

Exchange of emails between Per Peterson, Marvin Resnikoff, a member of the community (Donna Gilmore) and OC Register Reporter Teri Sforza

From: "David G. Victor" <david.victor@ucsd.edu>
Date: Monday, May 12, 2014 at 4:24 PM
To: Per Peterson <peterson@nuc.berkeley.edu>, Donna Gilmore <dgilmore@cox.net>, Teri Sforza <tsforza@ocregister.com>, Gene Stone <genston@sbcglobal.net>, Marvin Resnikoff <radwaste@rwma.com>
Cc: "sallevato@sanjuancapistrano.org" <sallevato@sanjuancapistrano.org>, "whparker@uci.edu" <whparker@uci.edu>, "garry@coastkeeper.org" <garry@coastkeeper.org>, "press@areva.com" <press@areva.com>, Ted Quinn <tedquinn@cox.net>, "lbartlett@danapoint.org" <lbartlett@danapoint.org>, Tim Brown <TBrown@towerco.com>, "pat.bates@ocgov.com" <pat.bates@ocgov.com>, "jmalpay@capousd.org" <jmalpay@capousd.org>
Subject: Re: SONGS community engagement panel....

Per

Thanks so much for your note. Do you mind if I send a copy of this exchange (Donna's question and your reply) to the full CEP as part of a packet of other questions and exchanges that have followed after our workshop.

All best

David

From: Per Peterson <peterson@nuc.berkeley.edu>
Date: Monday, May 12, 2014 at 3:30 PM
To: Donna Gilmore <dgilmore@cox.net>, Teri Sforza <tsforza@ocregister.com>, Gene Stone <genston@sbcglobal.net>, Marvin Resnikoff <radwaste@rwma.com>
Cc: "sallevato@sanjuancapistrano.org" <sallevato@sanjuancapistrano.org>, "whparker@uci.edu" <whparker@uci.edu>, "garry@coastkeeper.org" <garry@coastkeeper.org>, "press@areva.com" <press@areva.com>, Ted Quinn <tedquinn@cox.net>, "lbartlett@danapoint.org" <lbartlett@danapoint.org>, "David G. Victor" <david.victor@ucsd.edu>, Tim Brown <TBrown@towerco.com>, "pat.bates@ocgov.com" <pat.bates@ocgov.com>, "jmalpay@capousd.org" <jmalpay@capousd.org>
Subject: Re: SONGS community engagement panel....

Donna,

Thank you for sending the Billone reference. I have reviewed it, and you are correct that NRC interim staff guidance permits spent fuel cladding to be heated, when placed into dry cask canisters, to higher temperatures (up to 400°C) than occur during reactor service, during the vacuum drying of the fuel in the canister before it is filled with helium. The experiments performed by Billone et al. show that significant radial hydriding and embrittlement can occur in high-burnup cladding when heated to these temperatures.

I will follow up to learn more about this problem. I don't see a reason why drying cannot be accomplished while limiting peak fuel temperatures to significantly lower values, but it does appear possible that current drying protocols during canister loading may cause fuel to reach temperatures high enough to cause this additional radial hydriding and resulting cladding embrittlement.

-Per

Per F. Peterson
Floyd Professor of Nuclear Engineering
Department of Nuclear Engineering
University of California
4167 Etcheverry Hall
Berkeley, California 94720-1730
Office: (510) 643-7749 Fax: (510) 643-9685
http://www.nuc.berkeley.edu/People/Per_Peterson

On May 8, 2014, at 5:07 PM, Donna Gilmore wrote:

Here's a link to the Billone file Marvin attached.
<http://www.nwtrb.gov/meetings/2013/nov/billone.pdf>

Also, Dr. Arjun Makhijani addressed this and other important information in his comments to the NRC's Waste Confidence GEIS. This one paragraph mentions the Billone study regarding significant cladding damage upon drying.

"4.5. The study cited by the NRC for public health impact only considered spent fuel stored in a pool for 10 years followed by dry storage for 20 years. The experiments of Billone et al. on high burnup fuel – the only study cited in the Draft GEIS regarding damage to spent fuel as a result of high burnup – showed significant damage to high burnup fuel upon drying:

Pre-storage drying-transfer operations and early stage storage subject cladding to higher temperatures and much higher pressure-induced tensile hoop stresses relative to in-reactor operation and pool storage. Under these conditions, radial hydrides may precipitate during slow cooling and provide an additional embrittlement mechanism as the cladding temperature decreases below the ductile-to-brittle transition temperature (DBTT).

