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OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

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	)	
	)	

REQUEST FOR HEARING BY CONCERNED CITIZENS OF HONOLULU

I. INTRODUCTION

Pursuant to 10 C.F.R.§ 2.309, petitioner Concerned Citizens of Honolulu hereby requests a hearing regarding this proceeding on Pa'ina Hawaii, LLC's application to build and operate a commercial pool type industrial irradiator in Honolulu, Hawai'i, at the Honolulu International Airport.[1] This filing also responds to a Federal Register notice published by the U.S. Nuclear Regulatory Commission ("NRC") at 70 Fed. Reg. 44,396 (Aug. 2, 2005), establishing a deadline of October 3, 2005, for hearing requests.

As discussed below, Concerned Citizens has standing to participate in this NRC licensing proceeding on behalf of its members, under either a "proximity-plus" or traditional standing analysis. See Section II, infra. Concerned Citizens request a hearing to address safety and related concerns regarding Pa'ina Hawaii's license application (Section III.A, infra) and the

[1] Pursuant to 10 C.F.R. § 2.304(e), Concerned Citizens of Honolulu hereby designates David L. Henkin of Earthjustice's Honolulu office as the person on whom service may be made. Mr. Henkin's address is: Earthjustice, 223 South King Street, Suite 400, Honolulu, Hawai'i 96813. His electronic mail address is: dhenkin@earthjustice.org. His facsimile number is: (808) 521-6841.

All communications with Concerned Citizens of Hawai'i regarding this petition should be addressed to Mr. Henkin. Pursuant to 10 C.F.R. § 2.309(d)(1)(i), Concerned Citizens of Hawai'i states that its address is: 3254 Hoolulu Street, Honolulu, Hawai'i 96815. Its phone number is: (808) 735-2940.

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NRC's failure to comply with the National Environmental Policy Act ("NEPA") by preparing an environmental impact statement ("EIS") – or, at a minimum, an environmental assessment ("EA") – to evaluate the environmental impacts associated with Pa'ina Hawaii's proposal as well as alternatives that might achieve the goal of treating Hawaiian produce for fruit flies with less environmental harm (Section III.B, infra).

II. STANDING

A. Representational Standing.

A petitioner organization can demonstrate representational standing to participate in an NRC licensing proceeding on behalf of its members. See International Uranium (USA) Corp. (White Mesa Uranium Mill), CLI-01-21, 54 NRC 247, 250 (2001); Power Authority of the State of New York (James A. FitzPatrick Nuclear Power Plant; Indian Point, Unit 3), CLI-00-22, 52 NRC 266, 293 (2000). Concerned Citizens of Honolulu is a grassroots, unincorporated environmental organization that was created to ensure the people who live and work in Honolulu will be adequately protected from potential public health and safety and environmental impacts associated with Pa'ina Hawaii's proposed irradiator and to ensure that a thorough environmental review of the proposal – including consideration of alternate technologies and alternate locations that could achieve the project's goals with less risk to the public and environment – is performed before any project approvals are issued. As demonstrated by the attached declarations, Concerned Citizens of Honolulu's members include individuals who live, work, own property, and/or recreate in areas adjacent to Honolulu International Airport and who rely on the airport to travel to neighbor islands and the continental United States for work, for recreation, and/or to maintain relations with their friends and family. See Declarations of Brian Coulson, Marie-Therese Knoll, Darryl Ng, David Paulson, Grace Simmons, and Lia Young Hunt, attached hereto. These individuals have authorized Concerned Citizens of Honolulu to represent them in this proceeding.

B. "Proximity-Plus" Standing

In order to establish standing in the classic fashion, a petitioner must allege a concrete injury that would be caused by the challenged action, and could be redressed by a favorable decision in litigation. See Georgia Institute of Technology (Georgia Tech Research Reactor, Atlanta, Georgia), CLI-95-12, 42 NRC 111, 115 (1995). Under the NRC's precedents, however, there are circumstances in which petitioners may be presumed to have standing based on their geographic proximity to the facility. See Sequoyah Fuels Corp. and General Atomics (Gore, Oklahoma Site), CLI-94-12, 40 NRC 64, 75 n.22 (1994).

To establish standing in a proceeding like this one, which involves materials licensing, proximity must be coupled with a showing that the facility's activities involve a "significant source of radioactivity producing an obvious potential for offsite consequences." Id. (citing Armed Forces Radiobiology Institute (Cobalt-60 Storage Facility), ALAB-682, 16 NRC 150, 153-54 (1982); Northern States Power Co. (Pathfinder Atomic Plant), LBP-90-3, 31 NRC 40, 45 (1990)). In other words, for a neighbor to the proposed Pa'ina Hawaii irradiator to have presumptive standing depends upon three factors: (1) proximity to the facility, (2) the presence of a "significant source" of radioactivity at the facility, and (3) that source's "obvious potential" to cause offsite damage due to its radioactive properties.

In CFC Logistics, Inc. (Cobalt-60 Irradiator), LBP-03-20, 58 NRC 311 (2003), the Atomic Safety and Licensing Board analyzed "proximity plus" standing in the context of a license application for a Cobalt-60 ("Co-60"), pool type food irradiator nearly identical to the one proposed by Pa'ina Hawaii. The Licensing Board initially concluded that the amount of Co-

60 authorized for use at the facility – up to 1 million curies – represented a "significant source of radioactivity" for purposes of applying "proximity-plus" standing. Id. at 319. It then rejected claims that, due to the passive nature of the facility's protective systems, "there was no obvious potential for offsite consequences." Id. Instead, it concluded "it would be neither 'extravagant' nor 'a stretch of the imagination' to presume that some injury to neighbors could occur within the vicinity of the CFC irradiation facility," such as under the plausible, even if unlikely, "scenario in which an accident of some sort could damage the armored pool containing the Co-60 at the CFC facility." Id. at 320 (quoting Georgia Institute of Technology, 42 NRC at 117). Accordingly, the Licensing Board found "the cobalt-60 inventory that the license would authorize the Company to possess would be a significant source of radioactivity that produces an obvious potential for offsite consequences" and held "it is appropriate to make the 'proximity-plus presumption' available in this proceeding." Id. at 321.

For the same reasons, the Commission should allow Concerned Citizens to establish standing based on "proximity-plus." The same types of accidents envisioned in CFC Logistics are equally plausible in this case, which involves the same basic irradiator design. Indeed, in light of the unique threats associated with the proposed location of the Pa'ina Hawaii irradiator detailed below, the risk of an accidental release is far greater than the one found adequate to support "proximity-plus" standing in CFC Logistics.

Later in the CFC Logistics proceeding, the Licensing Board determined that any petitioner who lived within ¾ mile from the facility satisfied the requirements of "proximity-plus" standing. 60 NRC 475, 485 (2004). In so finding, the Board "hasten[ed] to add … that the 'obvious potential' aspect of 'proximity-plus' standing is not a concept that can be applied with engineering or scientific precision … ." Id. at 487. Given the particular factual circumstances of the CFC Logistics application, the Board felt "comfortable with limiting the distance that provides presumptive standing to considerably less than the 3 miles that was determined for the Armed Forces panoramic irradiator, even though the sources here are authorized to be three times larger." Id. at 487; see also Armed Forces, 16 NRC at 154 (holding that residing 3 miles from 320,000-curie Co-60 irradiator established standing based on geographic proximity).

Unlike the irradiator at issue in CFC Logistics, which was located in a remote, rural Pennsylvania county, Pa'ina Hawaii's irradiator would be in the middle of urban Honolulu, a city of approximately 400,000 people. Placing up to a million curies of Co-60 on the grounds of Honolulu International Airport and adjacent to Hickam Air Force Base and Pearl Harbor would present a tempting target for terrorists intent on disrupting one of the major transportation hubs in the Pacific and on striking near major military installations. Resnikoff Dec. ¶¶ 21-22; Thompson Dec. ¶¶ III-3, V-5 to -6, VI-3; see also Public Interest Report, Dirty Bombs: Response to a Threat, (March/April 2002) (Exh. F); National Nuclear Safety Administration ("NNSA") Press Release (Apr 13, 2005) (Exh. H).[2] Aviation accidents – which, on average happen more than twice a year at Honolulu International Airport – pose another unique threat to Pa'ina Hawaii's proposed irradiator, which would be located immediately adjacent to several runways, rendering it vulnerable to airplane crashes on either take-off or landing. Resnikoff Dec. ¶ 24; NTSB Aviation Accident Database Query (Exh. G).

The significant risk of natural disasters further distinguishes Pa'ina Hawaii's irradiator from the one at issue in CFC Logistics. The proposed site for the irradiator is in a tsunami evacuation zone and, thus, at risk from damage associated with wave run-up similar to that

[2] That the Reef Runway next to which the irradiator would be built is an alternate landing site for the space shuttle makes the target even more attractive to those seeking to strike a blow against symbols of American power. See Resnikoff Dec. ¶ 24.

experienced in the devastating tsunami in southeast Asia in December 2004. Resnikoff Dec. ¶ 23; O'ahu Civil Defense Agency, Tsunami Evacuation Oahu Map 19: Airport to Waikiki (Exh. I); see also Deborah Adamson, Hawai'i tsunami zone maps may be flawed, Honolulu Advertiser (Jan. 11, 2005), available at http://the.honoluluadvertiser.com/article/2005/Jan/11/ln/ln03p.html (noting "effects of tsunami generated by local events – earthquakes or undersea landslides – may be significantly under-estimated by the existing maps") (Exh. J). The irradiator would also be vulnerable to wave run-up and high winds associated with a major tropical storm or hurricane, as illustrated by the catastrophic losses suffered along the Gulf Coast in September 2005 from Hurricanes Katrina and Rita. Resnikoff Dec. ¶ 23; Oahu Civil Defense Agency, "Hurricanes in Hawaii," available at http://www.honolulu.gov/ocda/hurr1.htm (Exh. K).

Because of the significant risks of widespread dispersal of radioactive material from human and natural threats not present in the CFC Logistics case, "proximity-plus" standing should be available to petitioners who live, work, or have "frequent contacts" far beyond the ¾ mile limit established under the specific facts of that earlier proceeding. Sequoyah Fuels, 40 NRC at 75 n.22. A study prepared by the Federation of American Scientists concluded that, if a single Co-60 "pencil" from an irradiator such as the one Pa'ina Hawaii proposes to build were dispersed by an explosion, an area of approximately one-thousand square kilometers would be contaminated. Resnikoff Dec. ¶ 22; Thompson Dec. ¶ V-3; Public Interest Report at 7. Because such an event is "plausible," anyone living, working or having frequent contacts in Honolulu, as all Concerned Citizens' members do, should have the benefit of the "proximity-plus" doctrine. CFC Logistics, LBP-03-20, 58 NRC at 320-21.

Even if the NRC were to limit application of "proximity-plus" standing to only those with frequent contacts within ¾ mile of the proposed site for the Pa'ina Hawaii irradiator, Concerned

Citizens satisfies that test. Concerned Citizens has several members who work within ¾ mile of the proposed irradiator site, sufficient proximity to "be presumed to be affected by operation of the facility." Georgia Institute of Technology, 42 NRC at 114; see Coulson Dec. ¶ 2; Knoll Dec. ¶ 2; Young Hunt Dec. ¶ 2; see also International Uranium (USA) Corp., 54 NRC at 250 (organization has standing if "at least one of its members may be affected by the licensing action"). Members also frequently fly in and out of the airport and, thus, spend time on runways or at the flight service station, well within ¾ mile of the facility. See, e.g., Knoll Dec. ¶¶ 3-4; Paulson Dec. ¶ 3; Simmons Dec. ¶ 3. Such contacts are also adequate to establish "proximity-plus" standing. See Northern States Power Co. (Pathfinder Atomic Plant), LBP-90-3, 31 NRC 40 (1990) (commuting past plant adequate); Virginia Electric and Power Company (North Anna Nuclear Power Station, Units 1 and 2), ALAB-522, 9 NRC 54, 57 (1979) (recreational canoeing "in the general vicinity of the plant" adequate).

C. Traditional Standing.

Even if "proximity-plus" standing did not apply, Concerned Citizens can easily make the specific "injury-in-fact" showing under classic standing principles. CFC Logistics, 60 NRC at 489. To demonstrate standing, Concerned Citizens must allege:

> (1) an actual or threatened, concrete and particularized injury, that (2) is fairly traceable to the challenged action, (3) falls among the general interests protected by the Atomic Energy Act (or other applicable statute, such as the National Environmental Policy Act) and (4) is likely to be redressed by a favorable decision.

Sequoyah Fuels Corp. (Gore, Oklahoma Decommissioning), CLI-01-2, 53 NRC 9, 13 (2001).

As discussed in the declarations of Drs. Resnikoff and Thompson, construction and operation of Pa'ina Hawaii's proposed irradiator would subject Concerned Citizens' members to threats of radiation exposure through incidents including, but not limited to, mechanical failures, power outages, airplane accidents, acts of sabotage or terrorism, hurricanes, and tsunamis. "[A] minor exposure to radiation, even one within regulatory limits, is sufficient to state an injury in fact" for standing purposes. Duke Cogema Stone & Webster (Savannah River Mixed Oxide Fuel Fabrication Facility), LBP-01-35, 54 NRC 403, 417 (2001), rev'd on other grounds, CLI-02-24, 56 N.R.C. 335 (2002) (citing Yankee Atomic Electric Co. (Yankee Nuclear Power Station), CLI-96-7, 43 NRC 235, 247-48 (1996)); see also id. at 420 (standing inquiry does not require precision regarding probability of petitioner receiving unwanted dose of radiation). "[T]he asserted harm here – injury to the health and safety of [Concerned Citizens'] members from ionizing radiation – is clearly encompassed by the health and safety interests protected by the Atomic Energy Act. Id. at 417; see also 42 U.S.C. § 2013.

In addition, approval of Pa'ina Hawaii's license application in the absence of any environmental review pursuant to NEPA would cause procedural injury to Concerned Citizens and its members. NEPA is "our basic national charter for protection of the environment." 40 C.F.R. § 1500.1(a). It requires "each federal agency spearheading a major federal project," including the NRC, "to put on the table, for the deciding agency's and for the public's view, a sufficiently detailed statement of environmental impacts and alternatives so as to permit informed decision making." Lands Council v. Powell, 395 F.3d 1019, 1027 (9th Cir. 2005); see also 40 C.F.R. § 1500.1(c) (ultimate goal to foster "better decisions," helping federal agencies make decisions "based on understanding of environmental consequences, and take actions that protect, restore, and enhance the environment"). NEPA accomplishes its goals by ensuring environmental information – including analysis of "alternatives that might be pursued with less environmental harm," Lands Council, 395 F.3d at 1027 – "is available to public officials before decisions are made and before actions are taken." 40 C.F.R. § 1500.1(b) (emphasis added).

By promoting environmentally sensitive decision-making, NEPA's requirement to prepare EISs and EAs protects Concerned Citizens' "concrete interests" in avoiding harm to areas in Hawai'i its members "use and enjoy." Citizens for Better Forestry v. U.S. Department of Forestry, 341 F.3d 961, 971 (9th Cir. 2003). Conversely, refusal by the NRC to perform any environmental review of Pa'ina Hawaii's proposed irradiator would cause procedural injury to Concerned Citizens and its members, all of whom reside, work and/or recreate in areas potentially affected by radiation releases from the facility. "The 'asserted injury is that environmental consequences might be overlooked' as a result of deficiencies in the government's analysis under environmental statutes." Id. at 971-72.

Concerned Citizens' aforementioned injuries are likely to be redressed by a favorable decision. Denying or requiring substantial modifications to Pa'ina Hawaii's license application would help avoid or minimize the threats to public health and safety and to the environment that would otherwise harm Concerned Citizens. Moreover, a decision to prepare the requisite NEPA analysis prior to rendering a decision on Pa'ina Hawaii's application would cure Concerned Citizens' procedural injury. See id. at 976 ("A petitioner 'who asserts inadequacy of a government agency's environmental studies ... need not show that further analysis by the government would result in a different conclusion. It suffices that ... the [agency's] decision could be influenced by the environmental considerations that [the relevant statute] requires an agency to study") (alterations and emphasis in Citizens for Better Forestry).

III. CONTENTIONS SOUGHT TO BE RAISED

A. Safety and Related Issues Under Atomic Energy Act And Implementing Regulations.

In its license application, Pa'ina Hawaii has failed to address important issues related to the protection of public health and safety. Since Pa'ina Hawaii has not made the requisite showing that its "proposed equipment and facilities [would be] adequate to protect health and minimize danger to life or property," its application should be denied. 10 C.F.R. § 30.33(a)(2).

1. Inadequate Procedures to Ensure Safe Loading and Unloading of Cobalt-60 Pencils.

Loading and unloading the fresh and used Co-60 pencils present a risk of a cask drop. Resnikoff Dec. ¶ 12. Similar to a reactor, where a shipping cask has the potential to pass over the fuel pool and drop onto fuel rods, the irradiator here must have a system to prevent the cask from passing over the Co-60 pencils. Id.; see also id. ¶ 14 (doubtful crane designed to stop where sources are located). Moreover, the irradiator must have a single failure proof crane. Information regarding these essential safety measures is missing from the application, contrary to the requirement of 10 C.F.R. § 36.39(c) that "the licensee shall design the pool to assure...that a dropped cask would not fall on sealed sources."

In its application, Pa'ina Hawaii needs to assess the potential for release of Co-60 into the pool water if a 3 to 6.5 ton cask were to drop on the Co-60 pencils and bend the pencils. Resnikoff Dec. ¶ 12. It must also discuss, if the pencils were bent in a cask drop accident, how these bent Co-60 rods would be packaged and sent back to the manufacturer, i.e., how the applicant intends to recover from this accident. See 10 C.F.R. § 36.53(b). The potential for damage to the pool liner, and the potential impact of such an accident, must also be assessed.

The loading and unloading of Co-60 at the proposed irradiation facility would be precarious and susceptible to a major accident. Resnikoff Dec. ¶ 13. A nearly identical irradiator designed by Gray*Star was involved in CFC Logistics. The license application for that facility stated that a shipping cask containing 200,000 curies of Co-60 sources would be inserted into the pool. Sources would then be removed and placed underwater on one side of the pool, away from the cask. The plenum would be removed before this operation. As the shipping cask, which could weigh between 3 and 6.5 tons, is removed from the pool, it could drop onto the sources, seriously contaminating the pool water. This contamination would have to be removed with ion exchange columns that would become extremely radioactive. See 10 C.F.R. § 36.57(e). The steel-liner of the pool would become radioactive. Some of this radioactivity could be released to the sanitary sewers and the air. Resnikoff Dec. ¶ 13; see also id. ¶ 16.

Though the fuel suppliers and presumably the shipping casks are likely the same as the Genesis irradiator at issue in CFC Logistics, Pa'ina Hawaii's application contains no details about the type and weight of the cask, how the cask would be unloaded from the trailer bed and how the cask would be attached to the crane and lowered into the water. Id. at ¶ 13. Similar to operations at Neutron Products Incorporated ("NPI") in Dickerson, Maryland, where Co-60 material was shaped to fit different irradiators, Co-60 released to the environment could lead to a significant direct gamma dose, and would be expensive to decontaminate. Id. At NPI, despite the presence of HEPA filters to capture particulates, Co-60 was found off-site; the direct gamma dose rates were five times NRC regulatory limits.

The potential for a cask drop accident at Pa'ina Hawaii's proposed irradiator similarly poses a serious risk of irreparable harm, violating the requirement in 10 CFR § 30.33(a)(2) that "proposed equipment and facilities [must be] adequate to protect health and minimize danger to life or property." Despite this, the application has no emergency procedures for accidents that may occur during loading and unloading sources, violating 10 C.F.R. § 36.53(b). See Resnikoff Dec. ¶ 15.

2. Failure to Address Risks of Overheating.

Pa'ina Hawaii has not shown the system will not overheat. Resnikoff Dec. ¶ 17. The thermal projections based on worst case assumptions are redacted. These should be provided.

As far as can be ascertained from the redacted application, the helium system surrounding the Co-60 pencils is static. Id. Apparently, the heat will be dissipated through the helium to the plenum walls and then to the pool water. It is not clear how the temperature will be continuously monitored within the plenum. If the plenum overheats, there is danger that radioactive material will be released to the pool water. The Co-60 could then become airborne, be released to the air within the irradiator facility and subsequently to the external environment. The gamma dose rates would become elevated within the irradiator building. The ion exchange resins would become highly radioactive, and have to be transported to a low-level radioactive waste landfill, violating 10 C.F.R. § 36.57(e). Pa'ina Hawaii has not proposed shutdown criteria, if the Co-60 concentrations in the pool water or air above the pool reach certain specific concentrations.

When the plenum rack is loaded with Co-60 pencils, the loading is done underwater with long handling tools. Resnikoff Dec. ¶ 18. The plenum is then fit over the rack and helium is pumped in and water out of the plenum. At this point the Co-60 rods will heat up and the water on the Co-60 will evaporate. Pa'ina Hawaii fails to discuss the effect of this evaporation process and whether radioactive materials will enter the helium environment and the pool water. Reviss, one of the suppliers listed in Pa'ina Hawaii's application, has previously expressed concern about potential damage to the Co-60 pencils in this evaporation process. Id.

The application does not indicate who is carrying out the thermal calculations, calling into question whether they are being done correctly. Id. ¶ 19. Reviss, one of the fuel suppliers, provided the thermal calculations for the nearly identical irradiator at issue in CFC Logistics. Neither the designer, Gray*Star, nor the applicant have the expertise to analyze the thermal conditions in the plenum. Id.

3. Inadequate Provision for Quality Assurance.

While Gray*Star designed the Genesis II irradiator that Pa'ina Hawaii proposes to build and operate, it is not clear who will supply the components. Id. ¶ 20. The application indicates the Co-60 pencils would be supplied by either Nordion (Canada) or Reviss, which has Co-60 generated in Russia. How the NRC can possibly ensure the quality assurance of the process without actually inspecting the Canadian and Russian facilities is not spelled out in the application. According to 10 C.F.R. § 36.59(b), leak testing of the source must be carried out, but the application makes no provision for it.

4. Failure to Address Accidents Involving Prolonged Loss of Electricity.

Contrary to 10 C.F.R. § 36.53(b)(6), Pa'ina Hawaii's application fails to describe emergency procedures for accidents involving a prolonged loss of electricity. For example, Pa'ina Hawaii does not appear to have an emergency electric generator in case of an extended power failure. Without clear measures for recovering from a prolonged loss of electricity, the safety of neighboring members of the public cannot be assured. Resnikoff Dec. ¶ 27.

Moreover, the license application does not analyze the range of accidents that would arise from a loss of electricity. While the application does discuss the possibility of the loss of electricity supply in terms of overheating of sources, other credible accidents are not considered.

Id. ¶ 28.[3] For instance, movement of product near the plenum containing Co-60 sources occurs under bells inserted under water; the bottom of the bell is open, but water cannot enter due to a compressed helium supply. In the event that power is lost while a bell is underwater, the product could become water-logged and distribute itself within the pool, thereby clogging the filters and the water circulation system. In the changeover to new filters, Co-60 could bypass the containment system and be released as wastewater. Pa'ina Hawaii does not discuss this potential accident, or any procedures for recovering from this loss of electricity accident in which product floats in the pool.

Furthermore, in discussing the possibility of the loss of electricity supply in terms of overheating of sources, Pa'ina Hawaii fails to provide specific information regarding the heat rate and the number of hours till the source cladding degrades. Id. ¶ 29. In order to know how long the electricity may remain off before a serious accident ensues, the application needs to include detailed information on how rapidly the sources will heat up and the consequences of overheating. This information is completely missing. In the event of overheating, the cladding around the sources could fail, contaminating the air and overloading the HEPA filters. Co-60 could be released to the external environment. Id.

5. Lack of Procedures to Address Break in Helium Line.

Contrary to 10 C.F.R. § 36.53, Pa'ina Hawaii has no emergency procedures for accidents involving a break in the compressed helium line. This would allow water to enter the bells, and degrade the product. Id. ¶ 30.

[3] As discussed in Part III.A.2, supra, and below, the application's analysis of the risks of overheating is inadequate.

6. Inadequate Provision for Natural Phenomena.

As discussed in Part II.B, supra, the proposed site for the irradiator is in a tsunami evacuation zone and, thus, at risk from damage associated with wave run-up similar to that experienced in the devastating tsunami in southeast Asia in December 2004. The irradiator would also be vulnerable to wave run-up and high winds associated with a major tropical storm or hurricane, as illustrated by the catastrophic losses suffered along the Gulf Coast in September 2005 from Hurricanes Katrina and Rita. Pa'ina Hawaii's application has no discussion of the potential for such emergency events and the procedures that would be implemented should they occur, in violation of 10 C.F.R. § 36.53(b)(9).

7. Failure to Address Risks of Aviation Accidents.

Pa'ina Hawaii's application fails completely to address the likelihood and consequences of an air crash, either on take off or landing. As noted in the declaration of Dr. Resnikoff, the proposal to locate a nuclear facility in such close proximity to an airport runway is likely unprecedented. Resnikoff Dec. ¶ 24.

According to the National Transportation Safety Board, in the 23-year period between 1982 and 2004, on average 2.17 accidents per year occurred at the Honolulu International Airport. Id.; see also NTSB Aviation Accident Database Query. This is an extremely high accident rate for a nuclear facility located in such close proximity to a runway. Resnikoff Dec. ¶ 24. Pa'ina Hawaii must analyze the likelihood and consequences of an air crash, and discuss whether the location is appropriate for such a facility, including whether the facility can be hardened to mitigate the consequences of an accident.

8. Failure to Address Risks of Accidents Associated with Transporting Cobalt-60 to the Facility.

Pa'ina Hawaii's application fails to address risks to the public and the environment associated with transporting Co-60 pencils to the proposed facility. Resnikoff Dec. ¶ 25. Unlike irradiators located in the continental United States, whose source material can be supplied by rail or truck, this facility would require Co-60 to arrive by plane or boat, presenting unique risks. In particular, if the shipping cask is to be transported by plane, the impact of an air crash must be assessed. Id. The transportation cask is likely designed to withstand a 30 foot drop, but, obviously, planes fly higher than 30 feet. Id. If the cask is to be transported by ship, a discussion of the modal transfers and the likely exposure to workers, inspectors and the public must be provided. Id. The application must also address the threats to the communities through which sources arriving by ship at Honolulu Harbor must transit to reach the proposed irradiator site.

9. Inadequate Provision for Facility Security.

Co-60 is an attractive target for terrorists because it can be used to make dirty bombs. Resnikoff Dec. ¶ 21; Thompson Dec. ¶¶ V-1 to -6. It is also well-known that in general, nuclear facilities are targets of the Al Qaeda organization. If Co-60 were stolen from the proposed irradiator, or if the facility were attacked, Co-60 could be released into the environment, causing adverse health effects and spreading contamination that would be expensive to clean up. Resnikoff Dec. ¶¶ 21-22; Thompson Dec. ¶¶ V-2 to -4. Pa'ina Hawaii improperly proposes to place a major sabotage target into the local community without adequate provision to address threats to the community. Cf. Thompson Dec. ¶¶ VI-1 to -3 (lower risk alternatives exist).[4]

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[4] Unlike production and utilization facilities, material licensing facilities like Pa'ina Hawaii's irradiator are not relieved of the obligation to ensure adequate protection against

10. Inadequate Provision for Protecting Cobalt-60 Sources in Transit.

Even before arriving at the Pa'ina Hawaii facility, Co-60 sources, in transit from Canada or Russia, would be vulnerable to terrorist attack. Resnikoff Dec. ¶ 31; Thompson Dec. ¶ V-2. The NRC does not require armed escorts for Co-60 sources. Yet, potential saboteurs have significant fire power at their disposal. Resnikoff Dec. ¶ 31. The TOW2 and MILAN anti-tank missiles have a range of one km and can penetrate one meter of steel, far more steel and lead than the walls of a shipping cask. The newer Russian Koronet missile, used by former Iraqi armed forces, can penetrate 1.2 meters of steel and can be aimed precisely at a distance up to 5 km. These weapons have the ability to penetrate a shipping cask and disperse its contents. NUREG-0170, the document that potential NRC licensees cite in supporting its safety assurances, is silent on these safety and security issues.

