UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE SECRETARY

In the Matter of	)	
Pa‘ina Hawaii, LLC	)	Docket No. 030-36974
	)	
Materials License Application	)	
______________________________	)	

DECLARATION OF DR. GORDON R. THOMPSON
IN SUPPORT OF PETITIONER'S AREAS OF CONCERN

I, Gordon R. Thompson, declare that if called as a witness in this action I could testify of my own personal knowledge 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, Massachusetts 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. In addition to holding my position at IRSS, I am also a research professor at the George Perkins Marsh Institute, Clark University, Worcester, Massachusetts. My professional qualifications are discussed in Section II of this declaration.

I-2. I have been retained by Concerned Citizens of Honolulu as an expert witness in a proceeding before the US Nuclear Regulatory Commission (NRC), regarding an application by

Pa‘ina Hawaii, LLC, for a license to build and operate a commercial pool-type industrial irradiator in Honolulu, Hawai‘i, at the Honolulu International Airport.

I-3. The purpose of this declaration is to support Concerned Citizens' contention that "special circumstances" exist, precluding the NRC's use of a categorical exclusion from the National Environmental Policy Act's mandate to prepare either an environmental assessment (EA) or environmental impact statement (EIS) in the context of the proposed license.[1] In this declaration, I focus on the potential for acts of malice or insanity, related to the proposed Pa‘ina Hawaii irradiator, to cause harm to people and/or the environment. As part of that focus, I address the potential to reduce the risk of harm by adopting alternatives to the proposed mode of construction and operation of the irradiator. Also, I address the processes whereby acts of malice or insanity could be considered in a licensing proceeding or during the preparation of an EA or EIS. My focus on the implications of potential acts of malice or insanity does not indicate that I regard other issues, relevant to licensing of the proposed irradiator, as having a lesser significance.

I-4. The remainder of this declaration has seven sections. Section II discusses my professional qualifications. Section III discusses some of the characteristics of the proposed Pa‘ina Hawaii irradiator. The potential for commercial nuclear facilities, including irradiators, to be affected by acts of malice or insanity is addressed in Section IV. That discussion is continued in Section V, with a focus on irradiators. Section VI discusses the potential to reduce the risk of harm, arising from acts of malice or insanity, by adopting alternatives to the proposed design and mode of operation of the Pa‘ina Hawaii irradiator. Section VII addresses the processes whereby acts of malice or insanity could be considered in a licensing proceeding, or during the

[1] 10 C.F.R. § 51.22(b); see also id. § 2.335(b); 40 C.F.R. § 1508.4.

preparation of an EA or EIS, for the Pa‘ina Hawaii irradiator. Major conclusions are set forth in Section VIII. Documents cited in this declaration are listed in a bibliography that is appended to the declaration.

II. MY PROFESSIONAL QUALIFICATIONS

II-1. 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-2. Since 1977, a significant part of my work has consisted of technical analyses of safety, security 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. In a number of instances, my technical findings have been accepted or adopted by relevant governmental agencies. To illustrate my expertise, I provide in the following paragraphs some details of my experience.

II-3. During the period 1978-1979, 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 safety and security risks, and identified alternative options with lower risk. One of the risk issues that I identified and analyzed was the potential for self-sustaining, exothermic 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". 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 spent-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-4. My work has influenced decision making by safety officials in the US 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. The Department subsequently reached the same conclusion, and scrapped the reactors. 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-5. In 1977, and again during the period 1996-2000, I examined the safety and security 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 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. As a direct result of my investigation, the UK Nuclear Installations Inspectorate (NII) required the operator of the Sellafield site -- British Nuclear Fuels -- to conduct extensive safety analyses. These 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. 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-6. 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. 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 (POST) to conduct a thorough, independent analysis of this threat. I argued that the UK government and nuclear industry could not be trusted to provide a credible analysis. The Defence Committee subsequently adopted my recommendation, and a study was conducted by POST.