Photographs in Billone et al. show clear damage, including significant cracks in the cladding. The Draft GEIS statement that this “could influence the approach used for repackaging spent fuel” is so limited in scope as to provide almost no insight into the environmental impacts during accidents, further degradation during prolonged storage, and during handling and transfer operations. Repackaging is far from the only or even the most important issue from the environmental point of view. We note that the NRC has yet to demonstrate how it will transfer

damaged spent fuel from one cask to another (see paragraph 4.27 below)... "

See Arjun's full report at this link. I highly recommend reading it.

<http://www.nirs.org/radwaste/exhibitaarjundeclaration122013.pdf>

Donna Gilmore
SanOnofreSafety.org
949-204-7794

---- Marvin Resnikoff <radwaste@rwma.com> wrote:

Per:

Thanks for your comments at the CEP meeting. This is in response to your email note to CEP members. There may be some confusion about damaged fuel and when it is observed. As you see by the attached report by Argonne scientists, hydriding and defects of cladding occur as the fuel cools down, not when it is removed from the reactor. The Department of Energy may not accept damaged fuel that is not containerized because that fuel may not be easily retrievable after transportation. Consequently, Maine Yankee and Zion have chosen to can the high burnup fuel. The discussion at the CEP meeting revolved around whether containers leak or not, and missed the larger point. I'm not a lawyer, but it seems to me the less risky financial course for SoCal is to can the fuel because it may be subject to financial penalties by DOE down the road if fuel cannot be easily retrieved. Vibrations during travel may damage the hydrided and therefore brittle

cladding. Since SoCal has been put on notice about this issue, they cannot at some later date say they were not aware. And citizens support this additional protection as well.

I hope this is helpful.

Best,

Marvin Resnikoff

P.S. Maybe some day we'll have a chance to discuss your recent article in Foreign Affairs. Since we work for public interest groups on the fracking issue, we have some obvious differences.

From: Per Peterson <peter@nuc.berkeley.edu>

To: Teri Sforza <tsforza@ocregister.com>

Cc: "david.victor@ucsd.edu" <david.victor@ucsd.edu>; "jmalpay@capousd.org" <jmalpay@capousd.org>; "lbartlett@danapoint.org" <lbartlett@danapoint.org>; "garry@coastkeeper.org" <garry@coastkeeper.org>; Tim Brown <TBrown@towerco.com>; "sallevato@sanjuancapistrano.org" <sallevato@sanjuancapistrano.org>; "whparker@uci.edu" <whparker@uci.edu>; Ted Quinn <tedquinn@cox.net>; "pat.bates@ocgov.com" <pat.bates@ocgov.com>; "radwaste@rwma.com" <radwaste@rwma.com>; "press@areva.com" <press@areva.com>

Sent: Thursday, May 8, 2014 2:24 AM

Subject: Re: SONGS community engagement panel....

For the earlier and existing water cooled reactors, the burn-up of the fuel is directly related to the amount of time spent between refueling, where in our existing plants 1/3 of the fuel would be replaced.

Early on, refueling every one year was the target. Early fuels experienced frequent failures of cladding, and failed fuel pins (the tubes containing the fuel pellets) that were leaking had to be pulled out from the other pins in their assemblies and placed into sealed canisters. Over the years, there have been very large reductions in the numbers of fuel pins that leak, to my understanding due to better designs to prevent them from experiencing wear damage from outside (they vibrate due to the high velocity of the water flow through the assemblies, so designing the supports that hold them to prevent wear is important), and to prevent damage by high-temperature hydriding of the internal surfaces, a phenomena where exposure to hydrogen from water leaking into the pin causes damage to the metal cladding).

After fuel is removed from a reactor core, the processes which cause degradation (mechanical vibration and high-temperature corrosion) slow down enormously. To my understanding, so far it has been impossible to detect any further degradation occurring during storage of spent fuel after it has been removed, because any processes that cause degradation during storage are too slow to be measurable.