A Co-60 cask shipment, attacked within a city, could cause major environmental pollution and cancer fatalities. Resnikoff Dec. ¶ 32. Local residents would clearly have a greater risk than other persons. While shipments could leave Canada or Europe by a number of routes, once they get close to the facility, the route options are decidedly limited. Such an accident would subject the airport passengers and workers and residents of neighboring communities to irreparable harm. In addition to adverse health effects caused by contamination, such an accident would have significant economic impacts. The cost to decontaminate an accident involving a spill of 200,000 curies of Cobalt-60 could easily exceed $1 billion. Id.

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attacks by foreign enemy governments or individuals. Compare 10 C.F.R. § 50.13 with id. pt. 36.

11. Inadequate Liability Insurance.

Pa'ina Hawaii has offered the minimum $113,000 financial assurance for decommissioning, but, as discussed above, this would clearly be inadequate if a major accident were to occur. Id. at 34. Because of the unique threats associated with the proposed irradiator, the minimum level of financial assurance for decommissioning set forth at 10 C.F.R. § 30.35(d) is inadequate to ensure protection of public safety and health and the environment. Upon admission as a party to this licensing proceeding, Concerned Citizens intends to petition that the application of 10 C.F.R. § 30.35(d) be waived, or an exception made for this proceeding, due to the aforementioned "special circumstances." 10 C.F.R. § 2.335(b).

12. Improper Redacting Application

The version of Pa'ina Hawaii's application available for public review on the NRC website has much of the material redacted, with no justification given for the materials that are withheld. Resnikoff Dec. ¶ 26. Comparison with the publicly available version of the application for the nearly identical CFC Logistics irradiator (Docket No. 30-36239-ML), which was not redacted in the same heavy-handed manner, indicates the lack of any proprietary or security basis for the redactions in this case. Cf. id. ¶¶ 3, 13, 21 (relying on CFC Logistics application to inform analysis of Pa'ina Hawaii application).

Depriving the public of important information regarding Pa'ina Hawaii's proposed irradiator has precluded Concerned Citizens of the opportunity fully to evaluate the project's environmental impacts and determine how its interests may be affected. Id. ¶ 26; Thompson Dec. ¶ III-2; see, e.g., Resnikoff Dec. ¶ 17, 24, 25 (noting redacted information). Particularly in light of the NRC's requirement to include detailed contentions in support of requests for hearing, 10 C.F.R. § 2.309(f), which presupposes that the public is informed about the proposed project, the NRC's failure to provide adequate detail regarding Pa'ina Hawaii's application subverted the Atomic Energy Act's public hearing requirement, 42 U.S.C. § 2239, and deprived Concerned Citizens of due process of law.

B. Failure to Comply with NEPA.

1. Failure to Explain Application of Categorical Exclusion.

In its Federal Register notice of consideration of Pa'ina Hawaii's license application, the NRC announced that "[a]n environmental assessment for this licensing action is not required, since this action is categorically excluded under the provisions of 10 CFR 51.22(c)(14)(vii)." 70 Fed. Reg. at 44,396. While NEPA allows agencies to identify "typical classes of action ... [w]hich normally do not require either an environmental impact statement or an environmental assessment (categorical exclusions (§ 1508.4))," 40 C.F.R. § 1507.3(b)(2)(ii), it also mandates that agencies "provide for extraordinary circumstances in which a normally excluded action may have a significant environmental effect." Id. § 1508.4. Here, the NRC unlawfully failed to consider whether any extraordinary circumstances precluded application of the categorical exclusion to Pa'ina Hawaii's license application.

"When an agency decides to proceed with an action in the absence of an EA or EIS, the agency must adequately explain its decision." Alaska Center for the Environment v. U.S. Forest Service, 189 F.3d 851, 859 (9th Cir. 1999). The NRC "cannot avoid its statutory responsibilities under NEPA merely by asserting that an activity it wishes to pursue will have an insignificant effect on the environment." Jones v. Gordon, 792 F.2d 821, 828 (9th Cir. 1986) (quoting The Steamboaters v. FERC, 759 F.2d 1382, 1393 (9th Cir.1985)). "The agency must supply a convincing statement of reasons why potential effects are insignificant." Steamboaters, 759 F.2d at 1393. It cannot "simply restate[] the exclusion," as the NRC improperly did here. Alaska Center for the Environment, 189 F.3d at 859.

2. Failure to Prepare an Environmental Impact Statement or, At Minimum, an Environmental Assessment.

"[A]n agency adopting a categorical exclusion must "provide for extraordinary circumstances in which a normally excluded action may have a significant environmental effect." California v. Norton, 311 F.3d 1162, 1168 (9th Cir. 2002) (quoting 40 C.F.R. § 1508.4) (emphasis added); see also 10 C.F.R. § 51.22(b). "In determining whether an action requires an EA or EIS or is categorically excluded, federal agencies must not only review the direct impacts of the action, but also analyze indirect and cumulative impacts." Sierra Club v. United States, 255 F. Supp. 2d 1177, 1182 (D. Colo. 2002) (citing 40 C.F.R. §§ 1508.7, 1508.8); see also Thomas v. Peterson, 753 F.2d 754, 759 (9th Cir. 1985). "In addition, NEPA regulations require agencies to consider the impacts of 'connected actions.'" Sierra Club, 255 F. Supp. 2d at 1182 (quoting 40 C.F.R. § 1508.25(a)(1)); see also Thomas, 753 F.2d at 758-59.

When extraordinary circumstances are present, "a categorically excluded action would nevertheless trigger preparation of an EIS or an EA." California, 311 F.3d at 1168. The Ninth Circuit has emphasized that the mere "fact that exceptions may apply is all that is required to prohibit use of the categorical exclusion." Id. at 1177 (emphasis added).

Due to the potential for a range of events – including, but not limited to, mechanical failures, power outages, airplane crashes, hurricanes, or tsunamis – to cause a significant release of radioactive material from the Pa'ina Hawaii irradiator to the environment, "special circumstances" exist, precluding the NRC's use of a categorical exclusion from NEPA's mandate to prepare either an EA or EIS for the proposed license. Resnikoff Dec. ¶ 10 (quoting

10 C.F.R. § 51.22(b)). The aforementioned threats are unique to either the location or design of the proposed irradiator, and, thus, distinguish Pa'ina Hawaii's irradiator from the run-of-the-mill facility for which the NRC promulgated its categorical exclusion.

The significant risks associated with a terrorist attack on an irradiator placed at the hub of Hawai'i's air transportation system and immediately adjacent to military and symbolic targets including Hickam Air Force Base and Pearl Harbor further mandate preparation of an environmental analysis pursuant to NEPA, so that alternatives with fewer risks to the public and the environment can be evaluated. Resnikoff Dec. ¶¶ 10, 21-22, 31-32; Thompson Dec. ¶¶ I-3, VI-1 to -3.[5] While such threats were considered speculative when the NRC adopted its categorical exclusion for irradiators in 1984, following the tragic events of September 11, 2001:

> it can no longer be argued that terrorist attacks of heretofore unimagined scope and sophistication against previously unimaginable targets are not reasonably foreseeable. Indeed, the very fact these terrorist attacks occurred demonstrates that massive and destructive terrorist acts can and do occur and closes the door, at least for the immediate future, on qualitative arguments that such terrorist attacks are always remote and speculative and not reasonably foreseeable.

Duke Cogema Stone & Webster, 54 NRC at 446, rev'd in relevant part, CLI-02-24, 56 N.R.C. 335 (2002).

When, earlier this year, the National Nuclear Security Administration removed a 1,000-curie source of Co-60 from a research irradiator at the University of Hawai'i to prevent its use in a "dirty bomb," the agency announced "[t]he removal of these radiological sources has greatly reduced the chance that radiological materials could get into the wrong hands," and, accordingly, "[t]he University of Hawaii, its surrounding neighbors and the international

[5] Concerned Citizens recognizes the NRC recently concluded it need not consider the impacts of terrorism as part of its NEPA analysis for licensing decisions. Pacific Gas and Electric Co. (Diablo Canyon Power Plant Independent Spent Storage Fuel Installation), CLI-03-1, 57 NRC 1 (2003). With all due respect, Concerned Citizens believes the case, which is currently on appeal to the 9th Circuit, was wrongly decided.

community are safer today as a result of this effort." NNSA Press Release at 1; see also "Radioactive material destroyed," Honolulu Star-Bulletin (Apr. 15, 2005), available at http://starbulletin.com/2005/04/15/news/index11.html (Exh. L). Approval of Pa'ina Hawaii's irradiator would have precisely the opposite result, creating new threats of catastrophic harm to the people of Honolulu by placing in the middle of the airport a source of Co-60 one thousand times greater than the one the NNSA confiscated.

The difficulty of assessing with precision the risk of terrorist attack at Pa'ina Hawaii's proposed facility does not justify the NRC's resort to a categorical exclusion. There can be no question that multiplying the number of radioactive sources potentially available to terrorists by authorizing additional Co-60 irradiators may have a significant, cumulative effect on the human environment. Indeed, the very purpose of the NNSA's Global Threat Reduction Initiative is "to identify, secure, remove and/or facilitate the disposition of vulnerable, high-risk nuclear and other radiological materials around the world as quickly and expeditiously as possible." NNSA News Release at 1; see also id. ("To date, NNSA has recovered more than 10,500 high-risk sealed sources within the United States"). Since licensing additional irradiators in the current geopolitical climate threatens significant harm, these cumulative effects preclude the use of a categorical exclusion here. See 40 C.F.R. § 1508.4 (activities subject to categorical exclusion cannot have significant effect on environment "individually or cumulatively") (emphasis added); see also Thomas, 753 F.2d at 759.

That Pa'ina Hawaii intends to use the irradiator primarily to treat food for human consumption establishes additional special circumstances requiring preparation of an EA or EIS. When the NRC adopted the categorical exclusion for "irradiators" in 1984, it considered only "[t]ypical uses" such as "sterilization or microbiological reduction in medical and pharmaceutical supplies and insect eradication through sterile male release programs." 49 Fed. Reg. 9352, 9377 (Mar. 12, 1984). It did not consider the potentially harmful effects associated with irradiating food for human consumption. Indeed, at the time the NRC promulgated its categorical exclusion for irradiators, virtually no foods were approved for irradiation in the United States. See Center for Disease Control, "Frequently Asked Questions about Food Irradiation," available at http://www.cdc.gov/ncidod/dbmd/diseaseinfo/foodirradiation.htm (in 1984, only wheat flour and white potatoes approved for irradiation) (Exh. M).

It is clear Pa'ina Hawaii's irradiator "would not be built but for the contemplated" sale of irradiated food for human consumption. Thomas, 753 F.2d at 758. Consequently, the irradiator and the contemplated sale of irradiated food "are inextricably intertwined" and, thus, "are 'connected actions' within the meaning of the CEQ regulations." Id. at 759. Alternatively, the consumption of irradiated food is an indirect impact of the construction and operation of Pa'ina Hawaii's irradiator, which must be considered "[i]n determining whether an action requires an EA or EIS or is categorically excluded." Sierra Club, 255 F. Supp. 2d at 1182; see also 40 C.F.R. § 1508.8.

In the years since the NRC adopted its categorical exclusion for irradiators, numerous scientific studies have raised the alarm about potential adverse affects on human health associated with consumption of irradiated foods. A recently-discovered unique class of radiolytic products that are generated from the irradiation of fat-containing food is 2-alkylcyclobutanone ("2-ACB") with saturated and mono-unsaturated alkyl side chain: 2-decyl-, 2-dodecyl-, 2-dodecenyl-, 2-tetradecyl- and 2-tetradecenyl-cyclobutanone. Au Dec. ¶ 6(b). Studies have confirmed the presence of 2-ACB in irradiated mango and papaya, two types of fruit proposed for processing at the Pa'ina Hawaii facility, should it be approved. Id.

Since 1998, concern regarding health hazards from the consumption of irradiated food has focused on the toxicity of 2-ACB. Id. ¶ 6(c). Recent studies have demonstrated that 2-ACB compounds, which are found exclusively in irradiated dietary fats, may promote colon carcinogenesis in animals, identifying a new area of toxicity that neither the U.S. Food and Drug Administration nor the World Health Organization has yet examined. Id. ¶ 6(d). These studies indicate that consumption of irradiated food containing 2-ACB, such as the fruit Pa'ina Hawaii proposes to process, may increase the risk of humans developing colon cancer. Id. ¶ 6(f).

While the health concerns from consumption of irradiated food have not been resolved conclusively, the data indicate that consumption of irradiated food can cause genotoxic effects and therefore health hazards in the population. Id. ¶ 6(g). Moreover, there may be subpopulations, such as children, who are most susceptible to toxic effects of irradiated food. Id. In the final analysis, the only thing certain about the impacts on human health associated with the consumption of irradiated food, including the papayas, mangos, and other produce proposed to be processed at the Pa'ina Hawaii facility, is that they are the subjects of considerable scientific debate. Id. ¶ 6(h). Both the controversy over the irradiated food Pa'ina Hawaii would produce at its irradiator and the unknown risks involved preclude the NRC's use of a categorical exclusion. California, 311 F.3d at 1177; Jones, 792 F.2d at 826-29; 40 C.F.R. § 1508.27(b)(4), (5).

In light of the foregoing, Concerned Citizens contends that "special circumstances" exist, necessitating the preparation of an EA or EIS, and requests the NRC to so find. 10 C.F.R. § 51.22(b). Alternatively, upon admission as a party to this licensing proceeding, Concerned Citizens intends to petition that application of 10 C.F.R. § 51.22(c)(14)(vii) be waived, or an exception made for this proceeding, due to the aforementioned "special circumstances," 10

C.F.R. § 2.335(b), which include facts unique to Pa'ina Hawaii's facility that "were not contemplated in the regulation's adoption." CFC Logistics, 60 NRC at 492.

IV. CONCLUSION

For the foregoing reasons, petitioner Concerned Citizens of Honolulu has demonstrated it has standing to participate in this proceeding. Moreover, it has presented a set of admissible areas of concern.

Dated at Honolulu, Hawai'i, October 3, 2005.

Respectfully submitted,

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE SECRETARY

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

DECLARATION OF DR. WILLIAM W. AU
IN SUPPORT OF PETITIONER'S AREAS OF CONCERNS

I, William W. Au, declare that if called as a witness in this action I could testify of my own personal knowledge as follows:

1. Since 1991, I have been employed as a Professor in the Department of Preventive Medicine and Community Health, University of Texas Medical Branch, in Galveston, Texas. My office address is: Division of Environmental Toxicology, Department of Preventive Medicine and Community Health, Ewing Hall, 700 Harborside Drive, University of Texas Medical Branch, Galveston, Texas 77555-1110.

2. My curriculum vitae indicating my professional qualifications as a toxicologist is attached hereto as Exhibit "A." My primary research interest is in conducting molecular and cellular studies to elucidate toxicological mechanisms for the induction of human disease. Since obtaining my Ph.D. from the University of Cincinnati, I have more than 20 years of experience teaching, conducting and publishing peer-reviewed research, consulting and speaking internationally, editing professional publications, and serving on numerous expert committees. I am a member of the major scientific societies related to toxicology and have received approximately one dozen awards recognizing my professional contributions. I have delivered

more than 35 invited lectures internationally and published or co-published more than 200 articles in the toxicology field.

3. I have been retained by Concerned Citizens of Honolulu as an expert witness in a proceeding before the U.S. 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, to treat tropical fruit and other produce grown in Hawai'i for fruit flies, so that the produce may be exported to the continental United States.

4. The purpose of this declaration is to provide an evidentiary basis for Concerned Citizens' contention that, due to the significant scientific controversy surrounding the health impacts of consuming the irradiated food that the Pa'ina Hawaii irradiator would produce, "special circumstances" exist that distinguish this project from more common medical instrument sterilization and other non-food irradiators, precluding the NRC's use of a categorical exclusion from the National Environmental Policy Act's mandate to prepare either an environmental assessment or environmental impact statement for the proposed license. 10 C.F.R. § 51.22(b); see also id. § 2.335(b); 40 C.F.R. § 1508.4.

5. In formulating my opinions, I have reviewed relevant documents and studies and conducted independent research. I have also published a paper in an international, peer-reviewed journal on health hazards from the consumption of irradiated food (Ashley et al., 2004).[1]

6. My opinions, based on a reasonable degree of scientific certainty, are as follows:

a. The use of radiation to treat produce destined for human consumption for fruit flies and other agricultural pests should be evaluated for health concerns very carefully. Radiolytic products are formed during the irradiation of food (Schubert, 1969). Some radiolytic

[1] Full citations to the studies cited herein are attached to this declaration as Exhibit "B" and incorporated herein by reference.

products are unique to the food irradiation process, and there are scientific data indicating their potential health hazards. More research is needed on the products that are unique to the irradiation process.

b. A recently-discovered unique class of radiolytic products that are generated from the irradiation of fat-containing food is 2-alkylcyclobutanone (2-ACB) with saturated and mono-unsaturated alkyl side chain: 2-decyl-, 2-dodecyl-, 2-dodecenyl-, 2-tetradecyl- and 2-tetradecenyl-cyclobutanone (Miesch et al., 2002). Studies have confirmed the presence of 2-ACBs in irradiated mango and papaya, two types of fruit proposed for processing at the Pa'ina Hawaii facility, should it be approved (Ndiaye et al. 1999; Stewart et al., 2000).

c. Since 1998, concern regarding health hazards from the consumption of irradiated food has been focused on the toxicity of 2-ACB. Using in vitro assays, 2-ACB has been shown to be genotoxic and mutagenic (Delincee and Pool-Zobel, 1998; Delincee et al., 1998; Delincee et al., 2002; Burnouf et al., 2002). 2-ACB has also been tested in experimental animals. In one report (Horvatovich et al., 2002), laboratory rats were fed a very low concentration of 2-ACB in drinking water, and the absorption and excretion of the chemical were monitored. The study showed that less than 1% of the administered chemical was excreted in feces. A portion of the chemical crossed the intestinal barrier, entered the blood stream and accumulated in the adipose tissues of the animal. It follows that consumption of irradiated food for a long time can cause accumulation of toxic 2-ACB in the adipose tissues of human consumers.

d. The recent findings by Raul et al. (2002) raise a high level of concern. In the study, Wistar rats received a daily solution of 2-tetradecylcyclobutanone or 2-(tetradec-5'-enyl)-cyclobutanone and a known colon carcinogen (azoxymethane [AOM)]. Observations were made at two distinct intervals. At three months after initiation of the exposure, no significant changes in the number of pre-neoplastic colonic lesions were observed among the rats (all were exposed to AOM). At six months, however, the total number and the overall size of tumors were markedly increased in the 2-ACB-AOM treated rats as compared to the ethanol-AOM control rats. This demonstrates that compounds found exclusively in irradiated dietary fats may promote colon carcinogenesis in animals treated with a known carcinogen and identifies a new area of toxicity that neither the U.S. Food and Drug Administration nor the World Health Organization has yet examined.

e. A promoting agent does not usually cause cancer by itself but alters cellular functions (Zheng et al., 2002; Yamagata et al., 2002). The unique concern with promoters is that they can significantly enhance the carcinogenic effects of known carcinogens (Hecker et al., 1980; Slaga, 1983; Langenbach et al., 1986). Experimental animals that are treated with both promoters and carcinogens develop tumors much earlier and have more tumor nodules than animals treated with the carcinogens alone. Animals treated with the promoters alone would not develop tumors more often than the untreated animals.

f. Colon cancer (as was discovered in the rat study on 2-ACBs) is a serious health problem in humans, causing approximately 60,000 deaths per year in the United States. Consumption of improper diet is a major cause for colon cancer: foods that are high in fat especially from animal sources, meat cooked with high heat, charred meat, and food with high content of aromatic/heterocyclic amines (Colon cancer folder in the American Cancer Society website – www.cancer.org; Lang et al., 1986; Vineis and McMichael, 1996). Consumption of the improper diet together with food that contains 2-ACB, which acts as a tumor promoter, can increase the risk for the development of colon cancer. Under this scenario, individuals who would normally outlive the risk for colon cancer might develop the cancer.

g. Numerous other peer-reviewed published reports have long indicated the mutagenic activities of irradiated foods fed to mammals (Anderson et al., 1980; Bhaskaram and Sadasivan, 1975; Bugyaki et al, 1968; Maier et al., 1993; Moutschen-Dahmen, et al., 1970; Vijayalaxmi, 1975, 1976, 1978; Vijayalaxmi and Rao, 1976; Vijayalaxmi and Sadasivan, 1975). While the health concerns from consumption of irradiated food simply cannot be considered to have been resolved conclusively (Louria, 2001), the data indicate that consumption of irradiated food can cause genotoxic effects and therefore health hazards in the population. Moreover, there may be subpopulations, such as children, who are most susceptible to toxic effects of irradiated food. Strong reasons exist for considering children generally to be especially susceptible to toxic materials (Au 2002).

h. In the final analysis, the only thing certain about the impacts on human health associated with the consumption of irradiated food, including the papayas, mangos, and other produce proposed to be processed at the Pa'ina Hawaii facility, is that it is the subject of considerable scientific debate. A recent article I co-authored summarizing the controversy over this issue (Ashley et al., 2004) is attached hereto as Exhibit "C" and incorporated herein by reference.

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 Galveston, Texas, September 29, 2005.

WILLIAM W. AU

CURRICULUM VITAE

NAME: William Wingkam Au, Ph.D. DATE: August, 2005.

PRESENT POSITION AND ADDRESS:

Professor (since 1991)
Division of Environmental Toxicology
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Director (since 2000)
International Science Outreach Program
Sealy Center for Environmental Health and Medicine
University of Texas Medical Branch

Editor (since 1999)
International Journal of Hygiene and Environmental Health

Fellow (since 2003)
Collegium Ramazzini, an International Honor Society for Environmental and Occupational Health, with 180 life-time fellows from 33 countries

Member (since 2005)
Faculty Senate, University of Texas Medical Branch, Galveston, Texas

Chairman (1997 -2005)
Alexander Hollaender Committee for International Programs

BIOGRAPHICAL:

Date of Birth:	October 30, 1946
Place of Birth:	Hong Kong
Citizenship:	United States of America

EXHIBIT A

Home address:		2802 Plymouth Colony Drive, Webster, Texas 77598.	

EDUCATION:

1972, May	Biology	B.A.	University of North Carolina Greensboro, North Carolina
1977, May	Developmental Biology	Ph.D.	University of Cincinnati Cincinnati, Ohio

PROFESSIONAL AND TEACHING EXPERIENCE:

1991-present	Professor	Division of Environmental Toxi-cology, Department of Preventive Medicine and Community Health, University of Texas Medical Branch, Galveston, TX
1988-present	Graduate Faculty	Human Genetics and Cell Biology Program, Graduate School of Biomedical Sciences, UTMB, Galveston, TX
1985-1990	Associate Professor	Division of Environmental Toxi cology, Department of Preventive Medicine and Community Health, UTMB, Galveston, TX
1985-present	Graduate Faculty	Preventive Medicine and Community Health Program, Graduate School of Biomedical Sciences, UTMB, Galveston, TX
1984-1985	Assistant Professor	Division of Environmental Toxicology, Department of Preventive Medicine and Community Health, UTMB, Galveston, TX
1980-1984	Staff Scientist	Biology Division, Oak Ridge National Laboratory, Oak Ridge, TN

1979-1980	Research Associate	Department of Cell Biology, The University of Texas System Cancer Center, M.D. Anderson Hospital and Tumor Institute, Houston, TX
1977-1979	Post-doctoral fellow	Department of Biology, The University of Texas System Cancer Center, M.D. Anderson Hospital and Tumor Institute, Houston, TX

RESEARCH ACTIVITIES AND FUNDING HISTORY:

Dr. William Au's research interest is in conducting molecular and cellular studies to elucidate toxicological mechanisms for the induction of human disease. The working hypothesis is that individuals who have inherited variant metabolic and DNA repair gene alleles are susceptible to the induction of chromosome aberrations/gene mutations and thus have increased health risk from exposure to toxicants. Cancer patients are used as a model to document which susceptible versions of polymorphic genes are significantly associated with the disease. Cigarette smokers and populations with exposure to toxic substances are studied to demonstrate the toxicological mechanisms in support of the association. Besides using human volunteers, experimental animal and cells in culture are also used to conduct mechanistic studies under well-controlled exposure conditions. Molecular techniques and cytogenetic assays are used for the investigations. These studies provide data for understanding the etiology of disease, the toxicological mechanisms for development of disease, and the application of the knowledge to risk assessment and disease prevention.