II-7. I was the author or a co-author of two documents, published in 2003, that addressed the safety and security risks arising from the storage of spent fuel in high-density pools at US nuclear power plants.[2] This work expanded on analysis that I had first conducted in the context of the proposed nuclear fuel cycle center at Gorleben, as discussed in paragraph II-3, above. The two documents became controversial, and their findings and recommendations were challenged by the NRC. The US Congress recognized that our findings, if correct, would be significant for national security. Accordingly, Congress requested the National Academy of Sciences (NAS) to conduct an independent investigation of these issues. The Academy's report vindicated the work done by my co-authors and me.[3]

III. CHARACTERISTICS OF THE PROPOSED IRRADIATOR

III-1. According to the NRC, Pa‘ina Hawaii has stated that the proposed irradiator would be used primarily for the irradiation of fresh fruit and vegetables bound for the US mainland. Other items to be irradiated would include cosmetics and pharmaceutical products.[4] A story in the technical press has stated that the irradiator would be the Genesis model manufactured by Gray-Star, using a 1 million-Curie Cobalt-60 source located in a water-filled pool 22 feet deep.[5] Cobalt-60 is a radioactive isotope with a half-life of 5.3 years. According to an April 2004 NRC fact sheet, all US commercial irradiators regulated by the NRC currently use Cobalt-60; the amount used at each irradiator typically exceeds 1 million Curies and can range up to 10 million

[2] Thompson, 2003; Alvarez et al, 2003.
[3] NAS, 2005.
[4] NRC, 2005.
[5] Nuclear News, 2005.

Curies.[6] The Cobalt-60 is present in the form of sealed sources typically consisting of metallic "pencils" said to be about one inch in diameter and one foot long.[7]

III-2. The version of Pa‘ina Hawaii's license application that has been posted at the NRC website has major redactions. That document does not allow the reaching of any conclusion about the safety and security of the proposed irradiator.

IV. THE POTENTIAL FOR NUCLEAR FACILITIES TO BE AFFECTED BY ACTS OF MALICE OR INSANITY

IV-1. No commercial nuclear facility in the United States was designed to resist attack. Facilities have some capability in this respect by virtue of design for other objectives (e.g., resisting tornado-driven missiles). Beginning in 1994, with the NRC's promulgation of a vehicle-bomb rule, each US nuclear power plant has implemented site-security measures (e.g., barriers, guards) that have some capability to prevent attackers from damaging vulnerable parts of the plant. The scope of this defense was increased in response to the attacks of 11 September 2001. Nevertheless, it continues to reflect the NRC's judgment that a "light defense" of nuclear power plants, to use military terminology, is sufficient.[8] This judgment is not supported by any published strategic analysis. The NRC takes the same approach in regulating nuclear facilities other than power plants, including commercial irradiators.

IV-2. A strategic analysis of needs and opportunities for security of a nuclear facility should have three parts. It should begin with an assessment of the scale of damage that could arise from an attack. A major determinant of this scale is the amount of radioactive material that is available for release to the atmosphere or a water body; other determinants are the

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[6] NRC, 2004b.
[7] Kelly, 2002.
[8] NRC, 2004a.

vulnerability of the facility to attack, and the consequences of attack.[9] The second step in the strategic analysis should be to assess the future threat environment. The third step should be to assess the adequacy of present measures to defend the facility, and to identify options for providing an enhanced defense.

IV-3. The analyst should seek to understand the interests and perspectives of potential attackers. To illustrate, a sub-national group that is a committed enemy of the United States might perceive two major incentives for attacking a US commercial nuclear facility. First, release of a large amount of radioactive material could cause major, lasting damage to the United States. Second, commercial nuclear technology could symbolize US military dominance through nuclear weapons and associated technologies such as guided missiles; a successful attack on a commercial nuclear facility could challenge that symbolism. Conversely, the group might perceive three major disincentives for attack. First, nuclear facilities could be less vulnerable than other potential targets. Second, radiological damage from the attack would be indiscriminate, and could occur hundreds of km downwind in non-enemy locations (e.g., Mexico). Third, the United States could react with extreme violence.

