacs; David Lochbaum Ed Lyman; Arthur Motta; Daniel T. Stetson; Jerry Kern
Cc: Manuel Camargo; RANDALL GRANAAS; JERRY STEPHENSON; Kelli Gallion-Sholler; Doug Bauder; David G. Victor
Subject: (External): Expert assessment of scenarios

CAUTION EXTERNAL EMAIL
Dear Colleagues

Attached please find seven documents—six are the individual reports from the six experts, and the seventh is a copy of the request from me to the team.

Based on this process, my sense is that we have the following very high priorities for treatment in the meeting. I have binned the scenarios according to the group's assessments. Scenarios in green clearly need to be a focus of the meeting. Those in yellow we need to discuss as a team so we can understand the range of views. Those in red are out of scope for the meeting—some materials should be organized and offered online to explain why.

These rankings are a DRAFT—they are designed to focus our discussions, not the final word.

At tomorrow's meeting I would like to see, first, if there are any major disagreements with my categories. Then I would like to focus on the items in yellow.

NOTE: this ranking is based on this expert process only. We also have the petition and a set of inputs from city managers. Those processes will lead to more attention to some topics—for example, sea level rise.

Based on the expert responses, these topics are clearly important in terms of potential consequences:

- Terrorism, including internal sabotage

These scenarios may or may not be important for the meeting to address because we have a range of views:

- Canister drop [some experts point to analysis of robust canisters up to 25'; others point to fuel damage; I am not sure I see anyone saying that there would be radiological impacts beyond the fence line]
- Postulated crack allows water to enter, with hydrogen production and possible explosion [views and causal pathways seem to be all over the map]
- Extreme seismic events. [this is probable, but ISFSI design is beyond pga for most extreme 7.4m quake, so unless there are strong disagreements I think we set this aside as a major topic for the meeting]

The following scenarios need some attention at the meeting, but there are plausible and robust response strategies because the scnenarios unfold slowly:

- Vibration from D&D [we need DL to look at this, howver, because he ranks higher]
- Sea level rise

- Degradation of canisters due to stress corrosion cracking [we need DL to look at this because he ranks it higher]

These scenarios have been down weighted heavily because impacts are minimal and responses robust:

- Groundwater daylighting
- Tsunami inundation for a period of time

The following scnearios have been added to the mix, with some initial replies in brackets:

- Risk of refined products, natural gas or LNG operations near-by generating an explosion. [Response: SCE has looked into this over the last week and found all such pipelines are remote. That information will be written up and submitted in response to this new scenario]
- Highly orchestrated internal sabotage [this needs to be discussed]
- Aircraft impacts and jet fuel pools [this needs to be discussed]

Thanks again for all your help with this.

All best
David

The plant risk due to flammable vapor clouds is also directly proportional to the number of shipments past the plant. However, the flammable vapor cloud plant risk attributed to the transportation of LPG on the railroad was sufficiently low in 1991 that the flammable risk did not need to be reevaluated with the explosive risk. In the 1992 analysis, the rail accident frequency was updated. The ratio of the 1981 to the 1992 accident frequencies is applied to reduce the LPG rail flammable vapor cloud baseline hazard frequency for an updated baseline value. The current flammable vapor cloud hazard frequency is then calculated by the same ratio method applied to the explosive hazard frequency. The data is presented in Table 2.2-4.

2.2.3.1.3 Accidents Involving Natural Gas Pipelines

A 12-inch natural gas pipeline is located approximately 450 feet from the nearest plant structure. A probabilistic analysis of the potential hazard to the plant due to postulated natural gas pipeline accidents has been performed. The results confirm that no undue risk to the plant and, subsequently, to the health and safety of the public exists. The probability of pipeline rupture leading to an unacceptable air intake concentration at the plant is exceedingly small.

The pipeline is described in Paragraph 2.2.2.3.2. The pipeline is 5 feet west of the east side of the Highway 101 right-of-way and parallel to Highway 101. The pipeline is owned by Southern California Gas Company. It is 12 inches in diameter and buried nominally 30 inches. The section of pipe nearest the plant was constructed in 1966. The contents of the pipeline are gaseous methane (91%), ethane (5%), and miscellaneous (4%).

An analysis has been performed to determine the likelihood of a pipeline accident that leads to an unacceptable concentration of 4.4% natural gas at the air intake. The assessment of hazards posed by the proximity of a natural gas pipeline to the San Onofre Nuclear Generating Station involves the toxicity and flammability of natural gas concentrations. Methane is not generally classified as a toxic substance.[69] So the flammability limit is controlling. A value of 4.4% was chosen as a lower limit.[70][71][72] The analysis considers the likelihood of pipeline rupture with accompanying release of natural gas and transport to the plant by wind.

The frequency of unacceptable consequences is calculated as follows:

$$F = F_r * P_v * P_d * P_s * P_i * P_c$$

where:

- F = Frequency of unacceptable consequences
- F_r = Frequency of pipe rupture
- P_v = Probability of low initial upward velocity
- P_d = Probability of wind direction
- P_s = Probability of a spill
- P_i = Probability of air intake open
- P_c = Probability of actual unacceptable consequences considering that a 4.4% natural gas concentration at an air intake will not always lead to an unacceptable plant effect

Conservative assumptions used in the analysis include:

A. All pipe ruptures are double-ended guillotine ruptures
B. The 30 inches of overburden does not create an upward velocity
C. Cloud formation occurs without turbulent mixing
D. The air intake is always open
E. Existence of a 4.4% concentration at the air intake is unacceptable

The equation can be conservatively simplified to:

$$F = F_r * P_d * P_s$$

The American Gas Association Report NG-18, No. 106, An Analysis of Reportable Incidents for Natural Gas Transmission and Gathering Lines, 1969 through 1975, contains data for 285,000 miles of pipe over a 6-year period. The frequency of reportable incidents is 10^{-3}/year-mile. Southern California Gas Company, owner of the pipeline near San Onofre, was contacted and confirmed that the AGA data was appropriate for the SCG system (i.e., conservative). Adjusting the frequency to account for ruptures results in a frequency of 3.3×10^{-4}/ year-mile as F_r. F_r is thus based on 33% of reportable incidents being pipe ruptures and 67% being small leaks that would not be expected to create a cloud. This approach conservatively assumes that all ruptures are double-ended.

To assess the possible air intake effects, it is necessary to perform a cloud formation analysis, including the effects of natural gas buoyancy and air flow. Cloud formation is dependent upon mass flowrate from the broken pipe.

For this analysis, all ruptures were assumed to be double-ended guillotine breaks without effects of impingement against opposite flow or overburden. The flow is shown in Figure 2.2-8. The

initial upward velocity was considered to be essentially zero, with only buoyancy and diffusion accounting for cloud rise.

A cloud model was developed assuming axial conservation of species, conservation of total mass, conservation of x and y momentum, and conservation of energy. A contiguous plume with a Gaussian concentration distribution was used. A cross-section of the plant and terrain is illustrated in Figure 2.2-9, with cloud formation shown.

It is necessary to adjust the cloud movement to account for the downward displacement of the terrain past the bluff. The actual downward displacement is expected to be small due to flow separation at the bluff. Flow separation is indicated by diffusion data,[73] which shows steady separation to occur with half angles exceeding 24°. The bluff forms a 28° angle with the horizontal. To be conservative, however, it was assumed that the flow followed the terrain (also ignoring the obstructing buildings). Flow field was evaluated using an electrical analog method for potential flow. The plume was then deflected downward an amount corresponding to the displacement of streamline intersecting the 4.4% concentration line at the bluff. The resulting displacements are shown in Figure 2.2-10.