Right now, given the collapse of our federal program to manage spent fuel and nuclear waste, we must assume that spent fuel might be left in interim storage for over 100 years. This implies that our U.S. political system will remain insanely irresponsible in managing nuclear materials for the next century, in which case--quite frankly--this spent fuel is unlikely to be the most important source of our children's future problems.

The high burn-up fuel now being used in U.S. reactors has the lowest failure and leakage performance of any fuel we've ever used, due to design improvements that prevent degradation that causes localized damage to cladding that can cause leaks. The DOE is now engaged in a major effort to understand how this fuel might behave in dry storage over very long periods of time. It is my expectation that the conclusion will be that our older low-burnup fuel, which experienced much higher rates of leaking fuel pins and thus has more damage from external and internal sources causing localized thinning, will be the most likely to experience long-term problems due to this higher initial localized damage.

The major concern is that the U.S. government has completely abandoned its responsibility to develop the capacity to provide disposal of nuclear wastes, to the point where the U.S. 9th Circuit Court of Appeals has agreed that the DOE has no viable explanation to collect the Nuclear Waste Fund fee, and has directed the DOE to stop collecting this fee.

The worldwide historical, and likely (a least worldwide) future use of fission has and will create wastes that require long-term isolation. There exists a strong scientific and technical consensus that effective isolation can be achieved if these wastes are emplaced into deep, geologically stable formations.

It is critical that the U.S. restart its program to develop deep geologic disposal of nuclear wastes,

as well as to address the other policy problems that the Blue Ribbon Commission identified (particularly, to stop Congress from stealing the fees that ratepayers pay into the Nuclear Waste Fund).

My direct answer is that there is general consensus that spent fuel is likely to be quite stable in dry storage for long periods of time, whether it is old low-burnup fuel that experienced more damage and leakage, or newer designs for higher-burn-up fuel that experienced less damage and leakage while it was inside the reactor core.

But the long term risks posed by the older low-burnup fuel, and the newer high-burnup fuel, will depend most on whether the U.S. Congress restarts a nuclear waste program that is credible and can be successful. Senator Feinstein's bill is excellent to do this.

-Per

Per F. Peterson
Floyd Professor of Nuclear Engineering
Department of Nuclear Engineering
University of California
4167 Etcheverry Hall
Berkeley, California 94720-1730
Office: (510) 643-7749 Fax: (510) 643-9685
http://www.nuc.berkeley.edu/People/Per_Peterson

On May 7, 2014, at 3:21 PM, Teri Sforza wrote:

Hi, folks. Teri Sforza from the OC Register here.

I'm going to be doing something on post-Fukushima lessons learned, much from the recent GAO report (<http://www.gao.gov/products/GAO-14-109>).... And will likely get into the "high burnup fuel" issue that has been raised as of late, concerns over the stability of said fuel in dry casks over many decades. I've reviewed the presentations made to the panel Tuesday (http://www.songscommunity.com/050614_event.asp), as well as the NRC's summary (<http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/bg-high-burnup-spent-fuel.html>), but am wondering what your thoughts are on long-term storage of these casks, and what will be required to keep them stable....

Appreciate your thoughts. Thanks.

Teri Sforza
The Orange County Register
tsforza@ocregister.com

714.350.5365

Exchange between Mike McMahon and CEP Member Gene Stone

From: "MCMAHON Mike (AREVA)" <Michael.Mcmahon@areva.com>

Date: Saturday, May 10, 2014 at 2:14 PM

To: Gene Stone <genston@sbcglobal.net>

Cc: "David G. Victor" <david.victor@ucsd.edu>, "BONDRE Jayant (AREVA)" <jayant.bondre@areva.com>, "HAYS Jeff (AREVA)" <Jeffrey.Hays@areva.com>

Subject: RE: backup information

Gene,

I enjoyed meeting you and speaking with you at the CEP workshop. Presentations for all of the presenters at the 5/6 meeting are publicly available at the following website:

http://www.songscommunity.com/050614_event.asp

I note that the document posted on-line is a slightly older version of the presentation – the only difference is that the newer version has the correct number of high burnup fuel assemblies AREVA has shipped world-wide, which is 15,000 (vs. 13,000 as shown in the on-line presentation)

David Victor has asked for us to route any requests for additional information from CEP members through him to collect and collate, so I will send the technical comparison of the 24 vs. 32 assembly systems through him.

