UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE COMMISSION

In the Matter of	:	
	:	
Pacific Gas and Electric Company	:	
Diablo Canyon Nuclear Power Plant	:	Docket # 72-26
Units No. 1 and 2	:	
Independent Spent Fuel Storage Installation	:	

DECLARATION OF 7 SEPTEMBER 2002 BY DR. GORDON THOMPSON IN SUPPORT OF A PETITION BY AVILA VALLEY ADVISORY COUNCIL, SAN LUIS OBISPO MOTHERS FOR PEACE, PEG PINARD, ET AL

I, Gordon Thompson, declare as follows:

I. INTRODUCTION

(I-1) I am the executive director of the Institute for Resource and Security Studies (IRSS), a nonprofit, tax-exempt corporation based in Massachusetts. Our office is located at 27 Ellsworth Avenue, Cambridge, MA 02139. IRSS was founded in 1984 to conduct technical and policy analysis and public education, with the objective of promoting peace and international security, efficient use of natural resources, and protection of the environment. A statement of my professional qualifications is provided in Section II, below.

(I-2) I have been retained by the Avila Valley Advisory Council, San Luis Obispo Mothers for Peace, Peg Pinard, et al (hereafter described as "the Petitioners") as an expert adviser in regard to a Petition that is directed to the Commissioners of the US Nuclear Regulatory Commission (NRC). This Petition addresses two aspects of nuclear-facility operation at the Diablo Canyon site. First, the Petition addresses the pending application by the site licensee -- Pacific Gas and Electric Company (PG&E) -- for a license for an Independent Spent Fuel Storage Installation (ISFSI) at the site. Second, the Petition addresses the current operation of the two nuclear generation units (Units No. 1 and 2) at the site.

(I-3) The purpose of this declaration is to support the Petitioners' request that the NRC consider new and more rigorous measures to protect the public against the threat that acts of malice or insanity will release radioactive material from nuclear facilities at the Diablo Canyon site. The Petitioners' request has three components. First, the Petitioners request that the NRC conduct a comprehensive review of the adequacy of the protection that NRC regulations afford against acts of malice or insanity. Second, the Petitioners request that the licensing proceeding for the proposed Diablo Canyon ISFSI be suspended while this comprehensive review is conducted. Third, the Petitioners request that, if the NRC refuses to suspend the ISFSI licensing proceeding while the comprehensive review is being conducted, the scope of the proceeding be expanded to encompass the consideration of interim measures to improve public protection against acts of malice or insanity at Diablo Canyon.

(I-4) This declaration has twelve sections. After this introduction (Section I), Section II of the declaration addresses my professional qualifications. Then, Section III provides some information about the Diablo Canyon nuclear facilities, including the proposed ISFSI. Section IV provides a generic discussion of the history of, and potential for, acts of malice or insanity at nuclear facilities. This is followed, in Section V, by a generic discussion of the protection provided by NRC regulations against acts of malice or insanity at nuclear facilities. Section VI discusses the vulnerability of Diablo Canyon nuclear facilities to such acts. Then, Section VII outlines the potential offsite consequences of such acts at Diablo Canyon. Section VIII describes the types of measure that are available to protect the public against acts of malice or insanity at nuclear facilities, including those at Diablo Canyon. Section IX sets forth a process for consideration of such measures. Section X sets forth an approach to managing sensitive information about the vulnerability of nuclear facilities. Then, Section XI describes a set of interim measures that could improve public protection against acts of malice or insanity at Diablo Canyon. Conclusions are presented in Section XII.

II. MY PROFESSIONAL QUALIFICATIONS

(II-1) I am an expert in the technical analysis of safety and environmental issues related to nuclear facilities. My Curriculum Vitae is provided here as Attachment A.

(II-2) I received an undergraduate education in science and mechanical engineering at the University of New South Wales, in Australia. Subsequently, I pursued graduate studies at Oxford University and received from that institution a Doctorate of Philosophy in mathematics in 1973, for analyses of plasmas undergoing thermonuclear fusion. During my graduate studies I was associated with the fusion research program of the UK Atomic Energy Authority. My undergraduate and graduate work provided me with a rigorous education in the methodologies and disciplines of science, mathematics, and engineering.

(II-3) Since 1977, a significant part of my work has consisted of technical analyses of safety and environmental issues related to nuclear facilities. These analyses have been sponsored by a variety of nongovernmental organizations and local, state and national governments, predominantly in North America and Western Europe. Drawing upon these analyses, I have provided expert testimony in legal and regulatory proceedings, and have served on committees advising US government agencies. To illustrate my expertise, I provide in the following paragraphs some details of my experience.

(II-4) I have conducted, directed, and/or participated in a number of studies that evaluated aspects of the design and operation of nuclear facilities with respect to severe accident probabilities and consequences. These include generic studies and studies of individual facilities. For instance, with respect to generic studies on the potential for severe accidents at nuclear power plants, I was co-investigator in a study by the Union of Concerned Scientists on the "source term" issue -- the potential for release of radioactive material to the environment.[1] Also, I was one of a team of four scientists who prepared, for Greenpeace International, a comprehensive critique of the state of the art of probabilistic risk assessment (PRA) for nuclear power plants.[2] Our report noted that acts of malice, such as sabotage and acts of war, are not considered in PRAs, despite a history of malicious acts at many nuclear facilities. In addition, I conducted analysis on the relevance of PRA to emergency response planning, as part of a study on emergency planning for nuclear power plant accidents.[3] All of these studies required me to be highly familiar with the design and operation of nuclear power plants, as well as the characteristics of probabilistic risk assessment.

(II-5) I have also done considerable work on the risks posed by individual nuclear facilities. In addition to performing the studies described elsewhere in this declaration, I have studied the risks posed by the Seabrook and Three Mile Island plants (USA), the Darlington and Pickering stations (Canada), the Sizewell B station (UK) and the Dukovany plant (Czech Republic). All of these studies required me to become familiar with the relevant details of the design and operation of the facilities involved.

(II-6) To a significant degree, my work has been accepted or adopted by relevant governmental agencies. During the period 1978-1979, for example, I served on an international review group commissioned by the government of Lower Saxony (a state in Germany) to evaluate a proposal for a nuclear fuel cycle center at Gorleben. I led the subgroup that examined accident risks and identified alternative options with lower risk.[4] One of the risk issues that I identified and analyzed was the potential for self-sustaining, exothermic

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[1] Steven Sholly and Gordon Thompson, The Source Term Debate (Cambridge, Massachusetts: Union of Concerned Scientists, January 1986).

[2] H. Hirsch et al, IAEA Safety Targets and Probabilistic Risk Assessment (Hannover, Germany: Gesellschaft fur Okologische Forschung und Beratung mbH, August 1989).

[3] Dominic Golding et al, Preparing for Nuclear Power Plant Accidents (Boulder, Colorado: Westview Press, 1995).

[4] Jan Beyea, Yves Lenoir, Gene Rochlin and Gordon Thompson (subgroup chair), Report of the Gorleben International Review, Chapter 3: Potential Accidents and their Effects, submitted (in German) to the Government of Lower Saxony, March 1979.

oxidation reactions of fuel cladding in a high-density spent fuel pool if water is lost from the pool. Hereafter, for simplicity, this event is referred to as a "pool fire".[5] In examining the potential for a pool fire, I identified partial loss of water as a more severe condition than total loss of water. I identified a variety of events that could cause a loss of water from a pool, including aircraft crash, sabotage, terrorism and acts of war. Also, I identified and described alternative fuel storage options with lower risk; these lower-risk options included design features such as spatial separation, natural cooling and underground vaults. The Lower Saxony government accepted my findings about the risk of a pool fire, and ruled in May 1979 that high-density pool storage of spent fuel was not an acceptable option at Gorleben. As a direct result, policy throughout Germany has been to use dry storage in casks, rather than high-density pool storage, for away-from-reactor storage of spent fuel.

(II-7) My work has also influenced decisionmaking by safety officials in the U.S. Department of Energy (DOE). During the period 1986-1991, I was commissioned by environmental groups to assess the safety of the military production reactors at the Savannah River Site, and to identify and assess alternative options for the production of tritium for the US nuclear arsenal. Initially, much of the relevant information was classified or otherwise inaccessible to the public. Nevertheless, I addressed safety issues through analyses that were recognized as accurate by nuclear safety officials at DOE. I eventually concluded that the Savannah River reactors could not meet the safety objectives set for them by DOE.[6] DOE subsequently reached the same conclusion, and scrapped the reactors. The current national policy for tritium production is to employ commercial reactors, an option that I had concluded was technically attractive but problematic from the perspective of nuclear weapons proliferation.

(II-8) In 1977, and again during the period 1996-2000, I examined the safety of nuclear fuel reprocessing and liquid high-level radioactive waste management facilities at the Sellafield site in the UK. My investigation in the latter period was supported by consortia of local governments in Ireland and the UK, and I presented my interim findings at briefings in the UK and Irish parliaments in 1998. I identified safety issues that were not addressed in any publicly available literature about the Sellafield site.[7] As a direct result of my investigation, the UK Nuclear Installations Inspectorate (NII) required the operator of the Sellafield site -- British Nuclear Fuels (BNFL) -- to conduct extensive safety analyses. These

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[5] At water-cooled reactors, such as the Diablo Canyon reactors, the fuel cladding is made from a zirconium alloy that can enter into a vigorous exothermic oxidation reaction with either air or steam. For simplicity, this reaction can be referred to as a "fire".

[6] Gordon Thompson and Steven C. Sholly, No Restart for K Reactor (Cambridge, Massachusetts: Institute for Resource and Security Studies, October 1991).

[7] Gordon Thompson, High Level Radioactive Liquid Waste at Sellafield: Risks, Alternative Options and Lessons for Policy (Cambridge, Massachusetts: Institute for Resource and Security Studies, June 1998).

analyses confirmed the significance of the safety issues that I had identified, and in January 2001 the NII established a legally binding schedule for reduction of the inventory of liquid high-level radioactive waste at Sellafield.[8] The NII took this action in recognition of the grave offsite consequences of a release to the environment from the tanks in which liquid high-level waste is stored. I had identified a variety of events that could cause such a release, including acts of malice or insanity.

(II-9) In May 2000 I completed a study for Greenpeace International on the hazard potential of the La Hague site in France.[9] Nuclear fuel reprocessing and related activities are conducted at this site. The operator of the site -- COGEMA -- was at that time authorized to store 14,000 tonnes of spent fuel in high-density pools at La Hague, and proposed to increase the capacity of these pools to 17,600 tonnes. My study described the potential for a pool fire at La Hague, and identified events -- including acts of malice or insanity -- that could lead to a pool fire. One of the findings of my study was that neither COGEMA nor the French government had a thorough understanding of La Hague's hazard potential, including the potential for a pool fire. Subsequent to the terrorist events of 11 September 2001 in New York and Washington, media exposure brought La Hague's hazard potential to the attention of the French government. During October 2001 the French government deployed anti-aircraft missiles at La Hague.