Each case was run for the high initial flowrate and the steady-state flow-rate. The high initial flowrate is artificially depicted as creating a steady cloud rather than the decreasing flowrate release expected to occur. The plumes are shown in Figures 2.2-11 through 2.2-18. The figures are overlaid on a plant and terrain depiction for simplicity. This orientation represents a break at the point along the pipeline that is nearest to the plant and would be more conservative in breaks farther away. The declination of the cloud due to the bluff is not depicted in the plume plot. It is necessary to subtract the declination from the elevation of the cloud where the cloud concentration is 4.4%.

Considerable margin exists for all cases with steady-state flow due to both buoyancy and the lack of sufficient travel of the 4.4% concentration to reach the intake points. For the high flow cases, considerable margin exists due to the height of the 4.4% concentration at the intakes. The closest case is the high flowrate with a 10 m/s wind that failed to intersect the intake. The minimum distance is approximately 45 feet.

The above analysis results in a negligibly small probability of intersection of the 4.4% concentration with the plant intake. The equation $F = F_r * P_d * P_s$ must be integrated to include all cases that lead to a calculated intersection of the unacceptable concentration and the air intake. Since no case results in such intersection, the summation of all unacceptable cases is not performed. Instead, a conservative margin demonstration is included. This supplemental analysis is based upon the dual assumptions that wind speeds greater than 10 m/s do not rapidly mix the cloud to an acceptably low concentration and that the buoyancy effects do not exist.

The margin demonstration analysis arbitrarily assumed that a wind speed greater than 10 m/s would create a contiguous plume with travel of 1000 feet and diameter of 100 feet. It was further assumed that the cloud would not be elevated above the plant - that is, every cloud was depicted as 100 feet wide with a 1.0 probability of being at the height of the intake.

Using the distance of 1000 feet plume travel, the critical pipe segment capable of rupture and cloud formation with sufficiently close proximity to the plant to reach the intake was determined to be 1400 feet. This critical pipe was broken into 200-foot segments. A break was assumed to occur at the midpoint of the segment; the probability of wind direction toward the plant was taken from Table 2.3.6.2-1 in Appendix 2C of the Environmental Report, Operating License Stage, San Onofre Nuclear Generating Station, Units 2 and 3. The probability of intersection was taken as the width of the cloud divided by the width of the section; and the probability of direction and speed was determined for each segment. The results are as follows:

Pipe Segment (200 ft/Segment)	Wind Direction	P (Wind) 10 m/s	P (Intersection)	P(d) * P(int)
1	N	0	.36	0
2	N	0	.36	0
3	NNE	.0001	.36	3.6×10^{-5}
4	NE	.0002	.36	7.2×10^{-5}
5	NE	.0002	.36	7.2×10^{-5}
6	ENE	0	.36	0
7	ENE	0	.36	0

where:

P (wind) = P(d) = probability of wind > 10 m/s $= 1.8 \times 10^{-4}$ in a given direction

P (intersection) = P(int) = $\frac{\text{width of plume}}{\text{width of sector}}$ at plant (over 600 ft of pipe)

F (pipe rupture) $= 3.3 \times 10^{-4}$ /year-mile

F (interaction) $= \frac{3.3 \times 10^{-4}}{\text{year mile}} * 1.8 \times 10^{-4} * \frac{600 \text{ ft}}{5280 \text{ ft}} = 6.75 \times 10^{-9}$/year

This analysis is based on a single intake. However, taking into account the existence of several air intakes at the plant would yield a probability of interaction significantly less than 10^{-7}/year. Therefore, the probability is low enough that the potential impact on the plant is insignificant.

2.2.3.1.4 Offsite Fires

The effects of a serious fire were estimated using fire data provided by the U.S. Forest Service[8] for coastal areas such as Camp Pendleton. It is estimated the worst case Santa Ana fire will consume 3000 to 4000 acre/hr with the fire front moving up to 200 ft/min and a 30 mi/hr offshore wind. This fire is considered more limiting than from other postulated offsite sources.

NEI TECHNICAL REPORT

NEI 06-03 [Rev 2]

Pandemic Threat Planning, Preparation, and Response Reference Guide

Prepared by the Nuclear Energy Institute
Date: February 2020

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NEI Project Lead: Zachary Smith

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Executive Summary

A global outbreak of an infectious disease has the potential to cause severe disruptions to operations across the spectrum of critical infrastructure. This document was developed to provide guidance for facilities on how to prepare for and respond to a pandemic outbreak, with the goal of minimizing disruption to operations. Revision 1 has aligned the functions and actions for facilities to take with the Center for Disease Control and World Health Organization Planning Intervals for pandemic response. Lessons learned and studies conducted as result of outbreaks demonstrate the importance and effectiveness of non-pharmaceutical intervention in minimizing the impact of a pandemic. As the specific characteristics of a pandemic will vary from outbreak to outbreak, this document was developed with a general concept of planning in mind, aiming to achieve utilization and flexibility for use with many different types of outbreaks.

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1 INTRODUCTION

Business continuity planning requires preparing for the full range of threats facing the owners and operators of nuclear facilities. This document was developed with emphasis on nuclear power plants; however, owners and operators of other nuclear sector facilities will find it easy to tailor the guidance for use at their sites. The nuclear industry has abundant experience in planning for significant events including extreme adverse weather, technological challenges & failures, terrorism, and other threats. The industry must also be able to safely operate its nuclear facilities amidst the effects of a pandemic.

While influenza pandemic is the most probable type of outbreak to occur, and planning is largely based upon this threat type, the guidance provided in this document should be largely applicable to other infectious disease pandemics that may occur.

1.1 Pandemic Defined

A pandemic is a global disease outbreak that spreads on a worldwide scale and infects a large proportion of the human population.

It can be safely assumed that pandemics will periodically occur, but the timing and impact will depend on many factors that are difficult to predict. The most probable and potentially impactful pandemic to occur is an influenza pandemic. Influenza Pandemics have occurred four times in the past century. While influenza pandemic is the most probable type of outbreak to occur, and planning is largely based upon this threat type, the guidance provided in this document should be largely applicable to other infectious disease pandemics that may occur.

1.2 Planning Framework for the Nuclear Sector

The objective of this document is to describe the pandemic threat, frame it for discussion, provide information, and to assist nuclear sector owners and operators in developing plans to manage this threat to the sector's business continuity. As many factors of a pandemic (mode and ease of transmission, incubation period, mortality rate) cannot be determined ahead of time it is essential for stakeholders to develop flexible plans and be engaged in the earliest stages of a potential pandemic to ensure effective response to the particular threat.

2 BUSINESS CONTINUITY DIMENSIONS

The threat of a pandemic to business continuity needs to be carefully considered. It is different from most other threats for the following reasons:

- **Worldwide Impact**

  Unlike many threats that are localized, this has the potential to impact operations simultaneously across North America and around the world.

- **Duration**

  A pandemic outbreak would likely occur in a localized area for six to eight weeks, severely disrupt operations. Multiple outbreaks would likely occur simultaneously across difference geographical areas. Some level of fear would spread through the population prior to the actual outbreak and the

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actual "sickness" period would be for up to two weeks or more if complications occur for many individuals. This would then be multiplied as the pandemic worked its way through the population. The virus could mutate leading to multiple cycles or waves of illness.