The other people with me that were talking at the jeep were Dr. Jayant Bondre, AREVA TN VP & COO (jayant.bondre@areva.com) and Jeff Hays, AREVA VP, Commercial Decommissioning (Jeffrey.Hays@areva.com). I have placed both of them on copy.

Finally, I do not currently have plans to attend the 22 May CEP meeting,

Best regards,

Mike

MICHAEL V. MCMAHON

Senior Vice President

AREVA TN Americas

A Division of AREVA Inc.

7135 Minstrel Way, Suite 300

Columbia, Maryland 21045 USA

P: 410.910.6830

C: 301.310.4637

F: 434.382.3622

michael.mcmahon@areva.com

www.us.aveva.com/AREVATN

From: Gene Stone [<mailto:genston@sbcglobal.net>]

Sent: Thursday, May 08, 2014 12:40 PM

To: MCMAHON Mike (BE/TN)

Cc: Marvin Resnikoff; David Victor

Subject: backup information

Michael,

Thank you for coming to the SCE/CEP event Tuesday night with your great presentation. Could I get a copy of it to go over?

Also in your statement while talking about the Areva new 32 cask system SCE may use at SONGS you said that "the new technology is just better" while that is a great statement to make I would like to see any technical information that you could share so I can understand just how and why and what makes them safer. In a effort to be a competent SCE/CEP member I would like to review this in more depth with Marvin Resnikoff.

The other person with you talking by my jeep after the meeting, I lost his card. Could I get is info. Will you be at the next SCE/CEP meeting on May 22? If so I will be looking forward to talking with you again.

Sincerely,

Gene Stone

Residents Organized For a Safe Environment (ROSE)

949-233-7724, On twitter @gene_stone

<http://residentsorganizedforasafeenvironment.wordpress.com/>

<http://partoftheearth.blogspot.com/>

"Let us put our minds together and see what life we can make for our children." Sitting Bull



Holtec Center, One Holtec Drive, Marlton, NJ 08053

Telephone (856) 797-0900

Fax (856) 797-0909

May 14, 2014

Dr. David Victor
School of International Relations and Pacific Studies
University of California, San Diego
9500 Gilman Drive, MC 0519
La Jolla, CA 92093-0519

Subject: May 6, 2014 Technical Workshop

Dear Chairman Victor:

I had the privilege to watch the most informative and engaging proceedings of the panel from among the audience on May 6. The subject matter of the dialogue, namely, storage and transport of used nuclear fuel, has been the principal focus of my efforts over the past three decades as Holtec International's Chief Technology Officer. Over 40 of my patents pertain to novel devices and systems to improve dry storage and transport of "high level nuclear waste", as do dozens of my technical publications. Holtec, as most of your panelists likely know, is America's only domestic cask company and the nation's largest supplier of dry storage and transport systems. Holtec provides dry storage/transport systems to over 70 nuclear reactors around the world, 50 of which are in the United States. California's Diablo Canyon and Humboldt Bay are Holtec sites; the latter has the distinction of being the *first* user of our uniquely safe and robust *underground* storage technology that we sell under the trade name "HI-STORM UMAX". As I listened to the panelist address matters of dry storage safety and security at SONGS, I became persuaded that they should be made aware of the *underground* storage technology that has become available in recent years. The attached Holtec white paper on the UMAX storage facility is intended to serve as the introductory material for those interested in learning about this latest innovation in dry storage. The reader of the white paper will learn that, designed for the post-9/11 age, "UMAX" is visually inconspicuous, with the fuel protected by a 25 feet deep steel/concrete underground silo, making it inaccessible to the perils of nature as well as those that confront us in the 21st century. Many of the safety and security considerations embedded in "UMAX" were brought up during the May 6 parlay. I trust your co-panelists and CEP membership would find the White Paper informative.

Areva's panelist was right in stating that advances in fuel design have made nuclear fuel much more tolerant of "high burn-up" than was the case, say 20 years ago. Placing high burn-up fuel in dry storage should indeed be a matter for heightened safety and concern. The workshop discussions did not, however, get to the heart of the issue, as I explain below.