(II-10) As stated in paragraph II-6, I determined in the period 1978-1979 that partial loss of water from a high-density spent fuel pool is a more severe condition than total loss of water. This is because convective heat transfer is suppressed by the presence of residual water at the base of the fuel assemblies. During any scenario for loss of water from a spent fuel pool, there will be a period of time during which residual water is present. As a result, comparatively old fuel -- potentially including fuel aged 10 or more years after discharge from a reactor -- can ignite if water is lost from a high-density spent fuel pool. The NRC Staff failed, for more than two decades, to understand this point. An illustration of the Staff's lack of understanding was provided by its statements during a license amendment proceeding in regard to the expansion of spent fuel pool capacity at the Harris nuclear power plant. I served as an expert witness for Orange County, North Carolina, the intervenor in this proceeding. In filings during March and April 2000, the Staff repeatedly disparaged my statements that comparatively old fuel can ignite. A few months later, however, the Staff adopted my position. In a report dated October 2000, but not published until January 2001, the Staff recognized that the flow of air to exposed fuel assemblies

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[8] Nuclear Installations Inspectorate, "Specification Issued under Licence Condition 32(4) for the Limitation of the Accumulation or Storage of Liquid High Level Radioactive Waste in B215. Licence Instrument 343. January 2001."

[9] Gordon Thompson, Hazard Potential of the La Hague Site: An Initial Review (Cambridge, Massachusetts: Institute for Resource and Security Studies, May 2000).

could be blocked by the presence of collapsed structures -- which might be attributable, for example, to a cask drop or an earthquake -- or by the presence of residual water.[10] The Staff analyzed the heat transfer implications of flow blockage and concluded:[11]

> "While the February 2000 [draft] study indicated that for the cases analyzed a required decay time of 5 years would preclude a zirconium fire, the revised analyses show that it is not feasible, without numerous constraints, to define a generic decay heat level (and therefore decay time) beyond which a zirconium fire is not physically possible."

(II-11) On numerous occasions, I have drawn attention in my writings and oral presentations to the vulnerability of nuclear facilities to acts of malice or insanity. I have pointed out that PRAs do not address acts of malice or insanity, with the result that a PRA can, at best, provide a lower bound to the probability of a release of radioactive material.[12] In 1996 I wrote a generic report on war and terrorism as risk factors for nuclear power plants.[13] Among other findings, my report noted that an act of war or terrorism at a nuclear power plant might target not only the plant's reactors, but also the spent fuel stored at the plant. The report concluded with a statement that supports the Petitioners' concerns about potential acts of malice and insanity at Diablo Canyon. My statement was:

> "Public debate about the future operation of existing nuclear power plants, and the construction of new plants, should be broadened to encompass the possible involvement of nuclear plants in war or terrorism."

(II-12) In January 2002, I authored a submission to the UK House of Commons Defence Committee, addressing the potential for civilian nuclear facilities to be used by an enemy as radiological weapons.[14] The submission drew upon my own work, and the findings of other analysts, dating back as far as the mid-1970s. My primary recommendation was that the Defence Committee should call upon the Parliamentary Office of Science and Technology to conduct a thorough, independent analysis of this threat. I argued that the UK government

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[10] Timothy Collins et al (authors are all from the NRC Staff), Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Nuclear Power Plants, October 2000.

[11] Collins et al, October 2000 (op cit), page 2-1.

[12] The strengths and weaknesses of PRA methodology are discussed in Hirsch et al, August 1989 (op cit).

[13] Gordon Thompson, War, Terrorism and Nuclear Power Plants (Canberra: Peace Research Centre, Australian National University, October 1996).

[14] Gordon Thompson, Civilian Nuclear Facilities as Weapons for an Enemy: A submission to the House of Commons Defence Committee (Cambridge, Massachusetts: Institute for Resource and Security Studies, 3 January 2002).

and nuclear industry cannot be trusted to provide a credible analysis. The Defence Committee subsequently adopted my recommendation.[15]

III. THE DIABLO CANYON NUCLEAR FACILITIES

(III-1) The Diablo Canyon site has two nuclear generation units. These are essentially identical pressurized water reactors (PWRs), each rated at a nominal 1,100 MWe. The two units share an auxiliary building and some components of auxiliary systems. Each reactor has a dedicated fuel handling system and spent fuel pool. The reactors were furnished by Westinghouse. PG&E owns and operates both units and the plant site. The site is on the California coast, about 6 miles northwest of the community of Avila Beach. Unit 1 began commercial operation in May 1985 and Unit 2 in March 1986. The operating licenses expire in September 2021 for Unit 1 and April 2025 for Unit 2.[16]

(III-2) The two spent fuel pools at Diablo Canyon were originally equipped with low-density racks, so that each pool could accommodate one and one-third cores of spent fuel. Each reactor core contains 193 fuel assemblies. In the late 1980s, the low-density racks were replaced by high-density racks that are currently in use. Each pool can now accommodate 1,324 spent fuel assemblies. Each unit is operating on an 18-21 month refueling cycle, discharges 76-96 spent fuel assemblies per refueling, and has operated for 10 cycles. PG&E projects that each pool can accommodate a full-core offload and the accumulated inventory of discharged fuel until 2006.[17]

(III-3) The data in paragraph III-2 indicate that each spent fuel pool now contains 760-960 spent fuel assemblies. Thus, given a pool capacity of 1,324 assemblies, while allowing space for a full-core offload of 193 assemblies, each pool could now accommodate an additional 171-371 assemblies.

(III-4) To accommodate spent fuel discharged from Units 1 and 2 after the pools are full, PG&E proposes to establish an ISFSI on the Diablo Canyon site. This facility would hold up to 140 dry-storage casks, employing Holtec's HI-STORM 100 cask system. PG&E expects that most of the casks would be capable of holding 32 fuel assemblies per cask. Assuming 140 casks, each holding 32 assemblies, the proposed ISFSI could accommodate 4,480 spent fuel assemblies. PG&E projects that this storage capacity would be sufficient to hold all the spent

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[15] House of Commons Defence Committee, Defence and Security in the UK: Sixth Report of Session 2001-02 (London: The Stationery Office Limited, 24 July 2002), Volume I, paragraphs 127-131.
[16] Pacific Gas and Electric Company, Diablo Canyon Independent Spent Fuel Storage Installation: Environmental Report (Avila Beach, California: PG&E, 21 December 2001), page 1.1-1.
[17] Ibid, page 1.1-1.

fuel discharged by Diablo Canyon Units 1 and 2 through the duration of their present operating license terms.[18]

(III-5) The proposed ISFSI could be used, as PG&E has implied, to hold all the spent fuel discharged by Units 1 and 2 through the duration of their operating license terms. This use of the ISFSI would allow the spent fuel pools to be emptied after the Unit 1 and 2 operating licenses have expired. However, the proposed ISFSI could also be used in a different manner. If the pools remained in use, the combined capacities of the pools and the ISFSI could accommodate spent fuel discharged from Units 1 and 2 during a substantial period of operating license extension. Assuming that the pools are filled to capacity in 2006, PG&E will then need additional spent fuel storage capacity to accommodate 34 reactor-years of plant operation through the present operating license terms.[19] Given the refueling data in paragraph III-2, the additional storage capacity required to accommodate 34 reactor-years of operation would be 1,520-2,208 spent fuel assemblies.[20] The proposed ISFSI capacity of 4,480 assemblies would substantially exceed this requirement.

(III-6) PG&E plans to expand the ISFSI in increments. The storage casks would sit on concrete pads, 20 casks per pad in a 4 by 5 array. Ultimately, seven pads would be built side by side, covering an area about 500 ft by 105 ft. Initially, two pads would be built.[21] PG&E expects that, while reactor operation continues, spent fuel would be transferred from the pools to the ISFSI after at least 5 years of storage in the pools. Specifically, casks would be acquired as needed to accommodate spent fuel that must be removed from the pools in order to free up space in the pools for storage of fuel discharged from the reactors.[22] Thus, from 2006 through the present Unit 1 and 2 operating license terms, and for a longer period if the operating licenses are extended, the pools would hold spent fuel at nearly their full capacity. That capacity is 1,131 assemblies per pool, assuming that space is left free for a full-core offload. The average post-discharge age of the spent fuel in each pool would be about 10 years.

(III-7) Each cask in the ISFSI would be about 11 ft in diameter and 20 ft high. The surface-to-surface distance between casks would be about 6 ft. The ISFSI's full capacity of 140 casks would be achieved by placing casks in a 5 by 28 array. A security fence would surround the area needed for this array, at a distance of

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[18] Ibid, page 1.2-2.

[19] After 2006, completion of the present operating license terms would occur over the period 2007-2021 for Unit 1 and 2007-2025 for Unit 2.

[20] Given a refueling cycle of 18-21 months, and a discharge of 76-96 assemblies per refueling, 34 reactor-years of operation would yield 1,520-2,208 spent fuel assemblies.

[21] PG&E, ISFSI Environmental Report (op cit), page 3.1-1.

[22] Ibid, page 1.2-1.

about 50 ft from the outermost casks. That fence would in turn be surrounded by a second fence, at a distance of about 100 ft from the outermost casks.[23]

(III-8) The HI-STORM 100 dry-cask storage system employs a multi-purpose canister (MPC) that contains the fuel, and a storage overpack that surrounds the MPC during storage. The MPC is a thin-walled stainless steel cylinder containing a basket structure to hold the spent fuel assemblies. After the MPC receives fuel and is sealed, it is filled with helium. The overpack is a thick-walled concrete cylinder whose surfaces are clad with a thin coating of carbon steel. Cooling of the MPC occurs by natural circulation of ambient air in a space between the MPC and the overpack. This air enters the overpack through holes near its base, passes over the MPC, and leaves the overpack through holes near its top.[24]

(III-9) The preceding paragraphs of Section III have described the present and proposed nuclear facilities at Diablo Canyon. In considering the potential significance of acts of malice or insanity at these facilities, it is important to know their inventory of radioactive material. Each of these facilities contains a variety of radioactive isotopes, but one isotope --cesium-137 -- is especially useful as an indicator of the potential for radiological harm. Cesium-137 is a radioactive isotope with a half-life of 30 years. This isotope accounts for most of the offsite radiation exposure that is attributable to the 1986 Chernobyl reactor accident, and for about half of the radiation exposure that is attributable to fallout from nuclear weapons tests in the atmosphere.[25] Cesium is a volatile element that would be liberally released during a fire in a spent fuel pool. An NRC study has concluded that a generic estimate of the release fraction of cesium isotopes during a spent fuel pool fire -- that is, the fraction of the pool's inventory of cesium isotopes that would reach the atmosphere -- is 100 percent.[26] It is reasonable to assume such a high release fraction because cesium is volatile, because a fire in a high-density pool, once initiated, would eventually involve all of the fuel in the pool, and because pool buildings are not designed as containment structures.