- **Mortality**

  Due to the wide change of potential threats, the potential mortality rates are difficult to predict – a pandemic caused by influenza can have rates from 1/2 percent to 2 percent. Even a low-end mortality rate would cause severe disruption for employees who lose family members and friends. Typically, pandemic mortality rates are usually much higher in young children, the elderly, and individuals weakened by other illnesses such as tuberculosis, diabetes, cancer, and HIV. However, the variability of pandemic mortality is difficult to predict. During the 1918 pandemic, mortality rates were highest among young adults. In the 2009 H1N1 outbreak, the elderly population was not as severely impacted as in previous outbreaks.

  The nuclear sector has an excellent record of emergency planning. Proper planning will ensure the nuclear industry's portion of the nation's critical infrastructure will continue to function if a pandemic occurs. By working with federal agencies, in particular the Department of Homeland Security, the industry can be prepared to mitigate the impacts of a pandemic and continue safe and effective operation of its facilities.

3 PLANNING, PREPARATION AND RESPONSE REFERENCE GUIDE

Nuclear facilities should carefully consider all implications on the spread of the contagion if there are plans to use off-site personnel during the pandemic. Additionally, implications of the use of National Guard or federal troops for security should be carefully considered prior to such a request. It is likely that National Guard and federal troops will not be available for this purpose.

3.1 Business Continuity Planning Assumptions

The following assumptions are meant to provide situational planning parameters, and inform business continuity planning for a pandemic, using the planning assumptions developed by the U.S. Department of Health and Human Services' Pandemic Influenza Plan:

1. The timing of the outbreak of a pandemic remains uncertain.

2. Once human to human transmission of a contagion begins, the disease could spread worldwide. The rate of spread is pandemic-specific, but could occur within three to eight weeks.

3. The clinical disease attack rate could range from 20 to 40 percent of the overall population. infected employees may be very ill for up to two weeks or more if complications occur. Time periods away from work will depend on family situation and recovery.

4. The typical incubation period (the time between becoming infected and developing symptoms) for influenza is approximately two days. This could vary based on a number of factors.

5. Absenteeism rates for employees could approach 40 percent over a period of six to eight weeks.

6. Experience with past pandemics has led the U.S. Department of Health and Human Services to conclude mortality rates among infected persons could approach two per cent.

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7. Persons who contract the disease are not expected to contract it a second time due to the development of immunity. However, if the virus mutates substantially, there may be recurrences in individuals who were previously ill. These persons would be expected to be available during subsequent waves of the pandemic. However, if others in their families are ill in these later waves these persons may need to care for their family members.

8. Personnel and business processes will need to be managed differently to maintain essential business functions and to minimize the spread of the disease.

9. Vaccines for novel types of infectious contagions will likely not be available during early stages of the pandemic. When vaccines are developed, it is likely there will not be sufficient quantities for all persons. Prioritization of critical infrastructure workers is still under consideration by the government.

10. Antiviral medicines will be available in very limited quantities and will likely be allotted by government agencies to the very ill.

11. During the pandemic, at least two waves (potentially more) of infection will occur. each lasting six to eight weeks. There may be three to five months between waves.

12. Accurate and timely information distribution to employees, labor organizations and government will be imperative during the pandemic.

13. Nuclear power plants have existing plans for continued operations with limited staff. This guideline is a complement to those plans.

14. Electric system operators will keep the grid stable. Rolling blackouts will be used if load exceeds generation.

3.2 Interfacing Critical Infrastructure Sectors

The critical infrastructure sectors listed below are vital to the safe and secure generation of electricity by the nuclear sector. Pandemic response plans should be coordinated with the appropriate interfaces in these sectors. Other sectors may also be needed depending on local conditions.

- Chemical – deliveries of hydrogen, nitrogen, hydrazine, ammonia and other required chemicals
- Dams – river control, electric power and grid stability
- Emergency Services - fire, rescue, emergency medical service, and law enforcement
- Energy – electric power and grid stability, oil and natural gas if required
- Food and Agriculture – food distribution and services
- Information Technology – cyber security
- Postal and Shipping – daily deliveries of vital components and supplies
- Healthcare – state and local health departments, hospitals, and health clinics

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- Telecommunications – telephone and internet
- Transportation – movement of supplies to the plant and items from the plant
- Water – for human consumption and if plant systems require offsite water supplies

3.3 Pandemic Intervals

In 2013, the World Health Organization published an interim guidance for pandemic response which utilized phases. To align the national pandemic response framework with the WHO phases and develop updated pandemic response, The Center for Disease Control (CDC) released an updated framework that replaced the previously used stages with six intervals for response planning. The response actions in this document are aligned with the six intervals used by the United States government.

Investigation

Identification of a novel infectious disease in humans or animals in the world or United States with potential implications for human health.

Recognition

Increasing number of human case or clusters of a novel infectious disease in the world or United States with characteristics indicating increased potential for on-going human-to-human transmission.

Initiation

Confirmation of human cases of a pandemic disease in the world or United States with demonstrated efficient and sustained human-to-human transmission.

Acceleration

Consistently increasing rate of pandemic cases identified in the United States or local area, indicating established transmission.

Deceleration

Consistently decreasing rate of pandemic rate of pandemic cases in the United States or local area.

Preparation

Low pandemic activity but continued outbreaks possible in some jurisdictions.

3.4 Key Planning Actions by Function

The following provides an overview of specific planning functions by key actions associated with each pandemic interval. Include medical personnel in development of the plan. Ensure plans are flexible to be able to respond to a wide range of disease characteristics and on the availability of vaccine, antivirals, and other medical treatment options as applicable.

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Table 3-1 — Maintain Awareness and Communicate	
Function	**CDC Interval**
1. Company medical resources should monitor for health threats via official bulletins or web sites.	All intervals
2. Provide staff and decision makers with the most up-to-date information available by documenting specific characteristics of the virus, such as the following: • Mechanism(s), speed, and ease of transmission by which the virus is spread, and mode(s) of transmission, such as droplet, airborne, person to person, etc. • Time the virus remains active on surfaces, such as door handles. • Incubation period, time to exhibit symptoms, and maximum contagious period.	All intervals
3. Communicate early and regularly to staff, and include recommendations such as maintaining appropriate social distance (at least three feet) during discussions to minimize potential transfer of infectious agents, so these measures can be practiced and internalized. Anticipate fear; there may be no vaccine and the supply of other medicine may be limited. Identify community resources for timely and accurate information. If medicine is available in the community describe how to get it.	All intervals
4. Communicate early and regularly to staff, and include recommendations that minimize potential transmission of the virus among staff, so that these measures can be practiced and internalized. Use various media for communication: newsletters, posters, supervisor briefings. • Publicize what actions will be expected of employees who either become ill or exposed to an ill person, both when at work or outside of work. • Publicize pandemic hygiene practices such as covering one's mouth with a disposable tissue when sneezing or coughing.	Initiation

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• Publicize frequent hand washing as a means to prevent the spread of many diseases.	
5. Encourage pandemic vaccines for all employees, regardless of the pandemic phase.	Initiation
6. Coordinate with public health departments or emergency management agencies on the identification of critical staff as recipients of any available vaccine and antiviral medicine in the event of a pandemic outbreak.	Initiation

Table 3-2 — Develop Plans

Studies of the recent H1N1 pandemic in 2009 demonstrated the effectiveness of non-pharmaceutical intervention (NPI) to help reduce the impact of infectious disease outbreaks on business operations. With the likely limited availability of vaccines and anti-viral medicine, ensure NPI techniques (social distancing, isolation, workplace closure, frequent cleaning of surfaces, etc.) are included in pandemic response plans.