IV-4. The threat environment must be assessed over the entire period during which a nuclear facility is expected to operate. For spent-fuel storage facilities, that period could exceed a century. The risk of attack will accumulate over the period of operation. Forecasting international conditions over several decades is a notoriously difficult and uncertain enterprise. Nevertheless, an implicit or explicit forecast must underlie any decision about the level of security that is provided at a nuclear facility. Prudence dictates that a forecast in this context

[9] Direct release of radioactive material is not the only potential consequence of an attack on a nuclear facility. There is also concern that radioactive or fissile material could be removed from the facility and incorporated into a radiological or nuclear weapon.

should err on the side of pessimism. Decision makers should, therefore, be aware of a literature indicating that the coming decades could be turbulent, with a potential for higher levels of violence.[10] One factor that might promote violence is a perception of resource scarcity. It is noteworthy that many analysts are predicting a peak in world oil production within the next few decades.[11] Also, a recent international survey shows significant degradation in the Earth's ability to provide ecosystem services.[12]

IV-5. The potential for attacks on nuclear facilities has been studied for decades.[13] Nevertheless, the NRC remains convinced that these facilities require only a light defense. The NRC's position fails to account for the growing strategic significance of sub-national groups as potential enemies. Various groups of this kind could possess the motive and ability to mount an attack on a US nuclear facility with a substantial probability of success. The unparalleled military capability of the United States cannot deter such a threat if the attacking group has no territory that could be counter-attacked. Moreover, use of US military capability could be counter-productive, creating enemies faster than they are killed or captured. Many analysts believe that the invasion of Iraq has produced that outcome.

IV-6. The discussion in the preceding paragraphs shows that it would be prudent to consider options for providing an enhanced defense of nuclear facilities. Design studies have identified a large potential for increasing the robustness of new facilities.[14] This finding argues for careful consideration of alternative options during the licensing of a new facility. At existing facilities, there is usually less opportunity for increasing robustness. Nevertheless, there are

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[10] Kugler, 1995; Raskin et al, 2002.
[11] Hirsch et al, 2005.
[12] Stokstad, 2005.
[13] Ramberg, 1984.
[14] Hannerz, 1983.

many opportunities to enhance the defenses of an existing facility. I have identified such opportunities in a number of instances. For example, I have identified a set of measures that could provide an enhanced defense of the San Onofre nuclear power plant.[15]

V. POTENTIAL ACTS OF MALICE OR INSANITY IN THE CONTEXT OF IRRADIATORS

V-1. Section IV, above, shows that it would be prudent, in the licensing and regulation of a range of nuclear facilities, to consider the implications of potential acts of malice or insanity. Commercial irradiators, such as that proposed by Pa‘ina Hawaii, are among the facilities for which this consideration would be prudent. The reason is that these irradiators contain large amounts of Cobalt-60. If that material were removed from its containment and brought into proximity to humans and other life forms or their habitats, significant harm could occur. The nature of that harm is illustrated by a case study that is discussed in paragraph V-3, below.

V-2. An act of malice or insanity could remove Cobalt-60 from its containment, and bring this material into potential proximity to life forms, in two ways. First, a violent event involving mechanisms such as blast, impact and fire could release Cobalt-60 to the atmosphere from the irradiator facility or during transport of Cobalt-60 sealed sources to or from the facility.[16] This violent event could be a deliberate attack or, conceivably, a collateral event deriving from an attack directed elsewhere. Second, Cobalt-60 sealed sources could be removed intact from the irradiator facility or during transport to or from the facility, and these sources could be used to deliberately irradiate life forms or their habitats. This irradiation could be accomplished by atmospheric dispersal of Cobalt-60 from a sealed source, with or without

[15] Thompson, 2004.

[16] After release to the atmosphere, the Cobalt-60 would be present in fragments or particles of various sizes, which would eventually be deposited on the ground around or downwind of the point of release.

chemical and physical manipulation of the source prior to dispersal.[17] An explosive charge could be used to achieve dispersal, a process that is commonly described as the use of a "dirty bomb". Atmospheric dispersal might also be achieved, after chemical and physical manipulation of the source, through mechanisms such as spraying and combustion. As an alternative to atmospheric dispersal, hostile irradiation could be accomplished by clandestinely placing sealed sources, or fragments thereof, in locations (e.g., bus or train stations) where targeted populations are likely to be present.[18]