(III-10) The inventory of cesium-137 in the Diablo Canyon pools or the proposed ISFSI can be readily estimated. Three parameters govern such estimates -- the number of spent fuel assemblies, their respective burnups, and their respective ages after discharge. I have conducted such estimates, assuming a representative, uniform burnup of 46 GW-days per tonne. In addition, I have estimated the inventory of cesium-137 in the Diablo Canyon reactors. The results are provided in the following paragraph.

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[23] Ibid, Chapter 3.

[24] Ibid, Chapter 3.

[25] US Department of Energy, Health and Environmental Consequences of the Chernobyl Nuclear Power Plant Accident, DOE/ER-0332 (Washington, DC: DOE. June 1987).

[26] V. L. Sailor et al, Severe Accidents in Spent Fuel Pools in Support of Generic Safety Issue 82, NUREG/CR-4982 (Washington, DC: NRC, July 1987).

(III-11) As indicated in paragraph III-6, above, PG&E projections indicate that each of the Diablo Canyon pools will contain, from 2006 until the 2020s and potentially beyond, an inventory of spent fuel approaching the pool's capacity of 1,131 assemblies. The average post-discharge age of the fuel will be about 10 years. This inventory of spent fuel -- 1,131 assemblies aged for 10 years -- will contain about 56 million Curies (630 kilograms) of cesium-137. For comparison, the core of each Diablo Canyon reactor contains about 6 million Curies (67 kilograms) of cesium-137. As an indication of the amount of cesium-137 that could accumulate in the proposed Diablo Canyon ISFSI, consider one cask containing 32 fuel assemblies with an average post-discharge age of 20 years. This cask would contain about 1.3 million Curies (14 kilograms) of cesium-137.

(III-12) For comparison with the inventory estimates in paragraph III-11, note that the Chernobyl reactor accident of 1986 released about 2.4 million Curies (27 kilograms) of cesium-137 to the atmosphere. That release represented 40 percent of the Chernobyl reactor core's inventory of 6 million Curies (67 kg) of cesium-137.[27] Also, atmospheric testing of nuclear weapons led to the deposition of about 20 million Curies (220 kilograms) of cesium-137 across the land and water surfaces of the Northern Hemisphere.[28]

IV. POTENTIAL ACTS OF MALICE OR INSANITY AT NUCLEAR FACILITIES

(IV-1) For two decades or more it has been clear to many people that nuclear power plants and other nuclear facilities are potential targets of acts of malice or insanity, including highly destructive acts. The NRC has repeatedly rebuffed requests by members of the public that this threat be given the depth of analysis that would be expected, for example, in an environmental impact statement (EIS). This history is illustrated by a September 1982 ruling by the Atomic Safety and Licensing Board (ASLB) in the operating license proceeding for the Harris plant. The intervenor, Wells Eddleman, had proffered a contention alleging, in part, that the plant's safety analysis was deficient because it did not consider the "consequences of terrorists commandeering a very large airplane.....and diving it into the containment." In rejecting this contention the ASLB stated:[29]

> "This part of the contention is barred by 10 CFR 50.13. This rule must be read *in pari materia* with 10 CFR 73.1(a)(1), which describes the "design basis threat" against which commercial power reactors *are* required to be protected. Under that provision, a plant's security plan must be designed

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[27] Allan S. Krass, Consequences of the Chernobyl Accident (Cambridge, Massachusetts: Institute for Resource and Security Studies, December 1991).
[28] US Department of Energy, June 1987 (op cit).
[29] Carolina Power and Light Co. (Shearon Harris Nuclear Power Plant, Units 1 and 2), LBP-82-119A, 16 NRC 2069, 2098 (1982), (emphasis in original).

to cope with a violent external assault by "several persons," equipped with light, portable weapons, such as hand-held automatic weapons, explosives, incapacitating agents, and the like. Read in the light of section 73.1, the principal thrust of section 50.13 is that military style attacks with heavier weapons are not a part of the design basis threat for commercial reactors. Reactors could not be effectively protected against such attacks without turning them into virtually impregnable fortresses at much higher cost. Thus Applicants are not required to design against such things as artillery bombardments, missiles with nuclear warheads, or kamikaze dives by large airplanes, despite the fact that such attacks would damage and may well destroy a commercial reactor."

(IV-2) In the statement quoted in paragraph IV-1, the ASLB correctly described the design basis for US nuclear power plants. However, other design bases are possible. In the early 1980s the reactor vendor ASEA-Atom developed a preliminary design for a commercial reactor known as the PIUS reactor. The design basis for the PIUS reactor included events such as equipment failures, operator errors and earthquakes, but also included: (i) takeover of the plant for one operating shift by knowledgeable saboteurs equipped with large amounts of explosives; (ii) aerial bombardment with 1,000-pound bombs; and (iii) abandonment of the plant by the operators for one week.[30] It seems likely that this design basis would also provide protection against the impact of a large, fuel-laden aircraft. Clearly, ASEA-Atom foresaw a world in which acts of malice could pose a significant threat to nuclear facilities.

(IV-3) There is a rich history of events which shows that acts of malice pose a significant threat to nuclear power plants around the world. Many of these events, up to 1996, are summarised in a report that I prepared.[31] Consider some examples. Nuclear plants under construction in Iran were repeatedly bombed from the air by Iraq in the period 1984-1987. Yugoslav Air Force fighters made a threatening overpass of the Krsko nuclear plant in Slovenia -- which was operating at the time -- a few days after Slovenia declared independence in 1991. So-called research reactors in Iraq were destroyed by aerial bombing by Israel in 1981 and by the United States in 1991. In 1987, Iranian radio threatened an attack by unspecified means on US nuclear plants if the United States attacked launch sites for Iran's Silkworm antiship missiles. Bombs damaged reactors under construction in Spain in 1977 and in South Africa in 1982. Antitank missiles struck and penetrated the containment of a nuclear plant under construction in France in 1982. North Korean commandos were killed while attempting to come ashore near a South Korean plant in 1985. These and other events illustrate the "external" threat to nuclear plants. Numerous crimes and acts of sabotage by plant personnel illustrate the "internal" threat.

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[30] K. Hannerz, Towards Intrinsically Safe Light Water Reactors (Oak Ridge, Tennessee: Institute for Energy Analysis, February 1983).
[31] Thompson, October 1996 (op cit).

(IV-4) The threat posed to nuclear plants by truck bombs became clearly apparent from an October 1983 attack on a US Marine barracks in Beirut. In a suicide mission, a truck was driven at high speed past a guard post and into the barracks. A gas-boosted bomb on the truck was detonated with a yield equivalent to about 5 tonnes of TNT, destroying the building and killing 241 Marines. In April 1984 a study by Sandia National Laboratories titled "Analysis of Truck Bomb Threats at Nuclear Facilities" was presented to the NRC. According to an NRC summary:[32] "The results show that unacceptable damage to vital reactor systems could occur from a relatively small charge at close distances and also from larger but still reasonable size charges at large setback distances (greater than the protected area for most plants)." Eventually, in 1994, the NRC introduced regulations that require licensees to install defenses (gates, barriers, etc.) against vehicle bombs. The NRC was spurred into taking this action by two incidents in February 1993. In one incident, a vehicle bomb was detonated in a parking garage under the World Trade Center in New York. In the other incident, a man recently released from a mental hospital crashed his station wagon through the security gate of the Three Mile Island nuclear plant and rammed the vehicle under a partly-opened door in the turbine building.

(IV-5) The threat of suicidal aircraft attack on symbolic or high-value targets became clearly apparent from three incidents in 1994.[33] In April 1994 a Federal Express flight engineer who was facing a disciplinary hearing was travelling as a passenger on a company DC-10. He stormed the cockpit, severely wounded all three members of the crew with a hammer, and tried to gain control of the aircraft. The crew regained control with great difficulty. Federal Express employees said that the flight engineer was planning to crash into a company building. In September 1994 a lone pilot crashed a stolen single-engine Cessna into the grounds of the White House, just short of the President's living quarters. In December 1994 four Algerians hijacked an Air France Airbus 300, carrying 20 sticks of dynamite. The aircraft landed in Marseille, where the hijackers demanded that it be given a large fuel load -- three times more than necessary for the journey -- before flying to Paris. Troops killed the hijackers before this plan could be implemented. French authorities determined that the hijackers planned to explode the aircraft over Paris or crash it into the Eiffel Tower.

(IV-6) The incident described in paragraph IV-5 involving the Federal Express flight engineer illustrates the vulnerability of industrial systems, including nuclear plants, to "internal" threats. That vulnerability is further illustrated by a number of incidents. In December 2000, Michael McDermott killed seven coworkers in a shooting rampage at an office building in Massachusetts. He had

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32 T. A. Rehm, memo to the NRC Commissioners, "Weekly Information Report -- Week Ending April 20, 1984".
33 Matthew L. Wald, "US Failed to Learn From Earlier Hijackings", International Herald Tribune, 4 October 2001, page 6.

worked at the Maine Yankee nuclear plant from 1982 to 1988 as an auxiliary operator and operator before being terminated for exhibiting unstable behavior.[34] In 1997, Carl Drega of New Hampshire stockpiled weapons and killed four people -- including two state troopers and a judge -- on a suicide mission. He had passed security clearances at three nuclear plants in the 1990s.[35] In October 2000 a former US Army sergeant pleaded guilty to assisting Osama bin Laden in planning the bombing of the US embassy in Nairobi, which occurred in 1998.[36] In June 1999, a security guard at the Bradwell nuclear plant in Britain hacked into the plant's computer system and wiped out records. It emerged that he had never been vetted and had two undisclosed criminal convictions.[37] These and other incidents demonstrate clearly that it is foolish to ignore or downplay the "internal" threat of acts of malice or insanity at nuclear plants.

(IV-7) The events mentioned in the preceding paragraphs occurred against a background of numerous acts of terrorism around the world. Many of these acts have been highly destructive. US facilities have been targets on many occasions, as illustrated by the bombing of the US embassy in Beirut in 1983, the embassies in Nairobi and Dar es Salaam in 1998, and the USS Cole in 2000. There have been repeated warnings that the threat of terrorism is growing and could involve the US homeland. For example, three authors with high-level government experience have written:[38]

> "Long part of the Hollywood and Tom Clancy repertory of nightmarish scenarios, catastrophic terrorism has moved from far-fetched horror to a contingency that could happen next month. Although the United States still takes conventional terrorism seriously, as demonstrated by the response to the attacks on its embassies in Kenya and Tanzania in August, it is not yet prepared for the new threat of catastrophic terrorism."