Function	CDC Interval
1. Coordinate with public health officials or emergency management agencies and review plans and preparations with them.	All Intervals
2. Develop appropriate level response and contingency plans and procedures, include the following as a minimum: • Criteria for the recognition of an incident or threat, and appropriate response levels considering various international, federal, state and commercial resources • Roles and responsibilities of staff, supervisor, and staff medical personnel • State and local public health and medical contacts and phone numbers • Internal contacts for notification • Consider having as many staff as practical work from home. Determine whether IT support, plant and local internet structure are adequate. Block non-vital users or establish a priority access methodology. Since there will be many organizations with employees telecommuting it may be advisable to have as many people telecommute on evening or night shifts as possible. This may lessen the delays sure to occur due to overloads on all modes of internet connectivity.	Investigation

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• Plans and procedures should include support and assistance at an increased level, if necessary, from Human Resources staff to employees' families. • Prevention of spreading influenza virus	
3. Consider a plan to separate the work forces to establish independent locations, and/or preserve a "clean" site. • Consider a paperless work process to reduce human contact. • Establish a team at a site remote from the plant to screen people before they go to the plant site. Ensure personnel manning the screening site have adequate personnel protective equipment. No one will be infected in the workplace unless an infectious person is allowed into the workplace. Consider infra-red technologies to identify people with fevers. Look for signs of respiratory symptoms. Exclude people with sick family members. Allow only those persons identified in Function 4, below, on-site. Do not allow others. • Consider measures to sequester staff. The sequester strategy may be for a full pandemic wave or for a shorter period of time. It may consist of keeping a core group at the site through the critical period, or simply screening all persons entering the site for symptoms. This can also be accomplished by isolating the incoming individuals from the sequestered population for a period of time sufficient for symptoms to become obvious. Note that people may be infected with the virus and not show symptoms, but people with the virus are less likely to infect others until they show symptoms. In summary consider the strategy to be keeping out ill people, use appropriate sanitation measures to prevent spread of illness and provide personal protective equipment if it is appropriate.	Initiation
4. Identify those functions in your company critical to continue around the clock operations for six to eight weeks, and identify the people needed for those positions. • Pre-screen critical staff to ensure their willingness to receive a vaccine and antiviral medicine. • Involve your human resources staff as well as established mechanisms such as joint health and safety committees early. • At a minimum include operations, security, chemistry, health physics, maintenance, emergency planning, and information technology. • Consider supplies and accommodations needed for sequestered staff at each location.	Initiation

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• Relicense or requalify those who previously had senior reactor operator and reactor operator licenses or specific qualifications including but not limited to non-licensed operators, chemistry technicians, health physics technicians. Provide cross training for critical tasks. Consider use of retirees to supplement existing work force.	
5. Develop plans to buy and stockpile required supplies early and have contracts in place for support: • Respiratory masks • Hand washing and sterilization equipment and gloves • Contractors for frequent cleaning and disinfecting of work locations • Medical consultants • Food, water and other living supplies for sequestered staff • Medicines and antivirals • Critical supplies from foreign nations • Other critical supplies typically delivered "just in time." There will be shortages of several of these supplies as the pandemic begins. Large orders placed by government agencies of many nations may strain manufacturing capability. You may want to begin purchasing items early.	Initiation
6. Develop plans to buy and stockpile consumable supplies (such as compressed gases, chemicals, resin, and lubricants) that will be needed to operate the plant during the period of the pandemic. Early delivery of these items can reduce the workload during peak absentee periods and can also reduce the extent to which the site population is exposed to outside personnel who may transmit the disease. If items cannot be stockpiled then consider having the transportation companies drop trailers which can be moved and unloaded by site personnel.	Initiation
7. Develop plans to request regulatory relief	Initiation
8. Develop a contingency plan for diminished local law enforcement capability for activities such as evacuation route alerting and as responders for security events.	Initiation
9. Develop plans to coordinate civil authorities requests for National Guard or federal troops to provide security. Incorporate planning for segregation of supplemental forces after their arrival.	Initiation
10. Develop plans to address pandemic issues that affect other critical infrastructure.	Initiation

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• Transportation issues • Telephone and related communications failures • Food and water issues • Plant consumables such as diesel fuel and chemicals • Keep staff informed if supplies from infected areas need to be restricted.	
11. Develop plans to integrate with other corporate pandemic plans as appropriate. • Prioritize generation units to keep on-line if there is a personnel shortage.	Initiation
12. Review Emergency Preparedness procedures. Develop plans to use more extensive readiness reporting by individuals to know which ones are fit to respond on a daily or more frequent basis if a local outbreak occurs. Consider alternate methods to "all-call" staffing of facilities to reduce exposure of key individuals at a single time and location.	Initiation
13. Develop plans for outbreak occurrence during various types of outages. Consider that there may be more than one wave of infection. • Minimize the number of off-site personnel. • Defer work required by regulatory requirements after a licensing review unless needed for continued operation. • Establish refueling contractors as critical staff. • Quarantine outage workers prior to allowing them on site. The quarantine period should be based on the actual incubation period. • Review outage plans with local public health officials. • For forced outages consider implications of off-site workers on spread of the contagion. • Consider coasting if the load demand will allow.	Initiation
14. Develop plans for return to normal operations.	Initiation

Table 3-3 — Exercise

Function	CDC Interval
1. Periodically test and verify your preparedness plans and procedures via a simulation exercise, table top exercise or process walk through. Also test the IT infrastructure internally.	Investigation and Initiation

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Table 3-4 — Develop Policies	
Function	**CDC Interval**
1. Develop and update staff travel policy. • Do not travel to potentially infected areas even if human to human virus mutation has not occurred. • Do not let people who traveled to infected areas back to work until after the incubation period has ended. • Perform a thorough review of the need for travel and minimize or curtail travel as appropriate. • Consider mode of travel on potential impact for increased exposure to influenza virus.	Initiation
2. Develop and update meetings policy. • Minimize personal contact by using telephones, email, teleconferences, video conferences and web conferences.	Initiation
3. Develop a visitor policy that is to be implemented in the event of an employee health incident or threat.	Initiation
4. Develop and update human resources policies. • As permitted by federal, state and local laws then in effect, update the confidentiality policy for releasing names of staff that potentially have been exposed, to allow effective exposure tracking to be completed. Also include sick employees or employees with sick families. Local and state public health officials have great latitude in containing serious diseases. Coordinate with them. • Develop a policy regarding support of families of workers remaining at the plant for long periods. • Develop a policy to address employees who should not come to the plant. They may telecommute or not work during the pandemic. • Determine how employee practices will be monitored and enforced. • Encourage employees to stay home after they have been exposed. Consider: o Temporarily liberalizing the sick time policy to allow employees to stay home. o Granting an appropriate amount of time off to accommodate the recovery period.	Initiation

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• The Family and Medical Leave Act permits most long-term employees to stay home and care for sick family members. Consider paying employees who do so. • Update the policy to process a larger than normal volume of survivor benefits for families in expectation of the death of several employees in a short time period. • Develop or update the policy to accommodate employees with several deaths in the family.	
5. Develop and update telecommuting policy for office staff.	Initiation
6. Develop and update policies for employee compensation and sick-leave absences unique to a pandemic.	Initiation
7. Develop and update workforce deployment policies regarding teams and crews working together and the potential need to keep employees separated.	Initiation

Table 3-5 — Equipment and Facilities

(Consideration should be given to stockpiling supplies during the Initiation Interval. Supplies may be difficult to obtain as the pandemic worsens.)