V-3. Findings of a theoretical case study on atmospheric dispersal of Cobalt-60 were summarized in Congressional testimony by the Federation of American Scientists in 2002.[19] The case study assumed that one Cobalt-60 "pencil" from a commercial irradiator would be explosively dispersed at the lower tip of Manhattan. The results were compared with those from an assumed dispersal of radioactive cesium, in the following statement:[20]

> "Again, no immediate evacuation would be necessary, but in this case [the Cobalt-60 dispersal], an area of approximately one thousand square kilometers, extending over three states, would be contaminated. Over an area of about three hundred typical city blocks, there would be a one-in-ten risk of death from cancer for residents living in the contaminated area for forty years. The entire borough of Manhattan would be so contaminated that anyone living there would have a one-in-a-hundred chance of dying from cancer caused by the residual radiation. It would be decades before the city was inhabitable again, and demolition might be necessary."

V-4. Following an atmospheric dispersal of radioactive material such as Cobalt-60, the area of land that would be regarded as contaminated, and the overall economic consequences of the event, would depend on the contamination standard that would apply.[21] At present, there are

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[17] Zimmerman and Loeb, 2004.
[18] NRC, 2003.
[19] Kelly, 2002.
[20] Kelly, 2002.
[21] Reichmuth et al, 2005.

competing standards, and no clarity about which one would apply.[22] Resolving this issue could be politically difficult, either before or after a dispersal event. A further complicating factor is the exclusion of radiation risk from virtually all insurance policies written in the United States.[23]

V-5. A malicious actor who seeks to expose a population to radioactive material, such as Cobalt-60, could have a range of goals including: (i) causing prompt casualties; (ii) spreading panic; (iii) recruitment to the actor's cause; (iv) asset denial; (v) economic disruption; and (vi) causing long-term casualties.[24]

V-6. Many public officials in the United States and elsewhere are aware of the threat of malicious exposure to radioactive material. At times, substantial resources have been allocated to addressing this threat. For example, a major US government effort was mounted in December 2003 to detect "dirty bombs" in various US cities.[25] Recently, the Australian government has located large, unsecured radioactive sources in two countries in Southeast Asia. At least one of these sources was Cobalt-60.[26] Acting in a manner that invites comparison with licensing of the proposed Pa‘ina Hawaii irradiator, the National Nuclear Security Administration (NNSA) removed Cobalt-60 from an irradiator at the University of Hawai'i in March 2005.[27] This removal occurred during the same week in which the NRC issued a Notice of Violation that responded to an NRC-observed security breach at the irradiator in March 2003.[28] It is said that

[22] Medalia, 2004; Zimmerman and Loeb, 2004.
[23] Zimmerman and Loeb, 2004.
[24] Medalia, 2004.
[25] Mintz and Schmidt, 2004.
[26] Eccleston and Walters, 2005.
[27] NNSA, 2005.
[28] Environment Hawai'i, 2005b.

the irradiator contained about 1,000 Curies of Cobalt-60.[29] An NNSA official described the removal of this Cobalt-60 as follows:[30]

> "The removal of these radiological sources has greatly reduced the chance that radiological materials could get into the wrong hands. The university of Hawaii, its surrounding neighbors and the international community are safer today as [a] result of this effort."

V-7. There is a comparatively small technical literature on the safety and security of commercial irradiators, although it is known that safety and security incidents have occurred at these facilities.[31] Irradiators represent one application of sealed radioactive sources. Overall, the use of those sources has created grounds for concern from the perspective of security. According to NRC data, there were more than 1,300 instances of lost, stolen and abandoned sealed sources in the United States between 1998 and 2002.[32]

V-8. In June 2003, the NRC issued its first security order requiring enhanced security at large commercial irradiators.[33] The nature and scope of the required security measures have not been publicly disclosed. It is noteworthy that NRC officials have said that the NRC lacks sufficient staff to conduct inspections of all sealed-source licensees that are expected to receive security orders.[34]

V-9. If provided with relevant information about the design of commercial irradiators, and the security measures that are in effect at these facilities, independent analysts could assess the vulnerability of these facilities to potential acts of malice or insanity. That assessment could be performed in a manner such that sensitive information is not publicly disclosed. The

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[29] Environment Hawai'i, 2005a.
[30] NNSA, 2005.
[31] NRC, 1983.
[32] GAO, 2003, page 17.
[33] GAO, 2003, page 28.
[34] GAO, 2003, page 31.

assessment could, for example, assess the vulnerability of irradiators to shaped charges.[35] Also, the assessment could examine the NRC's undocumented assertion that it has "preliminarily determined that it would be extremely difficult for someone to explode a cobalt-60 source in a way that could cause widespread contamination".[36] As explained in paragraph V-2, above, explosive dispersal of an intact Cobalt-60 sealed source is one, but not the only, mechanism whereby Cobalt-60 could be brought into proximity to targeted populations.