(IV-8) A few years ago the US Department of Defense established an advisory commission on national security in the 21st century. This commission -- often known as the Hart-Rudman commission because it was co-chaired by former Senators Gary Hart and Warren Rudman -- issued reports in September 1999,

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[34] Anne Barnard and Ross Kerber, "Web posting tells of suspect's firing from Maine plant", The Boston Globe, 5 January 2001, page A12.
[35] Ibid.
[36] John J. Goldman, "Former sergeant admits role in bombings of US embassies", The Boston Globe, 21 October 2000, page A2.
[37] Kevin Maguire, "Security checks tightened after high-level alert", The Guardian, 9 January 2001.
[38] A. Carter, J. Deutch and P. Zelikow, "Catastrophic Terrorism", Foreign Affairs, November/December 1998, page 80.

April 2000 and March 2001. The findings in the September 1999 report included the following:[39]

> "America will become increasingly vulnerable to hostile attack on our homeland, and our military superiority will not entirely protect us.............States, terrorists and other disaffected groups will acquire weapons of mass destruction and mass disruption, and some will use them. Americans will likely die on American soil, possibly in large numbers."

(IV-9) From the preceding paragraphs in Section IV it is clear that the potential for acts of malice or insanity at nuclear facilities -- including highly destructive acts -- has been foreseeable for many years, and has been foreseen. However, the terrorist attacks on the World Trade Center and the Pentagon on 11 September 2001 provided significant new information. These attacks conclusively demonstrated that the threat of highly-destructive acts of malice or insanity is a clear and present danger, and that no reasonable person can regard this threat as remote or speculative. According to press reports, US authorities have obtained information suggesting that the hijackers of United Airlines flight 93, which crashed in Pennsylvania on 11 September 2001, were planning to hit a nuclear plant.[40] This may be true or false, or the truth may never be known. Whatever the truth is, it would be foolish to regard nuclear plants as immune from attack.

(IV-10) The NRC Staff has conceded that it cannot provide a quantitative assessment of the probability of an act of malice at a nuclear plant. In a SECY paper for the NRC Commissioners, the Staff has stated:[41]

> "The staff, as a result of its ongoing work with the Federal national security agencies, has determined that the ability to quantify the likelihood of sabotage events at nuclear power plants is not currently supported by the state-of-the-art in PRA methods and data. The staff also believes that both the NRC and the other government stakeholders would need to conduct additional research and expend significant time and resources before it could even attempt to quantify the likelihood of sabotage events. In addition, the national security agencies, Intelligence Community, and Law Enforcement Agencies do not currently

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[39] US Commission on National Security/21st Century, New World Coming: American Security in the 21st Century, Phase I report, 15 September 1999, page 4.

[40] Nicholas Rufford, David Leppard and Paul Eddy, "Nuclear Mystery: Crashed plane's target may have been reactor", The Sunday Times, London, 20 October 2001.

[41] William D. Travers, memo to the NRC Commissioners, "Policy Issues Related to Safeguards, Insurance, and Emergency Preparedness Regulations at Decommissioning Nuclear Power Plants Storing Fuel in Spent Fuel Pools (WITS 200000126), SECY-01-0100", 4 June 2001, pp 5-6.

quantitatively assess the likelihood of terrorist, criminal, or other malevolent acts."

(IV-11) Although the probability of an act of malice or insanity cannot be assessed quantitatively, it can be assessed qualitatively. From a qualitative perspective, the probability of a terrorist attack within the US homeland appears to be significantly greater in the current period than it was, for example, in the 1980s. There is now a focussed, well-organized and well-financed threat. For example, the press has reported that Al Qaeda has large amounts of gold obtained by selling opium and heroin.[42] Also, the press has recently disclosed intelligence assessments that Al Qaeda has a revamped command structure capable of sustaining a campaign of terrorism regardless of whether Osama bin Laden is alive or dead, and that Al Qaeda may be close to planning another high-profile attack on US interests.[43] There are also sources of threat other than Al Qaeda. As a notable example, the United States is contemplating a pre-emptive attack on Iraq that could generate many Iraqi casualties and arouse hostility in other countries. Such an attack might provoke a counter-attack within the US homeland, with or without the involvement of the Iraqi government. This new, heightened threat environment may persist for many years.

V. PROTECTION PROVIDED BY NRC REGULATIONS AGAINST ACTS OF MALICE OR INSANITY

(V-1) As discussed in paragraph IV-1, above, the NRC has long held the position that its licensees need not design or operate nuclear facilities to resist enemy attack. However, events have forced the NRC to progressively modify that position, so as to require greater protection against acts of malice or insanity. As discussed in paragraph IV-4, a series of incidents eventually forced the NRC to introduce, in 1994, regulations requiring licensees to defend nuclear power plants against vehicle bombs. The terrorist events of 11 September 2001 forced the NRC to require additional, interim measures by licensees to protect nuclear facilities, and are also forcing the NRC to consider strengthening its regulations in this area. Nevertheless, present NRC regulations and requirements afford limited and inadequate protection against acts of malice or insanity at nuclear facilities.

(V-2) Present NRC regulations and requirements to protect against acts of malice or insanity are focused on site security. As described in Section VIII, below, site security is one of four types of measure that, taken together, could provide "defense in depth" against acts of malice or insanity. The other three types of measure are, with some limited exceptions, ignored in present NRC

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[42] Douglas Farah, "Al Qaeda, Taliban said to stash gold in Sudan", The Boston Globe, 3 September 2002, page A11.
[43] Jimmy Burns, "Al-Qaeda planning attack on US interests", Financial Times, 5 September 2002.

regulations and requirements. Those regulations and requirements are summarized on the NRC web site (www.nrc.gov) under the heading "Nuclear Security and Safeguards". Further information is available in recent Congressional testimony by the NRC Chairman.[44] Additional relevant information is available in NRC responses to questions posed by US Representative Edward Markey.[45] The following paragraphs in Section V draw from these sources.

(V-3) At a nuclear power plant such as Diablo Canyon, the NRC requires the licensee to implement a set of physical protection measures. According to the NRC, these measures provide defense in depth by taking effect within defined areas with increasing levels of security. In fact, these measures provide only a fraction of the protection that could be provided by a comprehensive defense-in-depth strategy. Within the outermost physical protection area, known as the Exclusion Area, the licensee is expected to control the area but is not required to employ fences and guard posts for this purpose. Within the Exclusion area is a Protected Area encompassed by physical barriers including one or more fences, together with gates and barriers at points of entry. Authorization for unescorted access within the Protected Area is based on background and behavioral checks. Within the Protected Area are Vital Areas and Material Access Areas that are protected by additional barriers and alarms; unescorted access to these locations requires additional authorization.

(V-4) Associated with the physical protection areas are measures for detection and assessment of an intrusion, and for armed response to an intrusion. Measures for intrusion detection include guards and instruments whose role is to detect a potential intrusion and notify the site security force. Then, security personnel seek additional information through means such as direct observation and closed-circuit TV cameras, to assess the nature of the intrusion. If judged appropriate, an armed response to the intrusion is then mounted by the site security force, potentially backed up by local law enforcement agencies and the FBI.

(V-5) The design of physical protection areas and their associated barriers, together with the design of measures for intrusion detection, intrusion assessment and armed response, seeks to accommodate a "design basis threat" that is specified by the NRC in 10 CFR 73.1. The present design basis threat of radiological sabotage has the following features:[46]

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[44] NRC Chairman Richard Meserve, "Statement Submitted by the United States Nuclear Regulatory Commission to the Committee on Environment and Public Works, United States Senate, Concerning Nuclear Power Plant Security", 5 June 2002.

[45] Staff of Representative Edward Markey, "Security Gap: A Hard Look At the Soft Spots in Our Civilian Nuclear Reactor Security", 25 March 2002.

[46] 10 CFR 73.1 Purpose and Scope, from the NRC web site (www.nrc.gov).

"(i) A determined violent external assault, attack by stealth, or deceptive actions, of several persons with the following attributes, assistance and equipment: (A) Well-trained (including military training and skills) and dedicated individuals, (B) inside assistance which may include a knowledgeable individual who attempts to participate in a passive role (e.g., provide information), an active role (e.g., facilitate entrance and exit, disable alarms and communications, participate in violent attack), or both, (C) suitable weapons, up to and including hand-held automatic weapons, equipped with silencers and having effective long range accuracy, (D) hand-carried equipment, including incapacitating agents and explosives for use as tools of entry or for otherwise destroying reactor, facility, transporter, or container integrity or features of the safeguards system, and (E) a four-wheel drive land vehicle used for transporting personnel and their hand-carried equipment to the proximity of vital areas, and

(ii) An internal threat of an insider, including an employee (in any position), and

(iii) A four-wheel drive land vehicle bomb."

(V-6) After the events of 11 September 2001, the NRC concluded that its requirements for nuclear power plant security were inadequate. Accordingly, the NRC issued an order to licensees of operating plants in February 2002, and a similar order to licensees of decommissioning plants in May 2002, requiring "certain compensatory measures", also described as "prudent, interim measures", whose purpose is to "provide the Commission with reasonable assurance that the public health and safety and common defense and security continue to be adequately protected in the current generalized high-level threat environment".[47] The additional measures required by these orders have not been publicly disclosed, but the NRC Chairman has stated that they include:[48]

(i) increased patrols;
(ii) augmented security forces and capabilities;
(iii) additional security posts;
(iv) vehicle checks at greater stand-off distances;
(v) enhanced coordination with law enforcement and military authorities;
(vi) additional restrictions on unescorted access authorizations;
(vii) plans to respond to plant damage from explosions or fires; and
(viii) assured presence of Emergency Plan staff and resources.

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[47] The quoted language is from page 2 of the NRC's order of 25 February 2002 to all operating power reactor licensees. Almost-identical language appears at page 2 of the NRC's order of 23 May 2002 to all decommissioning power reactor licensees.
[48] NRC Chairman Richard Meserve, 5 June 2002 (op cit).

(V-7) In addition to requiring these additional security measures, the NRC has established a Threat Advisory System that warns of a possible attack on a nuclear facility. This system uses five color-coded threat conditions ranging from green (low risk of attack) to red (severe risk of attack). These threat conditions conform with those used by the Office of Homeland Security. Also, the NRC is undertaking what it describes as a "top-to-bottom review" of its security requirements. The NRC has stated that it expects that this review will lead to revision of the present design basis threat. The review is not proceeding on any specific schedule.

(V-8) A cursory examination of the present design basis threat, as set forth in paragraph V-5, reveals significant limitations. For example, this threat does not include aircraft bombs (e.g., fuel-laden commercial aircraft, light aircraft packed with high explosive) or boat bombs. This threat does not include lethal chemical weapons as instruments for disabling security personnel. This threat allows for one vehicle bomb, but not for a second vehicle bomb that gains access to a vital area after the first bomb has breached a security barrier. Also, this threat envisions a small attacking force equipped with light weapons, rather than a larger force (e.g., 20 persons) equipped with heavier weapons such as anti-tank missiles. In sum, the present design basis threat is inadequate in light of the present threat environment. The compensatory measures required by the NRC's recent orders do not correct this deficiency.