COMMITTEE RESPONSIBILITIES:

1. <u>National</u>

Consultant for Food and Drug Administration (1981-1998)
Gene-Tox Committee Member of the Environmental Protection Agency (1979-1980)
Member - Membership Committee of Environmental Mutagen Society (1987-1988)
Member - Program Planning Committee of Southwest Environmental Mutagen Society (1987-1988)
Member - Awards and Honors Committee of the Environmental Mutagen Society (1988-1989)
Member - Advisory Panel for the Texas Air Control Board (1989-1994)
Member - Peer Review Panel for Assessment of Radon Research Program for Department of Energy (1990)
Member - Peer Review Panel on DNA Repair and Genetics for Department of Energy (1990; 1991)
Member - Sub-committee on Anesthetic and Life Support Drugs, Food and Drug Administration (1990)
Member - Peer Review Panel for Medical Research and Development Command, United States Army (1993-1998)

Organizer - Expert Panel on the Use of Genetic Monitoring for Risk Assessment in Communities Exposed to Hazardous Chemicals. US EPA, February 7-8, 1994.
Member - Peer Review Panel for National Institute of Environmental Health Sciences (1995 - 2001)
Member - Environmental Mutagen Society Diversity Committee (1995 - 1998).
Member - Program Planning Committee of the Environmental Mutagen Society (1996).
Member - Environmental Health Sciences Panel, National Institutes of Health, (1997 to 2001).
Chairman - Alexander Hollaender Fund for International Programs, (1997 to present).
Councilor - U.S. Environmental Mutagen Society (1999- 2002).
Member – Board of Scientific Counselors, Agency for Toxic Substances and Disease Registry (May, 1999 – April, 2004).
Chairman – Community and Tribal Subcommittee, Board of Scientific Counselors, Agency for Toxic Substances and Disease Registry (May, 2000 – 2004).
Fellow – Collegium Ramazzini (life time member)

2. <u>University of Texas Medical Branch</u>

Member - University Curriculum Committee (1989-1991)
Member - University Chemical Safety Committee (1990-1994)
Member - Curriculum Committee, NIEHS - Toxicology Training Program (1994-1999)
Member - Seminar Committee, NIEHS - Toxicology Training Program (1994-1999)
Member - Internal Advisory Committee - Center for Environmental Toxicology (1997-8)
Member – Committee in Support of Science Education (1997 – present).
Presentation Judge – Undergraduate Research symposium (1996 – present).
Member - Radiation Safety Committee (1998-2001).
Member - Radioactive Drug Safety Committee (1998 - 2001)
Member - Chancellor's councilor, The University of Texas System (1995 to present).
Member – Admissions Committee, School of Medicine (1999 – 2002).
Chairman – Credential Committee, Graduate Program of the Department of Biological Chemistry and Genetics (2000 to present)
Member - Recruitment Committee, Graduate Program of the Department of Biological Chemistry and Genetics (2000 to 2001)
Member – Curriculum Committee, Graduate School of Biomedical Sciences (2000 – present)
Member – Curriculum Committee, BBSC, Graduate School of Biomedical Sciences (2001 - present)

3. <u>Departmental</u>

Chairman - Budget Committee - Graduate school program of the Department of Preventive Medicine and Community Health (1986-1987)
Member, Long-Range Planning Committee for the Department of Preventive Medicine and Community Health (1987-2001)

Member, PMCH Residency Planning Committee (1987-1988)
Member, Steering Committee for departmental review. (1989-1990)
Member, Appointment, Promotion and Tenure Committee (1990-1993)
Member, Admissions Committee, Department of Human Biological Chemistry and Genetics (1991-1994)
Member, Seminar Committee, Department of Preventive Medicine and Community Health (1994-2002)
Member and then Chairman - Advisory Committee, Graduate Program for Department of Human Biological Chemistry and Genetics (1994-1997)
Member - Long Range Planning Committee, Cell Biology Graduate Program (1997-2001)
Member – Credential Committee, Graduate Program for Department of Human Biological Chemistry and Genetics (2000 – present).
Member – Admission and Recruitment Committee, Cell Biology Graduate Program (1999 – 2001).
Member – Graduate Policy Committee, Preventive Medicine and Community Health (1999 - present).
Member – MPH course review committee, Preventive Medicine and Community Health (1999 – present)
Member – Comprehensive Examination Committee for Ph.D. candidacy, Preventive Medicine and Community Health (2003 and 2004)
Director - Graduate student seminar (2004 to present)

4. International

Project officer for U.S.-Egyptian Cytogenetic Program, 1985 – 1987.
Organizer - Participation of US scientists to present papers at the Second Southeast Asian Workshop on Short-Term Assays to Detect Environmental Mutagens, Carcinogens and Teratogens. Bangkok, Thailand, Feb. 6-17, 1989.
Co-Chairman: First International Conference on Environmental Mutagenesis on Human Populations at Risk, Cairo, Egypt, January 20-25, 1992.
Co-Chairman: International Conference on Exposure to Carcinogens and Mutagens in the Industrial and Ambient Environment. Jerusalem, Israel, January 29-30, 1992.
Member-Organizing and Scientific Committee, Satellite Meeting of the International Union of Toxicology, Bologna, Italy, June 4-6, 1992.
Member-Advisory Board of Latin American Environmental Mutagen Society, 1990-present
Member-International Advisory Board Pan African Environmental Mutagen Society, 1992-present
Co-Chairman: Second International Conference on Environmental Mutagens in Human Populations, Prague, Czech Republic, August, 1995.
Co-Chairman: Third International Conference on Environmental Mutagens in Human Populations, Bangkok, Thailand, December, 1998.
Councilor: International Association of Environmental Mutagen Societies, August, 1997 – July, 2001.
Member-Program Committee: 8th International Conference on Environmental

Mutagens, Shizuoka, Japan, October 21 – 26, 2001
Chairman – 4th International Conference on Environmental Mutagens in Human Populations, Brazil, 2003.
Scientific Advisor to Professor Dr. Her Royal Highness Princess Chulabhorn – organization of the Princess Chulabhorn Science Congress V, Bangkok, Thailand, 2004.
Chairman – International Advisory Board for the International Conference on Environmental Mutagens, San Franscisco, September, 2005.
Fellow – Collegium Ramazzini, an international honor society for environmental and occupational health, limited to 180 fellows with life-time membership, October, 2003.
Chairman – Hollaender course and conference on Environmental Health and Cancer, Iasi, Romania, June 1-5, 2004.

TEACHING RESPONSIBILITIES AT UTMB:

Chairman - Dissertation Committee for Kanokporn Rithidech (1984-1987)
Chairman - Dissertation Committee for Hasnaa Shafik (1984-1987)
Member - Dissertation Committee for Glen Talaska (1984-1987)
Chairman - Dissertation Committee for Mary Lowery (1984-1987)
Chairman - Dissertation Committee for Renate MacLaren (1984-1988)
Member - Dissertation Committee for Pamela Harris of The University of Texas Health Science Center in Houston (1987-1989)
Chairman - Dissertation Committee for Elie Hanania (1989-1992)
Member - Dissertation Committee for Zhidong Xu (1989-1992)
Chairman - Dissertation Committee for Treetip Chiewchanwit (1993-1996)
Chairman - Dissertation Committee for Lance Hallberg (1992-1997)
Chairman - Dissertation Committee for Randa El-Zein (1992-1998)
Course Director - Cytogenetics HGCB 6221, 1987-88.
Lecturer - Somatic Cell Genetics HGCB 6222, 1987-88.
Lecturer - Cell-Gene Course for the Medical School (1987-1992)
Lecturer - Preventive Medicine and Community Health for Medical School. (1990-1999)
Lecturer - Genetic Toxicology, PMCH 6325 (1987-1998)
Supervisor - Research project of a medical student, Miss Georgina Loya, 1992-1993
Lecturer - Principles of Drug Action (1994- 1998).
Lecturer - Cell Biology (1995- 1998).
Lecturer - Experimental Design (1995 - 1998).
Director - Environmental Health and Toxicology course for Preventive Medicine Residents and Graduate Students, PMCH 6328 (1996-present)
Lecturer - Issues in Preventive Medicine (1998 - 1998).
Lecturer – Oncogene course (1999 – 1998).
Lecturer – Environmental and Genetic Toxicology, for 4th year medical students, School of Medicine, PMCU 4002 (1999 to present).
Moderator – Practice of Medicine, School of Medicine (1999 – 2001)
Lecturer – Practice of Medicine, School of Medicine (1999 – 2001)

Lecturer – Cell Biology basic science course, Graduate School of Biomedical Sciences (1999 – 2000)
Director – Gene, Environment and Disease course, Graduate School of Biomedical Sciences, BBSC 6118 (2000 – 2003, lecturer; 2004 – present, Director)
Tutor – Interactive Learning Track, School of Medicine (2000 to 2002)
Group facilitator, Great Syndrome, School of Medicine (2001 – present)
Training – Advanced Facilitator Training Workshop, 2000.
Director – Research Design Course in PMCH, Graduate School of Biomedical Sciences, PMCH 6322, (2002 – present)

AS MENTOR TO DOCTORAL STUDENTS

Marilyn Aardema (1986)
Kanokpoon Rithidech (1987)
Hasnaa Shafik (1987)
Mary Lowery (1987)
Renate MacLaren (1988)
Elie Hanania (1992)
Treetip Chiewchanwit (1995)
Lance Hallberg (1997)
Randa El Zein (1998)
Marc McConnell (1999)
Hernan Sierra-Torres (1997 - 2001)
Nohelia Cajas (1997 - 2001)
Salama Salama (1998 - 2001)

ADVISORY ACTIVITIES TO OTHER STUDENTS:

Sasaly AbuBakar, (1991 – 1995, Ph.D.)
Dennis Sawyer, (1997 – 1999, Ph.D.)
Jeff Hill (1998 - present)
Jeff Jones, M.D., (1998 – 1999, M.S.)
Robert Cox (1997 - 2003)
Marc Madsen (1999 - 2000)
Philip Kovoor, medical student (2000)
Barbara Bowerstock, medical student (2000)
Boris Oberheitman, Germany (1998 – 2000)
Blake Chamberlain, Capstone project (2003 – 2004)
Mary Van Baalen, Ph.D. program (2003 – present)
Scott Alpard, M.D., Master of Medical Science (2004 to present)
Monica Longo, M.D., Ph.D. in Clinical Investigations (2003 to 2005)
Anita Reno, Ph.D. program in HBCG (2004 to present)

VISITING SCIENTISTS/POST-DOCTORAL FELLOWS:

Dr. Wagida Anwar - Fogarty International Fellow, Ain Shams University, Cairo, Egypt (May 1987-April 1988; August 1990-October, 1990)
Dr. Sawsan El-Ghazali - Peace Fellow, Ain Shams University, Cairo, Egypt (September 1989-January 1990).
Dr. Moon-Young Heo - University Fellow, Kangweon National University, Chuncheon, Korea (December 1989-November 1990).
Dr.. Randa El Zein - Alexandria University, Alexandria, Egypt (January 1990-December 1990).
Professor Luz Stella Hoyos - University of Antioquia, Colombia, South America (September, 1990-August, 1991)
Dr. Csilla Kormos, National Research Institute for Radiobiology and Radiohygiene, Budapest, Hungary (November, 1990-October, 1991)
Dr. Hongbao Ma, Tianjin Medical College, Tianjin, P.R. China (January, 1991-December 1992).
Dr. Shende Li, Chinese Academy of Medical Sciences, Beijing, P.R. China (April, 1991-July, 1992)
Dr. Shimin Cao, Chinese Academy of Medical Sciences, Beijing, P.R. China (March 1992-September, 1992).
Dr. Fatma Mohammed, Ain Shams University, Egypt (October, 1994- September, 1995)
Dr. Nivea Conforti Froes, University of San Paolo, Brazil (July, 1995-June, 1996)
Lecturer Mila Serrana, Miriam College Foundation, Manila, The Philippines (May, 1997 - April, 1998).
Lecturer Suparp Kietthebthew, Prince of Songkla University, Songkla, Thailand, October 1 - November 10, 1997.
Dr. Hyeong Oh, Director, Division of Genetic Toxicology, National Institute of Toxicological Research, Korean Food and Drug Administration, Seoul, Korea, December 26, 1998 - March 12, 1999.
Lecturer Suparp Kietthubthew, Prince of Songkla University, Songkla, Thailand, March 20 - June 10, 1999.
Professor Moon Heo, Kwangeon National University, Korea, December 20, 1999 to January 27, 2001.
Dr. Concepcion Arrastia, Clinical Fellow, Department of Obstetrics and Gynecology, The University of Texas Medical Branch, Galveston, Texas, March, 2000 to 2001.
Dr. Osama Badary, Department of Pharmacology and Toxicology, Al-Azhar University, Nasr City, Cairo, Egypt, July 1 – December 10, 2000.
Dr. Boris Oberheitmann, University of Bremen, Bremen, Germany, April 1 – 30, 2001.
Dr. Salama A. Salama, Department of Pharmacology and Toxicology, Al-Azhar University, Nasr City, Cairo, Egypt, October 1, 2001 – February 28, 2003.
Dr. Carsten Harms, University of Bremen, Bremen, Germany, November 15, 2001 – February 28, 2002.
Dr. Panida Navasumrit, Chulabhorn Research Institute, Bangkok, Thailand, September, 2003.

MEMBERSHIPS IN SCIENTIFIC SOCIETIES:

American Association for the Advancement of Science (1985- present)
Environmental Mutagen Society (1979-present)

Sigma Xi (1981-present)
Southwest Environmental Mutagen Society (1986-present)
Society for Risk Analysis (1990-present)

CONSULTATION

Corporate consultant - Molecular Epidemiology; Simultec, Meilen/Zurich, Switzerland.

Scientific consultant – Consumer Reports magazine, 2003

PATENT

"Methods for identifying and isolating unique nucleic acid sequences", filed April 30, 2003 (National Stage Patent Application of PCT Application No. PCT/EP03/04570; R & W reference number: 026.00702)

AWARDS AND HONORS:

1. International Cancer Research Technology Transfer Fellowship (1986) from the International Union Against Cancer

2. Visiting Professor, University of Bologna, Italy (1987)

3. Visiting Professor, Ain Shams University, Cairo, Egypt (1988-1991).

4. Chairman - First International Conference on Environmental Mutagenesis on Human Populations at Risk. Cairo, Egypt, January 20-25, 1992.

5. Chairman: International Conference on Exposure to Carcinogens and Mutagens in the Industrial and Ambient Environment. Jerusalem, Israel, January 29-30, 1992.

6. Chairman: Second International Conference on Environmental Mutagens on Human Populations, Prague, Czech Republic, August, 1995.

7. Symposium organizer: Genetic Susceptibility. Symposium for the US Environmental Mutagen Society, Minneapolis, Minnesota, April, 1997.

8. Chairman: Third International Conference on Environmental Toxicants on Human Populations. Bankok, Thailand, December, 1998.

9. Distinguished lecturer: Presented by the Commissioner, Korean Food and Drug Adminsitration, Seoul, Korea, June 16, 1999.

10. Recognition for Significant Contribution to the NATO (North Atlantic Treaty Organization) Conference, Turkey, September 23 – October 3, 1999, from the Director of the NATO Advanced Study Institute.

11. Award from the Environmental Mutagen Society for outstanding international education, research and services, in the Annual Conference, New Orleans, Louisiana, April, 2000.

12: Award from the University of Hong Kong as the Keynote Speaker in the 7th International Cancer Congress, 7 – 9 December, 2000.

13: Keynote speaker: NATO Advanced Research Workshop on Human Monitoring for Genetic Effects, Krakow, Poland, June 23-27, 2002.

14: Chairman: Fourth International Conference on Environmental Toxicants on Human Populations. Florianopolis, Brazil, May 2003.

15: Fellow: Collegium Ramazzini, an International Honor Society for Environmental and Occupational Health, with only 180 fellow members

16: Chairman: Hollaneder course and conference on Environmental Health and Cancer, Iasi, Romania, June 2-5, 2004.

17: Keynote speaker medal: Jubilee Conference for the Oncological Institute "Prof. Dr. Ion Chiricuta", Cluj, Romania, October 7-9, 2004.

EDITORIAL BOARD:

Member: Mutation Research (1990-present)
Member: Toxicology and Industrial Health, An International Journal (1990-present)
Associate Editor: Environmental Epidemiology and Toxicology (1998 to 2000)
Editor: International Journal of Hygiene and Environmental Health (2001 – present)

ADDITIONAL INFORMATION:

Reviewer for Human Genetics
Reviewer for Mutation Research
Reviewer for Environmental and Molecular Mutagenesis
Reviewer for Radiation Research
Reviewer for Toxicology and Industrial Health
Reviewer for Environmental Health Perspectives
Co-Editor for Environmental Health Perspectives, vol. 103, supplement 3, 1993.
Co-Editor for Environmental Health Perspectives, 1996.
Co-Editor for Mutation Research, 1999.

INVITED LECTURES AND WORKSHOP PRESENTATIONS (Selected Since 1991):

1. Seminar Speaker, Prediction of Potential Health Risks Using Short Term Cytogenetic Assays, The Upjohn Company, Kalamazoo, Michigan, January 21, 1991.

2. Symposium Speaker, Population Monitoring in First Latin American Workshop on Mutagenesis, Carcinogenesis and Teratogenesis. May 26-29, 1991, Caxambu, Brazil.

3. Symposium Speaker, Cytogenetics and Related Genetic Endpoints for Detection of Problems from Exposure to Hazardous Waste Chemicals. World Congress on Cell and Tissue Culture. Anaheim, CA, June 16-20, 1991.

4. Symposium Speaker, Abnormal Chromosome Repair and Risk to Develop Cancer. First International Conference on Environmental Mutagenesis in Human Populations at Risk, January 20-25, 1992, Cairo, Egypt.

5. Symposium Speaker, Identification of Potential Health Risk from Exposure to Occupational and Environmental Agents. Hebrew University, Jerusalem, Israel, January 29-30, 1992.

6. Symposium Speaker, Cytogenetic Approach to Document Factors that Contribute to the Development of Cancer. World Conference on Cell and Tissue Culture. Washington, D.C., June 20-25, 1992.

7. Symposium Speaker, Sensitivity and Application of Cytogenetic Assays for Detecting Biological Effects and for Prediction of Potential Health Risk. IV European ISSX Meeting, Bologna, Italy, July 3-6, 1992.

8. Course Director and Lecturer, Strategies for the Control of Mutagenic and Carcinogenic Risk. Sao Paolo State University. Sao Jose du Rio Preto, Brazil, August 12-22, 1992.

9. Invited symposium speaker on Environmental Mutagenesis and Carcinogenesis. National Biological Sciences Conference in Colombia, Papayan, Colombia, October 2-12, 1992.

10. Seminar Speaker, Cytogenetics and Molecular Biomarkers for Exposure to Toxicants and for Potential Health Risk. U.S. Environmental Protection Agency, Environ-mental Criteria and Assessment Office, Cincinnati, Ohio, March 8, 1993.

11. Seminar speaker and class lecturer, Prediction of potential health risk from exposure to hazardous agents. University of Texas at El Paso, February 24-25, 1994.

12. Symposium speaker, International Symposium on Health Hazards of Glycol Ethers, Nancy, France, April 19-21, 1994.

13. Member, Site Visit Team to Kazakhstan, Russia, to review radioactive contamination problems, July 29-August 9, 1994.

14. Symposium speaker, Induction of Abnormal DNA Repair Response from Exposure to Environmental Toxicants, 2nd Latin American Conference on Environmental Mutagenesis, Puerto Vallarta, Mexico, September 25-30, 1994.

15. Symposium speaker, Repair Deficiency in Cancer Susceptibility, Second InternationalConference on Environmental Mutagens in Human Populations, Prague, Czech Republic, August 20-25, 1995.

16. Keynote speaker, genetic predicposition for development of cancer. Colombian National Scientific Conference, Bogota, October 9-11, 1995; monitoring exposed populations for prediction of health risk. Workshop at University of Cauca, Popayan, Colombia, October 12-17, 1995.

17. Keynote speaker, Approaches in Using Standard and Molecular Biomarkers for Health Risk. Conference for the Pan African Environmental Mutagen Society,Cape Town, South Africa, January 23-25, 1996.

18. Seminar speaker, Genetic factors for predisposition to development of cancer, University of Texas MD Anderson Cancer Center, September 9, 1996.

19. Symposium speaker, Cancer risk assessment based on inheritance of polymorphic genes and exposure to environmental toxicants. Korean Environmental Mutagen Society Conference, Seoul, Korea, October 9-11, 1996.

20. Symposium speaker, IV Conference of the Asociacion Latinoamericana de Mutagenesis, Carcinogenesis y Teratogenesis Ambiental, Vina del Mar, Chile, November 3 - 7, 1996.

21. Symposium speaker, Princess Chulabhorn Conference on Environmental and Industrial Toxicology, Bangkok, Thailand, November 9 - 13, 1996.

22. Invited speaker, Conference on Cancer and Genetic Risk Assessment: Low Dose -Effect Studies. Heidelberg, Germany, September 4-6, 1997.

23. Invited Worshop faculty, 4th Alexander hollaender Training Course in Genetic Toxicology. Cairo, Egypt, September 15 - 18, 1997.

24. Invited speaker to the 5th Latinamerican Environmental Mutagen, Carcinogen and Teratogen Society Conference, Curitiba, Brazil, November 15 - 18, 1998.

25. Invited speaker to the 3rd International Conference on Environmental Mutagens in Human Populations. Bangkok, Thailand, November 28- Decemeber 4, 1998.

26. Invited speaker to the International Conference "Current Status and International Strategy on Endocrine Disrupters", Korean Food and Drug Administration,

Seoul, Korea, June 16 – 19, 1999. Presentation title: Genetic Susceptibility and Environmental Disease.

27. Invited by the Minister of Health and the Yang Ming University, Taiwain to Present lectures, Taipei, Taiwan, June 21 – 26, 1999. Lecture title: Use of Biomarkers for Exposure to Genotoxic Agents and for Health Risk Assessment.

28. Invited by the Osaka University Medical School to give lecture in the program "Research for the Future", Osaka, Japan, June 26 – July 1, 1999. Lecture title: A New Technology to Evaluate the Risk of Environmental Toxic Agents to Human.

29. Invited by the National Cancer Center Research Institute to give a lecture entitled "Genetic Variations in Metabolism of Environmental Toxicants and in Development of Environmental Disease", Tokyo, Japan, July 1 – July 3, 1999.

30. Invited by the NATO Advanced Study Institute to be a lecturer in the course entitled "Human Monitoring after Environmental and Occupational Exposure to Chemical and Physical Agents, September 23 – October 3, 1999, Antalya, Turkey.

31. Invited by the Brazilian Association for Environmental Mutagenesis, Carcinogenesis and Teratogenesis for a symposium lecture "Genetic Susceptibility to Environmental Disease", Aquas de Sao Pedro, Brazil, December 5 – 8, 1999.

32. Invited by the Colombian National Congress of Genetics and the Hollaneder course to give a lecture on "Genetic Susceptibility on the Quality of Life", Popayan, Colombia, February 23 – 25, 2000.

33. Invited by the 6th International Symposium on Pharmaceutical Sciences to present a lecture on "Metabolic Susceptibility on Environmental Disease and Response to Medication", Ankara, Turkey, June 27 – 29, 2000.

34. Invited by the 30th Annual Meeting of the European Society for Radiation Biology to give a lecture on "Inherited and Acquired Susceptibility on Environmental Disease", Warszawa, Poland, August 27 – 31, 2000.

35. Invited lecturer, "Life style factors and acquired susceptibility to environmental disease" in the conference on Biomarkers for Genetic and Acquired Susceptibility to Disease, Bremen, Germany, August 31 – September 1, 2000.

36. Keynote Speaker, Hong Kong International Cancer Congress, on "Genetic Susceptibility to Environmental Cancer." Hong Kong, December 6 – 9, 2000.

37. Invited speaker: 8th International Conference on Environmental Mutagens, on "Acquired biological effects from exposure to environmental toxicants." Shizuoka, Japan, October 21 – 26, 2001.

38. Keynote speaker: NATO Advanced Research Workshop on Human Monitoring for Genetic Effects, on "Genetic and Acquired Susceptibility to Environmental Cancer", June 23 – 27, 2002, Krakow, Poland.

39. Seminar speaker: Susceptibility, biomarkers and environmental disease, University of Mainz, Germany, October 5, 2002.

40. Invited symposium speaker: Infection and genetic susceptibility to environmental cancer. McLaughlin Symposium on Infectious Diseases, Galveston, Texas, February 13-15, 2003.

41. Invited symposium speaker, Genetic susceptibility to cervical and oral cancers. in The 4th International Conference on Environmental Mutagens in Human Populations, Florianopolis, Brazil, May 4-8, 2003.

42. Invited symposium speaker. Acquired and genetic susceptibility to environmental cancer. The International Conference on Toxicology in Developing Countries. Guilin, China, November 10 – 14, 2003.

43. Invited symposium speaker. Evolving Genetics and Its Impact on the World. The 5th Princess Chulabhorn Science Congress, Bangkok, Thailand, August 16 – 20, 2004.

44. Keynote speaker. Jubilee Conference for the Oncological Institute "Prof. Dr. Ion Chiricuta", Cluj, Romania, October 7-9, 2004.

45. Invited symposium speaker. Heritable susceptibility factors for the development of cancer. In: Transmissible Genetic Risk and Our Future, Osaka, Japan, March 17-20, 2005.

BIBLIOGRAPHY:

A. Peer-Reviewed Articles in Journals

1. **Au, W.W.**, Fechheimer, N.S., and Soukup, S. Identification of the Sex Chromosomes in the Bald Eagle. Canad. J. Genet. Cytogenet. 17: 187-191: 1975.

2. Soukup, S., and **Au, W.W.** The Effect of Ethylnitrosourea on Chromosome Aberrations In Vitro and In Vivo. Humangenetik 29: 319-328: 1975.

3. McAllister, R.M., Isascs, H., Rongey, R., Peer, M., **Au, W.W.** Establishment of a Human Medulloblastoma Cell Line. Int. J. Cancer 20: 206-212: 1977.

4. **Au, W.W.**, Soukup, S., and Mandybur, T.I. Excess Chromosome 4 in Ethylnitrosourea-induced Neurogenic Tumor Lines of the Rat. J. Natl. Cancer Inst. 59: 1709-1716: 1977.

5. **Au, W.W.**, Pathak, S., Collie, S., Hsu, T.C. Cytogenetic Toxicity of Gentian Violet and Crystal Violet on Mammalian Cells In Vitro. Mutation Res. 58: 269-276: 1978.

6. **Au, W.W.**, Butler, M.A., Bloom, S.E., and Matney, T.S. Further Study of the Genetic Toxicity of Gentian Violet. Mutation Res. 66: 103-112: 1979.

7. **Au, W.W.**, and Witek, Jo Ann. Cytochemical Analysis on a Case of Familial 17ps. Human Genetics 48: 195-199: 1979.

8. **Au, W.W.**, and Hsu, T.C. Studies on the Clastogenic Effects of Biological Stains and Dyes. Environ. Mutagenesis 1: 27-35: 1979.

9. **Au, W.W.**, Sokova, O.I., Kopnin, B., and Arrighi, F.E. Cytogenetic Toxicity of Cyclophosphamide and Its Metabolite In Vitro. Cytogenet. and Cell Genet. 26: 108-116: 1980.

10. Ledbetter, D.H., Riccardi, V.M., **Au, W.W.**, Wilson, D.P., and Holmquist, G.P. Ring Chromosome 15, Phenotype, Secondary Aneuploidy, Ag-NOR Analysis and Associated Chromosome Instability. Cytogenet. and Cell Genet. 27: 111-122: 1980.

11. **Au, W.W.**, Johnston, D.A., Collie, C.J., and Hsu, T.C. Short-Term Cytogenetic Assays of Nine Cancer Chemotherapeutic Drugs with Metabolic Activation. Environ. Mutagenesis 2: 455-465: 1980.

12. **Au, W.W.**, and Hsu, T.C. The Genotoxic Effects of Adriamycin in Somatic Cells and Germinal Cells of the Mouse. Mutation Res. 79: 351-361: 1980.

13. **Au, W.W.**, Butler, M.A., Matney, T.S., and Loo, T.L. A Comparative Structure-genotoxic Study of Three Aminoanthraquinone Drugs and Doxorubicin. Cancer Res. 41: 376-379: 1981.

14. Preston, R.J., **Au, W.W.**, Bender, M., Brewen, J.G., Carrano, T., Heddle, J.A.M., McFee, A.F., Wolff, S., and Wassom, J.S. In Vivo and In Vitro Cytogenetic Assays: A Report of the "Gene-Tox" Program. Mutation Res. 87: 143- 188: 1981.

15. Fabricant, J., **Au, W.W.**, Fabricant, R.N., Frost, A.F., and Morgan, K.S. Sister Chromatid Exchanges and Unscheduled DNA Synthesis Studies in a Family with Retinoblastoma. Teratog. Carcinog. Mutagen 2: 85-90: 1982.

16. **Au, W.W.**, Obergoenner, N., Goldenthal, K.L., Corry, P., and Willingham, V. Sister Chromatid Exchanges in Mouse Embryos After Exposure to Ultrasound In Utero. Mutation Res. 103: 315-320: 1982.

17. Li, Shende, **Au, W.W.**, Schmoyer, R.L., and Hsu, T.C. Spontaneous and Mitomycin C-induced Sister Chromatid Exchanges in a Melanoma and a Colon Tumor Cell Line. Cancer Genet. Cytogenet. 6: 243-248: 1982.

18. Meistrich, M.L., Finch, M., daCunha, M.F., Hacker, U., **Au, W.W.** Damaging Effects of Fourteen Chemotherapeutic Drugs on Mouse Testis Cells. Cancer Res. 42: 122-131: 1982.

19. **Au, W.W.**, Luippold, H.E., and Otten, J.A. Development of a transplantable mouse myeloid leukemia model system: a preliminary report. Prog. Nucl. Acid Res. and Mol. Biol. 29, 47-50: 1983.