VI. ALTERNATIVE OPTIONS

VI-1. The currently-proposed design and mode of operation of the Pa‘ina Hawaii irradiator implies a risk of harm to people and/or the environment, arising from potential acts of malice or insanity. Assessment of the nature and scale of that risk must await the provision of more information about the facility than is now publicly available. It is, however, already clear that lower-risk options exist. These options could be systematically examined in an EIS.

VI-2. Two options are available that could eliminate the risk. One such option would be to adopt non-irradiative methods of treating fresh fruit and vegetables. The second option would to use an irradiator that does not require radioactive material such as Cobalt-60. In this context, it is noteworthy that an existing commercial irradiator in Hawai'i employs electron-beam technology. This facility, known as Hawai'i Pride, was built at Kea'au in 2000. Some observers question whether two irradiators, or even one, can be economically viable in Hawai'i.[37]

VI-3. If the Pa‘ina Hawaii irradiator were to be built and operated, using Cobalt-60, its design, location and mode of operation could be modified to reduce the risk of harm arising from potential acts of malice or insanity. For example, site security and the robustness of the facility

[35] Walters, 2003.
[36] NRC, 2004b.
[37] Environment Hawai'i, 2005c.

could be enhanced. Alternative locations could potentially reduce the risk in two ways. First, the currently-proposed location might be especially attractive to attackers because of the proximity of military and symbolic targets including Hickam Air Force Base and Pearl Harbor. Second, the currently-proposed location at Honolulu International Airport might facilitate attack from the air by, for example, an explosive-laden general aviation aircraft. Full delineation of potential modifications, and assessment of their costs and contributions to risk reduction, must await the provision of more information about the facility than is now publicly available.

VII. CONSIDERATION OF ACTS OF MALICE OR INSANITY IN A LICENSE PROCEEDING, EA, OR EIS

VII-1. During an open session of a license proceeding, or in the published version of an EA or EIS, it would be inappropriate to disclose information that could assist the perpetrator of an act of malice or insanity that affects a nuclear facility. It does not follow, however, that acts of malice or insanity cannot be considered in a license proceeding, an EA, or an EIS. Well-tested procedures are available whereby this consideration could occur without publicly disclosing sensitive information. In the context of a license proceeding, some of the sessions, and the accompanying documents, could be open only to authorized persons. Similarly, an EA or EIS could contain sections or appendices that are available only to authorized persons. Interested parties, including public-interest groups, could nominate representatives, attorneys and experts who can become authorized persons on their behalf.

VIII. MAJOR CONCLUSIONS

VIII-1. It would be prudent, in the licensing and regulation of a range of nuclear facilities, to consider the implications of potential acts of malice or insanity. Commercial irradiators, such as that proposed by Pa‘ina Hawaii, are among the facilities for which this consideration would be prudent.

VIII-2. The currently-proposed design and mode of operation of the Pa‘ina Hawaii irradiator implies a risk of harm to people and/or the environment, arising from potential acts of malice or insanity. Assessment of the nature and scale of that risk must await the provision of more information about the facility than is now publicly available. It is, however, already clear that lower-risk options exist. These options could be systematically examined in an EIS.

VIII-3. Well-tested procedures are available whereby acts of malice or insanity could be considered in a license proceeding, an EA, or an EIS related to the proposed Pa‘ina Hawaii irradiator.

I declare under penalty of perjury that I have read the foregoing declaration and know the contents thereof to be true of my own knowledge.

Dated at Cambridge, Massachusetts, 3 October 2005.

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GORDON R. THOMPSON

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