VI. VULNERABILITY OF DIABLO CANYON NUCLEAR FACILITIES TO ACTS OF MALICE OR INSANITY

(VI-1) This section of my declaration addresses the vulnerability of nuclear facilities at Diablo Canyon, focussing on the two reactors, the two spent fuel pools and the proposed ISFSI. In this context, the word "vulnerability" refers to the potential for an act of malice or insanity to cause a release of radioactive material to the environment. Most of the radioactive material at the site will be in the reactors, the pools and the ISFSI.

(VI-2) The Diablo Canyon reactors, like all US commercial reactors, have been subjected to a PRA-type study by the licensee. This study addressed the reactors' potential to experience accidents, but did not consider acts of malice or insanity. Neither of the pools nor the proposed ISFSI has been subjected to a PRA-type study or a study of its vulnerability to acts of malice or insanity. Indeed, there has never been a comprehensive, published study of the vulnerability of any US nuclear facility to acts of malice or insanity. Spurred by the terrorist events of 11 September 2001, the NRC has sponsored secret, ongoing studies on the vulnerability of nuclear facilities to impact by a large commercial aircraft. Available information suggests that these studies are narrow in scope, and will provide limited guidance regarding the overall vulnerability of nuclear facilities.

(VI-3) A comprehensive study of a facility's vulnerability would begin by identifying a range of potential hostile actions at the facility. The probability of each potential hostile action would be qualitatively estimated, with consideration of the factors (e.g., international events, changing availability of instruments of attack) that could alter the probability over time. Site-specific factors affecting the feasibility and probability of hostile actions include local terrain and the proximity of coastlines, airports, population centers and national symbols. A range of instruments of attack would be considered, including vehicle bombs, boat bombs, aircraft bombs, lethal chemical weapons, and armed intruders arriving from land, sea or air. Attack using a nuclear weapon would also be considered. Diversionary events and phased attacks would be considered. Application of each of the above-mentioned instruments of attack could be accompanied by insider actions.

(VI-4) After identifying a range of hostile actions, a comprehensive study would examine the vulnerability of the subject facility to those actions. This could be done by adapting and extending known techniques of PRA, with an emphasis on the logical structure of PRA rather than the numerical probabilities of events. The analysis would consider the potential for interactions among facilities at a site. For example, a potentially important interaction could be the prevention of personnel access at one facility (e.g., a spent fuel pool) due to a release of radioactive material at another facility (e.g., a reactor). Attention would be given to the potential for "cascading" scenarios in which attacks at some parts of a nuclear power plant site (e.g., control room, switchyard, diesel generators) lead to releases from reactors and/or spent fuel pools that were not directly attacked.

(VI-5) In the absence of any comprehensive study of vulnerability, one is obliged to rely upon partial information. However, sufficient information is available to show that the reactors, the spent fuel pools and the proposed ISFSI at Diablo Canyon are vulnerable to a range of hostile actions. Consider the threat of aircraft impact. In regard to this threat, the NRC Chairman has conceded that "no existing nuclear facilities were specifically designed to withstand a deliberate, high-velocity, direct impact of a large commercial airliner".[49]

(VI-6) Aircraft impact at the Diablo Canyon site could, through a variety of mechanisms, potentially cause a reactor accident, a loss of water from a spent fuel pool, or a breach in one or more of the casks at the proposed ISFSI. A scenario involving the hijacking of a commercial aircraft may be less likely now than it was before 11 September 2001, because the airline industry is now aware of this threat. However, according to the physicist Richard Garwin, a scenario involving a rented or stolen cargo aircraft may be no less likely than before 11 September 2001. Garwin, who has served on numerous panels advising the US government, warns that a cargo aircraft may be used against a nuclear power

[49] NRC Chairman Richard Meserve, 5 June 2002 (op cit).

plant.[50] Also, one must consider a scenario in which a licensed crew member of a passenger or cargo aircraft engages in a suicide attack. Finally, one must consider the aerial equivalent of a vehicle bomb, in which an aircraft is packed with high explosive. Such an aircraft bomb might employ a light aircraft, which would be comparatively easy to obtain throughout the United States.

(VI-7) As indicators of the forces that could accompany an aircraft impact, consider the weights and fuel capacities of some typical commercial aircraft.[51] The Boeing 737-300 has a maximum takeoff weight of 56-63 tonnes and a fuel capacity of 20-24 thousand liters. The Boeing 747-400 has a maximum takeoff weight of 363-395 tonnes and a fuel capacity of 204-217 thousand liters. The Boeing 757 has a maximum takeoff weight of 104-116 tonnes and a fuel capacity of 43 thousand liters. The Boeing 767 has a maximum takeoff weight of 136-181 tonnes and a fuel capacity of 63-91 thousand liters.

(VI-8) Commercial jet fuel typically has a heat of combustion of about 38 MJ per liter. For comparison, 1 kilogram of TNT will yield 4.2 MJ of energy. Thus, complete combustion of 1 liter of jet fuel will yield energy equivalent to that from 9 kilograms of TNT. Complete combustion of 100 thousand liters of jet fuel -- about half the fuel capacity of a Boeing 747-400 -- will yield energy equivalent to that from 900 tonnes of TNT. Thus, the impact of a fuel-laden aircraft can lead to a violent fuel-air explosion. Fuel-air munitions have been developed that yield more than 5 times the energy of their equivalent weight in TNT, and create a blast overpressure exceeding 1,000 pounds per square inch.[52] A fuel-air explosion arising from an aircraft impact will be less efficient than a munition in converting combustion energy into blast, but could nevertheless generate a highly-destructive blast, especially if fuel vapor accumulates in a confined space before igniting.

(VI-9) A rough indication of the vulnerability of the Diablo Canyon reactors to aircraft impact can be obtained from the PRA for the Seabrook reactor. The Seabrook reactor and Diablo Canyon Units 1 and 2 are all 4-loop Westinghouse PWRs with large, dry containments. Thus, PRA findings for Seabrook are roughly indicative of findings for Diablo Canyon Units 1 and 2. The Seabrook PRA finds that any direct impact on the containment by an aircraft weighing more than 37 tonnes will lead to penetration of the containment and a breach in the reactor coolant circuit. Also, the Seabrook PRA finds that a similar impact on the control building or auxiliary building will inevitably lead to a core melt.[53] All

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[50] Richard Garwin, "The Many Threats of Terror", The New York Review, 1 November 2001, pp 16-18.
[51] Data here are from Paul Jackson (editor), Jane's All the World's Aircraft, 1996-97 (Alexandria, Virginia: Jane's Information Group, 1996).
[52] Tom Gervasi, Arsenal of Democracy (New York: Grove Press, 1977), page 177.
[53] Pickard, Lowe and Garrick Inc, Seabrook Station Probabilistic Safety Assessment, Main Report (Irvine, California: PLG, December 1983), pp 9.3-10 to 9.3-11.

of the typical, commercial aircraft mentioned in paragraph VI-7 weigh considerably more than 37 tonnes. Moreover, the Seabrook PRA does not consider the effects of a fuel-air explosion and/or fire as an accompaniment to an aircraft impact. Thus, one could plausibly infer from the Seabrook PRA that the impact of a typical, commercial aircraft on Diablo Canyon Unit 1 or Unit 2 -- which share an auxiliary building and whose containments are near to each other -- could lead to a core melt and a breach of containment, resulting in a large release of radioactive material to the environment. It is noteworthy that the Seabrook containment was designed to withstand impact by an aircraft weighing 6 tonnes, whereas the Diablo Canyon containments were not specifically designed to withstand aircraft impact.[54]

(VI-10) Analytic techniques are available for estimating the effects that aircraft impact will have on the structures and equipment of a nuclear facility. However, those techniques focus on the kinetic energy of the impacting aircraft. The effects of an accompanying fuel-air explosion and/or fire are given, at best, a crude analysis. A 1982 review by Argonne National Laboratory of the state of the art for aircraft impact analysis stated:[55]

> "Based on the review of past licensing experience, it appears that fire and explosion hazards have been treated with much less care than the direct aircraft impact and the resulting structural response. Therefore, the claim that these fire/explosion effects do not represent a threat to nuclear power plants has not been clearly demonstrated."

My experience in reviewing PRAs and related studies for nuclear facilities leads me to conclude that the Argonne statement remains valid today. Indeed, in view of the large amount of energy that can be liberated in a fuel-air explosion (see paragraph VI-8), I conclude that previous analyses of aircraft impacts may have grossly underestimated the vulnerability of nuclear facilities to such impacts.

(VI-11) The vulnerability of the Diablo Canyon spent fuel pools deserves special attention because these pools contain large amounts of long-lived radioactive material (see paragraph III-11) that could be liberally released during a pool fire (see paragraph III-9). The potential for such a fire exists because the pools have been equipped with high-density racks. In the 1970s, the spent fuel pools of US nuclear power plants were typically equipped with low- or medium-density, open-frame racks. If water were partially or totally lost from such a pool, air or steam could circulate freely throughout the racks, providing cooling to the spent fuel. By contrast, high-density racks -- such as those now located in the Diablo Canyon pools -- have a closed structure. To suppress criticality, each fuel assembly is surrounded by solid, neutron-absorbing panels, and there is little or

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[54] Staff of Representative Edward Markey, 25 March 2002 (op cit), page 73.
[55] C. A. Kot et al, Evaluation of Aircraft Crash Hazards Analyses for Nuclear Power Plants, NUREG/CR-2859 (Washington, DC: NRC, June 1982), page 78.

no gap between the panels of adjacent cells. This configuration allows only one mode of circulation of air and steam around a fuel assembly -- vertically upward within the confines of the neutron-absorbing panels.

(VI-12) If water is totally lost from a high-density pool, air will pass downward through available gaps such as the gap between the pool wall and the outer faces of the racks, will travel horizontally across the base of the pool, will enter each rack cell through a hole in its base, and will rise upward within the cell, providing cooling to the spent fuel assembly in that cell. If the fuel has been discharged from the reactor comparatively recently, the flow of air may be insufficient to remove all of the fuel's decay heat. In that case, the temperature of the fuel cladding may rise to the point where a self-sustaining, exothermic oxidation reaction with air will begin. In simple terms, the fuel cladding -- which is made of zirconium alloy -- will begin to burn. The zirconium alloy cladding can also enter into a self-sustaining, exothermic oxidation reaction with steam. Other exothermic oxidation reactions can also occur. For simplicity, the occurrence of one or more of the possible reactions can be referred to as a pool fire.

(VI-13) In many scenarios for loss of water from a pool, the flow of air that is described in paragraph VI-12 will be blocked. For example, a falling object (e.g., a shipping cask) might distort rack structures, thereby blocking air flow. As another example, an attack might cause debris (e.g., from the roof of the fuel handling building) to fall into the pool and block air flow. The presence of residual water in the bottom of the pool would also block air flow. In most scenarios for loss of water, residual water will be present for significant periods of time. Blockage of air flow, for whatever reason, will lead to ignition of fuel that has been discharged from a reactor for long periods -- potentially 10 years or longer.[56] The NRC Staff failed to understand this point for more than two decades (see paragraph II-10).