20. **Au, W.W.**, Callaham, M.F., Workman, M.L., and Huberman, E. Double minute chromatin bodies and other chromosome alterations in human myeloid HL-60 leukemia cells susceptible or resistant to induction of differentiation by phorbol-12-myristate-13-acetate. Cancer Res. 43, 5873-5878: 1983.

21. **Au, W.W.**, O'Neill, J.P., Wang, W., Luippold, H.E., and Preston, R.J. Induction of chromosome aberrations and specific locus mutation but not sister chromatid exchanges in Chinese hamster ovary cells by neocarzinostatin. Teratog. Carcinog. Mutagen 4, 515-522: 1984.

22. **Au, W.W.**, and Goldenthal, K.L. Normal sister chromatid exchange frequencies during growth of a transplantable murine myeloid leukemia. Cancer Genet. Cytogenet. 14, 125-130: 1985.

23. Schaefer, E., **Au, W.W.**, and Selkirk, J. Differential induction of sister chromatid exchanges by benzo[a]pyrene in variant mouse hepatoma cells. Mutat. Res. 143, 69-74: 1985.

24. Aardema, M.J., **Au, W.W.**, Hand, R.E., and Preston, R.J. Differential sensitivity of a mouse myeloid leukemia cell line and normal bone marrow cells to x-ray-induced chromosome aberrations. Cancer Res. 45:5321-5327: 1985.

25. Rithidech, K., **Au, W.W.**, Sadagopa Ramanujam, V.M., Whorton, E.B., Jr., and Legator, M.S. Induction of chromosome aberration in lymphocytes of mice after subchronic exposure to benzene. Mutat. Res. 188:135-140: 1987.

26. Talaska, G., **Au, W.W.**, Randerath, K., Ward, J.B., Jr. and Legator, M.S. The Correlation between DNA Adducts and Chromosomal Aberrations in the Target Organ of Benzidine Exposed, Partially-hepatectomized Mice. Carcinogenesis, 8:1899-1905: 1987.

27. Shafik, H.M., **Au, W.W.** and Legator, M.S. Chromosomal radiosensitivity of Down syndrome lymphoyctes at different stages of the cell cycle. Hum Genet 78:71-75: 1988.

28. **Au, W.W.**, Ward, J.B., Jr., Sadagopa Ramanujam, V.M., Harper, B.L., Moslen, M.T. and Legator, M.S. Genotoxic effects of a sub-acute low level inhalation exposure to a mixture of carcinogenic chemicals. Mutat Res 203:103-115: 1988.

29. **Au, W.W.**, Bibbins, P., Ward, J.B., Jr. and Legator, M.S. Development of a rodent lung macrophage chromosome aberration assay. Mutat. Res. 208:1-7: 1988.

30. Parkening, T.A., Collins, T.J. and **Au, W.W.** Paternal age and its effects on reproduction in C57B1/6NNia mice. J. Gerontology 43:879-84: 1988.

31. Hagmar, L., Bellander, T., Hogstedt, B., Hallberg, T., Attewell, R., Raihle, G., **Au, W.W.**, Legator, M.S., Mitelman, F. and Skerfving, S. Biological effects in a chemical factory with mutagenic exposure. I. Cytogenetic and haematological parameters. Int. Arch. Occup. Environ. Health 60:437-444: 1988.

32. Rithidech, K., **Au, W.W.**, Sadagopa Ramanujam, V.M., Whorton, E.B., Jr., and Legator, M.S. The persistence of micronuclei in peripheral blood normochromatic erythrocytes of subchronically benzene-treated male mice. Environ Mol. Mutag: 12:319-329: 1988.

33. AbuBakar, S., **Au, W.W.**, Legator, M.S. and Albrecht, T.B. Induction of chromosome aberrations and mitotic arrest by cytomegalovirus in human cells. Environ. Mol. Mutag. 12:409-420: 1988.

34. Anwar, W.A., **Au, W.W.**, Legator, M.S. and Sadagopa Ramanujam, V.M. Effect of dimethyl sulfoxide on the genotoxicity and metabolism of benzene in vivo. Carcinog. 3:441-445: 1989.

35. Anwar, W.A., **Au, W.W.**, Sadagopa Ramanujam, V.M. and Legator, M.S. Enhancement of benzene clastogenicity by praziquantel in mice. Mutat. Res. 222:283-289: 1989.

36. MacLaren, R.A., **Au, W.W.** and Legator, M.S. The effect of 3- aminobenzamide on x-ray induction of chromosome aberrations in Down syndrome lymphocytes. Mutat. Res. 222(1):1-7: 1989.

37. Harper, B.L., Ward, Jr., J.B., Sadagopa Ramanujam, V.M., Ammenheuser, M.A., **Au, W.W.**, Moslen, M.T. and Legator, M.S. A combined testing protocol for assessing genotoxicity in individual animals: application to environmental toxicology. J. Appl. Tox. 9(2):97-102: 1989.

38. **Au, W.W.**, Cantelli-Forti, G., Hrelia, P., and Legator, M.S. Cytogenetic assays in genotoxic studies: Somatic cell effects of benzene and germinal cell effects of dibromochloropropane. Teratog.Carcinog.Mutag. 10:125-134. 1990.

39. Lowery, M.C., **Au, W.W.**, Adams, P.M., Whorton, E.B. Jr. and Legator, M.S. Male-mediated behavioral abnormalities. Mutation Research: 229:213-230,1990.

40. Shafik, H.M., **Au, W.W.**, Whorton, E.B. and Legator, M.S. Distribution of x-ray induced chromosome breakpoints in Down syndrome lymphocytes. Am. J. Med. Genet.: 57:195-200, 1990.

41. **Au, W.W.**, Anwar, W., Paolini, M., Sadagopa Ramanujam, V.M. and Cantelli-Forti, G. Mechanism of Genotoxic and Co-Genotoxic Activity of Cremophore with Benzene in Mice. Carcinogenesis, 12:53-57, 1991.

42. **Au, W.W.**, Walker D.M., Ward, J.B., Whorton E., Legator, M.S., and Singh V. Factors contributing to chromosome damage in lymphocytes of cigarette smokers. Mutation Research, 260:137-144, 1991.

43. **Au, W.W.**, Ramanujam, V.M.S., Ward, Jr., J.B., and Legator, S.M. Chromosome aberrations in lymphocytes of mice after sub-acute low-level inhalation exposure to benzene. Mutation Research, 260:219-224, 1991.

44. Ammenheuser, M.M., Ward, J.B., **Au, W.W.**, Whorton, E.B., Jr., and Belli, J.A. Comparison of Hprt Variant Frequencies and Chromosome Aberration Frequencies in Lymphocytes from Radiotherapy and Chemotherapy Patients: A Prospective Study. Environ. Mol. Mutag., 18:126-135, 1991.

45. Deng, C.Z., AbuBakar, S., Fons, M.P., Boldogh, I., **Au, W.W.** and Albrecht T. Human Cytomegalovirus-Enhanced Induction of Chromosome Aberrations in Human Peripheral Blood Lymphocytes Treated With Potent Genotoxic Agents. Environ. Mol. Mutag. 19:304-310, 1992.

46. Hoyos, L.S., **Au, W.W.**, Heo, M.Y. and Legator, M.S. Evaluation of the Genotoxic Effects of a Folk Medicine, Petiveria Alliacea. Mutat. Res. 280:29-34, 1992.

47. Legator, M., and **Au, W.W.** Genetic monitoring: the practical approach to population studies. Int. J. Occup. Med. Toxicol. 1: 101-108, 1992.

48. Anwar, W., **Au, W.W.**, Massoud, A., Gentile, J., and Ashby, J. First International Conference on Environmental Mutagens in Human Populations at Risk. Mutat Res. 272:83-88, 1992.

49. Ma, H., An, J., Hsie, A.W., **Au, W.W.** Mutagenicity and cytotoxicity of 2-methoxyethanol and its metabolites in Chinese hamster cells. Mutat. Res. 298:219-225, 1993.

50. Heo, M.Y., Yu, K.S., Kim, K.H., Kim, H.P. and **Au, W.W.** Anticlastogenic Effect of Flavonoids Against Mutagen-Induced Micronuclei in Mice. Mutat. Res. 284:243-249, 1993.

51. **Au, W.**, Morris, D.L. and Legator, M.S. Evaluation of the clastogenic effects of 2-methoxyethanol in mice. Mutat. Res. 300:273-280, 1993.

52. **Au, W.W.** Abnormal chromosome repair and risk to develop cancer. Environ. Health Persp. 101(S3):303-308, 1993.

53. Heo, M.Y., Kwon, C.H., Sohn, D.H., Lee, S.J., Kim, S.W., Kim, J.H. and **Au, W.W.** Effects of flavonol derivatives on the micronuclei formation by n-methyl-n'-nitro-n-nitrosoguanidine and the enhancement of bleomycin-induced chromosome aberration by n-methyl-n'-nitro-n-nitrosoguanidine. Arch. Pharm. Res. 16(3):196-204, 1993.

54. Ashby, J., Anwar, W., **Au, W.W.**, Massoud, A. and Gentile, J. Genetic toxicology in developing countries: comments and recommendations. Environ. Health Persp. 101(S3):335-340, 1993.

55. **Au, W.**, Lakoski, J.M. and Legator, M.S. Evaluation of toxic and genotoxic effects of bromacil. Part I: Cytogenetic study using bone marrow cells of B6C3F1 mice. J. Occup. Med. Tox. 2:169-171, 1993.

56. Lakoski, J.M., Arentsen, M.I., Kneisley, M.L., **Au, W.W.** and Legator, M.S. Evaluation of toxic and genotoxic effects of bromacil: Part II: Open Field Behavioral Assessment of Locomotor Effects in the Rat. J. Occup. Med. Tox. 2:172-182, 1993.

57. Lee, S.J., Kwon, C.H., Kim, K.H., Sohn, D.H., Heo, M.Y. and **Au, W.W.** Anti-clastogenic effects of galangin against N-methyl-N'-nitro-N-nitrosoguanidine-induced micronuclei in bone-marrow cells of C57BL/6 mice. Journal of Appl. Pharmacol. 2:183-187, 1993.

58. Ahmed, A.E., Jacob, S. and **Au, W.W.** Quantitative whole body autoradiographic disposition of glycol ether in mice: effect of route of administration. Fund. Applied Tox. 22:266-276, 1994.

59. Chiewchanwit, T. and **Au, W.W.** Cytogenetic effects of methoxyacetaldehyde: a metabolite of 2-methoxyethanol in mammalian cells in vitro. Mutat. Res. 320: 125-132, 1994.

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Health concerns regarding consumption of irradiated food

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Abstract

Food irradiation is being promoted as a simple process that can be used to effectively and significantly reduce food-borne illnesses around the world. However, a thorough review of the literature reveals a paucity of adequate research conducted to specifically address health concerns that may directly result from the consumption of irradiated food. Consequently, there is considerable debate on the issue of health concerns from irradiated food among international agencies and between different nations. This report presents a critical review of scientific data and recommendations from different agencies and consumer groups. The objective of this review is to provide the scientific community and the general public with a balanced discussion on irradiated food from the viewpoint of an environmental or public health professional. As a result of this review, the authors conclude that current evidence does not exist to substantiate the support or unconditional endorsement of irradiation of food for consumption. In addition, consumers are entitled to their right of choice in the consumption of irradiated versus un-irradiated food. Different countries should further evaluate their local and global risks and benefits prior to developing and recommending national and international food irradiation policies.

Key words: Food irradiation – environmental health – public health – mutagenesis – tumor promotion – food safety – food borne illness

Introduction

Food safety is a global issue with paramount environmental and public health consequences if inadequately maintained. With the increased globalization of food supply, ensuring the safety of this supply to consumers has become an international collaborative endeavor. The concern for ensuring food safety can be illustrated by the extent of food-borne illnesses around the world. Even with a well-established food inspection and supply system in the US, food-related health problems are estimated to cause 76 million illnesses, 323,000 hospitalizations and 5,000 deaths annually (Mead et al., 1999). A large portion of the health problems is caused by the contamination of food by infectious agents such as *Salmonella*, *E. coli* and *Listeria*. The potential for contamination is inherent at each step along the food supply and preparation processes. Therefore, a variety of procedures have been developed and

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used to reduce food-borne contamination Since the late 1980's, the World Health Organization and the US Food and Drug Administration have approved the irradiation of food by ionizing radiation at the beginning of the food supply chain as an inexpensive and effective procedure (http://www.cdc.gov/ncidod/dbmd/diseaseinfo/foodirradiation.htm; http://www.who.int/archives/inf-pr-1997/en/pr97-68.html). In a recent conference (First World Conference, 2003), it was estimated that there were approximately 7,000 stores representing more than 50 retail chains that sold irradiated food. Additionally, more than 2,000 restaurants (including major fast food chains) served meals containing irradiated food. Although the application of the food irradiation procedure has been heavily promoted and recommended, unresolved health concerns related to the consumption of irradiated food remain. In this review, background information and concerns with the use of irradiation for food preservation are presented followed by recommendations for academic, industry and consumer consideration.

Food irradiation technology typically uses electron beam and ionizing radiation (e.g. X-rays). The energy from the irradiation breaks chemical bonds and produces toxic ions and free radicals that react with cellular constituents in food to form altered products (often classified as radiolytic products). With respect to dose, the amount of radiolytic products increases in proportion to the radiation dose (Federal Register, 1997). It is by breaking the bonds in a microorganism's DNA structure and prohibiting its replication that food irradiation prevents spoiling and food-born illness. However, irradiated food is not radioactive.

The radiation dose and exposure time can affect the taste and consistence of foods in addition to its effect on microorganisms. Odd odors and discoloration have been noted in some irradiated foods in the past, and radiolytic compounds have been implicated. Specifically, radiolytic compounds have been shown to cause oxidation of myoglobin and fat in meat, which in turn is thought to produce foul odors and discoloration. Ozone can be produced from oxygen during irradiation which can also cause discoloration. Irradiating food at appropriate doses and under appropriate conditions such as a reduced oxygen environment and/or a frozen state can minimize these effects (Federal Register, 1997). Perhaps the most important radiolytic products are 2-alkylcyclobutanones (2-ACBs) which are produced from the irradiation of fat in food. This family of cyclobutanones includes 2-dodecylcyclobutanone (2-DCB) from irradiation of palmitic acid, 2-tetradecylcyclobutanone (2-TCB) from stearic acid, and 2-tetradecenylcyclobutanone (2-TDCB) from oleic acid (Delincee et al., 2002). To date there is no evidence that 2-ACBs are found in any non-irradiated foods and concern for cytotoxic and genotoxic effects from these by-products has been raised (Delincee et al., 2002).

Results

In vitro toxicological evaluation

The generation of altered cellular substances, e.g. radiolytic products, by radiation has caused concern regarding the mutagenicity of irradiated food. Several in vitro studies have therefore been conducted using bacterial mutagenic assays to address this concern. A summary of these published studies is shown in Table 1. In order to test irradiated foodstuffs, which are complex macromolecules, early in vitro tests were conducted utilizing natural juices, extracts or digests from irradiated food. Inherent limitations with these approaches are apparent. For example, it is difficult to extract all compounds from all food types. Chemically altered macromolecules that are different from those found under human study conditions may be formed during the preparation process. Cellular uptake of the mixtures by the bacteria, especially the toxic component, is unknown. Food juices, extracts, and digests may contain compounds that interfere with the essential component of the test, e.g., the presence of histidine will render the Ames assay ineffective (Ames, 1975). In addition, many of the in vitro assays were not conducted in a systematic and comprehensive manner. As shown in Table 1, the majority of the studies using food juice, extracts and digests produce negative results in mutagenic assays.

During the last few years, attention has been focused on evaluating the mutagenic effects of unique radiolytic products from irradiated food, e.g., 2-ACBs. Testing of these products becomes possible because they can be synthesized instead of extracted from irradiated food. As shown in Table 1, one of the 2-ACBs, 2-DCB, was tested in bacterial and mammalian cells for toxic activities (Delincee and Pool-Zobel, 1998; Delincee, 2002; Titeca et al., 2003; Sommers, 2003). These studies did not depict 2-DCB as mutagenic. However, cytotoxic and other biological effects were observed. As shown in the next section, some radiolytic products have been shown to be probable tumor promoters. Since tumor promoters are not mutagenic agents, 2-ACBs are not expected to cause gene mutations. However, testing

Table 1. In vitro mutagenicity studies

Study	Food	Cell type	Dose (Kgy)	High dose irradiation mutagenic effect	Author
1	Glucose, peptone	*E. coli*	50	Negative	Bugyaki et al., 1963
2	Sucrose	Human lymphocytes	20	**Possible*** Chromosomal breaks in human lymphocytes	Shaw and Hayes, 1966
3	Sucrose	Vicia faba	20	**Possible*** Chromosome changes	Bradley et al., 1968
4	Strawberry	*Salmonella*, Human	15	Negative	Schubert et al., 1973
5	Paprika	*Salmonella*	50	Negative	Central Food Research Institute, 1977
6	Sucrose, ribose	*Salmonella*	20	**Possible***	Aiyar and Rao, 1977
7	Cod	*Salmonella*	12	Negative	Joner et al., 1978
8	Growth medium	Human lymphocytes	10, 20	Negative	Vijayalaxmi, 1980
9	Herring	*Salmonella*	12	Negative, possible effect of nutrition or diet	Joner and Underdal, 1980
10	Dates, fish, chicken	*Salmonella*, CHO cells	10	Negative	Phillips et al., 1980a
11	Dates, fish, chicken	CHO cells	10	Negative	Phillips et al., 1980b
12	Onion powder	*Salmonella*	13.6	Negative	Münzer and Renner, 1981
13	Spice mix	*Salmonella*	14, 45	Negative	Farkas et al., 1981
14	Beef, pork, veal	*Salmonella*	50	Negative	Münzer, 1983
15	Sucrose, fructose, glucose, maltose, mango	*Salmonella*	50	**Possible*** Simple sugar mutagenic in one of five strains. Negative in Mango	Niemand et al., 1983
16	2-DCBs	Rat and human colon cells	N/A	**Possible** DNA strand breaks and oxidative damage, cytotoxic, genotoxic	Delincée and Pool-Zobel, 1998
17	2-DCBs	Human colon cells	N/A	**Possible** Cytotoxic, genotoxic	Delincée et al., 2002
18	2-DCBs	*Salmonella*	N/A	**Possible** Cytotoxic	Titeca et al., 2003
19	2-DCBs	*E. coli*	N/A	Negative	Sommers, 2003

May have this mutagenic effect as a result of radiation-induced chemistry of simple carbohydrate solutions
Table adapted from FAO/IAEA/WHO 1999.

should still be conducted on 2-ACBs to determine the degree of tumor promotion activity.

In vivo toxicological evaluation

Experimental animal studies with whole food

In 1999, the Food and Agriculture Organization (FAO), International Atomic Energy Agency (IAEA) and World Health Organization (WHO) reviewed the scientific literature on in vivo toxicological evaluation of irradiated food and produced the Technical Report #890 that is entitled "High-Dose Irradiation: Wholesomeness of Foods Irradiated Above 10Kgy" (FAO/IAEA/WHO, 1999). A summary from the technical report is shown in Table 2. The Table includes 27 peer-reviewed publications that mostly report negative results but ignores 5 peer-reviewed publications that illustrate toxicologic effects (Vijayalaxmi, 1975; 1976; 1978; Vijayalaxmi and Sadasivan, 1975; Vijayalaxmi and Rao, 1976). The latter publications were disregarded based on the decision that the observed toxicity could have been caused by confounding factors such as nutritional and dietary deficiencies. However, the exclusion of these studies has been criticized (Vijayalaxmi, 1999; Kimbrell and Hauter, 2002; http://www.centerforfoodsafey.org/li.html).

Based on the review by the WHO and FDA (FAO/IAEA/WHO, 1999; Food and Drug Administration, 1986), the wholesomeness of irradiated food is generally considered to be safe to consumers. There are, however, major limitations with regard to published animal studies that were used in support of this position. There is no documentation to indicate that the experimental animals had in fact consumed the putative hazardous (e.g. radiolytic) products in the food mixture. In addition, the animal bioassays are not designed to show adverse effects

Table 2. In vivo mammalian mutagenicity studies

Study no	Food type (% in diet)	Species type	Irradiation dose (kGy)	Notations	Reference
1	Black beans	Mouse Swiss-55	15, 20	NHDIR. Dominant lethal test. No difference in pregnancy rates, total implants, live and dead implants, sex distribution, or abnormalities.	Bemardes et al. (1981)
2	Chicken (35%)	Mouse	59	NHDIR. Dominant lethal test. Feeding of radiation-sterilized chicken meat did not induce dominant lethal events. Positive control produced negative results, unsuiTable for supporting safety.	Raltech Scientific Services (1978)
3	Glucose powder	Mouse Swiss	20, 50	NHDIR. Dominant lethal test. No mutagenic effects.	Varma et al. (1982)
4	Glucose powder	Mouse Swiss	20, 50	NHDIR. Micronucleus test in bone marrow cells and chromosomal aberration assay. No evidence of mutagenic effects in somatic or germ cells.	Varma et al. (1986)
5	**Laboratory diet: solid cakes**	**Mouse C57BL**	**50**	NHDIR/PEND. Dominant lethal test. Increased pre-implementation embryonic deaths; not confirmed by cytological analysis.	**Moutschen-Dahmen et al., (1970)**
6	Laboratory diet: pellets, enriched with amino acids and vitamins	Rat SPF Wistar	50	NHDIR. Dominant lethal test. No evidence of mutation.	Eriksen and Emborg (1972)
7	**Laboratory diet: food pellets**	**Mouse Swiss SPF**	**0, 7.5, 15, 30**	NHDIR/PEND. Host-mediated assay. Significant increase in the mutation frequency induced by the high-dose irradiated food.	**Johnston-Arthur et al. (1979)**
8	Laboratory diet: pellets	Mouse	0, 7.5, 15, 30	NHDIR/PEND. Host-mediated assay for 3 commercial food pellets. Irradiation increased mutation frequency between 10 and 60 fold for the 3 products compared to controls. Subsequent extraction study found mutagenic agent extracted by alcohol. Water extract had a lower effect and ether extract had no effect.	Johnston-Arthur et al. (1975)
9	Laboratory diet, 10% moisture	Rat Wistar	25	NHDIR. Dominant lethal test. No evidence of mutagenic effects.	Chauhan et al. (1975a)
10	Laboratory diet, 10% moisture	Mouse Swiss	25	NHDIR. Dominant lethal test. No evidence of mutagenic effects.	Chauhan et al. (1975b)
11	Laboratory diet: pellets	Mouse	45	NHDIR. Host-mediated assay. No mutagenic effects.	Münzer and Renner (1975)
12	Laboratory diet	Mouse BALB/c	28.5	NHDIR. Bone marrow and male germ cells examined for chromosome aberrations. No mutagenic effects.	Leonard et al. (1977)
13	Laboratory diet: pellets	Chinese hamster	45	NHDIR/PEND. No increase in chromosomal aberrations;	Renner (1977)

Tab. 2 (cont.)

Study no	Food type (% in diet)	Species type	Irradiation dose (kGy)	Notations	Reference
				slightly increased incidence of polyploidy.	
14	**Laboratory diet**	**Mouse CD1**	**10, 25, 50**	**NHDIR/PEND. Dominant lethal test. Used 4 diets on 2 strains. Some evidence of weakly mutagenic effect with one diet.**	**Anderson et al. (1981)**
15	Laboratory feed	Mouse, SPF Ha/ICR (Swiss)	30	NHDIR. Host-mediated assay. No mutagenic effects.	Münzer and Renner (1976)
16	Milk powder (35%)	Mouse: NMRI/Han, Rat, Sprague-Dawley	45	NHDIR. Dominant lethal test, reproduction. High content of radicals in the irradiated food. No harmful effects.	Renner et al. (1973)
17	Onion powder (10%)	Chinese hamster, Mouse	13.6	NHDIR. Sister chromatid exchange tests negative in hamsters and 3 strains of mice.	Münzer and Renner (1981)
18	Paprika	Mouse	50	NHDIR. Host-mediated assay. No increase in number of revertants.	Central Food Research Institute (1977)
19	Paprika (20%) 8.6% moisture	Mouse Swiss	30	NHDIR. Micronucleus test. No differences in the incidence of erythrocytes with micronuclei, and polychromatic:normal ratio comparable among all groups.	Chaubey et al. (1979)
20	Spice mix pepper	Rat CFY	15	NHDIR. *E. coli* inductest on blood of rats. No induction of lysogenic bacteria.	Farkas and Andrassy (1981)
21	Spice mix	Rat CFY	15, 45	NHDIR. Negative Ames test on irradiated spice extracts and on urine of rats fed irradiated spices.	Farkas et al. (1981)
22	Spice mix (25%)	Rat Sprague-Dawley	15	NHDIR. Dominant lethal test. No significant difference between irradiated spice groups and controls.	Barna (1986)
23	Strawberry	Mouse	15	NHDIR. No clastogenic effects.	Schubert et al. (1973)
24	Sucrose, ribose solutions	Mouse	50	NHDIR. Host-mediated assay. No increase in number of revertants.	Aiyar and Rao (1977)
25	**Wheat (50%)**	**Mouse**	**0, 50**	NHDIR/PEND. Chromosomal abnormalities in germ cells presumed due to formation of peroxides and radicals with subsequent loss of lipids and carotenoid fractions in irradiated diet.	**Bugyaki et al. (1968)**
26	Wheat (freshly irradiated)	Chinese hamster	0, 15, 30	NHDIR. No difference in polyploids in bone marrow cells or micronuclei in reticulocytes 72h after diets irradiated in N2 or air. Analyses of micronuclei in peripheral blood of rat fed wheat flour irradiated at 0.75kGy done at 6 and 12 weeks.	Tanaka et al. (1992)

NHDIR = negative for high-dose irradiation effect (> 10 kGy); PEND = possible effect of nutrition or diet; % in diet based on dry weight unless otherwise specified indicated. Information presented in bold font indicates positive findings.
Table modified from FAO/IAEA/WHO, 1999.

from the consumption of a small amount of toxic substances, e.g., 2-ACBs in food. Traditionally, pure compounds, not mixtures, are tested in animal bioassays to generate dose-response observations and possibly to document the lowest no adverse effect dose. With the data that is obtained, it is then practical to evaluate the toxicity or safety of the compound and to extrapolate experimental findings to how it may pertain to human consumers. With these major limitations, the current data from animal studies are inadequate for making valid health risk assessment and such assessment has not enjoyed wide-spread acceptance.

Human studies with whole food

Only two human studies have been reported. In one study, ten children (2 to 5 years old) suffering from severe protein-calorie malnutrition were fed freshly irradiated wheat (N = 5) or stored irradiated wheat (N = 5) for six weeks (Bhaskaram and Sadasivan, 1975). These ten children were compared to a matched control group of five children who were fed unirradiated food during the same time period. The first group of five children developed significantly more polyploid cells and other cellular abnormalities in their lymphocytes than the five who were fed the stored irradiated food. In addition, the abnormality persisted for up to two months after the feeding period ended. None of the children fed the un-irradiated diet developed any abnormal cells.

In another study, healthy adults were fed irradiated food for three months (Institute of Radiation Medicine, 1987). They did not display any increase of chromosomal aberrations when compared to a control group. Upon reanalysis of the data (Louria, 1990), an increase in chromosomal aberrations was demonstrated. Although these results were from small scale investigations, the information is based on human responses and does raise some safety concerns about the health risk of irradiated food.