Dr. David Victor
University of California, San Diego
May 14, 2014
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As was explained by Dr. Resnikoff in the meeting, the fuel rod (which is actually a tube) may lose some of its wall thickness because of oxidation of its outer surface while cooking in the hellish environment inside the reactor. Another effect, not mentioned in the intra-panel dialogue, is the fact that the pressure inside the tube rises with increasing burn-up because of the continuous generation of “fission” gases as the fuel burns inside the reactor. The increased internal pressure, along with reduced wall thickness, causes increased stress in the tube’s wall (called “cladding” by the nuclear engineers). This increase in the cladding stress is a principal source of threat to the integrity of the fuel cladding during its storage life cycle.

To protect this pressurized tube from failure due to excessive internal stress, we must ensure that it does not get too hot because its internal gas pressure will rise with temperature (following ideal gas law taught in High School physics). Maintaining the fuel rod temperature as-low-as-possible (ALAP) is the solution to this technical challenge. “Canning”, mentioned in the CEP meeting as the panacea, unfortunately, is a cure that is worse than the disease. Placing a “can” around the fuel has the perverse effect of raising its temperature (just as wrapping oneself in a blanket would raise a person's body temperature) which, as I mentioned above, is bad for a fuel of high burn-up persuasion. I agree with the lady in the green sweater (Donna?) who handed me a citizens' pamphlet which asks the high burn-up fuel's temperature to be kept low. Holtec, guided by the need to prevent damage to fuel, recommends limiting the peak cladding temperature in canisters containing high burn-up fuel to approximately 350 deg. C. (50 deg. C lower than 400 deg. C permitted by the NRC guidelines) both during long-term storage and during drying.

I should close by noting that Areva's delegate was quite chivalrous in stating the seismic loading to which SONGS' dry storage is designed: it is 1.0 g vertical and 1.5 g's in *two* orthogonal directions which equals 2.124g net horizontal (not 1.5 g mentioned in his slide). This Design Basis earthquake for SONGS dry storage is easily 2.5 times the strongest earthquake recorded anywhere on our planet.

With regard to transport of “high burn-up fuel”, I would like to limit my input to only a few words in the following (because transport is not a priority item for SONGS at this time):

The ALAP principle should be observed in transport also.



Holtec Center, One Holtec Drive, Marlton, NJ 08053

Telephone (856) 797-0900

Fax (856) 797-0909

Dr. David Victor
University of California, San Diego
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- i. Holtec licensed the first HBF cask (HI-STAR 180) in 2008; the NRC literature on HBF in the HI-STAR 180 docket is rich in technical material that the CEP membership should find informative.
- ii. The secret to a safe transport strategy is to use weather-insensitive, high efficiency, metallic impact limiters, not those made of balsa wood and redwood that some use to minimize cost.

Thank you again for inviting me to share my thoughts. I attach my synopsised biographical profile to acquaint you with my professional antecedents.

Sincerely,

Kris Singh, Ph.D., PE
President and CEO

Attachments: Holtec White Paper on SONGS Dry Storage
Biographical Profile of Dr. Kris Singh

cc: By Email

Mr. Thomas J. Palmisano, SCE
Mr. Christopher Thompson, SCE
Mr. Edward Avella, SCE
Mr. Pierre Oneid, Holtec

WHITE PAPER ON STORING SONGS' USED FUEL IN HI-STORM UMAX BEYOND THE REACH OF ENVIRONMENTAL THREATS SUCH AS EARTHQUAKES, TSUNAMI, MARINE AIR, CRASHING AIRCRAFT AND THE LIKE



Holtec International has devised and licensed an *underground* dry storage system, called **HI-STORM UMAX**, which provides complete physical protection to the spent nuclear fuel and other nuclear waste by storing the fuel and waste below grade in reinforced vertical silos. Prior to the storage in the vertical cavities of HI-STORM UMAX, the fuel is packaged inside all-welded stainless steel canisters known as Multi-Purpose Canisters (MPCs). The MPCs are made of a stainless alloy that is well known to withstand severe salt air environments. Each MPC contains 37 used fuel assemblies in each vertical cavity fortified by steel and concrete on all sides. The storage cavities are approximately 18 feet apart and are structurally impenetrable to crashing aircraft or shoulder launched shoulder. The heat produced by the decaying fuel inside the MPCs is rejected to the ambient environment by an internal ventilation system configured to block the release of radiation to the environment. As a result, the entire inventory of the SONGS fuel placed in HI-STORM UMAX will accrete less than 0.1% of the radiation dose from the sun to a person standing only a few hundred feet away on the beach. HI-STORM UMAX is the maximum capacity version of Holtec's first underground storage system, HI-STORM 100U, developed in the wake of the September 11th terrorist attacks in 2001 and licensed by the US NRC (CoC 72-1014) in 2009.