(VI-14) Partial or total loss of water from a spent fuel pool could occur through leakage, evaporation, siphoning, pumping, displacement by objects falling into the pool, or overturning of the pool. These modes of loss of water could arise, directly or indirectly, from a range of acts of malice or insanity. As a simple example, consider leakage as a direct result of aircraft impact on the wall of a pool. An NRC Staff study includes a crude, generic analysis of the conditional probability that aircraft impact will cause a loss of water from a spent fuel pool.[57] The pool is assumed to have a 5-ft-thick reinforced concrete wall. Impacting aircraft are divided into the categories "large" (weight more than 5.4 tonnes) and "small" (weight less than 5.4 tonnes). The Staff estimates that the conditional

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[56] The role of residual water in promoting ignition of old fuel is discussed in: Gordon Thompson, <u>Risks and Alternative Options Associated with Spent Fuel Storage at the Shearon Harris Nuclear Power Plant</u> (Cambridge, Massachusetts: Institute for Resource and Security Studies, February 1999), Appendix D.
[57] Collins et al, October 2000 (op cit), page 3-23 and Appendix 2D.

probability of penetration of the pool wall by a large aircraft is 0.45, and that 50 percent of penetration incidents involve a loss of water which exposes fuel to air. Thus, the Staff estimates that, for impact of a large aircraft, the conditional probability of a loss of water sufficient to initiate a pool fire is 0.23 (23 percent).

(VI-15) Paragraph VI-4, above, mentions the potential for interactions among facilities on a site, and points out that a potentially important interaction could be the prevention of personnel access at one facility (e.g., a spent fuel pool) due to a release of radioactive material at another facility (e.g., a reactor). This type of interaction was partially addressed during a licensing proceeding for the Harris nuclear power plant, as mentioned in paragraph II-10. In that proceeding, the NRC Staff conceded that a fire in one spent fuel pool would preclude the provision of cooling and makeup to nearby pools, thereby leading to fires in those pools.[58] This situation would arise mostly because the initial fire would contaminate the site with radioactive material, generating high radiation fields. An analogous situation could arise in which the release of radioactive material from a damaged reactor precludes the provision of cooling and makeup to nearby pools. For example, an aircraft impact on Diablo Canyon Unit 1 or Unit 2 could lead to a rapid-onset core melt with an open containment, accompanied by a raging fire. That event would create high radiation fields across the site, potentially precluding any access to the site by personnel. One can envision a variety of "cascading" scenarios, in which there might eventually be fires in the Unit 1 and Unit 2 pools at Diablo Canyon, accompanied by core melt events at Unit 1 and Unit 2.

(VI-16) A pool fire could begin comparatively soon after water is lost from a pool. For example, suppose that most of the length of the fuel assemblies is exposed to air, but the flow of air to the base of the racks is precluded by residual water or a collapsed structure. In that event, fuel heatup would be approximately adiabatic. Fuel discharged for 1 month would ignite in less than 2 hours, and fuel discharged for 3 months would ignite in about 3 hours. The fire would then spread to older fuel. Once a fire has begun, it could be impossible to extinguish. Spraying water on the fire would feed an exothermic zirconium-steam reaction that would generate flammable hydrogen. High radiation fields could preclude the approach of firefighters.

(VI-17) The proposed ISFSI at Diablo Canyon (see Section III, above) would employ up to 140 casks on pads covering an area about 500 ft by 105 ft. The casks would be about 11 ft in diameter and 20 ft high, with a space of about 6 ft between casks. Each cask would consist of a concrete overpack surrounding a thin-walled, stainless-steel canister. This arrangement would be vulnerable in

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[58] ASLBP No. 99-762-02-LA, "Affidavit of Gareth W. Parry, Stephen F. LaVie, Robert L. Palla and Christopher Gratton in Support of NRC Staff Brief and Summary of Relevant Facts, Data and Arguments upon which the Staff Proposes to Rely at Oral Argument on Environmental Contention EC-6", 20 November 2000, paragraph 29.

two major ways. First, this type of cask would not be robust against a determined attack. Second, given this tightly-packed array of casks, an attack could cause a release of radioactive material from a number of casks.

(VI-18) As pointed out in paragraph VI-2, above, the proposed ISFSI has not been subjected to a study of its vulnerability to acts of malice or insanity. However, an indication of the vulnerability of the casks is provided by the design parameters of the proposed ISFSI.[59] The cask vendor (Holtec) has designed the casks to withstand impact at a speed of 126 mph by an automobile weighing 1,800 kg or an 8-inch-diameter steel cylinder weighing 125 kg. Aircraft impact is not considered a design-basis event for this ISFSI. In regard to fire, the bounding design-basis event is the burning of 50 gallons of fuel from the tank of the transporter vehicle. In regard to explosion, the bounding design-basis event is the detonation of a vehicle fuel tank, propane bottle or acetylene bottle at a distance of 50 ft. These design parameters do not indicate robustness against a determined attack.

(VI-19) Paragraphs VI-4 and VI-15 discuss the potential for interactions among the facilities on a site, especially through contamination of a facility by radioactive material released at another facility. Through this mechanism, access of personnel to a facility could be hindered even if that facility were not directly attacked. A release from the proposed ISFSI could hinder access to the reactors and spent fuel pools, and vice versa. For example, ongoing maintenance of the ISFSI, such as ensuring that air vents in the casks are not blocked, could be significantly hindered if the ISFSI were contaminated by a radioactive release from Unit 1 or Unit 2.

VII. POTENTIAL OFFSITE CONSEQUENCES OF ACTS OF MALICE OR INSANITY AT DIABLO CANYON

(VII-1) Paragraph III-9 explains that cesium-137 is a useful indicator of the potential consequences of a release of radioactive material to the environment. The same paragraph shows that it is reasonable to assume that 100 percent of the cesium-137 in a spent fuel pool would be released to the atmosphere in the event of a pool fire. During a pool fire or a release event at a reactor or an ISFSI cask, cesium-137 would be released to the atmosphere in small particles that would travel downwind and be deposited on the ground and other surfaces. The deposited particles would emit intense gamma radiation, leading to external, whole-body radiation doses to exposed persons. Cesium-137 would also contaminate water and foodstuffs, leading to internal radiation doses.

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[59] Pacific Gas and Electric Company, Diablo Canyon Independent Spent Fuel Storage Installation: Safety Analysis Report (Avila Beach, California: PG&E, 21 December 2001), Sections 2.2, 3.4 and 8.2.

(VII-2) One measure of the scope of radiation exposure attributable to deposition of cesium-137 is the area of land that would become uninhabitable. For illustration, I assume that the threshold of uninhabitability is an external, whole-body dose of 10 rem over 30 years. This level of radiation exposure, which would represent about a three-fold increase above the typical level of background (natural) radiation, was used in the NRC's 1975 Reactor Safety Study as a criterion for relocating populations from rural areas.

(VII-3) A radiation dose of 10 rem over 30 years corresponds to an average dose rate of 0.33 rem per year.[60] The health effects of radiation exposure at this dose level have been estimated by the National Research Council's Committee on the Biological Effects of Ionizing Radiations.[61] This committee has estimated that a continuous lifetime exposure of 0.1 rem per year would increase the incidence of fatal cancers in an exposed population by 2.5 percent for males and 3.4 percent for females.[62] Incidence would scale linearly with dose, in this low-dose region.[63] Thus, an average lifetime exposure of 0.33 rem per year would increase the incidence of fatal cancers by about 8 percent for males and 11 percent for females. About 21 percent of males and 18 percent of females normally die of cancer.[64] In other words, in populations residing continuously at the threshold of uninhabitability (an external dose rate of 0.33 rem per year), about 2 percent of people would suffer a fatal cancer that would not otherwise occur.[65] Internal doses from contaminated food and water could cause additional cancer fatalities.

(VII-4) The increased cancer incidence described in paragraph VII-3 would apply at the boundary of the uninhabitable area. Within that area, the external dose rate from cesium-137 would exceed the threshold of 10 rem over 30 years. At some locations, the dose rate would exceed this threshold by orders of magnitude. Therefore, persons choosing to live within the uninhabitable area would experience an incidence of fatal cancers at a level higher than is set forth in paragraph VII-3.

(VII-5) For a postulated release of cesium-137 to the atmosphere, the area of uninhabitable land can be estimated from calculations done by Dr Jan Beyea. My use of these calculations is described in a report that I prepared for Orange

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60 At a given location contaminated by cesium-137, the resulting external, whole-body dose received by a person at that location would decline over time, due to radioactive decay and weathering of the cesium-137. Thus, a person receiving 10 rem over an initial 30-year period would receive a lower dose over the subsequent 30 -year period.

61 National Research Council, Health Effects of Exposure to Low Levels of Ionizing Radiation: BEIR V (Washington, DC: National Academy Press, 1990).

62 Ibid, Table 4-2.

63 The BEIR V committee assumed a linear dose-response model for cancers other than leukemia, and a model for leukemia that is effectively linear in the low-dose range. See National Research Council, 1990 (op cit), pp 171-176.

64 National Research Council, 1990 (op cit), Table 4-2.

65 For males, 0.08 x 0.21 = 0.017. For females, 0.11 x 0.18 = 0.020.

County, North Carolina.[66] Three releases of cesium-137 are postulated here, drawing upon data from paragraph III-11. The first release is 56 million Curies, representing the fuel that PG&E projections indicate will be in each of the Diablo Canyon spent fuel pools from 2006 until the 2020s and potentially beyond. The second postulated release is 3 million Curies, representing 50 percent of the cesium-137 inventory in the core of the Unit 1 or Unit 2 reactor at Diablo Canyon. A release fraction of 50 percent -- from the reactor core to the atmosphere -- is a reasonable assumption for certain types of severe reactor accident. Higher release fractions could occur for some attack scenarios, especially those that lead to a rapid-onset core melt with an open containment. The third postulated release is also 3 million Curies, representing the cesium-137 inventory in two casks at the proposed Diablo Canyon ISFSI. Such a release could occur from an attack that breaches a number of casks, and is not an upper bound on the release that could occur from the ISFSI.

(VII-6) For typical weather conditions, a release of 56 million Curies of cesium-137 would render about 110,000 square kilometers of land uninhabitable, assuming that the radioactive plume travels inland rather than out to sea. A release of 3 million Curies would render uninhabitable about 7,500 square kilometers. The use of a little imagination shows that a pool fire at Diablo Canyon could be a regional and national disaster of historic proportions, with health, environmental, economic, social and political dimensions. The long-term consequences of an attack on a Diablo Canyon reactor or the proposed ISFSI could also be grave.