Potentially harmful radiolytic products

In the modern era, a new concern has arisen in regard to some of the radiolytic products formed uniquely in irradiated food. Of particular interest is 2-ACB, a radiolytic derivative of triglycerides. In one report (Horvatovich et al., 2002), laboratory rats were fed a low concentration of 2-ACBs in drinking water, and the absorption and excretion of the chemicals were monitored. The study showed that a substantial portion of the chemical crossed the intestinal barrier, entered the blood stream, and accumulated in adipose tissue. Therefore, consumption of irradiated food can possibly result in a significant accumulation of 2-ACBs in the adipose tissues of consumers. The long-term health consequences of this observation are unclear at this time.

In another study (Raul et al., 2002), Wistar rats received a daily solution of 2-tDCB or 2-tDeCB (while controls received ethanol) in combination with an intraperitoneal injection of a known carcinogen (azoxymethane [AOM]). Observations were made at two distinct intervals. At three months after initiation of the exposure, no significant changes in the number of pre-neoplastic colonic lesions were observed among the rats (all were exposed to AOM). At six months, however, the total number and the overall size of tumors were markedly increased in the 2-ACB-AOM treated rats as compared to the ethanol-AOM control rats. This demonstrates that compounds found exclusively in irradiated dietary fats may promote colon carcinogenesis in animals treated with a known carcinogen and identifies a new area of toxicity that the FDA and WHO have yet to examine. The 2-ACB tumor promotion activities should be further investigated, and their effects evaluated systematically.

Recommendations from regulating agencies

Various agencies from around the world have made recommendations regarding the safety of irradiated food consumption. The recommendations from major agencies that will be discussed in this review are the World Health Organization, the European Parliament, the US Food and Drug Administration, and the US Department of Agriculture.

World Health Organization (WHO)

The WHO has been an advocate of food irradiation since their appraisal of the technology. Based on a review of scientific evidence, their expert panel concluded that food irradiated at an appropriate dose was safe to consume and nutritionally adequate. The panel also concluded that an upper dose limit did not need to be imposed; stating "irradiated foods are deemed wholesome throughout the technologically useful dose range from below 10 kGy to envisioned doses above 10 kGy" (FAO/IAEA/WHO, 1999). In addition, they also stated that the limit could be set as based on the deterioration on the quality of the irradiated food. However, such decision that is based on vigorous scientific evaluation of public health impact should be more reliable.

Recently the Joint FAO/IAEA/WHO Food Standards Program (2003) under the United Nations promoted irradiation doses beyond the 10 kGy limit. During the deliberations, Germany objected to the absence of a 10 kGy limit and the United States argued for a 30 kGy limit to kill micro-

Table 3. Radiation conditions recommended by the FDA

Approval date	Food/product dose (kGy)*	Purposey
1964, 1965	Potatoes, 0.05–0.15	Inhibit sprouting (and extend shelf life)
1983	Spices and dry seasonings, <30	Disinfestation and decontamination
1985	Pork, 0.3–1.0	Control of *Trichinella spiralis*
1985, 1986	Dry or dehydrated enzymes, <10	Control of insects and microorganisms
1986	Fruit, <1	Delay maturation and disinfestation
1986	Fresh vegetables, <1	Disinfestation
1986	Herbs, spices and seasoning, <30	Control of microorganisms
1990	Poultry, fresh or frozen, <3	Control of microorganisms
1995	Meat, frozen and packaged (solely for use in NASA), >44	Sterilization
1995	Animal feed and pet food, 2–25	Control of *Salmonella*
1997, 1999	Red meat, meat products (uncooked) Kv chilled (refrigerated), <4.5 Kv frozen, <7.0	Control of microorganisms

organisms on spices. In the end the Commission adopted a revised standard over the objections of Austria, Denmark, Germany, Greece, Hungary, Italy, Mexico, Poland, Spain and Sudan. The Commission argued that the higher levels of irradiation (30 kGy) were justified to eliminate bacterial spores. The Codex Alimentarius (Food Code) is a compilation of standards, codes of practice, guidelines and recommendations of the 169 countries represented in the Codex Alimentarius Commission, a subsidiary body of FAO and WHO. This commission previously recommended a minimum of 1 kGy and a limit of 10 kGy.

The European Parliament

The European community has provided funding for some of the recent studies on the safety of irradiated food (e.g. Horvatovich et al., 2002; Raul et al., 2002). Based on the observed adverse effects resulting from these investigations, the European Parliament has retained the 10 kGy limit and has issued a moratorium on the addition of food items for irradiation:

"In adopting this resolution, a majority of MEPs took the view that the current list of food ingredients authorized for irradiation treatment should not be extended at this stage. An amendment was adopted in favor of the third Commission option, the most restrictive one. The current list should be regarded as complete, which would mean that only dried aromatic herbs, spices and vegeTable seasonings are permitted for irradiation in the European Union as and when scientific knowledge suggested that it was safe and efficacious to do so." (Breyer, 2002)

The Food and Drug Administration (FDA)

The regulations from the FDA are codified in CFR 21 Part 179 (1986) and the recommended irradiation conditions are listed in Table 3. Since the regulation does not supercede the authority of the U.S. Department of Agriculture (USDA), anyone irradiating food needs to comply with regulations set forth by the Food Safety and Inspection Service.

Under general labeling requirements, the FDA requires that the label bear the radura symbol and a prominent phrase "treated with radiation" or "treated by irradiation." However, if irradiated ingredients are additives to foods that are not irradiated they do not require any special labeling. Labeling is also not needed for irradiated food items that are prepared and served in restaurants. To ensure foods are not irradiated multiple times, pre-retail labeling is required for any food that may need further processing. The FDA encourages other truthful statements about food irradiation on labels to educate consumers.

U.S. Department of Agriculture (USDA)

In May of 1993, the USDA released specifications to guide the National School Lunch Program in purchasing irradiated ground beef. Under the 2002 Farm Bill, the USDA may not prohibit approved food safety technologies on foods purchased for the National School Lunch Program. In California, the legislature has recommended that the local school boards provide consumer educational materials on irradiated food and decide on how to serve irradiated food (Legislative Session in Sacramento, California, June–July, 2004).

Meat and poultry establishments that use irradiation must meet sanitation and Hazard Analysis and Critical Control Point (HACCP) regulations. Additionally, the USDA conducts microbial testing to ensure processing plants are producing wholesome products.

Concerned citizen groups positions on irradiated food

Citizen groups, like citizens themselves, have widely varying opinions on the safety of irradiated food. For the context of this review, the consumer groups will be classified broadly into those who oppose food irradiation, those that are neutral, and those who support it. In addition, only positions from representative citizen groups that are not observably funded by industry or whose opinions are not obviously based on financial or political interest are presented.

Groups that are against food irradiation, e.g. Public Citizen and The Center for Food Safety, base their concerns on peer-reviewed journal articles that state that the safety of consuming these foods has not been established (Is Irradiated Food Safe, 2003; Kimbrell and Hauter, 2002; http://www.centerforfoodsafety.org/li.html). They believe there are unique by-products of irradiated fat that can potentially cause cancer. They also believe that these products, 2-ACBs, have not been tested properly in the traditional toxicological manner. Another argument of the anti-irradiation food groups is the concept of sterilized filth. These groups contend that the food industry will use irradiation as a substitute for normal precautions when handling food, thus leaving the entrails, feces, blood, pus, tumors and other contaminates on the meat (Kimbrell and Hauter, 2002). Providing credence to this statement, the European Parliament has cited examples of illegal use of irradiation at European facilities to clean up contaminated seafood (Breyer, 2002). The consumer groups also contend that food irradiation would lead to a false sense of security in consumers. Consequently, consumers of irradiated foods may believe these foods cannot ever become contaminated, and would thus minimize traditional precautions instituted to ensure sanitary and safe food preparation, ultimately leading to more food-borne illness.

Another category of consumer groups is comprised of organizations that maintain a neutral position (e.g. Consumer Reports, Safe Tables Our Priority (STOP), The American Council on Science and Health, and the Center for Science in the Public Interest). These groups are well aware of the dangers of food-borne pathogens and see a need to improve the process of food handling overall. Some of them, such as STOP are groups of concerned citizens which have themselves, or have a relative, that has been a victim of food-borne illness. In general, these groups have no official policy stance on food irradiation, but they can see its potential benefit in protecting the general public from food-borne pathogens such as *Eschericia coli*, *Salmonella* and *Campylobacter*. These groups do emphasize the need to maintain normal safety precautions when handling food, and recommend that food be irradiated in its final packaging to reduce the chances of recontamination (Donley, 1999; Consumer Union, 2003). They feel that the irradiated products should be clearly labeled and the words "treated by irradiation" be used, as opposed to "cold pasteurized or electric pasteurized" (Donley, 1999; Mitchell, 1999). As long as the proper labeling (which includes the radura symbol) is present, and the public is educated about the possibility of recontamination, these groups contend that consumers can vote with their pocketbooks, thus choosing for themselves whether or not they want irradiated food products. These groups believe that the benefits of a safer food supply protected from bacterial and viral pathogens may outweigh any risks.

The last category of citizen groups, including the Hudson Institute's Center for

Global Food Issues and the Competitive Enterprise Institute, endorse food irradiation. They contend irradiation defeats well-known and potentially deadly food-borne pathogens, and will save lives. These groups cite the fact that food irradiation has been used for decades by the military and NASA to prepare long shelf-life food products for soldiers and astronauts (CEI Staff, 1999; Avery, 2003). They also referenced estimates from the USDA that the American consumer would receive approximately $ 2 in benefits from reduced spoilage and less illness for each $ 1 spent on food irradiation (Loaharanu, 2003).

Whether citizen groups are for or against food irradiation, nearly all groups agree the consumers should be informed of any food that has been irradiated. However, the groups that are most in favor of irradiation do not usually mention the issue of labeling.

Other methods for food preservation and sanitation.

In addition to destroying, inhibiting, or removing microorganisms from food products, other goals of food processing are to retard or prevent deleterious biochemical, chemical and physiochemical changes, to maintain and generate accepTable organoleptic (taste, texture, color, and aroma) properties, and to preserve and enhance the nutritive value. Examples of bacteriostatic food processing methods include drying, freezing, pickling, salting, smoking, and fermenting. Bacteriocidal procedures include thermal processing, electric energy, high pressure processing, and electromagnetic microwave technology.

Emerging electromagnetic microwave technology has some highly desirable features (http://www.pubit.it/sunti/euc0301q.html; http://www.techmonitor.net/techmon/03sep_oct/fpr/fpr_preserve.htm). The process has the potential to extend shelf life of food for a minimum of nine months, eliminate the need for refrigeration and offer the convenience of ready-to-eat food while maintaining organoleptic qualities and more than 90% of the nutritional value. In addition, the process uses a patented electromagnetic microwave (non-ionizing radiation) that has not been shown to generate unique radiolytic products. Nevertheless, the overall quality and safety of the application needs to be determined scientifically and systematically.

Regardless of the ultimate technology applied, emphasis on sanitary processing of food prior to the radiation phase and also at the time of food preparation by the consumer, should not be undermined. To prevent food-borne illnesses, it would be prudent to practice the four Cs of food safety: Clean well, Cook thoroughly, Combat cross contamination (separate), and Chill (refrigerate).

Discussion

Improvement of food safety and prevention of food-borne illness are fundamental and crucial public health objectives. The use of radiation on food has been heavily promoted as the approach to achieve these stated objectives. However, less emphasis has been placed on determining the potential health consequences that can result from this process. The justification used for approving food irradiation is based mainly on early studies which demonstrate that (1) the process did not generate substances that are not also generated by other food preservation procedures and (2) the wholesomeness of irradiated food is safe based on animal bioassays. However, recent studies have propagated uncertainty with regard to the safety of irradiated food that is to be provided to the consumer.

The in vitro and in vivo research outlined in this review clearly depict the formation of radiolytic products, e.g. 2-ACBs, in irradiated food that are not found in food items prepared by using other food processing technologies. Preliminary studies demonstrate that 2-ACBs accumulate in fatty tissues in experimental animals, exhibit toxicity, and possess tumor promoting activities. Testing for toxicity using wholesome irradiated food in animal bioassays is not entirely appropriate because these assays are not designed to show the adverse effects of exposure to small concentrations of toxic substances such as 2-ACBs in food. These assays are traditionally used to test pure compounds, not mixtures, in order to demonstrate a dose-response effect for toxicity evaluation. Up to this point in time, there have been no comprehensive and systematic studies to assess human toxic effects resulting from irradiated food. Given the history of use of this technology thus far, one could argue that if it were unsafe then we should have seen some specific adverse health effects. However, if the toxic by-products are acting as promoters we may only recognize a small increase in cancer in the population (in terms of percentages but not in terms of number of affected individuals) and it would be very difficult to prove that irradiated food was in fact the direct cause of increased cancer morbidity and mortality. Any argument would have to be made inferentially based on the data presented.

The greatest concern expressed by mainstream consumer advocacy groups is the use of the technology without first informing the consumer. Even the names used are confusing. The proposed labeling statements "cold pasteurization" and "electronic pasteurization" instead of radiation are misleading to consumers.

There are many differing opinions on the use of radiation in food processing. However, there appears to be universal support for sanitary processing as being one of the most important considerations. Irradiation of poorly processed food only sterilizes something that should not be consumed in the first place. In addition, other useful procedures that do not generate health concerns should not be precipitately discarded without due consideration. The other major consideration is that evolving technology may replace the need to use radiation as a means to process food.

Recommendations

In summary, it is quite clear that additional research is needed in order to fully address the issue and concerns of irradiated food. The toxicity of unique radiolytic products should be tested vigorously, especially in regards to the tumor promoting activities. Animal bioassays should be conducted systematically and comprehensively with whole food and with unique radiolytic products to generate a dose-response understanding of the toxicity and safety of irradiated food. It would prove beneficial to establish a dose that does not cause any observable toxic effects in an experimental animal model. The data obtained would better substantiate extrapolation and application in human health risk evaluation. In addition, as of now, there are no extensive human trials available to assess irradiated food safety in human populations. Regulatory agencies in the US and around the world need to be proactive in resolving these health concerns prior to the ubiquitous consumption of irradiated food. It is noTable that the European Parliament has halted the addition of new food products for irradiation and has chosen to maintain the 10kGy limit on irradiation.

In a global perspective, prevention of food-borne illness is a critically important practice. Third world countries with malnutrition, widespread famine and limited hygiene resources may view the concept of irradiated food differently from developed countries. Nevertheless, considerations for the approval of irradiated food for consumption need to be based on realistic and informed evaluation of the risk and benefits to the populations.

This illustrates the core issue in processing food with radiation. One can argue their respective position based on sound reasoning and with a convincing tone. Therefore, the decision to consume irradiated food should be made through knowledgeable risk assessment, using all available scientific evidence-based data, and involving all stakeholders prior to achieving an informed decision.

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE SECRETARY

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

**DECLARATION OF MARVIN RESNIKOFF, Ph.D.
IN SUPPORT OF PETITIONER'S AREAS OF CONCERNS**

Under penalty of perjury, I, Dr. Marvin Resnikoff, hereby declare that:

1. I am a physicist with a Ph.D. in high-energy theoretical physics from the University of Michigan and also the Senior Associate of Radioactive Waste Management Associates (RWMA), a private technical consulting firm based in New York City. I have researched radioactive waste issues for the past 30 years and have extensive experience and training in the field of nuclear waste management, storage, and disposal. RWMA works, among other areas, primarily on three subjects: transportation and storage of radioactive waste and materials, radiation induced injuries, and decontamination and site remediation of radioactively contaminated facilities. A copy of my resume is attached to this declaration as Exhibit D.

2. I have considerable training and experience in the field of risk assessment involving nuclear and hazardous facilities, serving as an expert witness in numerous personal injury cases in which I estimated radiation doses and the likelihood these exposures caused cancer. These cases involved uranium mining and milling, oil pipe cleaning, X-rays, thorium contamination and other issues. This work involved the use of

computer codes, such as CAP88PC, RADTRAN, RESRAD, RISKIND, MILDOS and HOTSHOT, and spreadsheets employing dose conversion factors, to estimate radiation doses.

3. I investigated the Genesis irradiator licensed by CFC Logistics, Inc. (Docket No. 030-36239) and prepared affidavits in support of the Petitioner's Areas of Concern and Motion for a Stay. I also toured the irradiator licensed by CFC Logistics, Inc., whose design is almost identical to the design proposed for the Pa'ina Hawaii irradiator. The Co-60 suppliers are also the same.

4. I previously assisted a local group in Dickerson, MD regarding Neutron Products, Inc., a company that processed Co-60 into specific forms for irradiation devices.

5. A paper on decommissioning reactors I wrote in 1976 (*Environment*, December 1976) was the first to show that reactors would remain radioactive for hundreds of thousands of years. The importance of our discovery was noted by *Science* magazine in 1982, which is attached hereto as Exhibit E. As part of our work analyzing radioactive waste shipments to low-level waste facilities and waste impacts of the nuclear fuel cycle, I have stayed up-to-date on the decommissioning literature, including more recent Nuclear Regulatory Commission (NRC) reports.. I reviewed decommissioning reports for the Rancho Seco reactor in California, the Big Rock Point reactor in Michigan, the Yankee Atomic reactor in Rowe, Massachusetts, and the Connecticut Yankee reactor in Haddam Neck, Connecticut.

6. In addition RWMA has conducted technical analyses for public interest groups and local governments at each of the proposed low-level waste disposal facilities

across the country, including Martinsville (IL), S. Windsor (CT), Chatham County (NC), Hudspeth County (TX), Ward Valley (CA) and Boyd County (NE). In the process of conducting these analyses, we have examined and used the computer programs MODFLOW, PRESTO-CPG and IMPACTS, used to estimate groundwater flow and risk due to radioactive materials. I served as project manager and focused on the risk assessment sections of our reports.

7. RWMA is involved in several major personal injury cases involving radiation due to uranium mining and milling operations, and oil pipe cleaning operations (NORM). We also serve as technical advisors to the States of Utah and Nevada and several counties in Nevada and California on issues involving transportation, handling and storage of irradiated fuel.

8. I am one of the Petitioner's expert witnesses in support of its petition to intervene in this hearing, which relates to the Materials License Application proposed by Pa'ina Hawaii, LLC for a Genesis II Irradiator in Honolulu, Hawaii. I participated in the drafting of Petitioner's issues of concern.

9. To prepare this affidavit, I reviewed Pa'ina Hawaii's Materials License Application, and other filings in this and other NRC dockets. I am also familiar with NRC regulations and guidance documents related to this application.

10. In my best professional judgment, the applicant has not shown that the public health and safety will be protected and therefore the application should be denied. In addition, due to the potential for a range of events – including, but not limited to, mechanical failures, power outages, airplane accidents, acts of sabotage or terrorism, hurricanes, or tsunamis – to cause a significant release of radioactive material from the

Pa'ina Hawaii irradiator to the environment, "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 or environmental impact statement for the proposed license. 10 C.F.R. § 51.22(b); see also id. § 2.335(b); 40 C.F.R. § 1508.4. This declaration discusses the bases for these conclusions.

11. **Loading and Unloading Procedures.** RWMA serves as a technical consultant to the States of Utah and Nevada regarding the transportation, handling and storage of irradiated reactor fuel. The safety issues raised by handling and storage of Co-60 are similar to the safety issues raised by handling and storage of irradiated reactor fuel.

12. Loading and unloading the fresh and used Co-60 pencils present a risk of a cask drop. If a 3 to 6.5 ton cask were to drop on the Co-60 pencils and bend the pencils, the potential for release of Co-60 into the pool water must be assessed. The potential for damage to the pool liner must also be assessed, and its potential impact must also be assessed. Similar to a reactor, where a shipping cask has the potential to pass over the fuel pool and drop onto fuel rods, the irradiator here must have a system to prevent the cask from passing over the Co-60 pencils. This information is missing from the application, contrary to the requirements of 10 C.F.R. § 36.39(c), "the licensee shall design the pool to assure...that a dropped cask would not fall on sealed sources." The details of the loading and unloading procedures are contained in the withheld materials, GL-201 – GL-206. If the pencils are bent, the applicant must discuss how these bent Co-60 rods will be packaged and sent back to the manufacturer, that is, how the applicant intends to recover from this accident. (10 C.F.R. § 36.53(b)) And similar to the reactor,

the irradiator must have installed a single failure proof crane, so that the crane cannot fail.

13. Based on my experience with loading and unloading irradiated fuel, this stage is the most precarious and susceptible to a major accident if the equipment, training and emergency procedures were not up to this difficult task. For similar reasons, I believe the loading and unloading of Co-60 at the proposed irradiation facility will be precarious and susceptible to a major accident. According to the CFC Logistics license application, a shipping cask containing 200,000 Ci of Co-60 sources would be inserted into the pool. Sources would be removed and placed underwater on one side of the pool, away from the cask. The plenum would be removed before this operation. As the shipping cask, which could weigh between 3 and 6.5 tons, is removed from the pool, it could drop onto the sources, seriously contaminating the pool water. This contamination would have to be removed with ion exchange columns that would become extremely radioactive. The discussion must be in accordance with 10 C.F.R. § 36.57(e). The steel-liner of the pool would become radioactive. Some of this radioactivity could be released to the sanitary sewers and the air. Though the fuel suppliers and presumably the shipping casks are likely the same as the Genesis irradiator in Pennsylvania, the application contains no details about the type and weight of the cask, how the cask is unloaded from the trailer bed and how the cask is attached to the crane and lowered into the water. Similar to operations at Neutron Products Incorporated (NPI) in Dickerson, Maryland, where Co-60 material was shaped to fit different irradiators, Co-60 released to the environment could lead to a significant direct gamma dose, and would be expensive to decontaminate. At NPI, despite the presence of HEPA filters to capture particulates, Co-

60 was found off-site; the direct gamma dose rates were five times NRC regulatory limits. Therefore, I consider the potential for a cask drop accident to pose a serious risk of irreparable harm, violating the requirement in 10 CFR § 30.33(a)(2) that "proposed equipment and facilities [must be] adequate to protect health and minimize danger to life or property."

14. It is doubtful that the crane is designed to stop where the sources are located since it is the same crane used to move product over the entire pool.

15. Further, the application has no emergency procedures for accidents that may occur during loading and unloading sources. This is contrary to 10 C.F.R. § 36.53(b). The application has no emergency procedures for remedying a cask drop accident. No phone numbers for policy, fire and ambulance, assuming they would know what to do. No training. No drills.

16. In 1980 a shipping cask containing irradiated fuel from the Connecticut Yankee reactor overheated, and contaminated the Battelle Columbus Laboratory fuel pool with fission products and Co-60. The contamination in the pool set off the air monitors, and led to major radiation exposures. On the basis of this accident, on behalf of the Sierra Club, I petitioned the NRC to replace air within casks with an inert gas so the contents would not oxidize. While the petition was ostensibly denied, the NRC did order all shippers to inert shipping casks with helium or nitrogen. The physical and chemical properties of irradiated fuel are admittedly different from Co-60 sources at Pa'ina Hawaii, but the possibility of radioactivity becoming airborne in an accident are similar to what may occur at Pa'ina Hawaii. If the Co-60 sources were damaged in an accident, Co-60 could become airborne and be released from the cask.

17. **Thermal Considerations.** The applicant has not shown that the system will not overheat. The thermal projections based on worst case assumptions are redacted. These should be provided. As far as can be ascertained, the helium system surrounding the Co-60 pencils is static. Apparently the heat will be dissipated through the helium to the plenum walls and then to the pool water. It is not clear how the temperature will be continuously monitored within the plenum. If the plenum overheats, there is danger that radioactive material will be released to the pool water. The Co-60 could then become airborne, be released to the air within the irradiator facility and subsequently to the external environment. The gamma dose rates would become elevated within the irradiator building. The ion exchange resins would become highly radioactive, and have to be transported to a low-level radioactive waste landfill. This would be contrary to 10 CFR § 36.57(e). The applicant has not proposed shutdown criteria, if the Co-60 concentrations in the pool water or air above the pool reach certain specific concentrations.

18. When the plenum rack is loaded with Co-60 pencils, the loading is done underwater with long handling tools. The plenum is then fit over the rack and helium is pumped in and water out of the plenum. At this point the Co-60 rods will heat up and the water on the Co-60 will evaporate. The applicant does not discuss the effect of this evaporation process and whether radioactive materials will enter the helium environment and the pool water. Reviss, one of the suppliers listed in Pa'ina Hawaii's application, has previously expressed concern about the potential damage to the Co-60 pencils in this evaporation process, requesting that there be no ingress of water droplets into the plenum and that, "there is absolutely no liquid water present in normal operation and that the

atmospheric humidity in the plenum chambers can be demonstrated to be indistinguishable from the humidity of air in the surrounding neighbourhood."

19. It is not clear who is carrying out the thermal calculations. In a previous reincarnation of the Genesis II irradiator in Pennsylvania, Reviss, one of the fuel suppliers, provided the thermal calculations. Neither the designer, Gray*Star, nor the applicant have the expertise to analyze the thermal conditions in the plenum.

20. In addition, while Gray*Star designed the Genesis II irradiator, it is not clear who is actually supplying the components; the Co-60 pencils are being supplied either by Nordion (Canada) or Reviss, who has Co-60 generated in Russia. How the NRC ensures the quality assurance of the process without actually inspecting the Canadian and Russian facilities is not spelled out in the application. According to 10 CFR § 36.59(b), leak testing of the source must be carried out.

21. **Security.** It is well-known that Cobalt-60 is an attractive target for terrorists, because it can be used to make dirty bombs. It is also well-known that in general, nuclear facilities are a target of the Al Qaeda organization. If cobalt-60 were stolen from the proposed facility[1] or if the facility were attacked, cobalt-60 could be released into the environment, causing adverse health effects and spreading contamination that would be expensive to clean up. To put the amount of radioactivity in each Co-60 pencil into perspective, a person standing one meter from an unshielded one curie source of Co-60 would receive a dose of 1.37 mrem/hr, using specific gamma ray dose constants.[2] While the applicant has not stated how much radioactivity will be in the proposed facility, drawing from the previous Genesis application, we know that 17,000

[1] If Co-60 were fashioned into a dirty bomb and directly dispersed into the environment.
[2] Shleien, B. *et al, Handbook of Physics and Radiological Health*, Williams and Watkins, Baltimore, 1998, Table 6.2.2.

Ci of Co-60 would be in each pencil, providing an LD50 dose in one minute. Though the previous Genesis irradiator was designed to operate with one million Ci, it had the capacity to hold up to 256 sources, or 4.35 million curies. The total amount of radioactivity in the Pa'ina Hawaii irradiator has not been specified.

22. In sum, the applicant is placing a major sabotage target into the local community without an evaluation of the risk to the community. The effect of an accident distributing 17,000 Ci of Co-60 has been analyzed by the Federation of American Scientists. See Public Interest Report, vol. 58, No. 2, March/April 2002, attached hereto as Exhibit F and incorporated herein by reference. Their report estimates that, if a single Cobalt "pencil" were dispersed by an explosion at the lower tip of Manhattan, an area of approximately one-thousand square kilometers would be contaminated, and tens of thousands of New York City residents could die.

23. **Tsunami and Hurricanes.** Tsunami and wave run-up from a major tropical storm/hurricane are threats to the proposed facility, as experienced with the tsunami in SE Asia and hurricanes along the Gulf Coast. The proposed facility is only 7.7 feet above sea level. A major rush of water could badly damage the irradiator building and short out the electricity. This would expose the nearby public and emergency workers to radiation exposure. The facility must also be designed to withstand hurricane velocity winds. The application has no discussion of the potential for such emergency events and the procedures that would be implemented, in violation of 10 C.F.R. § 36.53(b)(9).