Function	CDC Interval
1. As a part of a program to help reduce the spread of a pandemic, consideration should be given to the disinfection of fixed surfaces that are shared by multiple employees. This applies to any devices which would be used by individuals from several different shifts such as tools (i.e., test equipment, wrenches, screwdrivers, etc.), computer keyboards and mouse pointing devices, fork lift steering wheels and shifters, crane controls, telephone handsets, full body radiation monitors, etc. Essentially, consider any surface that is used or controlled by handling that is shared among several different personnel. Each of these devices has different types of disinfection methods. For instance, tools, steering wheels and shift levers are considerably more robust structures and can be washed or wiped down with strong disinfecting agents. Test equipment and computer components cannot withstand such disinfecting regimes. For more sensitive items such as electronic devices consideration should be made to provide washable type devices such as those that can be found in use in the medical practices area. Examples of these would be membrane keyboards or disposable keyboard covers. In the first case, the keyboard itself would be washed at the beginning and end of each shift and for the latter the cover is	Acceleration

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replaced. Pointing devices like touch pads that can be readily disinfected can be used instead of mice that would require more effort to clean. For test equipment either guidance from the equipment manufacturer should be solicited and followed or equipment with washable surfaces should be acquired.	
2. Provide each workstation with a disinfecting agent, paper towels and latex or vinyl gloves.	Acceleration
3. Purchase and store sufficient quantities of personal protective equipment (masks and gloves). Some masks deliver better speech clarity than others. Some masks are designed to protect the person wearing the mask; other masks protect exposure of others from the person wearing the mask. N95 masks seem to provide an appropriate level of assurance to prevent the spread of a contagion. Before the N95 masks are used for respiratory protection, a written respiratory protection program must be implemented meeting all OSHA requirements such as medical evaluation, training and fit testing. Shelf life should be considered for masks and gloves. Used masks and gloves may contain respiratory droplets that are the transmission vector so they would be considered medical waste. Consider handling a larger than normal volume of medical waste. Training should be provided to persons outside the current group who handle medical waste. Vendors should be secured for the removal and disposal of medical waste.	Initiation/Acceleration
4. Stock up on ready to eat meals, disposable plates and utensils, water, beverages, and other food, especially items that require heating. Also procure other items required if staff will be sequestered at the plant. This would include basic medical supplies, bedding, laundry supplies and personal care items. Consider sufficient supplies for a long duration.	Initiation
5. Post personal protection techniques such as hand washing and social distance posters in all washrooms and common areas (kitchens, break rooms, etc.).	Acceleration
6. Close non-critical common areas, such as exercise room and cafeteria.	Acceleration
7. If appropriate, isolate certain areas, post signs stating temporary quarantine at all exits, and change access control list.	Acceleration/Deceleration

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Table 3-6 — Response Actions by the Affected Employee	
Function	**CDC Interval**
1. When an employee has contracted or suspects that they have contracted the virus, the employee is to seek medical attention immediately and advise his or her supervisor or line manager accordingly.	Acceleration/Deceleration

Table 3-7 — Response Actions by Plant Management to be Implemented throughout the Plant (The following is a list of roles, responsibilities, and actions to respond to a case in which one or more plant staff are infected or suspected of being infected.)	
Function	**CDC Interval**
1. Advise affected employees to contact their doctors and the company medical staff. Be aware that doctors and medical facilities may be overwhelmed and may not be able to help.	Acceleration/Deceleration
2. Line manager or supervisor contacts the company medical staff to follow up on affected employees.	Acceleration/Deceleration
3. Implement a process such that all employees and visitors to critical facilities are subject to appropriate screening to aid in identifying whether they are a potential risk. (For example: Have you visited a high-risk location in the past two days?). Post screening tool(s) at all entrances. The screening may be done at the security check point, further out on the access road(s) or at entrances to the plant buildings.	Acceleration/Deceleration
4. If appropriate, contract a cleaning service/agency and request the disinfection of the affected employee's workstation and shared work areas as well as all shared equipment and facilities (including washrooms, kitchen areas and meeting rooms). Assess the need for separation of plant staff from cleaning personal if they are from off-site. Ensure the cleaning personnel are appropriately trained on disinfection techniques.	Acceleration/Deceleration
5. Close non-critical common areas, such as exercise room, or perhaps the cafeteria.	Acceleration/Deceleration
6. Assess the need to direct staff to maintain a safe distance from each other.	Acceleration/Deceleration
7. Assess the need for complete separation of staff including the activation of any backup facilities.	Acceleration/Deceleration
8. Assess the need to release non-critical staff from on-site duties to reduce the risk of infection of critical staff.	Acceleration/Deceleration

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9. If appropriate, provide each workstation with a disinfecting agent, paper towels, and latex or vinyl gloves. Have each crew member wipe down all equipment and surfaces before and after each shift. Provide each workstation with sanitizing lotion with instructions on use.	Acceleration/Deceleration
10. Provide regular communication to all staff with the latest medical advisories and emphasize adherence to actions suggested. This includes actions to be taken to prevent the spread of the pandemic.	Acceleration/Deceleration
11. Provide on-site personnel with personal protective equipment.	Acceleration/Deceleration
12. If appropriate, isolate the building, post signs stating temporary quarantine at all exits.	Acceleration/Deceleration
13. Notify all staff on site to leave their full name, employee ID, and after- hours contact number(s), including numbers where they may be potentially relocated, such as parents, family etc. Instruct all employees when they are allowed to return to work, such as the following business day unless advised otherwise.	Acceleration/Deceleration
14. Have visitors provide their home and company contact numbers as well as after-hours contact numbers for follow-up.	Acceleration/Deceleration
15. Coordinate with corporate staff and with groups such as electric system operators, LLEA, local hospitals and the local health department. Be aware that hospitals and other medical facilities may be overwhelmed and may not be able to help. Consider coordination with all supporting critical infrastructure sectors. (there are 16 actual Sectors in the plan?) • Chemical • Dams • Emergency Services • Energy • Food and Agriculture • Information Technology • Postal and Shipping • Public Health • Telecommunications • Transportation • Water Coordinate with other sectors as needed based on local conditions. In some locales coordination between sectors may be coordinated by emergency management agencies.	Acceleration/Deceleration

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16. If antiviral medicine is available consider the time sensitivity of reporting the illness to begin the antiviral course as soon as possible.	Acceleration
17. Update procedures for operator rounds and routine maintenance to accommodate reduced staff.	Acceleration
18. Establish a Rumor Control Organization to deal with possible misinformation that may spread by employees.	Acceleration
19. Take reasonable action that departs from a license condition or a technical specification (contained in a license issued under this part) in an emergency when this action is immediately needed to protect the public health and safety and no action consistent with license conditions and technical specifications that can provide adequate or equivalent protection is immediately apparent. This is permitted by 10 CFR 50.54(x).	Acceleration/Deceleration
20. Implement enhanced verification of emergency response personnel availability to ensure ability to continuously implement emergency plan in the event of an emergency declaration. Ensure Emergency Response Facilities are equipped with supplies to minimize spread/prevent contamination of individuals.	Acceleration/Deceleration