(VII-7) The core of an operating reactor contains short-lived radioisotopes that are not present in a spent fuel storage facility. Notably, the core contains tellurium isotopes with half-lives of up to 3 days, and iodine isotopes with half-lives of up to 8 days. Calculations show -- for an assumed severe reactor accident designated as the SST1 accident -- that tellurium and iodine isotopes account for 70 percent of the whole-body dose received in 1 day by a person downwind of the reactor.[67] By contrast, cesium isotopes -- principally cesium-137 -- account for 66 percent of long-term radiation exposure and cancer deaths.[68]

(VII-8) A severely-damaged reactor will release to the atmosphere a plume that contains telluriums, iodines and other radioisotopes. The plume will travel downwind. Persons in the path of this plume could receive high radiation doses. For example, consider the plume from a PWR2 release, one of the severe accident releases examined in the NRC's 1975 Reactor Safety Study. Calculations

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[66] Thompson, February 1999 (op cit), Appendix E.

[67] Daniel J. Alpert et al, Relative Importance of Individual Elements to Reactor Accident Consequences Assuming Equal Release Fractions, NUREG/CR-4467 (Washington, DC: NRC, March 1986), page 14.

[68] Ibid.

show that the whole-body radiation dose received in 1 day by a person who is unable to shelter or escape from the plume, assuming a windspeed of 6 miles/hr and Class D atmospheric stability, will exceed 100 rem if the person is between 2.5 and 20 miles from the reactor.[69] (In this scenario, the plume passes above persons located within 2.5 miles of the reactor.) Inability to shelter or escape could arise, for example, if a person is caught in a traffic jam.

(VII-9) A guidance document published by the US Department of Health and Human Services states:[70] "Most authorities agree that observation and treatment in a specialized hospital is indicated for whole-body exposures greater than 100 rem." The same document states that the LD 50/60 (the dose that is lethal within 60 days to 50 percent of the persons exposed) is about 450 rem.[71]

(VII-10) The preceding paragraphs provide some illustrative information about the potential consequences of a radioactive release. In the context of reactor accidents, potential consequences have been examined in great detail in a number of studies. The findings show that a variety of adverse health effects can occur, their incidence depending upon: (i) the nature of the release; (ii) weather conditions, including wind direction and speed; and (iii) the ability of persons to reduce their exposure by actions such as sheltering, evacuation, respiratory protection, avoidance of contaminated food and water, the ingestion of potassium iodide pills, and permanent relocation from contaminated land. Health effects can be roughly divided into two categories according to the timing of their onset. "Early" health effects are manifested over a period of days or weeks, while "late" health effects, principally cancers, are manifested years after the exposure.

VIII. TYPES OF MEASURE AVAILABLE TO PROTECT THE PUBLIC AGAINST ACTS OF MALICE OR INSANITY AT NUCLEAR FACILITIES

(VIII-1) Four types of measure, taken together, could provide a comprehensive, defense-in-depth strategy against acts of malice or insanity at a nuclear facility. The four types of measure, which are described in the following paragraphs, are in the categories: (i) site security; (ii) facility robustness; (iii) damage control; and (iv) emergency response planning. The degree of protection provided by these measures would be greatest if they were integrated into the design of a facility before its construction. This could be done for an ISFSI at Diablo Canyon. However, a comprehensive set of measures could provide significant protection at existing facilities, such as the Diablo Canyon reactors and spent fuel pools.

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[69] T. S. Margulies and J. A. Martin, Dose Calculations for Severe LWR Accident Scenarios, NUREG-1062 (Washington, DC: NRC, May 1984), page 36.
[70] Bernard Shleien, Preparedness and Response in Radiation Accidents (Washington, DC: US Department of Health and Human Services, August 1983), page 91.
[71] Ibid.

(VIII-2) Site security measures are those that reduce the potential for implementation of destructive acts of malice or insanity at a nuclear site. Some measures of this kind would be implemented at offsite locations, and the implementing agency might have no direct connection with the site. Airline or airport security measures are examples of measures in this category. The remaining site security measures would be implemented at or near the site; the implementing agencies would include the licensee, the NRC and, potentially, other entities (e.g., National Guard, Coast Guard). The physical protection measures now required by the NRC, as discussed in Section V, are examples of site security measures in this category. More stringent measures could be developed.

(VIII-3) Facility robustness measures are those that improve the ability of a nuclear facility to experience destructive acts of malice or insanity without a significant release of radioactive material to the environment. In illustration, the PIUS reactor design, as discussed in paragraph IV-2, was intended to withstand aerial bombardment by 1,000-pound bombs without suffering core damage or releasing a significant amount of radioactive material to the environment. An ISFSI at the Diablo Canyon site could be constructed wth a similar degree of robustness. At existing facilities, a variety of opportunities are available for enhancing robustness. As one example, the Diablo Canyon spent fuel pools could be re-equipped with low-density racks, so that spent fuel would not ignite if water were lost from a pool. As a second example, the Diablo Canyon reactors could operate at reduced power, either permanently or at times of alert. Many other opportunities could be identified.

(VIII-4) Damage control measures are those that reduce the potential for a release of radioactive material from a facility following damage to that facility due to destructive acts of malice or insanity. Measures of this kind could be ad hoc or pre-engineered. One illustration of a damage control measure would be a set of arrangements for patching and restoring water to a spent fuel pool that has been breached. Many other illustrations can be provided. It appears, from the list of additional measures set forth in paragraph V-6, above, that the NRC's recent orders have required licensees to undertake some planning for damage control following explosions or fires.

(VIII-5) Emergency response planning measures are those that reduce the potential for exposure of offsite populations to radiation, following a malice- or insanity-induced release of radioactive material from a nuclear facility. Measures in this category would in many respects be similar to emergency planning measures that are designed to accommodate "accidental" releases of radioactive material arising from human error, equipment failure, natural forces (e.g., earthquake), etc. However, there are two major ways in which malice- or insanity-induced releases might differ from accidental releases. First, a malice- or insanity-induced release might be larger and begin earlier than an accidental release.[72] Second, a malice- or insanity-induced release might be accompanied by deliberate degradation of emergency response capabilities (e.g., the attacking group might block an evacuation route). Accommodating these differences could require additional measures of emergency response.

IX. A PROCESS FOR CONSIDERATION OF MEASURES TO IMPROVE PUBLIC PROTECTION

(IX-1) As articulated in paragraph I-3, above, the Petitioners are requesting the NRC to consider new and more rigorous measures to protect the public against the threat that acts of malice or insanity will release radioactive material from nuclear facilities at the Diablo Canyon site. The Petitioners' request has three components: (i) that the NRC conduct a comprehensive review of the adequacy of the protection that NRC regulations afford against acts of malice or insanity; (ii) that the licensing proceeding for the proposed Diablo Canyon ISFSI be suspended while this comprehensive review is conducted; and (iii) that, if the NRC refuses to suspend the ISFSI licensing proceeding while the comprehensive review is being conducted, the scope of the proceeding be expanded to encompass the consideration of interim measures to improve public protection against acts of malice or insanity at Diablo Canyon. A set of interim measures is articulated in Section XI of this declaration.

(IX-2) The Petitioners' request could lead to two tracks for consideration of measures to improve public protection. On one track, the NRC would conduct a comprehensive review of the adequacy of its regulations, with a view to modifying those regulations. On the second track, the NRC would expand the scope of the ISFSI licensing proceeding to encompass the consideration of interim measures. In the following paragraphs of Section IX of this declaration, I set forth a process whereby, on either track, measures to improve public protection could receive appropriate consideration.

(IX-3) The process must be basically open and must allow the involvement of stakeholders. Experience shows very clearly that a closed, secret process that excludes certain stakeholders will not identify a full range of public-protection measures, and will not yield a reliable assessment of the measures that are identified. Nevertheless, consideration of public-protection measures will involve the use of sensitive information about the vulnerability of nuclear facilities, and unrestricted circulation of this information would not be appropriate. Section X of this declaration sets forth an approach to managing sensitive information of this kind.

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[72] Present plans for emergency response do not account for the potential for a large release of radioactive material from spent fuel, as would occur during a pool fire. The underlying assumption is that a release of this kind is very unlikely. That assumption cannot be sustained when the potential for acts of malice or insanity is considered.

(IX-4) Consideration of improved public-protection measures should begin with an assessment of the vulnerability, under present conditions, of the subject facilities. Specifications for such an assessment are set forth in paragraphs VI-3 and VI-4, above. The offsite consequences of potential attacks on the subject facilities should then be estimated. In the next step, a range of potential measures for improved public protection should be identified. Relevant measures would fall within the four categories set forth in Section VIII of this declaration. Then, each of the potential measures should be evaluated to determine the contribution that it could make, as part of a defense-in-depth strategy, in terms of improved public protection. Also, the costs (monetary and otherwise) of each potential measure should be estimated. Finally, individual measures and groups of measures should be ranked in terms of their contribution to improved public protection, and in terms of their costs.

(IX-5) The assessment process set forth in paragraph IX-4 would have much in common with the preparation of an EIS. However, the assessment would be more narrowly-focused than an EIS, which must address a wide range of impacts.

X. SENSITIVE INFORMATION ABOUT THE VULNERABILITY OF NUCLEAR FACILITIES

(X-1) A perpetrator of an act of malice or insanity at a nuclear facility will typically seek information about the facility's vulnerability, before committing the act. Information of this kind could improve the perpetrator's likelihood of damaging the facility, and could increase the magnitude of the radioactive release that is caused by his act. Thus, some items of information about a facility's vulnerability to acts of malice or insanity are inappropriate for general distribution.

(X-2) The NRC has established procedures for designating certain information as classified information, safeguards information or commercially confidential information. However, there is a body of information that falls within none of these categories but is nevertheless sensitive because it might, if inappropriately distributed, facilitate an act of malice or insanity. For example, some of the information contained in PRAs that have been published and widely distributed is sensitive in this way. Also, independent analysts can perform studies, drawing upon information in the public domain, that yield sensitive information.

(X-3) In the following paragraphs of Section X of this declaration, I identify a category of information that is potentially sensitive. Also, I set forth an approach whereby sensitive information could be managed in the context of an open process conducted by the NRC, such as a licensing proceeding. None of the information in this declaration is sensitive, and the declaration is appropriate for general distribution.

(X-4) Before considering the need to limit the distribution of information in the context of an NRC process, it is important to consider the countervailing need for openness. There are two powerful arguments for openness about issues that affect the safety and security of nuclear facilities. First, experience shows that the safety and security of nuclear facilities is significantly and adversely affected by a culture of secrecy. Second, secrecy about civil nuclear facilities is incompatible with democracy.

(X-5) I have studied, observed and written about the adverse effects that a culture of secrecy has on the safety of nuclear facilities.[73] One of my findings is that the culture of secrecy in the former USSR was a major factor contributing to the occurrence of the 1986 Chernobyl reactor accident. Through direct experience, I have observed the adverse effects that a culture of secrecy has on the safety of nuclear facilities. Secrecy inhibits the development of accurate knowledge about safety problems, promotes complacency, and discourages actions that are needed to address safety problems. My direct experience has been in three contexts. In each instance, the culture of secrecy has been less intense than in the USSR, but the effects on safety have been significant and adverse. One context has been the operation of defense materials production reactors at the Savannah River site in South Carolina. The second context has been the operation of the Sellafield site in Britain. The third context has been the operation of the La Hague site in France.