24. **Air crash.** Since the proposed irradiator will be located adjacent to the Honolulu airport, the applicant must analyze the likelihood and consequences of an air

crash, either on take off or landing. In our experience, no nuclear facility has ever been located in such close proximity to an airport runway, in this case, Reef Runway, which has also been designated as an alternate landing site for the space shuttle. According to the National Transportation Safety Board, in the 23-year period between 1982 and 2004, on average 2.17 accidents per year occurred at the Honolulu International Airport (HNL). See NTSB Aviation Accident Database Query, attached hereto as Exhibit G and incorporated herein by reference. This does not include lower level accidents, aircraft incidences. This is an extremely high accident rate for a nuclear facility located in such close proximity to the runway. It is important to note that jet planes in distress at adjacent to Hickam Air Force Base may land at the Honolulu airport, because the runways may be much longer. The applicant must determine the likelihood and consequences of an air crash, and determine whether the location is appropriate for such a facility, and if not, whether the facility can be hardened to mitigate the consequences of an accident. In general, for nuclear reactors and high-level waste facilities, the NRC Commissioners have established an accident probability of one in a million. This risk calculation involving an air crash must include the loss of aircraft fuel. An air crash and combustion of jet fuel implies the facility will be exposed to the external environment, safety systems will be disabled and Co-60 will be released to the external environment. The possibility of such an accident and its consequences are not discussed in the application. Information regarding the location of the proposed licensee's facilities and details of the surrounding area has similarly been redacted. Under the National Environmental Policy Act, an agency must prepare at least an environmental assessment to analyze any potentially significant harm, without regard to a threshold risk level.

25. **Transportation.** Transportation of Co-60 pencils to the proposed facility has not been discussed in the application. Co-60 will either arrive by plane or boat. The cask itself may weigh 3 to 6.5 tons, but this part of the application is missing. The specific casks that will be employed are not discussed in the application. Unlike nuclear reactors where the details of the fuel cycle – production of nuclear fuel (the environmental impact of uranium mining and milling, enrichment and conversion) and the environmental impact of waste disposal – must be listed, as Table S-3, and the impact of transportation, listed as Table S-4, no such details are included in the application. In particular, if the shipping cask is transported by plane, the impact of an air crash must be assessed. The transportation cask is likely designed to withstand a 30 foot drop. Obviously planes fly higher than 30 feet. If the cask is transported by ship, a discussion of the modal transfers and the likely exposure to workers, inspectors and the public must be evaluated If the sources arrive by ship, they must be transported by truck through residential communities.

26. **Redacted application.** The application has a great deal of material redacted, presumably for either proprietary or security reasons. But the bases for redactions have not been spelled out. In my 30 years experience with NRC license applications and documents, NRC staff require signed affidavits attesting to the basis for a redaction, usually proprietary or security materials. Here the staff have accepted the application with redactions. The effect is that the public and affected parties are not able fully to evaluate the environmental impacts and determine how their interests may be affected.

27. **Loss of electricity.** Contrary to 10 C.F.R. § 36.53(b)(6), the licensee has no emergency procedures for accidents involving a prolonged loss of electricity. Without clear measures for recovering from a prolonged loss of electricity, the safety of neighboring members of the public cannot be assured. The licensee does not appear to have an emergency electric generator in case of an extended power failure.

28. Moreover, the license application does not analyze the range of accidents that would arise from a loss of electricity. While the application does discuss the possibility of the loss of electricity supply in terms of overheating of sources, other credible accidents are not considered. For instance, movement of product near the plenum containing Co-60 sources occurs under bells inserted under water; the bottom of the bell is open, but water cannot enter due to a compressed helium supply. In the event that power is lost while a bell is underwater, the product could become water-logged and distribute itself within the pool, thereby clogging the filters and the water circulation system. In the changeover to new filters, Co-60 could bypass the containment system and be released as wastewater. The applicant does not discuss this potential accident, or any procedures for recovering from this loss of electricity accident in which product floats in the pool.

29. Moreover, in discussing the possibility of the loss of electricity supply in terms of overheating of sources, the application fails to provide specific information regarding the heat rate and the number of hours till the source cladding degrades. The application should contain detailed information on how rapidly the sources will heat up and the consequences of overheating. This information is needed to know how long the electricity may remain off before a serious accident ensues. In the event of overheating,

the cladding around the sources could fail, contaminating the air and overloading the HEPA filters. Co-60 could be released to the external environment.

30. **Damaged helium line.** Contrary to 10 C.F.R. § 36.53, the licensee has no emergency procedures for accidents involving a break in the compressed helium line. This would allow water to enter the bells, and degrade the product.

31. **Transportation accidents: safety and environmental impact.** Cobalt-60 sources, in transit from Canada or Russia to the Pa'ina Hawaii plant, would not be well-protected from a terrorist attack. The NRC does not require armed escorts for Co-60 sources. Yet, potential saboteurs have significant fire power at their disposal. The TOW2 and MILAN anti-tank missiles have a range of one km and can penetrate one meter of steel, far more steel and lead than the walls of a shipping cask. The newer Russian Koronet missile, used by former Iraqi armed forces, can penetrate 1.2 meters of steel and can be aimed precisely at a distance up to 5 km. These weapons have the ability to penetrate a shipping cask and disperse its contents. NUREG-0170, the document that potential NRC licensees cite in supporting its safety assurances, is silent on these safety and security issues.

32. A Cobalt-60 cask shipment, attacked within a city, could cause major environmental pollution and cancer fatalities. Local residents would clearly have a greater risk than other persons. While shipments could leave Canada or Europe by a number of routes, once they get close to the facility, the route options are decidedly limited. Such an accident would subject the airport passengers and workers and residents of neighboring communities to irreparable harm. In addition to adverse health effects caused by contamination, such an accident would have significant economic impacts.

Based on an analysis done by us for the State of Nevada, it is reasonable to estimate that the decontamination of an accident involving a spill of 200,000 curies of Cobalt-60 costs could easily exceed $1 billion.

33. The environmental impact of shipping Co-60 sources has not been seriously investigated by the applicant, nor the NRC, and is a major deficiency of the application. The application is silent on transportation aspects.

34. **Liability Insurance.** The applicant has offered the minimum $113,000 financial assurance for decommissioning, but this would clearly be inadequate if a major accident were to occur. Nuclear reactors are insured for billions of dollars under Price-Anderson, but Pa'ina Hawaii does not appear to be insured for credible accidents.

35. If the Petitioner's concerns are admitted for litigation, I would testify regarding my opinion in support of their conclusions. The technical facts and analyses described in paragraphs numbers 11 through 34 provide an abstract of the testimony I would give, based on the information that has been furnished to date. I would expect to be able to expand upon and refine my testimony, after having an opportunity to review materials produced by Pa'ina Hawaii and the NRC Staff.

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

New York, New York
Executed at ~~Cambridge, Massachusetts~~ on this 30th day of September, 2005.

Dr. Marvin Resnikoff, Senior Associate
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Resume of Marvin Resnikoff, Ph.D.

Dr. Marvin Resnikoff is Senior Associate at Radioactive Waste Management Associates and is an international consultant on radioactive waste management issues. He is Principal Manager at Associates and is Project Director for dose reconstruction and risk assessment studies of radioactive waste facilities and transportation of radioactive materials. Dr. Resnikoff has concentrated exclusively on radioactive waste issues since 1974. He has conducted studies on the remediation and closure of the leaking Maxey Flats, Kentucky radioactive landfill for Maxey Flats Concerned Citizens, Inc. and of the leaking uranium basin on the NMI/Starmet site in Concord, Massachusetts under grants from the Environmental Protection Agency. He also conducted studies of the Wayne and Maywood, New Jersey thorium Superfund sites and proposed low-level radioactive waste facilities at Martinsville (Illinois), Boyd County (Nebraska), Wake County (North Carolina), Ward Valley (California) and Hudspeth County (Texas). He investigated phosphogypsum plants in Florida, Texas and Alberta, Canada, and served as an expert witness in a personal injury case involving a Texas phosphogypsum worker. He has also served as an expert witness for CRPE, a public interest groups, regarding the proposed expansion of the Buttonwillow, California NORM landfill. He has conducted several studies of transportation accident risks and probabilities for the State of Nevada and several counties in Nevada (Lander, Churchill, Clark) and California (Inyo) and dose reconstruction studies of oil pipe cleaners in Mississippi and Louisiana, residents of Canon City, Colorado near a former uranium mill, residents of West Chicago, Illinois near a former thorium processing plant, and residents and former workers at a thorium processing facility in Maywood, New Jersey. In West Chicago he calculated exposures and risks due to thorium contamination and served as an expert witness for plaintiffs A Muzzey, S Bryan, D Schroeder and assisted counsel for plaintiffs KL West and KA West. He is presently serving as an expert witness for plaintiffs in Karnes County, Texas, Milan, NM and Uravan, CO, who were exposed to radioactivity from uranium mining and milling activities and for former workers and residents at the ITCO oil pipe cleaning yard in Louisiana. He also evaluated radiation exposures and risks in worker compensation cases involving G Boeni and M Talitsch, former workers at Maywood Chemical Works thorium processing plant. He served as an expert witness for a public interest group in the licensing of a food irradiator in Milford Township, Pennsylvania. In June 2000, he was appointed to a Blue Ribbon Panel on Alternatives to Incineration by DOE Secretary Bill Richardson.

In March 2004, Dr. Resnikoff was project director and co-author of a study of groundwater contamination at DOE facilities, *Danger Lurks Below.* He also authored or co-authored books on transporting radioactive fuel (*The Next Nuclear Gamble*) for the Council on Economic Priorities, and on DOE facilities (*Deadly Defense*) and low-level waste facilities (*Living Without Landfills*) for the Radioactive Waste Campaign.

In February 1976, assisted by four engineering students at State University of New York at Buffalo, Dr. Resnikoff authored a paper that, according to *Science*, changed the direction of power reactor decommissioning in the United States. His paper showed that power reactors could not be entombed for long enough periods to allow the radioactivity to decay to safe enough levels for unrestricted release. The presence of long-lived radionuclides meant that large volumes of decommissioning waste would still have to go to low-level or high-level waste disposal facilities. He assisted public interest groups on the decommissioning of the Yankee-Rowe, Diablo Canyon,

EXHIBIT D

Big Rock Point and Haddam Neck reactors. He served as an expert witness for the Town of Wiscasset, Maine, on a case involving property assessment of a dry storage facility.

Under a contract with the State of Utah, Dr. Resnikoff is a technical consultant to DEQ on the proposed dry cask storage facility for high-level waste at Skull Valley, Utah and proposed storage/transportation casks. He is assisting the State on licensing proceedings before the Nuclear Regulatory Commission. In addition, at hearings before state commissions and in federal court, he has investigated proposed dry storage facilities at the Point Beach (WI), Prairie Island (MN), Palisades (MI) and Maine Yankee reactors. He has also prepared studies on transportation risks and consequences for the State of Nevada and Clark and White Pine Counties.

In Canada, he conducted studies on behalf of the Coalition of Environmental Groups and Northwatch for hearings before the Ontario Environmental Assessment Board on issues involving radioactive waste in the nuclear fuel cycle and Elliot Lake tailings and the Interchurch Uranium Coalition in Environmental Impact Statement hearings before a Federal panel regarding the environmental impact of uranium mining in Northern Saskatchewan. He also worked on behalf of the Morningside Heights Consortium regarding radium-contaminated soil in Malvern and on behalf of Northwatch regarding decommissioning the Elliot Lake tailings area before a FEARO panel. He conducted a study for Concerned Citizens of Manitoba regarding transportation of irradiated fuel to a Canadian high-level waste repository.

He was formerly Research Director of the Radioactive Waste Campaign, a public interest organization conducting research and public education on the radioactive waste issue. His duties with the Campaign included directing the research program on low-level commercial and military waste and irradiated nuclear fuel transportation, writing articles, fact sheets and reports, formulating policy and networking with numerous environmental and public interest organizations and the media. He is author of the Campaign's book on "low-level" waste, *Living Without Landfills,* and co-author of the Campaign's book, *Deadly Defense, A Citizen Guide to Military Landfills.*

Between 1981 and 1983, Dr. Resnikoff was a Project Director at the Council on Economic Priorities, a New York-based non-profit research organization, where he authored the 390-page study, *The Next Nuclear Gamble, Transportation and Storage of Nuclear Waste.* The CEP study details the hazard of transporting irradiated nuclear fuel and outlines safer options.

Dr. Resnikoff is an international expert in nuclear waste management, and has testified often before State Legislatures and the U.S. Congress. He has extensively investigated the safety of the West Valley, New York and Barnwell, South Carolina nuclear fuel reprocessing facilities. His paper on reprocessing economics (Environment, July/August, 1975) was the first to show the marginal economics of recycling plutonium. He completed a more detailed study on the same subject for the Environmental Protection Agency, "Cost/Benefits of U/Pu Recycle," in 1983. His paper on decommissioning nuclear reactors (Environment, December, 1976) was the first to show that reactors would remain radioactive for hundreds of thousands of years. In January 2004, a book on groundwater contamination at DOE facilities he investigated will be released by ANA, a consortium of public interest groups residing near DOE facilities.

Dr. Resnikoff has prepared reports on incineration of radioactive materials, transportation of irradiated fuel and plutonium, reprocessing, and management of low-level radioactive waste. He has served as an expert witness in state and federal court cases and agency proceedings. He has served as a consultant to the State of Kansas on low-level waste management, to the Town of Wayne, New Jersey, in reviewing the cleanup of a local thorium waste dump, to WARD on disposal of radium wastes in Vernon, New Jersey, to the Southwest Research and Information Center and New Mexico Attorney General on shipments of plutonium-contaminated waste to the WIPP facility in New Mexico and the State of Utah on nuclear fuel transport. He has served as a consultant to the New York Attorney General on air shipments of plutonium through New York's Kennedy Airport, and transport of irradiated fuel through New York City, and to the Illinois Attorney General on the expansion of the spent fuel pools at the Morris Operation and the Zion reactor, to the Idaho Attorney General on the transportation of irradiated submarine fuel to the INEL facility in Idaho and to the Alaska Attorney General on shipments of plutonium through Alaska. He was an invited speaker at the 1976 Canadian meeting of the American Nuclear Society to discuss the risk of transporting plutonium by air. As part of an international team of experts for the State of Lower Saxony, the Gorleben International Review, he reviewed the plans of the nuclear industry to locate a reprocessing and waste disposal operation at Gorleben, West Germany. He presented evidence at the Sizewell B Inquiry on behalf of the Town and Country Planning Association (England) on transporting nuclear fuel through London. In July and August 1989, he was an invited guest of Japanese public interest groups, Fishermen's Cooperatives and the Japanese Congress Against A- and H- Bombs (Gensuikin).

Between 1974 and 1981, he was a lecturer at Rachel Carson College, an undergraduate environmental studies division of the State University of New York at Buffalo, where he taught energy and environmental courses. The years 1975-1977 he also worked for the New York Public Interest Group (NYPIRG).

In 1973, Dr. Resnikoff was a Fulbright lecturer in particle physics at the Universidad de Chile in Santiago, Chile. From 1967 to 1973, he was an Assistant Professor of Physics at the State University of New York at Buffalo. He has written numerous papers in particle physics, under grants from the National Science Foundation. He is a 1965 graduate of the University of Michigan with a Doctor of Philosophy in Theoretical Physics, specializing in group theory and particle physics.

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EXPERIENCE:

April 1989 - present **Senior Associate**, Radioactive Waste Management Associates, management of consulting firm focused on radioactive waste issues, evaluation of nuclear transportation and military and commercial radioactive waste disposal facilities.

1978 - 1981; 1983 - April 1989 **Research Director**, Radioactive Waste Campaign, directed research program for Campaign, including research for all fact sheets and the two books, *Living Without Landfills*, and *Deadly Defense*. The fact sheets dealt with low-level radioactive waste landfills, incineration of radioactive waste, transportation of high-level waste and decommissioning of nuclear reactors. Responsible for fund-raising, budget preparation and project management.

1981 - 1983 **Project Director**, Council on Economic Priorities, directed project which produced the report *The Next Nuclear Gamble*, on transportation and storage of high-level waste.

1974 - 1981 **Instructor**, Rachel Carson College, State University of New York at Buffalo, taught classes on energy and the environment, and conducted research into the economics of recycling of plutonium from irradiated fuel under a grant from the Environmental Protection Agency.

1975 - 1976 **Project Coordinator**, SUNY at Buffalo, New York Public Interest Research Group, assisted students on research projects, including project on waste from decommissioning nuclear reactor.

1973 **Fulbright Fellowship** at the Universidad de Chile, conducting research in elementary particle physics.

1967 - 1972 **Assistant Professor of Physics**, SUNY at Buffalo, conducted research in elementary particle physics and taught range of graduate and undergraduate physics courses.

1965 - 1967 **Research Associate**, Department of Physics, University of Maryland, conducted research into elementary particle physics.

EDUCATION

University of Michigan	PhD in Physics, June 1965
Ann Arbor, Michigan	M.S. in Physics, Jan 1962
	B.A. in Physics/Math, June 1959

From *Science* magazine.

Isotopes the Nuclear Industry Overlooked

The problem of what to do with worn-out nuclear power plants has taken on an important new dimension in the past few years, as evidence has come to light that some reactor components may remain radioactive for thousands of years after a plant is shut down. The conventional wisdom had previously been that radiation levels would decline to insignificance after several decades.

The culprits are very long lived isotopes of nickel and niobium, which are formed as the result of bombardment by neutrons. The formation of these isotopes was overlooked by the nuclear industry until the late 1970, when the problem was brought to public attention largely as the result of work by undergraduate students.

Their discovery may have an important impact on regulations governing the decommissioning of nuclear plants. In particular, the Nuclear Regulatory Commission (NRC) may forbid utilities to entomb reactors in concrete and leave them in place-an option that was long considered the cheapest way of dealing with the problem. Instead, the NRC staff is considering requiring that reactors be dismantled relatively soon after they are shut down and that the radioactive waste be shipped to a disposal site (see accompanying story). Components containing the long-lived isotopes may even have to be consigned to a a geological repository when one is eventually established.

When a reactor is first shut down, the pressure vessel and other components close to the core are intensely radioactive, largely because of the presence of cobalt-60. This isotope is formed when atoms of cobalt, a constituent of most steels, are hit by neutrons from fission reactions in the reactor fuel. Because cobalt-60 has a half-life of 5.27 years, the radioactivity diminishes relatively quickly. After a century, the amount of cobalt-60 will have dropped by a factor of about one million.

Although it has always been known that isotopes of other elements would be formed by neutron bombardment, it was thought that they would be present in such tiny quantities that they would contribute negligible amounts of radioactivity. Thus, once the cobalt-60 had decayed, the reactor would be relatively harmless. In February 1976, however, Marvin Resnikoff, a physicist then on the staff of the New York Public Interest Research Group, went public with calculations indicating that nickel-59 may pose a long-term radiation problem.

Resnikoff says that he and four undergraduate students realized that nickel-59 may cause difficulties when they looked at data on the dismantling of the Elk River reactor, a small power plant in Minnesota that was shut down in 1968 after only 4 years of operation. Although only trace amounts of nickel-59 were present in Elk River components, Resnikoff calculated that significant quantities would be formed in a large power reactor during 30 years of operation.

Nickel-59 is potentially important because, although it contributes only a tiny fraction of the radiation inventory when a reactor is shut down, it has a half-life of about 80,000 years. It will therefore be around long after cobalt-60 has decayed to insignificance, giving off radiation well above permitted levels.

Resnikoff recalls that he was initially anxious about releasing his calculations because "they went against the whole mindset at the time." The nuclear industry was then saying that if a reactor is entombed for 180 years, it will cool down to a safe level, he pointed out. Nevertheless, he published a press release challenging the industry's plans. Resnikoff says that his calculations were vigorously attacked by the industry, but most studies since then have acknowledged the problem with nickel-59. "It is an example of what happens when you have thousands of engineers all moving in one direction, and a handful of outside critics takes a look at their work," Resnikoff claims.

A year later, a second long-lived isotope, niobium-94 was identified as a potential problem in irradiated reactor components. Again, the discovery came from researchers outside the nuclear industry.

Robert Pohl, a professor of physics at Cornell University, said that he decided, in the light of Resnikoff's findings, to see whether there are any hazardous activation products among trace elements in steel. An undergraduate student, John Stephens, looked through data on radioactive isotopes and flagged niobium-94 as a potential problem. It decays with a half-life of 20,300 years, emitting very energetic gamma rays. A literature search indicated that niobium is added to some steels to inhibit cracking, and that it is a trace constituent in stainless steel. Pohl and Stephens published their findings in *Nuclear Engineering and Design* in 1978.

"Nobody in the nuclear business knew of the problem at the time," says Pohl. It is now generally accepted, however. A 1980 report by Battelle Pacific Northwest Laboratories indicates, for example, that the decay of niobium-94 will dominate the radiation dose rate from irradiated steel about 70 years after a reactor is shut down.

An environmental impact statement on reactor decommissioning, published last year by the NRC, indicates that the dose rate from niobium-94 in reactor components will be about 17,000 rems per year if the reactor is operated for 30 to 40 years. That from nickel-59 will be about 800 rems per year. "These dose levels are substantially above acceptable residual radioactivity levels," the statement notes. Entombing a disused reactor in concrete would thus be acceptable only if the long-lived isotopes were removed or if the integrity of the entombing structure could be maintained for thousands of years, the study concludes.

After the problems with nickel-59 and niobium-94 were discovered, the NRC commissioned a study to see whether any other potential activation products may cause trouble. "So far, we haven't identified any on the scale of those two," says Donald Calkins, NRC's manager of decommissioning programs.- Colin Norman.

EXHIBIT E

Public Interest Report

Journal of the Federation of American Scientists

Volume 55, Number 2 March/April 2002

Dirty Bombs: Response to a Threat

Henry Kelly testified before the Senate Foreign Relations Committee on March 6, 2002 on the threat of radiological attack by terrorist groups. This excerpt is taken from the text of his written testimony, based on analysis by Michael Levi, Robert Nelson, and Jaime Yassif, which can be found at www.fas.org.

Surely there is no more unsettling task than considering how to defend our nation against individuals and groups seeking to advance their aims by killing and injuring innocent people. But recent events make it necessary to take almost inconceivably evil acts seriously. Our analysis of this threat has reached three principle conclusions:

1. Radiological attacks constitute a credible threat. Radioactive materials that could be used for such attacks are stored in thousands of facilities around the US, many of which may not be adequately protected against theft by determined terrorists. Some of this material could be easily dispersed in urban areas by using conventional explosives or by other methods.

Continued on page 6

In This Issue

1 Dirty Bombs: Response to a Threat

1 Making Sense of Information Restrictions After September 11

3 The "War on Terror" and the "War on Drugs": A Comparison

9 Results of the FAS Member Survey

11 FAS Staff News

Making Sense of Information Restrictions After September 11

By Steven Aftergood and Henry Kelly

The Bush Administration introduced a series of new restrictions on public access to government information following the terrorist attacks of last year. Under the new policy, agencies have removed thousands of pages from government web sites and withdrawn thousands of government documents and technical reports from public libraries. In one case, government depository libraries around the country were ordered to destroy their copies of a recently issued USGS CD-ROM on US water resources.

The new restrictions have alarmed scientists, public interest groups, and concerned citizens because they interfere with the conduct of research and limit legitimate access to information needed for public discussion of key policy issues. Continued growth of restrictions without any clear end in sight creates understandable concern that we are watching a veil of indiscriminate security descending on significant portions of the American policy process.

Without debating the merits of any particular case, it is clear that the new information restrictions have been undertaken in a largely ad hoc fashion. While the unprecedented emergency required quick action in the short term, the inconsistent and often arbitrary policies that have emerged are clearly not satisfactory over the long term. While terrorist threats require reshaping some standards, they do not call for wholesale abandonment of existing processes and safeguards. Few of the issues raised are new. The challenge of drawing a line between what should be protected and what should not has been the subject of years of debate that has

Continued on page 2

EXHIBIT E

The FAS Public Interest Report

The FAS Public Interest Report (USPS 188-100) is published bi-monthly at 1717 K St. NW Suite 209, Washington, DC 20036. Annual subscription is $50/year.

Archived FAS Public Interest Reports are available online at www.fas.org or phone (202) 546-3300, fax (202) 675-1010, or email fas@fas.org.

"Dirty Bombs" Continued from page 1

2. While radiological attacks would result in some deaths, they would not result in the hundreds of thousands of fatalities that could be caused by a crude nuclear weapon. Attacks could contaminate large urban areas with radiation levels that exceed EPA health and toxic material guidelines.
3. Materials that could easily be lost or stolen from US research institutions and commercial sites could contaminate tens of city blocks at a level that would require prompt evacuation and create terror in large communities even if radiation casualties were low. Areas as large as tens of square miles could be contaminated at levels that exceed recommended civilian exposure limits. Since there are often no effective ways to decontaminate buildings that have been exposed at these levels, demolition may be the only practical solution. If such an event were to take place in a city like New York, it would result in losses of potentially trillions of dollars.

Background

Significant amounts of radioactive materials are stored in laboratories, food irradiation plants, oil drilling facilities, medical centers, and many other sites. Cobalt-60 and cesium-137 are used in food disinfection, medical equipment sterilization, and cancer treatments. During the 1960s and 1970s the federal government encouraged the use of plutonium in university facilities studying nuclear engineering and nuclear physics. Americium is used in smoke detectors and in devices that find oil sources.

With the exception of nuclear power reactors, commercial facilities do not have the types or volumes of materials usable for making nuclear weapons. Facility owners provide adequate security when they have a vested interest in protecting commercially valuable material. However, once radioactive materials are no longer needed and costs of appropriate disposal are high, security measures become lax, and the likelihood of abandonment or theft increases.

We must wrestle with the possibility that sophisticated terrorist groups may be interested in obtaining these materials and with the enormous danger to society that such thefts might present. Significant quantities of radioactive material have been lost or stolen from US facilities during the past few years and thefts of foreign sources have led to fatalities. In the US, sources have been found abandoned in scrap yards, vehicles, and residential buildings.

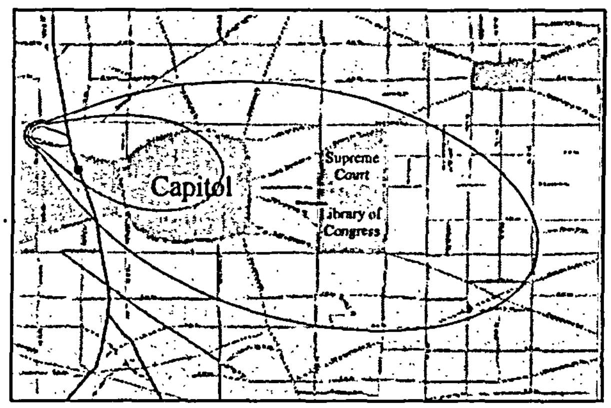

Figure 1. Long-term Contamination Due to Cesium Bomb in Washington, DC
Inner Ring: One cancer death per 100 people due to remaining radiation
Middle Ring: One cancer death per 1,000 people due to remaining radiation
Outer Ring: One cancer death per 10,000 people due to remaining radiation; EPA recommends decontamination or destruction

If these materials were dispersed in an urban area, they would pose a serious health hazard. Intense sources of gamma rays can cause acute radiation poisoning, or even fatalities at high doses. Long-term exposure to low levels of gamma rays can cause cancer. If alpha emitters, such as plutonium, americium or other elements, are present in the environment in particles small enough to be inhaled, these particles can become lodged in the lungs and damage tissue, leading to long-term cancers.