Holtec's intellectual property on the HI-STORM UMAX technology is safeguarded by US Patent Nos. 8098790B1, 7933374B2 and 7590213B1.

HI-STORM UMAX's MISSION: DELIVER UNCONDITIONAL SAFETY TO THE HOST COMMUNITY

- **Extreme Resistance to Earthquakes:** HI-STORM UMAX storage system, if built at SONGS, will feature over 25 feet thick block of steel and concrete surrounded by the site's San Mateo soil emulating a rigid inclusion in the earth's sub-grade during an earthquake. The MPCs are stored inside the water impregnable thick walled container which provides the MPCs full structural support during an earthquake event. Calculations show the *system is so seismic-resistant that even a hyper-quake, more than twice as strong as that recorded at any place on earth, would fail to cause any of the SONGS' stored MPCs to develop a leak.*
- **Inconspicuous:** Founded on flat land, HI-STORM UMAX is an inconspicuous structure comparable to the stature of a cemetery stone (see Figure 1). However, the top pad of the storage system can be raised by elevating the grade at owner's option. Thus, the HI-STORM UMAX ISFSI can serve as a berm, a tsunami barrier, or be founded inconspicuously on flat land, at SCE's option.
- **Zero Risk of Damage from Fire, Flood, Hurricanes, Tsunami, etc.:** HI-STORM UMAX has large margins of safety against all natural events such as tsunamis, hurricanes, tornados and other forces of nature, applied independently or concurrently. Submersion of the storage facility by flood water or coastal flooding will pose no threat to the storage system. Removal of the flood waters and waterborne debris will be the only nuisance.

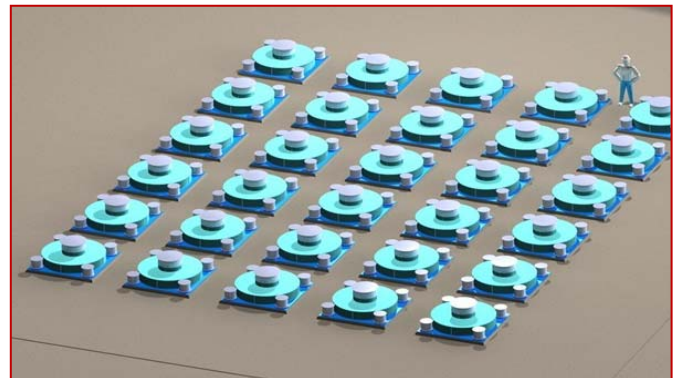


Figure 1: A HI-STORM UMAX ISFSI IN PERSPECTIVE VIEW

Did You Know?

- ✓ HI-STORM UMAX is engineered to prevent significant deposit of solids in the storage module by wind borne sand and debris
- ✓ Combustible material, if introduced in the storage cavity, cannot sustain its burn
- ✓ Thermal performance is enhanced, not degraded by floodwater intrusion

- **Zero Risk of Release of Radioactivity Under Extenuating Events:** Release of radioactivity from HI-STORM UMAX by any mechanical means (including crashing aircraft, missile, etc.) is virtually impossible. The only access path into the cavity for a missile is vertically downward, which is guarded by a concrete-fortified steel lid weighing in excess of 30,000 lbs. The lid design is configured to withstand a crashing aircraft and can be further buttressed to withstand more severe battlefield weapons if required for security reasons.
- **Vanishingly Small Dose in the Vicinity of the Facility:** The depth of HI-STORM UMAX can be increased virtually without limit. The dose from a HI-STORM UMAX loaded with extremely “hot” fuel (70 GWD/MTU, 5-year cooled) is only about 1/1000 of one mrem per hour, which is a small fraction of the background radiation already present in the environment.
- **Zero Risk of Ground Water Incursion:** There is no credible risk of ground water reaching the MPC storage cavity even if the storage system is located well below the water table. The guaranteed protection against ground water intrusion is guaranteed by over eight feet of concrete that guards the MPC storage cavity from the surrounding ground water, backed by a thick steel container that has no penetrations or joints and is fortified by a preservative suited to the geological characteristics of the site to prevent corrosion. Therefore, *there is no path for ground water to enter the storage cavity.*
- **Security Friendly:** The HI-STORM UMAX is configured to be visually inconspicuous (the profile of the module is less than 2 ft. tall) making it a diminutive target from the air and reducing visibility from adjacent land. There are no areas on the ISFSI where a person may hide, eliminating the risk of human intrusion. The world’s first underground storage system resides at the Humboldt Bay Nuclear Plant in California, which is safely storing high level waste (HLW) and GTCC waste (see Figure 2). The inconspicuousness of the underground Humboldt ISFSI is evident from the aerial photo of the site below (see Figure 3). We call upon the reader to find it!
- **Decommissioning Friendly:** The HI-STORM UMAX module is constructed for low-cost decommissioning once the canister is removed at the end of the ISFSI's service life.