(X-6) The US nuclear industry exists to supply a commercial product -- electricity -- to the citizens of a democracy. Thus, the nuclear industry should exhibit, at a minimum, the level of openness that is expected for any industry. In addition, the operation of nuclear facilities raises significant issues related to public safety and environmental protection. Moreover, the industry's liability for damages is limited, and state governments have no power over the industry in regard to safety issues. Thus, if the operation of the nuclear industry is to be compatible with democracy, then the industry and the NRC must exhibit a level of openness that is much greater than that of other industries.

(X-7) In light of the considerations addressed in paragraphs X-5 and X-6, any action to limit the distribution of information generated during the course of an NRC process must be regarded as a temporary measure under emergency conditions, and restriction of the distribution of information must be applied sparingly. The information that I define as sensitive would have entered the public record during licensing proceedings conducted in former years.

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[73] Gordon Thompson, "Science, democracy and safety: why public accountability matters", in F. Barker (editor), Management of Radioactive Wastes: Issues for local authorities (London: Thomas Telford, 1998). See also: Thompson, June 1998 (op cit), Appendix E; and Thompson, May 2000 (op cit).

(X-8) To date, the NRC has failed to grapple effectively with the issue of sensitive information. For example, the NRC Staff has stated that "discussion of the potential vulnerabilities of SFPs [spent fuel pools] to radiological sabotage is Safeguards Information (SGI)......."[74] This statement shows that the Staff has used a narrow definition of "sabotage", and has not understood the full potential for acts of malice or insanity to cause a pool fire. There are many similarities between: (i) pool fire scenarios that have been thought of as "accidents"; and (ii) pool fire scenarios that are initiated by acts of malice or insanity. For example, pool fire scenarios initiated by cask drop or aircraft impact have been thought of by the Staff as "accidents", and have been examined accordingly. The Staff has never categorized information about these scenarios as safeguards information. Yet, similar scenarios could be initiated by the deliberate dropping of a cask or the deliberate impact of an aircraft.

(X-9) Information should be regarded as sensitive only if it would directly assist a malicious or insane party to identify and exploit a vulnerability in a nuclear facility. Thus, information about the potential consequences of acts of malice or insanity is not sensitive. Similarly, information about the history of malicious events is not sensitive, with one possible exception. The possible exception would be detailed information about specific vulnerabilities that were exploited in the past.

(X-10) Judgment must be exercised in identifying items of information that are truly sensitive. For example, there is a large, widely-available engineering literature about explosions and aircraft impacts, in general and in the context of nuclear facilities. Limiting the distribution of such literature, in the context of an NRC process, would be a fruitless and unnecessary exercise. Instead, efforts to identify sensitive information should focus on detailed, highly-specific information. For example, a drawing showing the precise location of a vulnerable component could be sensitive information. Mature judgment, together with cooperation and mutual respect among the stakeholder representatives involved in the process, would make the identification of sensitive information go more smoothly.

(X-11) Items of information that are determined to be sensitive should be freely available to individuals who are designated by each stakeholder group that is involved in the process. Further distribution of this information would be restricted according to agreed rules. For processes -- such as a licensing proceeding -- where a record is published, a separate, limited-distribution record would be made of any oral or written arguments that disclose sensitive information.

XI. INTERIM MEASURES TO IMPROVE PUBLIC PROTECTION AGAINST ACTS OF MALICE OR INSANITY AT DIABLO CANYON

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[74] SECY-01-0100, 4 June 2001 (op cit), page 8.

(XI-1) This section of my declaration articulates a set of interim measures that, if implemented, would improve public protection against acts of malice or insanity at Diablo Canyon. These interim measures would supplement existing measures and planned measures that meet the NRC's present regulations and requirements.

(XI-2) The interim measures proposed here do not purport to be optimal measures for long-term use at Diablo Canyon or any other nuclear site. Instead, these interim measures are proposed because they satisfy six criteria. First, each of these measures could be implemented comparatively quickly; some could be implemented within a few months while none should require more than 5 years. Second, these measures would allow the Diablo Canyon reactors to continue operating through their present operating license terms. Third, the cost of these measures, taken together, would be more than offset by the resulting gain in protection of the public. Fourth, none of these measures requires a substantial effort of research and development. Fifth, none of these measures would preclude the subsequent implementation of more stringent measures. Sixth, these measures would be consistent with storage of spent fuel on the site for a period of several decades or longer. Taken overall, the proposed measures are modest and reasonable.

(XI-3) These interim measures fall into the four categories of measure that are described in section VIII, above. Taken together, these interim measures would provide a defense-in-depth strategy against a range of threats. This range would not encompass the more extreme threats, such as an attack using a nuclear weapon. Accommodating such threats would require the shutting down of the Diablo Canyon reactors, which would be inconsistent with the second criterion set forth in paragraph XI-2.

(XI-4) Proposed interim measures in the "site security" category (as defined in paragraph VIII-2) are:

(i) establishment of a mandatory aircraft exclusion boundary around the plant;
(ii) deployment of an approaching-aircraft detection system that triggers a high-alert status at the plant;
(iii) expansion of the design basis threat to include additional intruders, heavy weapons, lethal chemical weapons and a second vehicle bomb; and
(iv) the ISFSI to receive protection similar to that provided for the reactors.

(XI-5) Proposed interim measures in the "facility robustness" category (as defined in paragraph VIII-3) are:

(i) automated shutdown of the reactors upon initiation of a high-alert status at the plant, with provision for completion of the automated shutdown sequence if the control room is disabled;
(ii) deployment of diesel-driven pumps and pre-engineered piping to be available to provide emergency water supply to reactors, steam generators and spent fuel pools;
(iii) re-equipment of the spent fuel pools with low-density racks, excess fuel being stored in the ISFSI; and
(iv) re-design of the ISFSI to use thick-walled metal casks, dispersal of the casks, and protection of the casks by berms or bunkers in a configuration such that pooling of aircraft fuel would not occur in the event of an aircraft impact.

(XI-6) Proposed interim measures in the "damage control" category (as defined in paragraph VIII-4) are:

(i) establishment of a damage control capability using onsite personnel and equipment for first response and offsite resources for backup;
(ii) periodic exercises of damage-control capability;
(iii) establishment of a set of damage-control objectives -- to include patching and restoring water to a breached spent fuel pool, fire suppression in the ISFSI, and provision of cooling to a reactor whose support systems and control room are disabled -- with accompanying plans; and
(iv) provision of equipment and training to allow damage control to proceed on a radioactively-contaminated site.

(XI-7) Proposed interim measures in the "emergency response planning" category (as defined in paragraph VIII-5) would implement a model emergency response plan developed by a team based at Clark University in Massachusetts.[75] This model plan was specifically designed to accommodate radioactive releases from spent fuel storage facilities, as well as from reactors. That provision, and other features of the plan, would provide a capability to accommodate both accidental releases and malice- or insanity-induced releases. Major features of the model plan include:[76]

(i) structured objectives;
(ii) improved flexibility and resilience, with a richer flow of information;
(iii) precautionary initiation of response, with State authorities having an independent capability to identify conditions calling for a precautionary response[77];

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[75] Dominic Golding et al, Managing Nuclear Accidents: A Model Emergency Response Plan for Power Plants and Communities (Boulder, Colorado: Westview Press, 1992).
[76] Ibid, pp 8-13.
[77] A security alert could be a condition calling for a precautionary response.

(iv) criteria for long-term protective actions;
(v) three planning zones, with the outer zone extending to any distance necessary;
(vi) improved structure for accident classification;
(vii) increased State capabilities and power;
(viii) enhanced role for local governments;
(ix) improved capabilities for radiation monitoring, plume tracking and dose projection;
(x) improved medical response;
(xi) enhanced capability for information exchange;
(xii) more emphasis on drills, exercises and training;
(xiii) improved public education and involvement; and
(xiv) requirement that emergency preparedness be regarded as a safety system equivalent to in-plant systems.

(XI-8) The Petitioners request (see paragraph IX-1) that the Diablo Canyon ISFSI licensing proceeding be suspended while the NRC reviews its regulations. In the alternative, the Petitioners request that the scope of the ISFSI proceeding be expanded to encompass the consideration of interim measures, such as those articulated in the preceding paragraphs. These requests take account of the improvement in public protection that could be achieved through re-design of the proposed ISFSI, as outlined in paragraph XI-5. Construction of the ISFSI using the present design would preclude this improvement. The presence of an ISFSI, or shipment of spent fuel to an offsite location, would be necessary to gain the improvement in public protection that could be achieved through re-equipment of the Diablo Canyon spent fuel pools with low-density racks, as mentioned in paragraph XI-5. However, PG&E's present plan (see paragraph III-6) is to expand the ISFSI slowly while using the existing high-density racks in the pools to their full capacity. Thus, any delay that might arise from considering re-design of the ISFSI would not adversely affect the protection of the public.

XII. CONCLUSIONS

(XII-1) The potential for acts of malice or insanity at nuclear facilities has been evident for many years. At present, the potential for a determined attack on a US facility seems significantly higher than in previous periods. This new, heightened threat environment may persist for many years.

(XII-2) Present NRC regulations and requirements afford limited and inadequate protection of the public against acts of malice or insanity at nuclear facilities. These regulations and requirements provide only a fraction of the protection that could be provided by a comprehensive, defense-in-depth strategy.

(XII-3) The reactors, spent fuel pools and proposed ISFSI at Diablo Canyon are vulnerable to a range of credible threats. An attack could release to the environment a large amount of radioactive material, especially from a spent fuel pool.

(XII-4) An attack on a Diablo Canyon spent fuel pool could render a large area of land uninhabitable. This event would be a regional and national disaster of historic proportions. The long-term consequences of an attack on a Diablo Canyon reactor or the proposed ISFSI could also be grave.

(XII-5) Measures can be identified whereby a defense in depth is provided for existing or new nuclear facilities. The components of this defense would be site security, facility robustness, damage control, and emergency response planning.

(XII-6) Effective consideration of measures to provide improved protection of the public would require a basically open process with full engagement of stakeholders. Within such a process, sensitive information about the vulnerability of nuclear facilities can be appropriately managed.

(XII-7) A set of interim measures is available that, if implemented at Diablo Canyon, would provide improved protection of the public. These measures could be implemented comparatively quickly, and would not preclude the subsequent implementation of more stringent measures.

I declare, under penalty of perjury, that the foregoing facts are true and correct to the best of my knowledge and belief, and that the opinions expressed above are based on my best professional judgment.

Executed on 7 September 2002.

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Gordon Thompson