Table 3-8 — Response Actions by Medical Staff

Function	CDC Interval
1. Communicate regularly with company senior management. Consider assisting management in designing health decision trees for employees to follow, anticipating that they may require ongoing updates according to most recent available information.	Acceleration/Deceleration
2. Advise the affected employee to contact their doctor and to adhere to the advice given.	Acceleration/Deceleration
3. Advise the affected employee to contact their direct supervisor if they have not already done so.	Acceleration/Deceleration
4. Request that the affected employee keep you informed of their condition.	Acceleration/Deceleration
5. Advise the affected employee not to return to work until directed to do so by their doctor and the company doctor/nurse.	Acceleration/Deceleration
6. Support and provide input into employee communications.	Acceleration/Deceleration
7. Arrange for the placement of waterless hand cleaner and cleansers and/or wipes at key communal areas (washrooms, kitchens, workstations). They should be at each person's work station to encourage hourly hand cleaning.	Acceleration/Deceleration

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8. Provide regular communication to all staff on the latest health advisories and recommend adherence to actions suggested.	Acceleration/Deceleration
9. Provide regular communication to all staff on any additional specific requirements or information.	Acceleration/Deceleration
10. Provide employees means to access mental health and social services providers.	Acceleration/Deceleration

4 ADDITIONAL INFORMATION

Additional information can be found at:

- U.S. Health and Human Services, www.hhs.gov
- U.S. Centers for Disease Control and Prevention, www.cdc.gov
- World Health Organization, www.who.int
- U.S. Office of Personnel Management, www.opm.gov
- Public Health Agency of Canada, http://www.phac-aspc.gc.ca/
- Australian Department of Health and Aging, http://www.health.gov.au/
- United Kingdom Department of Health, www.dh.gov.uk
- Occupational Safety and Health Administration, Pandemic Influenza, https://www.osha.gov/SLTC/pandemicinfluenza/
- National Pandemic Influenza Plans, https://www.cdc.gov/flu/pandemic-resources/planning-preparedness/national-strategy-planning.html

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Decommissioning San Onofre Nuclear Generating Station

CEP Outlier Topic Planning Update
Thursday, March 19, 2020
4:00 – 5:00 pm
Dial in: 1-213-297-0156 – Conference ID: 656313726#

SAN ONOFRE NUCLEAR GENERATING STATION		
Purpose of Meeting & Desired Outcome(s): • Provide overview of CEP outlier topic planning progress		
AGENDA		
Time	**Topic**	**Who**
4:00 – 4:05 pm (5 min)	Introductions and agenda review (Reference biographies on expert reviewers)	David Victor
4:05 – 4:15 pm (10 min)	Brief review of planning process and community engagement • External stakeholders, including petition • Local cities • Third party experts	David Victor, Jerry Kern, Dan Stetson
4:15 – 4:30 pm (15 min)	Summary of expert engagement • Review of scenarios and references • Event ranking	David Victor, Expert Reviewers
4:30 – 4:45 pm (15 min)	Approach to CEP public meeting • Opening comments by key stakeholders in the community • Summary of radiation & contamination (to be addressed at March 26 CEP meeting) • Panel #1 – Dry storage outlier events • Panel #2 – Emergency response • Public comment and facilitated public dialogue	David Victor
4:45 – 4:50 pm (5 min)	Timing and meeting logistics • Meeting date moved to May 28 • Virtual “livestream” meeting TBD per COVID-19	David Victor
4:50 – 4:55 pm (5 min)	Workshop preparations • Agenda refinement, presentation development • Expert panelists availability	Manuel Camargo
4:55 – 5:00 pm (5 min)	Review actions and next steps	Lorraine Sandstrom

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Decommissioning San Onofre Nuclear Generating Station

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Expert Reviewer Bios:

1. **Michael L. Corradini, Ph.D**. - is a professor in the Department of Engineering Physics at the University of Wisconsin, Madison. Dr. Corradini's research focus is nuclear engineering and multiphase flow with specific interests that include light-water reactor safety, fusion reactor design and safety, waste management and disposal, vapor explosions research and molten core–concrete interaction research, and energy policy analysis. He received his B.S. in mechanical engineering from Marquette University and his M.S. and Ph.D. degrees in nuclear engineering from the Massachusetts Institute of Technology. He is a member of the American Institute of Chemical Engineers, the American Society of Engineering Education, and the American Society of Mechanical Engineers, and a Fellow of the American Nuclear Society. Dr. Corradini has received numerous awards including the National Science Foundation's Presidential Young Investigator Award, the American Nuclear Society reactor safety best paper award, and the University of Wisconsin, Madison, campus teaching award. He has served on various technical review committees, including the research review panel of the U.S. Nuclear Regulatory Commission. He currently serves on the U.S. Nuclear Regulatory Commission's Advisory Committee on Reactor Safeguards and was president of the American Nuclear Society in 2013-2014. Dr. Corradini was elected to the National Academy of Engineering in 1998.

2. Kevin D. Crowley, Ph.D. - has been an advisor to the NRSB since entering phased retirement in August 2017. His professional interests focus on the application of science and technology to improve societal well-being, advance public policy making, and enhance international cooperation, particularly with respect to the safety, security, and efficacy of nuclear and radiation-based technologies and applications. He previously held several positions at the National Academies, including senior board director of the NRSB (2005–2017), director of the Board on Radioactive Waste Management (1996–2005), and principal investigator for a long-standing cooperative agreement between the National Academy of Sciences and the Department of Energy to provide scientific support to the Radiation Effects Research Foundation in Hiroshima, Japan (2010–2017). Before joining the National Academies staff in 1993, Dr. Crowley held teaching and research positions at Miami University of Ohio, the University of Oklahoma, and the U.S. Geological Survey. He holds an M.A. and a Ph.D., both in geology, from Princeton University.

3. **Tom Isaacs** - ET and NWT, development of Strategic Plan, & international nuclear waste issues in Canada. Former Director, Office of Policy within the U.S. DOE

   Currently, advisor to Canadian Nuclear Waste Management Organization (NWMO) on management and storage of Canada's SNF, last 13 years. Mr. Isaacs is a well-recognized national and international leader in the field of nuclear energy, nuclear waste management, nuclear security, repository siting, and public trust and confidence.

   Recognized leader and frequent invited speaker both within the U.S. and around the world, including Canada, Japan, South Korea, Stanford, MIT, among many others on issues of nuclear waste management program strategy and implementation, fuel cycle, facility siting, public trust and confidence, and stakeholder engagement. Education includes a B.S. with honors in Chemical

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Engineering from the University of Pennsylvania (Tau Beta PI, Phi Lambda Upsilon honor societies) and a M.S. in Engineering and Applied Physics from Harvard University (while studying nuclear engineering at MIT).

Education: B.S. with honors In Chemical Engineering from the University of Pennsylvania (Tau Beta PI, Phi Lambda Upsilon honor societies) and M.S. in Engineering and Applied Physics from Harvard University (while studying nuclear engineering at MIT).
Was seconded by the Administration to the Senate Energy and Natural Resources Committee where I worked intimately with Committee Chair Senator Bennett Johnston and senior committee staff to develop and pass the Nuclear Waste Policy Amendments Act Identifying Yucca Mountain as the preferred site for the first U.S. spent fuel repository. Led U.S. DOE activities to integrate a national monitored retrieval storage facility for spent fuel Into the U.S. program of management and disposal, this included strategy development, siting, licensing, and engagement activities.