Figure 2: Holtec’s Underground Dry Storage System at Humboldt Bay



Figure 3: Humboldt Bay hosts World’s First Underground Storage Facility by Holtec (2007)

BIOGRAPHICAL PROFILE



Dr. Kris Singh
President and CEO, Holtec International
Holtec Center
One Holtec Drive / Marlton, NJ 08053
Telephone: (856) 797-0900
Email: k.singh@holtec.com

Dr. Kris Singh is the President and CEO of Holtec International, a diversified energy technology company that he founded in 1986. Dr. Singh received his Ph.D. in Mechanical Engineering from the University of Pennsylvania, Philadelphia (1972), M.S. in Engineering Mechanics also from Penn (1969), and B.S. in Mechanical Engineering from BIT Sindri (Ranchi University), India (1967). Dr. Singh is a member of the National Academy of Engineering, a Fellow of the American Society of Mechanical Engineers, and a member of the American Nuclear Society. He is a registered Professional Engineer in Pennsylvania and Michigan. Over the past 40 years, he has published over sixty technical papers in the permanent literature, authored an authoritative text book on heat exchangers, and contributed to numerous monographs, symposia volumes, as well as national codes and standards. An array of patents (over 50 U.S. and foreign patents granted, and some 15 in the process of being granted) memorialize Dr. Singh's inventions over the past 40 years and form the bedrock of technology that supports Holtec International's global leadership in nuclear, solar, fossil and geothermal technologies.

Dr. Singh has held executive management positions since 1979. Since 1986, he has led Holtec International, building the company into a technological powerhouse respected for its engineered goods and services around the world with nine major operations centers in three countries and an active business presence on four continents. A firm believer in the power of the atom to power the globe, Dr. Singh has been driving the development of an innovative small modular reactor design since 2009, with the goal of making nuclear energy the paragon of safety and a commercially attractive source of clean energy around the world.

Dr. Singh serves on the following boards: Board of Trustees of the University of Pennsylvania, Board of Overseers of the University's School of Engineering and Applied Science, Board of Trustees of the Cooper Health System based in Camden, New Jersey, Board of Directors of the Nuclear Energy Institute, Board of Directors of Holtec International (Chairman), and Board of Directors of the KPS Charitable Foundation (Chairman).

The Foundation's signature accomplishment is the completion of the Krishna P. Singh Center for Nanotechnology at the University of Pennsylvania.

In response to questions received following the CEP Workshop on May 6th, AREVA TN is issuing the following clarification to our presentation:

1. AREVA TN presentation slide #8 stated the following:

- All known damaged fuel has already been canned and stored in NUHOMS[®] systems at SONGS

It should have more accurately stated:

- All known damaged fuel **identified at the time of previous dry fuel storage loading campaigns** has already been canned and stored in NUHOMS[®] systems at SONGS

During the first spent fuel transfer loading campaigns at SONGS Units 2 and 3 in 2005 and 2007 respectively, all damaged fuel known at that time was transferred into dry storage. There are 9 24PT1-DSCs containing 27 damaged fuel assemblies and 6 24PT4-DSCs containing 67 damaged fuel assemblies currently in the ISFSI. Since this time, additional damaged fuel has been identified. There are 35 additional known or suspect damaged spent fuel assemblies in the Units 2 and 3 spent fuel pools, including two rod storage baskets containing damaged rods, and two trash cans containing filters with fuel particulate which will require storage in failed fuel cans or damaged fuel compartments.