Case Studies

We have chosen three specific cases to illustrate the range of impacts that could be created by malicious use of comparatively small radioactive sources: the amount of cesium that was discovered recently abandoned in North Carolina, the amount of cobalt commonly found in a single rod in a food irradiation facility, and the amount of americium typically found in oil well logging systems. The impact would be much greater if the radiological device in question released the enormous amounts of radioactive material found in a single nuclear reactor fuel rod, but it would be quite difficult and dangerous for anyone to attempt to obtain and ship such a rod without death or detection. The Committee will undoubtedly agree that the danger presented by modest radiological sources that are comparatively easy to obtain is significant as well.

The impact of radioactive material release in a populated area would vary depending on a number of factors, such as the amount of material released, the nature of the material, the details of the device that distributes the material, the direction and speed of the wind, other weather conditions, the size of the particles released (which affects their ability to be carried by the wind and to be inhaled), and the location and size of buildings near the release site. Uncertainties inherent in the complex models used in predicting the effects of a radiological weapon mean that it is only possible to make crude estimates of impacts; the estimated damage we show might be off by an order of magnitude.

In all three cases we have assumed that the material is released on a calm day (wind speed of one mile per hour) and that the material is distributed by an explosion that causes a mist of fine particles to spread downwind in a cloud. People will be exposed to radiation in several ways.

- They will be exposed to material in the dust inhaled during the initial passage of the radiation cloud, if they have not been able to escape the area before the dust

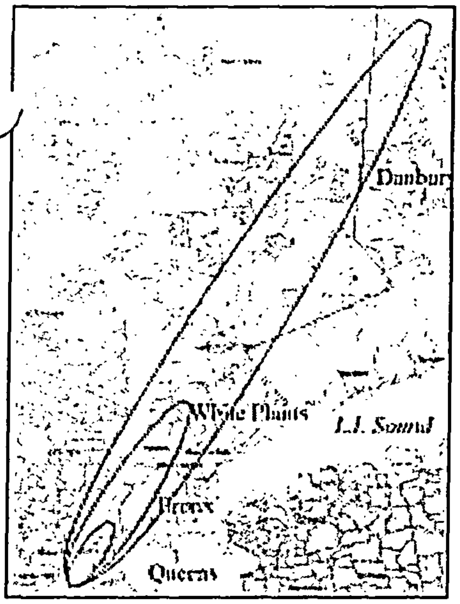

Figure 2. Long-term Contamination Due to Cobalt Bomb in NYC - EPA Standards

Inner Ring: One cancer death per 100 people due to remaining radiation

Middle Ring: One cancer death per 1,000 people due to remaining radiation

Outer Ring: One cancer death per 10,000 people due to remaining radiation; EPA recommends decontamination or destruction

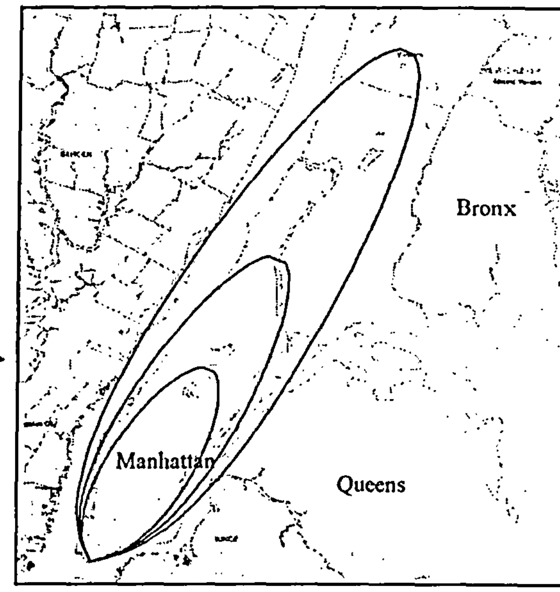

Figure 3. Contamination Due to Cobalt Bomb in NYC - Chernobyl Comparison

Inner Ring: Same radiation level as *permanently closed zone* around Chernobyl

Middle Ring: Same radiation level as *permanently controlled zone* around Chernobyl

Outer Ring: Same radiation level as *periodically controlled zone* around Chernobyl

cloud arrives. We assume that about twenty percent of the material is in particles small enough to be inhaled. If this material is an alpha emitter, it will stay in the body and lead to long term exposure.

- Anyone living in the affected area will be exposed to material deposited from the dust that settles from the cloud. If the material contains gamma emitters, residents will be continuously exposed to radiation from this dust. If the material contains alpha emitters, dust that is pulled off the ground and into the air by wind, automobile movement, or other actions will continue to be inhaled, adding to exposure.
- In a rural area, people would also be exposed to radiation from contaminated food and water sources.

The EPA has a series of recommendations for addressing radioactive contamination that would likely guide official response to a radiological attack. Immediately after the attack, authorities would evacuate people from areas contaminated to levels exceeding those guidelines. People who received more than twenty-five times the threshold dose for evacuation would have to be taken in for medical supervision.

In the long term, the cancer hazard from the remaining radioactive contamination would have to be addressed. Typically, if decontamination could not reduce the danger of cancer death to about one-in-ten-thousand, the EPA would recommend the contaminated area be eventually abandoned. Several materials that might be used in a radiological attack can chemically bind to concrete and asphalt, while other materials would become physically lodged in crevices on the surface of buildings, sidewalks and streets. Options for decontamination would range from sandblasting to demolition, with the latter likely being the only feasible option. Some radiological materials would also chemically bind to soil in city parks, with the only disposal method being large scale removal of contaminated dirt. In short, there is a high risk that the area contaminated by a radiological attack would have to be deserted.

Example 1: Cesium (Gamma Emitter)

Two weeks ago, a lost medical gauge containing cesium was discovered in North Carolina. Imagine that the cesium in this device was exploded in Washington, DC in a bomb using ten pounds of TNT. The initial passing of the radioactive cloud would be relatively harmless, and no one would have to evacuate immediately. However, residents of an area of about five city blocks, if they remained, would have a one-in-a-thousand chance of getting cancer. A swath about one mile long covering an area of forty city blocks would exceed EPA contamination limits, with remaining residents having a one-in-ten thousand chance of getting cancer. If decontamination were not possible, these areas would have to be abandoned for decades. If the device was detonated at the National Gallery of Art, the contaminated area might include the Capitol, Supreme Court, and Library of Congress, as seen if Figure 1.

Example 2: Cobalt (Gamma Emitter)

Now imagine if a single piece of radioactive cobalt from a food irradiation plant were dispersed by an explosion at the lower tip of Manhattan. Typically, each of these cobalt "pencils" is about one inch in diameter and one foot long, with hundreds of such pieces often being found in the same facility. Admittedly, acquisition of such material is less likely than in the previous scenario, but we still consider the results, depicted in Figure 2. Again, no immediate evacuation would be necessary, but in this case, 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.

Continued on page 8

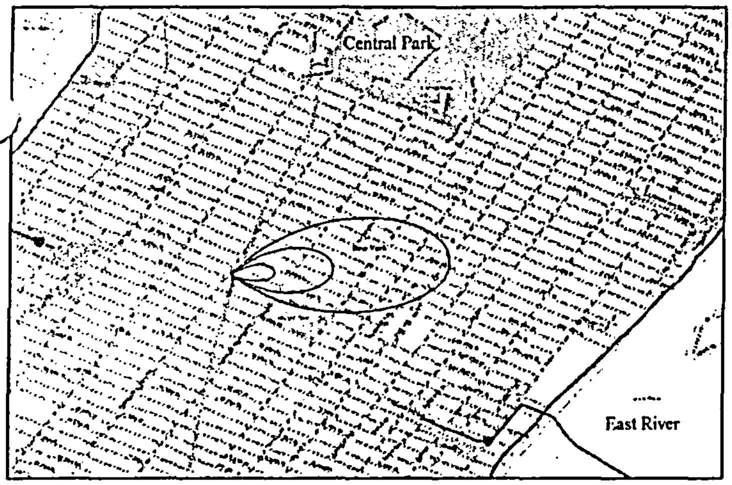

Figure 4. Immediate Effects Due to Americium Bomb in New York City
Inner Ring: Everyone must receive medical supervision
Middle Ring: Maximum annual dose for radiation workers exceeded
Outer Ring: Area should be evacuated before radiation cloud passes

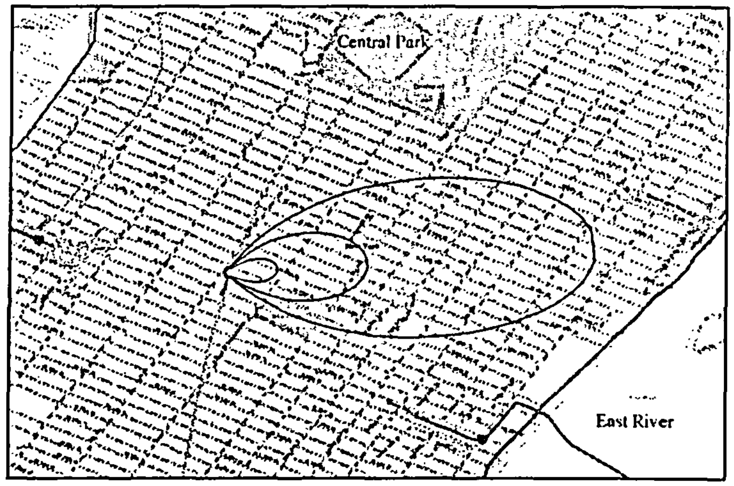

Figure 5. Contamination Due to Americium Bomb in New York City.
Inner Ring: One cancer death per 100 people due to remaining radiation
Middle Ring: One cancer death per 1,000 people due to remaining radiation
Outer Ring: One cancer death per 10,000 people due to remaining radiation; EPA recommends decontamination or destruction

"Dirty Bombs" *Continued from page 7*

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.

For comparison, consider the 1986 Chernobyl disaster, in which a Soviet nuclear power plant went through a meltdown. Radiation was spread over a vast area, and the region surrounding the plant was permanently closed. In our current example, the area contaminated to the same level of radiation as that region would cover much of Manhattan, as shown in Figure 3. Furthermore, near Chernobyl, a larger area has been subject to periodic controls on human use such as restrictions on food, clothing, and time spent outdoors. In the current example, the equivalent area extends fifteen miles.

Example 3: Americium (Alpha Emitter)

If a typical americium source used in oil well surveying were blown up with one pound of TNT, people in a region roughly ten times the area of the initial bomb blast would require medical supervision and monitoring, as depicted in Figure 4. An area thirty times the size of the first area (a swath one kilometer long and covering twenty city blocks) would have to be evacuated within half an hour. After the initial passage of the cloud, most of the radioactive materials would settle to the ground. Of these materials, some would be forced back up into the air and inhaled, thus posing a long-term health hazard, as illustrated by Figure 5. A ten-block area contaminated in this way would have a cancer death probability of one-in-a-thousand. A region two kilometers long and covering sixty city blocks would be contaminated in excess of EPA safety guidelines. If the buildings in this area had to be demolished and rebuilt, the cost would exceed fifty billion dollars.

Recommendations

A number of practical steps can be taken that would greatly reduce the risks presented by radiological weapons. Since the US is not alone in its concern about radiological attack, and since we clearly benefit by limiting access to dangerous materials anywhere in the world, many of the measures recommended should be undertaken as international collaborations.

1. Reduce access to radioactive materials

Measures needed to improve the security of facilities holding dangerous amounts of these materials will increase costs. In some cases, it may be worthwhile to pay a higher price for increased security. In other instances, however, the development of alternative technologies may be the more economically viable option. Specific security steps include the following:

Fully fund material recovery and storage programs. Hundreds of plutonium, americium, and other radioactive sources are stored in dangerously large quantities in university laboratories and other facilities. In all too many cases they are not used frequently, resulting in the risk that attention to their security will diminish over time. At the same time, it is difficult for the custodians of these materials to dispose of them since in many cases only the Department of Energy (DoE) is authorized to recover and transport them to permanent disposal sites. The DoE Off-Site Source Recovery Project, which is responsible for undertaking this task, has successfully secured over three-thousand sources and has moved them to a safe location. Unfortunately, the inadequate funding of this program serves as a serious impediment to further source recovery efforts. This program should be given the needed attention and firm goals should be set for identifying, transporting, and safeguarding all unneeded radioactive materials.

Review licensing and security requirements and inspection procedures for all dangerous amounts of radioactive material. Human Health Services, the DoE, the Nuclear Regulatory Commission and other affected agencies should be provided with sufficient funding to ensure that physical protection measures are adequate and that inspections are conducted on a regular basis. A thorough reevaluation of security regulations should be conducted to ensure that protective measures apply to amounts of radioactive material that pose a homeland security threat, not just those that present a threat of accidental exposure.

Fund research aimed at finding alternatives to radioactive materials. A research program aimed at developing inexpensive substitutes for radioactive materials in functions such as food sterilization, smoke detection, and oil well logging should be created and provided with adequate funding.

2. Early Detection

Expanded use of radiation detection systems. Systems capable of detecting dangerous amounts of radiation are comparatively inexpensive and unobtrusive. The Office of Homeland Security should act promptly to identify all areas where such sensors should be installed, ensure that information from these sensors is continuously assessed, and ensure adequate maintenance and testing. High priority should be given to key points in the transportation system, such as airports, harbors, rail stations, tunnels, highways. Routine checks of scrap metal yards and land fill sites would also protect against illegal or accidental disposal of dangerous materials.

Fund research to improve detectors. A program should be put in place to find ways of improving upon existing detection technologies as well as improving plans for deployment of these systems and for responding to alarms.

3. Effective Disaster response

An effective response to a radiological attack requires a system capable of quickly gauging the extent of the damage, identifying appropriate responders, developing a coherent response plan, and getting the necessary personnel and equipment to the site rapidly.

First responders and hospital personnel need to understand how to protect themselves and affected citizens in the

Continued on page 10

FAS Conclusions

Radiological attacks constitute a credible threat. Radioactive materials that could be used for such attacks are stored in thousands of facilities around the US, many of which may not be adequately protected against theft by determined terrorists. Some of this material could be easily dispersed in urban areas by using conventional explosives or by other methods.

Radiological attacks would not result in the hundreds of thousands of fatalities that could be caused by a crude nuclear weapon, though they could contaminate large urban areas.

Materials that could easily be lost or stolen could contaminate tens of city blocks at a level that would require prompt evacuation and create terror in large communities even if radiation casualties were low. But, since there are often no effective ways to decontaminate buildings that have been exposed at these levels, demolition may be the only practical solution.

FAS Recommendations

Reduce access to radioactive materials

1. Fully fund material recovery and storage programs.
2. Review licensing and security requirements and inspection procedures for all dangerous amounts of radioactive material.
3. Fund research aimed at finding alternatives to radioactive materials.

Early Detection

1. Expanded use of radiation detection systems.
2. Fund research to improve detectors.

Effective Disaster response

1. First responders and hospital personnel need to understand how to protect themselves and affected citizens.
2. Research into cleanup of radiologically contaminated cities.

Just In! Results of the FAS Member Survey

In early 2002, FAS conducted a survey of our members. Our purpose was to better understand member interests, document expertise, and engage members in helping affirm old priorities and set new ones.

The survey's results profile a highly educated membership with in-depth expertise in such sciences as physics, biology, and chemistry, and who work either full-time in these fields or are retired from positions in academic institutions. FAS members share the concerns of civil rights, environmental, and human rights organizations, and are active supporters of Environmental Defense, the Natural Resources Defense Council, the ACLU, People for the American Way, and Human Rights Watch. The largest percentage of our members joined FAS in the 1970s. When asked how members came to join FAS, 60% said that they had "known about FAS forever." While half of FAS' responding members are over 70 years of age, a growing number of individuals under the age of 50 are joining up. We were pleased to learn that 68% of our members find the Public Interest Report "informative, timely and relevant;" 20% agreed that the PIR "is perfect as is;" and 19% would like us to cover more energy and environmental issues.

FAS' members are a group with mutual concerns, common backgrounds, and scientific interests. Their survery responses do differ, though. Let's take a closer look.

"My fields of expertise are..."

FAS was founded by physicists working on the Manhattan Project in 1945 and was known back then as the "scientists lobby" and the social conscience of the nation's scientists. When we asked members to identify the fields in which they worked, sciences such as physics, biology and engineering outnumbered the fields of foreign policy, economics, law and finance. Nearly 30% of survey respondents identified themselves as physicists. The

Continued on page 10

"Dirty Bombs" *Continued from page 9*

event of a radiological attack and be able to rapidly determine if individuals have been exposed to radiation. There is great danger that panic in the event of a radiological attack on a large city could lead to significant casualties and severely stress the medical system. While generous funding has been made available for this training, the program appears in need of a clear management strategy. Dozens of federal and state organizations are involved, and it is not clear how materials will be certified or accredited.

Research into cleanup of radiologically contaminated cities has been conducted in the past, primarily in addressing the possibility of nuclear war. Such programs should be revisited with an eye to the specific requirements of cleaning up after a radiological attack.

Conclusion

The events of September 11 have created a need to very carefully assess our defense needs and ensure that the resources we spend for security are aligned with the most pressing security threats. The US has indicated its willingness to spend hundreds of billions of dollars to combat threats that are, in our view, far less likely to occur than a radiological attack. This includes funding defensive measures that are far less likely to succeed than the measures that we propose in this testimony. The comparatively modest investments to reduce the danger of radiological attack surely deserve priority support.

In the end, however, we must face the brutal reality that no technological remedies can provide complete confidence that we are safe from radiological attack. Determined, malicious groups might still find a way to use radiological weapons or other means when their only goal is killing innocent people, and if they have no regard for their own lives. In the long run our greatest hope must lie in building a prosperous, free world where the conditions that breed such monsters have vanished from the earth. ***PIR***

"Survey" *Continued from page 9*

next largest fields represented were medicine (18%), biology (15%), engineering (15%) and chemistry (13%).

It is especially interesting to compare fields represented by FAS earliest members with more recent members. Nearly half of FAS members who joined before 1955 are physicists. FAS newest members, who joined since 2000, are also physicists (21%), but 29% said their field of expertise is national security, 25% said aerospace, and 22% said computer science. This reflects significant growth in security-related fields over the past decades—and an increasingly diverse membership. Other fields were environmental science, psychology, public policy, finance, law and transportation. Nearly half of responding members work in nonprofit or academic institutions as opposed to private industry (13%) or in government (8%).

> Based on survey results, [FAS] members' priorities are right on target with FAS' agenda.

"The highest level of education I have attained is..."

FAS continues to attract highly educated scholars and analysts, and the composition of members' level of education does not change as the fields of expertise do from one age group to another. Among all respondents, 63% have Ph.Ds. Individuals with professional doctoral degrees such as doctors or lawyers account for 14%. A master's degree is the highest level of education attained by 12%, and 7% have a bachelor's degree. Two percent of members are high school students or graduates. These two latter goups are our most recent members, having come to us through our website.

"Go to <www.fas.org>..."

In addition to giving access to technical information and policy analysis, the FAS website is our most effective member recruitment tool. Since 2000, 85% of FAS newest members joined over the web. More than half of these members also use the website once a month; more than a third use it every week. The survey also shows that among FAS' earliest members (members who joined between 1945 and 1970), 43% use the website once a month or less. For members who joined in the 1980s and 90s, we see a modest increase in members' use (46%). Only 7% of our members have no access to the Internet.

The feature of the website that FAS members use most often are the technical details about weapons technologies and arms control treaties, and the country-by-country weapons sales and possessions tables. Eighteen percent refer to the site for this information, while 15% use the site to keep up to date on FAS findings and projects. This does not capture the hundreds of thousands of hits that the website receives daily from non-member users. Surprisingly, one third of our members were not aware of the site at all.

"I subscribe to..."

The survey offered members a wide range of choices of journals and trade magazines, including Bulletin of Atomic Scientists, Foreign Affairs, Fortune, Time, Science, Scientific American, and US News and World Report. By far, the most subscribed to magazines were Science (48%) and Scientific American (36%). Subscribers to the Bulletin of Atomic Scientists and New Scientists each account for 21% of member respondents. While subscription to Science and Scientific American is steady among FAS members throughout the generations, only 6% of our most recent members subscribe to the Bulletin.

"I am also a member of..."

Our survey shows that FAS members live up to their reputation as scientists with a conscience. They support numerous causes, working to protect the world's environmental resources, eliminate weapons of mass

Aviation Accident Database & Synopses

The NTSB aviation accident database contains information from 1962 and later about civil aviation *accidents* and selected *incidents* within the United States, its territories and possessions, and in international waters. Generally, a **preliminary** report is available online within a few days of an accident. **Factual** information is added when available, and when the investigation is completed, the preliminary report is replaced with a **final** description of the accident and its probable cause. Full narrative descriptions may not be available for dates before 1993, cases under revision, or where NTSB did not have primary investigative responsibility.

The following information is available:

- Database Query - interactive search capability for the NTSB database, updated daily; see the general instructions before using the form for the first time.
- Monthly lists - accidents sorted by date, updated daily.
- Completed investigations - periodically updated list of cases scheduled for release of probable cause.
- Downloadable datasets - one complete dataset for each year beginning from 1982, updated monthly in Microsoft Access 95 MDB format; this FTP site also provides weekly "change" updates and complete documentation.
- GILS record - complete description of the accident database, including definition of "accident" and "incident".
- FAA incident database - complete information about incidents, including those not investigated by NTSB, is provided by the Federal Aviation Administration.
- Data & Information Products - lists other sources of information about aviation accidents, including publications, dockets, and press releases

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Hints and instructions are available for each field by clicking on the associated link.

Accident/Incident Information			
Date Range	01/01/1982 and 12/31/2004 *1962 - present*		
	(mm/dd/yyyy) *(mm/dd/yyyy)*		
City	Honolulu	Investigation Type	Accident
State	HAWAII	Injury Severity	All
Country	United States		

Aircraft			
Category	All	Amateur Built	All
Make/Model		Registration	

Operation			
Operation	All	Schedule	All
Airline			

Enter your word string below: (Searches both synopsis and full narrative; will slow the query performance)

EXHIBIT G

(see Search Tips)

NTSB Status			
Accident Number	Report Status	Probable Cause Issued between	
	All	and	
		(mm/dd/yyyy)	*(mm/dd/yyyy)*

Sort by: Date in Descending order. Show 10 records per page.

Submit Query Reset

NOTES:
- On Jan. 8, 2001, dynamic access to the accident data repository was implemented. Static files are no longer available.
- On Oct. 2, 2001, minor cases which do not fall under the definition of "accident" or "incident" were removed from the database; these entries were previously identified with "SA" in the NTSB number.
- On Sept. 18, 2002, data from 1962-1982 were added to the aviation accident information. The format and type of data contained in the earlier briefs may differ from later reports.

NTSB Home Page | Aviation Page | Switch to Monthly Lists

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Current Synopsis	PDF Report (s)	Event Date	Probable Cause Released	Location	Make / Model	Regist. Number	Event Severity	Type of Air Carrier Operation and Carrier Name (Doing Business As)
Probable Cause	Factual, Probable Cause	8/13/2004	10/28/2004	Honolulu, HI	Cessna 172S	N3554Y	Nonfatal	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	2/15/2004	4/28/2004	Honolulu, HI	Cessna 177A	N30599	Nonfatal	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	7/7/2002	9/29/2004	Honolulu, HI	Aerospatiale AS350 BA	N141MK	Nonfatal	NSCH Part 135: Air Taxi & Commuter
Probable Cause	Factual, Probable Cause	12/9/2001	10/24/2002	Honolulu, HI	Cessna 150K	N6136G	Nonfatal	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	2/5/2000	12/14/2001	HONOLULU, HI	Piper PA-28-161	N140ND	Nonfatal	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	11/7/1999	7/25/2002	HONOLULU, HI	McDonnell Douglas DC-10-30F	N602GC	Nonfatal	NSCH Part 121: Air Carrier GEMINI AIR CARGO
Probable Cause	Factual, Probable Cause	6/30/1999	8/14/2001	HONOLULU, HI	Cessna 150M	N63614	Nonfatal	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	8/7/1997	2/11/2000	HONOLULU, HI	Lockheed L-1011-385-1-15	N740DA	Nonfatal	SCHD Part 121: Air Carrier DELTA AIR LINES INC.
Factual	Factual	6/21/1997		HONOLULU, HI	McDonnell Douglas MD-11	EICDK	Nonfatal	SCHD Part 129: Foreign GARUDA INDONESIAN AIRWAYS PT
Probable Cause	Factual, Probable Cause	2/22/1997	12/31/1998	HONOLULU, HI	Beech H18	N7969K	Nonfatal	NSCH Part 135: Air Taxi & Commuter

1 of 5 Pages

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Probable Cause	Factual, Probable Cause	12/15/1996	3/31/1998	HONOLULU, HI	de Havilland DHC-8	N801WP	Nonfatal	SCHD Part 121: Air Carrier ALOHA ISLANDAIR INC. (D.B.A. ISLAND AIR)
Probable Cause	Factual, Probable Cause	7/8/1996	3/31/1998	HONOLULU, HI	Hughes 369D	N64MK	Nonfatal	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	7/8/1996	3/31/1998	HONOLULU, HI	Mooney M20J	N5801N	Nonfatal	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	12/30/1995	6/6/1996	HONOLULU, HI	ATR ATR 42-300	N4202G	Nonfatal	SCHD Part 121: Air Carrier MAHALO AIR
Probable Cause	Factual, Probable Cause	5/30/1995	3/21/1996	HONOLULU, HI	PIPER PA-28-151	N6243J	Fatal(3)	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	5/10/1995	11/6/1995	HONOLULU, HI	SCHWEIZER SGS 2-33A	N7768S	Nonfatal	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	3/16/1995	1/29/1996	HONOLULU, HI	de Havilland DHC-6-200	N37ST	Nonfatal	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	11/22/1994	10/13/1995	HONOLULU, HI	ROBINSON R-22B	N31MK	Nonfatal	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	11/4/1994	12/19/1995	HONOLULU, HI	PIPER PA-28-140	N3198Q	Fatal(2)	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	8/10/1993	7/18/1994	HONOLULU, HI	ROBINSON R-22 BETA	N4017J	Fatal(2)	Part 91: General Aviation

2 of 5 Pages

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Current Synopsis	PDF Report (s)	Event Date	Probable Cause Released	Location	Make / Model	Regist. Number	Event Severity	Type of Air Carrier Operation and Carrier Name (Doing Business As)
Probable Cause	Factual, Probable Cause	7/7/1993	9/15/1994	HONOLULU, HI	ROBINSON R22B	N501R	Fatal(1)	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	8/8/1992	5/3/1993	HONOLULU, HI	CESSNA 310M	N26070	Fatal(2)	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	7/31/1992	9/14/1993	HONOLULU, HI	HUGHES 369D	N64MK	Nonfatal	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	1/14/1992	7/2/1993	HONOLULU, HI	CESSNA 310Q	N787AM	Fatal(5)	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	10/3/1991	12/4/1992	HONOLULU, HI	ROBINSON R22B	N900AB	Nonfatal	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	3/30/1991	3/31/1993	HONOLULU, HI	HUGHES 269C	N8656F	Nonfatal	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	3/8/1991	3/31/1993	HONOLULU, HI	BELL 206B	N2072C	Nonfatal	NSCH Part 135: Air Taxi & Commuter
Probable Cause	Factual, Probable Cause	7/27/1989	8/22/1990	HONOLULU, HI	CESSNA 337H	N2AC	Nonfatal	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	2/24/1989	6/25/1990	HONOLULU, HI	BOEING 747-122	N4713U	Fatal(9)	SCHD Part 121: Air Carrier UNITED AIRLINES (D.B.A. UNITED AIRLINES,INC.)
Probable Cause	Factual, Probable Cause	2/8/1989	12/10/1990	HONOLULU, HI	CESSNA 150K	N6149G	Nonfatal	Part 91: General Aviation