Mr. Isaacs has had significant leadership positions in the technical, strategic, programmatic, policy, siting, societal, engagement, and communications dimensions of nuclear waste management for over 30 years. He was instrumental in: the siting of the Yucca Mountain candidate repository Site; the passage of the Nuclear Waste Policy Amendments Act of 1987 that defined the U.S. waste program; the development of the Blue Ribbon Commission on America's Nuclear Future (BRC) report written at the direction of the President of the United States that recommended the path forward for the U.S. nuclear waste program; and the strategic approach currently being implemented by the Nuclear Waste Management Organization of Canada to manage and dispose of spent fuel.

Director, Office of Policy within the U.S. DOE office responsible for spent fuel and high level radioactive waste (HLW) management and disposal (The DOE Office of Civilian Radioactive Waste Management). Responsible for the strategic direction of the national program to manage and dispose of spent nuclear fuel and high-level radioactive waste. Major responsibilities Included setting program directions, priorities, and policies for this $400 million per year program, leading policy and technical analyses, and managing a federal and contractor staff. Managed the comparative evaluation of candidate sites for the for the first U.S. repository program for the disposal of U.S. spent nuclear fuel and high-level radioactive (HLW).

4. **David Lochbaum** - Former director, Nuclear Safety Project, Mr. Lochbaum received a BS in Nuclear Engineering from the University of Tennessee in 1979 and worked as a nuclear engineer in nuclear power plants for 17 years. In 1992, he and a colleague identified a safety problem in a plant where they were working. When their concerns were ignored by the plant manager, the utility, and the Nuclear Regulatory Commission (NRC), they took the issue to Congress. The problem was eventually corrected at the original plant and at plants across the country. Lochbaum joined UCS in 1996 to work on nuclear power safety. He spent a year in 2009-10 working at the NRC Training Center in Tennessee. He retired in 2018. Areas of expertise: Nuclear power safety, nuclear technology and plant design, regulatory oversight, plant license renewal and decommissioning

5. **Edwin Lyman** - is a *summa cum laude* from NYU with a M.S. and Ph.D. from Cornell in theoretical physics. For the last 16 years he has been Senior Scientist at the Union of Concerned Scientists in Washington, D.C. He has an “L” security clearance from the NRC and has written and spoken widely on nuclear issues. His *vitae* (https://www.nrc.gov/docs/ML1814/ML18141A892.pdf) include 37 journal articles and scientific reports, 39 conferences papers, 69 invited lectures, and 18 Op-Ed articles. Edwin Lyman is an internationally recognized expert on nuclear proliferation and nuclear

Decommissioning San Onofre Nuclear Generating Station
Safety | Stewardship | Engagement

CEP Outlier Topic Planning Update
Thursday, March 19, 2020
4:00 – 5:00 pm
Dial in: 1-213-297-0156 – Conference ID: 656313726#

terrorism as well as nuclear power safety and security. He is a member of the Institute of Nuclear Materials Management, and has testified numerous times before Congress and the Nuclear Regulatory Commission. Since joining UCS in 2003, he has published articles in a number of journals and magazines, including *Science, the Bulletin of the Atomic Scientists, Science and Global Security,* and *Arms Control Today,* and he has been cited in thousands of news stories, including articles in the *Boston Globe, Chicago Tribune, Los Angeles Times, New York Times, Wall Street Journal, Washington Post,* and *USA Today*, and in segments on ABC, CBS, CNN, C-SPAN, MSNBC, NBC, NPR and PBS. Dr. Lyman also co-authored the critically acclaimed book, *Fukushima: The Story of a Nuclear Disaster* (New Press), which was published in February 2014. In 2018, Dr. Lyman was awarded the 2018 Leo Szilard Lectureship Award from the American Physical Society.
Some years back he authored a 66 page report "The Health and Economic Impacts of a terrorist attack at the Indian Point Nuclear Plant." I would suggest him as one of our top choices who might focus on the physics of extreme events and what might happen with a terrorist attack.

6. **Arthur T. Motta, Ph.D.** - is Chair of the Nuclear Engineering Program and a professor of nuclear engineering and of materials science and engineering at Pennsylvania State University. His research focuses on the environmental degradation of materials in the reactor environment with specific emphasis on nuclear fuel cladding. His research interests include radiation damage, corrosion and hydrogen ingress, mechanical behavior of materials, and materials characterization. He holds a B.Sc. in mechanical engineering and an M.Sc. in nuclear engineering from the Federal University of Rio de Janeiro, Brazil, and a Ph.D. in nuclear engineering from the University of California, Berkeley. Before coming to Penn State, he worked for the CEA at the Centre for Nuclear Studies in Grenoble, France, and for Atomic Energy of Canada Limited at the Chalk River Laboratories in Canada. He is a member of the editorial board of the *Journal of Nuclear Materials*. He received the Mishima Award from the American Nuclear Society for sustained contributions to nuclear fuel research and has just been awarded the Kroll Medal from ASTM for significant contributions to zirconium metallurgy.

7. **Patrick Papin -** (SDSU Health Physicist) Professor Patrick Papin received his B.S. degree in physics from Cleveland State University, M.S. degree in radiological physics from San Diego State University, and Ph.D. in biomedical physics from UCLA. He joined the physics faculty at SDSU in 1985. He has served as Chair of both the Department of Physics and the University Senate. He also has served as associate and interim Dean of the College of Sciences. He is actively involved in the mentoring and advising students in physics, environmental sciences, and homeland security. He has been involved with the Homeland Security Science and Technology Testbed and the Regional Technology Center (RTC) in efforts related to Golden Guardian 2010 and DHS-DNDO West Coast Maritime Preventative Radiological and Nuclear Detection Pilot (PRND).

   Research Interests:
   Dr. Papin's work involves both experimental and computer modeling in radiological physics. His research involves the use of positron emitting radionuclides for mammography imaging. Radiation transport modeling work is within the areas of imaging and dosimetry. Also, these transport models predict radiological dose distributions as a result of a nuclear accident or by actions of terrorism. Currently advising thesis research for Erik Bray and Dennis Seely in the area of positron emission mammography. Also advising graduate student Anastasiya Irkhin in the area of homeland security.

From: Manuel Camargo
Sent: Thursday, February 27, 2020 1:20 PM
To: CityManager@san-clemente.org
Cc: Ward, Kathy; David Victor (UCSD); Daniel T. Stetson; Jerry Kern (Oceanside); Doug Bauder; Chris Thompson; Lorraine Quinn Sandstrom; James, Gene
Subject: Request for Input on Matter Regarding San Onofre Nuclear Plant

Dear Mr. Dunek,

I write on behalf of Southern California Edison (SCE) and the San Onofre Community Engagement Panel (CEP) to seek your input on a matter related to decommissioning of the retired nuclear plant.

Background
The CEP was formed by SCE and the other San Onofre co-owners to encourage an open dialogue on matters of interest to local communities. One area of interest is the potential effects of "outlier events"—whether natural or manmade—on the San Onofre Nuclear Generating Station and the spent nuclear fuel stored in the spent fuel facility at the station. The NRC, cask vendors, and/or licensees such as SCE consider a range of potential scenarios that could impact the safe storage of spent fuel such as tsunamis and acts of terrorism.