AREVA TN also received the following request for additional information from CEP member Gene Stone:

“Also in your statement while talking about the Areva new 32 cask system SCE may use at SONGS you said that “the new technology is just better” while that is a great statement to make I would like to see any technical information that you could share so I can understand just how and why and what makes them safer. In an effort to be a competent SCE/CEP member I would like to review this in more depth with Marvin Resnikoff.”

The table below shows a side by side comparison of key features and parameters of the 24PT4 Dry Shielded Canister (DSC)/AHSM system compared to the newer and more advanced 32PTH2 DSC/AHSM-HS system. In qualitative terms, compared to the 24PT4/AHSM system, the 32PTH2/AHSM-HS system has the following features/benefits:

- Larger DSC diameter/greater DSC length
- Higher Total Heat Load Capacity/Higher per Fuel Assembly Heat Load Capacity, which translates into:
 - Shorter minimum cooling times
 - Increased safety margins
- Stronger and more rigid basket design for increased safety margin in accident conditions



- Increased fuel compartment wall thickness for increased safety margin in accident conditions
- AHSM-HS has a broader “footprint” and lower center of gravity for increased safety margin during seismic events
- 2 inlet and outlet air vents (vs. 1 in the 24PT4) to reduce the probability of air vent blockage and increase safety margins
- Improved shielding design to reduce external radiation dose

Design Feature	24PT4-DSC and AHSM	32PTH2-DSC and AHSM-HS
Storage Capacity	24 Spent Fuel Assemblies (SFA)	32 Spent Fuel Assemblies (SFA)
Maximum DSC Heat Load	24 kW	37.2 kW
Maximum SFA Heat Load	1.26 kW	1.5 kW
Maximum SFA Enrichment	4.85 wt% U ²³⁵	5.0 wt% U ²³⁵
Maximum SFA Burnup	60 GWd/MTU	62.5 GWd/MTU
SFA Basket Design	Assembly of the 32PTH2 fuel compartment tubes packed and welded together at intermittent locations along the axial length of the basket results in a design that is very rigid and structurally stronger than the spacer disc design of the 24PT4 for accident loads such as seismic.	
Basket Design	Structural support for the PWR fuel and basket guide sleeves is provided by circular spacer disc plates.	Tube basket
Basket Poison material	Criticality is controlled by utilizing the fixed borated neutron absorbing material, Boral®	Metal Matrix Composite (MMC)
Fuel Compartments	Guide sleeves for fuel	Fuel compartment tubes are 3x thicker than the guide sleeves that confine the fuel in the 24PT4. This ensures that the fuel cladding structural is maintained protected under all normal, off-normal, and postulated accident conditions
Heat Transfer Capability	Spacer disk type design where the only heat conduction path to the shell is thru the intermittent spacer disks.	Tube type design with poison and aluminum plates in an egg-crate configuration and aluminum transition rails that is much more efficient in rejecting heat from the fuel assemblies.
DSC Shell Material	5/8" 316L SS	5/8" 316L SS



Damaged Fuel	Up to 12 damaged or failed fuel assemblies can be stored in a failed fuel can	Up to 16 damaged fuel assemblies can be stored in fuel compartments with end caps.
Dry Unloaded DSC Weight	38,338 lbs	45,800 lbs
Dry Loaded DSC Weight	85,000 lbs	106,000 lbs
DSC Diameter	67.19 inches	69.76 inches
DSC Length	196.3 inches	198.5 inches
Storage Module Dimensions	The AHSM is 8'6" wide, 19'7" long and 18' 6" tall	The AHSM-HS is 9'8" wide, 20' 8" long and 18' 6" tall Greater stability for each individual AHSM-HS (lower CG and bigger footprint) compared to AHSM
Storage Module Heat Transfer	One inlet and outlet per individual AHSM	Two inlet vents and two outlet vents per individual AHSM-HS (lower probability for vent blockage)
Storage Module Design		Optimized mass distribution (approx. 4 feet all exterior surfaces of AHSM-HS array) The AHSM-HS has an array of 6" pipes in the inlet and outlet vents as an optional dose reduction capability