The CEP leadership and SCE are planning a public CEP meeting at which plausible outlier events will be addressed within the context of the robust and passively cooled dry storage facility. Out of scope will be implausible events such as a meteor strike.

During the planned meeting, we also will address the emergency response capabilities of on- and off-site emergency response professionals.

Request for Input
Given that the City of San Clemente is an important local stakeholder, we at SCE and on the CEP would like to know whether you have any specific concerns regarding these or other outlier events based on comments you may have heard from your constituents.

Any feedback that we receive from you or city managers in other neighboring cities will be considered as we prepare to address the topic of outlier events.

Thank you in advance for your consideration.

Copying CEP member Kathy Ward and alternate Gene James. Also copying the CEP leadership and some of my Edison colleagues, for their awareness.

Best Regards,

Manuel

Manuel C. Camargo Jr.
Principal Manager, Strategic Planning
SONGS Decommissioning
Southern California Edison

Local City Manager List for CEP Workshop Letter and Responses

Updated 3-10-20

#	City	City Manager / CEP Member	Response
1	**San Clemente**	**Robert Dunek /Kathy Ward** CityManager@san-clemente.org wardk@san-clemente.org	**Response received 2/28/20**: I went through emails I had from the public and came upon this paragraph which the resident calls "external threats" as opposed to your subject of "outlier events." I have highlighted the portion that refers to the external threats: So, the list would be: **Terrorist attacks from land, sea, air** **Long-range nuclear or conventional missiles** **Short-range missiles** **Airplane Crashes** **Drone Attacks** **Truck bombs** **Large Earthquake** I have also heard tsunami, but more recently a concern of sea level rise and water table concerns affecting the canisters because the canisters are too close to the ocean. So I would add those to the list of outlier events.
2	**Dana Point**	**Mike Killebrew / Paul Wyatt** MKILLEBREW@DanaPoint.org pwyatt@danapoint.org	
3	**San Juan Capistrano**	**Benjamin Siegal / John Taylor** bsiegel@sanjuancapistrano.org jtaylor@sanjuancapistrano.org	Lynn Mata, Emergency Services Manager, from San Juan Capistrano said that they do not have any concerns. They have been active in the interjurisdictional meetings regarding SONGS and feel comfortable with the handling and progress at the site. (Response received by Jerry Kern, CEP Secretary)
4	**Laguna Beach**	**John Pietig** cmoffice@lagunabeachcity.net	**Response received 2/27/20:** Although this topic has not recently come up at a City Council meeting, I know that an active segment of Laguna Beach citizens remain concerned about risks associated with San Onofre and the storage of spent nuclear materials. The concerns generally are: • Cask failure; • Cask handling; • Earthquake, tsunami, terrorism, etc.; • The time and logistics associated with alerts and the actual evacuations; and • Fear of the unknown and unanticipated. I appreciate the preparation going into the meeting and hope it is successful.

Local City Manager List for CEP Workshop Letter and Responses

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5	**Newport Beach**	**Grace K. Leung** gleung@newportbeachca.gov	
6	**Oceanside**	**Deanna Lorson** CityManager@OceansideCa.org	**Response received 3/2/20:** I have inquired with staff and am advised that: 1. The Oceanside Fire Department has a little a bit less concern for the spent fuel storage than we did with a full operating plant. All those scenarios have contingencies and our job has not changed. We train for the release of radiation and maintain the equipment. 2. The Oceanside Fire Department maintains capability to track and respond to a radiological release from the plant. Should funding be reduced or eliminated and our capability is degraded due to lack of funding, the OFD will likely stop providing the service. 3. The City has launched a comprehensive update of our General Plan – issues related to SONGS will likely be evaluated from a policy standpoint in the updated Safety Element of the General Plan. Please let us know the date/time of the community meeting and outcomes of the meeting.
7	**Carlsbad**	**Scott Chadwick/ Jason Habor** manager@carlsbadca.gov Jason.haber@carlsbadca.gov	**Response received 2/28/20**: Sept. 10, 2019, the Carlsbad City Council adopted the attached Resolution No. 2019-166, requesting the California State Legislature and California Governor address concerns regarding the safe handling and storage of nuclear waste generated at the decommissioned San Onofre Nuclear Generating Station. Based on comments provided by our constituents, the resolution identifies specific concerns regarding the vulnerability of SONGS to damage from seismic activity, landslides, tsunamis and sea-level rise. We would appreciate your consideration of these risks as you prepare to address the topic of outlier events.
8	**Encinitas**	**Karen P. Brust** kbrust@encinitasca.gov	
9	**Solana Beach**	**Greg Wade** auruburu@cosb.org (exec. assistance)	**Response received 3/4/20:** As you may be aware, our City Council has been approached on many occasions by concerned members of our community about the potential dangers created by the storage of spent nuclear fuel rods at SONGS. To that end, we have been actively engaged with Representative Mike Levin's Task Force on this matter with one of our Council Members participating in that effort. As such, City will likely be following the Task Force's recommendations through our participation in that forum and believe that many of the concerns we have heard from our community and those our own Council

Local City Manager List for CEP Workshop Letter and Responses

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			Members have expressed will be included in the Task Force report. To your question about specific outlier events, and in addition to the emergency response capabilities and deployment mentioned in your email below, we believe that a topic list of such "outlier events" should include but not be limited to the following: • Major Earthquake on nearby faults • Major Tsunami due to Earthquakes • Terrorism attack • Significantly faster than expected sea-level rise (equivalent to permanent tsunami) • Major Fire (either on site or a wildfire) • Significant on-site accident (e.g. dropping and rupturing of a storage canister during handling) • Key people familiar with site operations die from or are incapacitated by a pandemic We do hope that these issue areas will be considered in your discussions.

Agenda Topic	Presenter	Time
CEP and SCE welcome & opening comments • Skype – how to participate in public comment period • SONGS pandemic protocol and sewage treatment plant wastewater release	David Victor Doug Bauder	5:30 - 5:35 (5 min)
The big picture: SONGS decommissioning • Fuel transfer operations and dismantlement activities	Doug Bauder	5:35 – 5:40 (5 min)
Outlier events and response strategies – Initial comments • Overview of process and events in and out of scope	David Victor External stakeholders Doug Bauder	5:40 – 5:50 (10 min)
"Radiation 101" • Radiation and contamination • Spent fuel design and operating experience	Patrick Papin Randall Granaas (SCE)	5:50 – 6:05 (15 min) 6:05 – 6:15 (10 min)
Plausible event scenarios and responses - Analysis (probability/consequence), hazards, mitigations, radiation, contamination and dose to the public • Outliers, experts and perspectives • Canister degradation • Terrorism / sabotage • San Onofre Security	Tom Isaacs Mike Corradini Kevin Crowley Ed Lyman / Ross Quam	6:15 – 6:45 (30 min)
Layers of emergency preparedness • On-site response capabilities • Off-site response capabilities – local, state, and federal	Kelli Gallion Donna Boston (OC) Stephen Rea (SD Co.)	6:45 – 7:05 (20 min)
Break		7:05 – 7:15 (10 min)
Public comment period (Q&A related to agenda topics and general questions & comments)		7:15 – 8:15 (60 min)
Facilitated public dialogue	Dan Stetson Jerry Kern	8:15 - 8:30 (15 min)
SCE and CEP closing comments	Doug Bauder David Victor	8:30 – 8:35 (5 min)