3 of 5 Pages

FIRST PREVIOUS NEXT LAST

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Current Synopsis	PDF Report(s)	Event Date	Probable Cause Released	Location	Make / Model	Regist. Number	Event Severity	Type of Air Carrier Operation and Carrier Name (Doing Business As)
Probable Cause	Factual, Probable Cause	2/8/1989	12/10/1990	HONOLULU, HI	CESSNA 152	N88TE	Nonfatal	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	5/29/1988	7/10/1989	HONOLULU, HI	BELL 206B	N83203	Nonfatal	NSCH Part 135: Air Taxi & Commuter
Probable Cause	Factual, Probable Cause	3/17/1988	1/24/1990	HONOLULU, HI	BELL 206B	N2995W	Nonfatal	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	11/20/1987	5/26/1989	HONOLULU, HI	PIPER PA-31-350	N27512	Nonfatal	SCHD Part 135: Air Taxi & Commuter
Probable Cause	Factual, Probable Cause	11/17/1987	1/25/1989	HONOLULU, HI	CESSNA 150M	N2973V	Nonfatal	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	11/14/1987	1/11/1989	HONOLULU, HI	HUGHES 369D	N1113L	Nonfatal	Part 133: Rotorcraft Ext. Load
Probable Cause	Factual, Probable Cause	5/14/1987	4/24/1989	HONOLULU, HI	CESSNA 150M	N704QH	Nonfatal	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	4/10/1987	3/10/1988	HONOLULU, HI	NIHON YS-11A	N118MP	Nonfatal	SCHD Part 121: Air Carrier MID PACIFIC AIRLINES, INC.
Probable Cause	Factual, Probable Cause	2/8/1987	2/20/1989	HONOLULU, HI	HUGHES 369D	N1102U	Fatal(1)	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	11/6/1986		HONOLULU, HI	CESSNA 172N	N6184D	Nonfatal	Part 91: General Aviation

4 of 5 Pages

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Current Synopsis	PDF Report (s)	Event Date	Probable Cause Released	Location	Make / Model	Regist. Number	Event Severity	Type of Air Carrier Operation and Carrier Name (Doing Business As)
Probable Cause	Factual, Probable Cause	3/3/1986	1/25/1988	HONOLULU, HI	BOEING 747-122	N4729U	Nonfatal	SCHD Part 121: Air Carrier UNITED AIRLINES
Probable Cause	Factual, Probable Cause	12/11/1985		HONOLULU, HI	CESSNA 150K	N6347G	Nonfatal	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	1/21/1985		HONOLULU, HI	HUGHES 369E	N121JP	Nonfatal	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	11/16/1984		HONOLULU, HI	BOEING 747-122	N4714U	Nonfatal	SCHD Part 121: Air Carrier UNITED AIRLINES
Probable Cause	Factual, Probable Cause	7/17/1984		HONOLULU, HI	BEECH H18S	N21S	Nonfatal	NSCH Part 135: Air Taxi & Commuter
Probable Cause	Factual, Probable Cause	5/25/1984		HONOLULU, HI	HUGHES 369D	N211EH	Nonfatal	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	12/22/1983		HONOLULU, HI	de Havilland DHC 7-102	N929HA	Nonfatal	SCHD Part 121: Air Carrier HAWAIIAN AIRLINES, INC.
Probable Cause	Factual, Probable Cause	1/9/1983		NEAR HONOLULU, HI	PIPER PA-28-151	N32658	Nonfatal	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	11/16/1982	11/16/1983	HONOLULU, HI	PIPER PA-28-140	N56351	Nonfatal	Part 91: General Aviation
Probable Cause	Factual, Probable Cause	1/17/1982	1/17/1983	HONOLULU, HI	CONVAIR 440	N21DR	Nonfatal	SCHD Part 135: Air Taxi & Commuter

5 of 5 Pages

FIRST PREVIOUS

Return to Query Page | Index of Months
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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE SECRETARY

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

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

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[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

[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

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[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

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[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.

G. R. Thompson

GORDON R. THOMPSON

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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 DAVID L. HENKIN

I, David L. Henkin, declare:

1. I am an attorney at law, duly licensed to practice before all courts of the State of Hawai'i, the U.S. District Court for the District of Hawai'i, the U.S. Court of Appeals for the 9th Circuit, and the U.S. Supreme Court. I am the lead attorney for petitioner Concerned Citizens of Honolulu.

2. I make this declaration in support of Concerned Citizens' Request for Hearing. This declaration is based on my personal knowledge, and I am competent to testify about the matters contained herein.

3. Attached hereto as Exhibit "H" is a true and correct copy of an April 13, 2005 press release from the National Nuclear Security Administration entitled "NNSA Removes Radioactive Sources From University Facility."

4. Attached hereto as Exhibit "I" is a true and correct copy of "Tsunami Evacuation Oahu Map 19: Airport to Waikiki," prepared for the O'ahu Civil Defense Agency. This map is reproduced in the current Verizon telephone directory for O'ahu.

5. Attached hereto as Exhibit "J" is a true and correct copy of a January 11, 2005 article from the Honolulu Advertiser entitled "Hawai'i tsunami zone maps may be flawed." The article is available on the web at: http://the.honoluluadvertiser.com/article/2005/Jan/11/ln/ ln03p.html.

6. Attached hereto as Exhibit "K" is a true and correct copy of an article from the O'ahu Civil Defense Agency entitled "Hurricanes in Hawaii." It is available on the web at: http://www.honolulu.gov/ocda/hurr1.htm.

7. Attached hereto as Exhibit "L" is a true and correct copy of an April 15, 2005 article from the Honolulu Star-Bulletin, entitled "Radioactive material destroyed." The article is available on the web at: http://starbulletin.com/2005/04/15/news/index11.html.

8. Attached hereto as Exhibit "M" are excerpts from a true and correct copy of a fact sheet from the Centers for Disease Control entitled "Frequently Asked Questions about Food Irradiation." It is available on the web at: http://www.cdc.gov/ncidod/dbmd/diseaseinfo/ foodirradiation.htm.

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 Honolulu, Hawai'i, October 3, 2005.

DAVID L. HENKIN

NNSA NEWS
National Nuclear Security Administration
U.S. Department of Energy

For Immediate Release
April 13, 2005

Bryan Wilkes
202-586-7371

NNSA Removes Radioactive Sources From University Facility

WASHINGTON, DC – Radioactive materials that could be used in a dirty bomb were recently removed from at a University of Hawaii facility and have arrived safely at a secure National Nuclear Security Administration (NNSA) facility, the agency said today.

NNSA removed a substantial quantity of radioactive cobalt-60 from a research irradiator at the university. The removal is part of a national effort by NNSA's U.S. Radiological Threat Reduction Program to recover and secure radiological materials that could be used to make a dirty bomb.

"The removal of these radiological sources has greatly reduced the chance that radiological materials could get into the wrong hands," said NNSA Deputy Director for Nonproliferation Paul Longsworth. "The University of Hawaii, its surrounding neighbors and the international community are safer today as result of this effort."

The U.S. Department of Energy in the 1960s produced cobalt-60 sources and lent 100 of those sources to the university for agricultural research. When the facility stopped conducting agricultural research, the remaining sources stored at the facility became a security and safety concern.

To reduce this threat, NNSA facility contractors and subcontractors with expertise in removing, packaging and transporting cobalt-60 completed removing the materials on March 28, 2005. The material arrived at a secure NNSA facility on April 12 and has been permanently disposed.

The program is part of the Bush administration's Global Threat Reduction Initiative (GTRI), which works to identify, secure, remove and/or facilitate the disposition of vulnerable, high-risk nuclear and other radiological materials around the world as quickly and expeditiously as possible.

GTRI has initiated radiological threat reduction efforts in 40 countries in Europe, Asia, Africa, and South and Central America. NNSA recovers high-risk radioactive sealed sources declared excess and unwanted by domestic licensees and securely stores them at NNSA sites. To date, NNSA has recovered more than 10,500 high-risk sealed sources within the United States.

Established by Congress in 2000, NNSA is a semi-autonomous agency within the U.S. Department of Energy responsible for maintaining and enhancing the safety, security, reliability and performance of the U.S. nuclear weapons stockpile without nuclear testing; working to reduce global danger from weapons of mass destruction; providing the U.S. Navy with safe and effective nuclear propulsion; and responding to nuclear and radiological emergencies in the U.S. and abroad.

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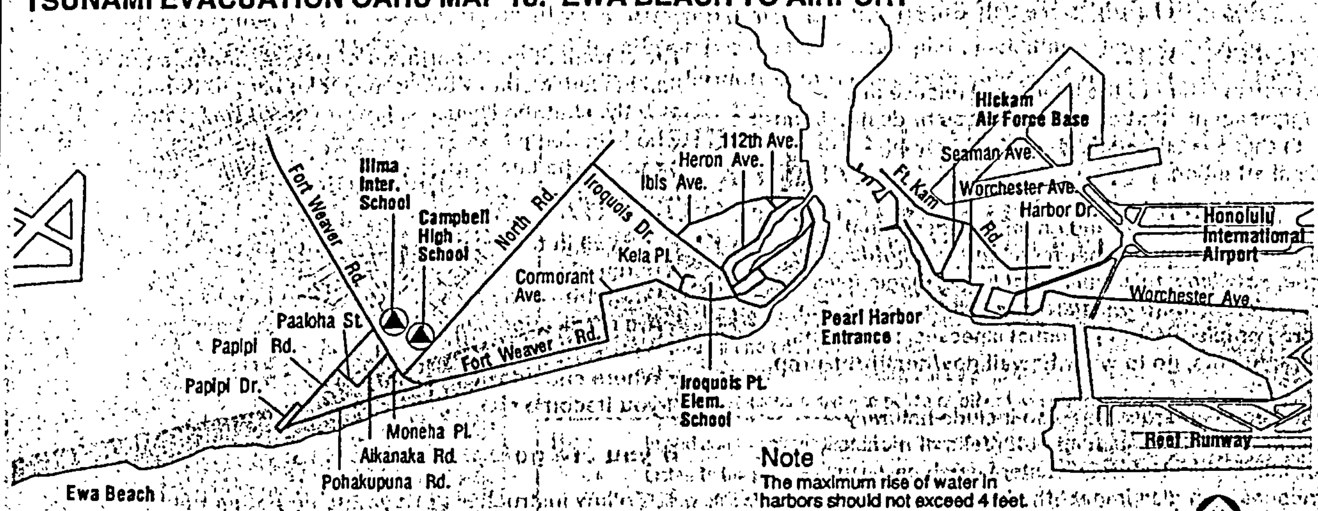
NA-05-07

EXHIBIT H

TSUNAMI EVACUATION OAHU MAP 18: EWA BEACH TO AIRPORT



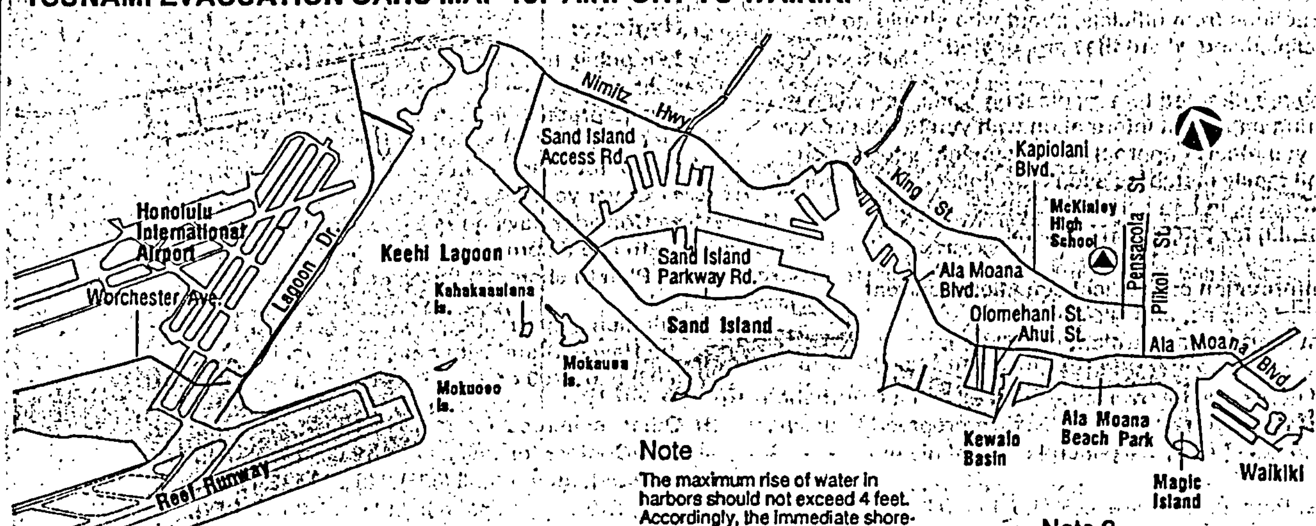
Note 1
When evacuation boundaries are drawn along streets and roadways, they are considered to be safe from wave action.

Note 2
Steel and/or concrete buildings of six or more stories in height should provide adequate protection if people move to the third floor or above.

Note
The maximum rise of water in harbors should not exceed 4 feet. Accordingly, the immediate shoreline and beach areas should be evacuated. All vessels should be secured, removed, or put to sea due to the probability of strong horizontal currents, surges and wave action.

Tsunami: Public Shelter/ Refuge Area

TSUNAMI EVACUATION OAHU MAP 19: AIRPORT TO WAIKIKI



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Note 1
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Steel and/or concrete buildings of six or more stories in height should provide adequate protection if people move to the third floor or above.

Tsunami: Public Shelter/ Refuge Area

EVACUATE ALL SHADED AREAS

EXHIBIT I

HonoluluAdvertiser.com

Posted on: Tuesday, January 11, 2005

Hawai'i tsunami zone maps may be flawed

By Deborah Adamson
Advertiser Staff Writer

Hawai'i's tsunami evacuation maps haven't been updated in 13 years and may be inaccurate since they're based on an outdated computer model, several experts said yesterday.

And it will take five to 10 years before the statewide maps will be completely revised to reflect the effect of tsunamis emanating not only from the Pacific Rim but also from elsewhere around the globe and from waters off the Big Island.

"Some of the maps might not be that accurate," said Kwok Fai Cheung, chairman of the Ocean and Resources Engineering Department at the University of Hawai'i-Manoa, who was hired by the state last year to update the maps.

The effects of tsunami generated by local events — earthquakes or undersea landslides — may be significantly under-estimated by the existing maps, he said.

Even though a local tsunami "is not as frequent ... if it happens, the effect would be quite disastrous," he said.

The evacuation maps, found in the front of Hawai'i telephone books, were first published in 1991 and have not been updated since.

While Cheung started working on his project a year ago, the recent Indian Ocean disaster has raised interest in detection and preventive measures in tsunami-prone states, such as Hawai'i.

Cheung has studied the potential of a tsunami impact on O'ahu's North Shore and as a result the evacuation line for parts of the area will be extended farther inland, said Brian Yanagi, tsunami program manager for the state's Civil Defense Division. Cheung's study will cover all coastlines in the state, and could take as long as 10 years to complete, Yanagi said.

The existing maps are one-dimensional, in the sense that they do not take into account the effects of ocean-floor topography that can change the way a wave behaves as it approaches the shoreline. As an example, the shape of the ocean floor in Hilo Bay seems to enhance the power of an incoming tsunami, and that has caused Hilo to be severely impacted by tsunamis in 1946 and 1960, while other parts of the state hit by the same waves did not suffer such severe damage.

The new computer model uses up-to-date ocean-floor mapping data to create what Cheung calls a two-dimensional tsunami map, which he said overcomes the older program's shortcomings.

One of Cheung's main concerns is the effect of a tsunami generated off the Kona coast, which would hit the Big Island in minutes and reach Honolulu in half an hour. He's going to work with the state to

EXHIBIT J

possibly develop a second evacuation map that would reflect the effects of a locally generated tsunami.

Gerard Fryer, an associate geophysicist and tsunami specialist at the Hawaii Institute of Geophysics and Planetology, said that with the exception of the Big Island, current evacuation maps should generally suffice for any locally generated tsunamis, even from a 7.8-point earthquake, which he believes is the largest possible there.

However, Fryer acknowledges that the reliability of the current maps has to be confirmed by Cheung's updated methods.

"We don't know they're good until we run the model," he said.

He has already spotted some inaccuracies in the existing tsunami maps: For instance, they show that Ala Moana Boulevard wouldn't be deluged if a tsunami occurs.

"Ala Moana Boulevard is likely to have boats on it," he said.

Staff writer Jan TenBruggencate contributed to this report. Reach Deborah Adamson at dadamson@honoluluadvertiser.com or 525-8088.

Back

Government | Kama'aina | Business | Visitors | Kids World | Seniors World | On-Line Services | Economic Development

Quick Find: Select One: Search: GO

You are here: Main / Civil Defense / Hurricanes In Hawaii

Oahu Civil Defense Agency

HURRICANES IN HAWAII

Major hurricanes are relatively rare events at any location. Residents of the Hawaiian Islands have a good chance of living many years without experiencing one. But none of our islands is immune. "Not here! We haven't had a hurricane in years," could be the most dangerous words you'll ever hear. It's best to be prepared. This could be the year.

Tropical cyclone is the general term that describes a low pressure system that originates over the tropical oceans. By international agreement, tropical cyclones are classified according to their intensity. The terms used are:

Tropical Depression:

- An area of developing counterclockwise (in the northern hemisphere, clockwise in the southern hemisphere) wind circulation that may include localized rain and thunderstorms. Maximum sustained winds up to 38 MPH (33 Knots). It is assigned a number by the National Weather Service.

Tropical Storm:

- A well defined area of counterclockwise rotating wind of 39-73 MPH (34-63 Knots). Usually includes rain and thunderstorms. It is assigned a name.

Hurricane:

- A severe tropical cyclone with sustained winds of 74 MPH (64 Knots) or greater. They can move rapidly and in an erratic manner. The major hazards include high winds, heavy rainfall, flooding, storm surge and high surf. If the hurricane has developed from a tropical storm, it keeps the same name.

Hurricanes are tropical cyclones in which winds reach sustained speeds of 74 miles per hour or more, and blow around a relatively calm center--the eye of the hurricane. Every year, these violent storms bring destruction to coastlines and islands in their

EXHIBIT K

erratic path.

Stated very simply, hurricanes are giant whirlwinds in which air moves in a large tightening spiral around a center of extreme low pressure, reaching maximum velocity in a circular band extending outward 20 or 30 miles from the rim of the eye. This circulation is counterclockwise in the Northern Hemisphere, and clockwise in the Southern Hemisphere. Near the center, hurricane winds may gust to more than 200 miles per hour, although storms reaching Hawaii have been less powerful than this. The entire storm dominates the ocean surface and lower atmosphere over tens of thousands of square miles.

The eye, like the spiral structure of the storm, is unique to hurricanes. Here, winds are light and skies are clear or partly cloudy. But this calm is deceptive, bordered as it is by maximum force winds and torrential rains. Many persons have been killed or injured when the calm eye lured them out of shelter, only to be caught in the maximum winds at the far side of the eye, where the winds blow from a direction opposite to that in the leading half of the storm.

What makes hurricanes the dangerous storms they are is that they combine the triple hazard of violent winds, torrential rains, and abnormally high waves and storm tides. Each of these by itself can pose a serious threat to life and property. Taken together they are capable of causing widespread destruction.

Hurricanes are categorized 1 through 5, by the Saffir/Simpson Scale, according to the amount of potential damage and wind speed.

	The Categories Are			
	Description of Damage	**Wind Speeds (MPH)**	**Storm Surge (feet)**	**Examples**
1	Minimal	74 - 95	4 - 5	Iwa, 92 MPH, Nov. 1982
2	Moderate	96 - 110	6 - 8	None
3	Extensive	111 - 130	9 - 12	Uleki, 128 MPH, Sep. 1992
4	Extreme	131 - 155	13 - 18	Iniki, 145 MPH, Sep. 1992
5	Catastrophic	> - 155	> - 18	Emilia & Gilma, 161 MPH, Jul 94, John, 173 MPH Aug. 1994

In Hawaii, hurricane winds, especially where augmented by local terrain, have been very damaging to trees, vegetation, and crops, as well as to lightly built dwellings and other structures. Heavy and prolonged hurricane rains falling over our steep hillsides can cause landslides and severe flash flooding. Large swell moving out ahead of the hurricane may begin to reach island shores while the storm itself is still several hundred miles away. As the hurricane nears the coastline, rapidly rising water levels from above-normal storm tides and high wind-driven waves will inundate coastal areas, erode beaches, and pound and undermine waterfront structures, highways, and other facilities.

During the last 50 years many hurricanes and tropical storms have come close to the Hawaiian Islands, but only three have had direct impact. In all three cases, Kauai was the hardest hit, although Oahu suffered significant damages as well. Hurricane Iniki was by far the most destructive storm to strike Hawaii in recorded history, with widespread wind and water damage exceeding 2.2 billion dollars. Losses in Hurricane Dot, August of 1959 were about 6 million dollars. Hurricane Iwa, in November of 1982 caused over 250 million dollars in damages.

Other hurricanes have occasionally come close enough to cause relatively minor damage, mainly in coastal areas vulnerable to high waves. Thus, Hurricane NINA, in late November 1957, brought surf of 35 feet to Kauai's southern coast, while waves from Hurricane FICO in July 1978 damaged homes and roads on the Big Island's Ka'u coast when the storm itself was more than 400 miles to the southeast.

Tropical cyclones of less than hurricane strength also have been destructive. For example, in August 1958, flooding rains and high winds from a storm that crossed Hawaii Island caused more than $500 thousand in damage.

Most Central Pacific hurricanes originate near the coasts of Central America or southern Mexico. Long before reaching the Hawaiian area, however, many of these storms die off when they move northwestward over cooler water or encounter unfavorable atmospheric conditions. Of those that survive, most remain far enough away to spare us their effects. Some hurricanes form nearer the Hawaiian Islands, while a few, like NINA and IWA, originate far to the southwest.

Hurricane season begins in June and lasts through November in the Hawaiian Islands.

In some hurricane seasons, many Central Pacific tropical cyclones occur; in others, few or none. In 1978, for example, there were 13, three of them full-fledged hurricanes, while the following year had none. There is no way of telling in advance how active a hurricane season is likely to be.

Hurricanes begin as relatively small tropical cyclones, generally off the southwest coast of Mexico or west coast of Central America. Some have, however, slowly formed south of the state of Hawaii. They then drift to the west-northwest, imbedded in the westward-blowing tradewinds of the tropics. Under certain conditions these disturbances increase in size, speed, and intensity until they become full-fledged hurricanes.

The storms move forward very slowly in the tropics, and may remain almost stationary for short periods of time. The initial forward speed is usually 15 miles per hour or less. Then, as the hurricane moves farther from the Equator, its forward speed tends to increase; at middle latitudes it may exceed 50 miles per hour in extreme cases.

The great storms are driven by the heat released by condensing water vapor, and by external mechanical forces. Once cut off from the warm ocean, the storm begins to die, starved for water and heat energy, and dragged apart by friction as it moves over the land.

Resource: A pamphlet republished by the Federal Emergency Management Agency and Hawaii State Civil Defense in cooperation with the National Oceanic and Atmospheric Administration.

Give us Feedback we want to hear from you!

Thursday, December 09, 2004

Article URL: http://starbulletin.com/2005/04/15/news/story11.html

News
starbulletin.com

Friday, April 15, 2005

Radioactive material destroyed

A former professor's research could have been used in a bomb

Star-Bulletin staff

Radioactive material loaned to the University of Hawaii-Manoa since the 1960s was safely removed and disposed of through a program designed to prevent it from ending up in terrorists' hands.

In a news release, the National Nuclear Security Administration said it removed a "substantial quantity" of radioactive cobalt-60 from a research irradiator at UH-Manoa.

The NNSA said the material could have been used in a "dirty bomb," a combination of explosive and radioactive material that could spread and contaminate a large area with radioactive material.

The removal was part of a nationwide effort to secure radioactive materials, the federal agency said in the news release.

UH-Manoa radiation safety officer Irene Sakimoto said the material was safely secured and kept under 12 feet of water to prevent any threat of exposure to people who worked with it. She said there are no other such materials on campus.

The material had been used by a UH-Manoa professor who recently retired. His experiments focused on irradiating tropical fruits to kill fruit flies, said UH-Manoa spokesman Jim Manke.

Sakimoto said the irradiator was also used over the years to sterilize fruit flies and in genetic experiments to isolate DNA, and by astronomy and physics researchers to test how radiation affects certain materials that could be used in space.

The radioactivity of the material has also been declining, and once the professor retired, no one

EXHIBIT L

had any use for the irradiator, Sakimoto said.

She said UH-Manoa asked the NNSA to take care of the disposal, since the Department of Energy owned the material. Funds were available to remove and dispose of the material through the new anti-terrorism program, which is part of the Bush administration's Global Threat Reduction Initiative.

If the university had to dispose of the material, "it would have been very expensive," Sakimoto said. She estimates the cost would have been about $1 million.

The university had about 1,000 curies of cobalt-60, a measurement that is also an indication of its radioactivity, Sakimoto said. Cobalt-60 has a half-life of about five years, meaning its radioactivity and mass declines in half every five years. Originally, the material was about 42,000 curies, she said.

The material was removed by a contractor on March 25 and disposed of at a secure NNSA facility on Tuesday, the agency said.

Sakimoto said about 100 pieces of material fit into a 2-by-3-foot lead box.

National Nuclear Security Administration
www.nnsa.doe.gov/

University of Hawaii
www.hawaii.edu

Article URL: http://starbulletin.com/2005/04/15/news/story11.html

Using irradiation to eliminate *Salmonella* from the seeds may require a dose of irradiation that also interferes with the viability of the seeds themselves. Combining irradiation with other strategies to reduce contamination with germs may overcome these limitations.

Top of Page

Which foods have been approved for irradiation in the United States?

A variety of foods have been approved for irradiation in the United States, for several different purposes. For meats, separate approval is required both from the FDA and the USDA.

Approval Year	Food	Dose	Purpose
1963	Wheat flour	0.2-0.5 kGy	Control of mold
1964	White potatoes	0.05-0.15 kGy	Inhibit sprouting
1986	Pork	0.3-1.0 kGy	Kill Trichina parasites
1986	Fruit and vegetables	1.0 kGy	Insect control, increase shelf life
1986	Herbs and spices	30 kGy	Sterilization
1990 - FDA	Poultry	3 kGy	Bacterial pathogen reduction
1992 - USDA	Poultry	1.5-3.0 kGy	Bacterial pathogen reduction
1997 - FDA	Meat	4.5 kGy	Bacterial pathogen reduction
1999 - USDA (pending)	Meat	4.5 kGy	Bacterial pathogen reduction

Top of Page

Which foods are being irradiated in the U.S.?

A facility in Florida has been irradiating strawberries and other fruits on a limited basis, to prolong shelf life. On a trial basis, fresh tropical fruits from Hawaii have been irradiated before shipping them to the mainland, instead of fumigating them to eliminate the fruit fly pests that could spread to the mainland. Some spices for commercial use have been irradiated. In addition irradiation is widely used to sterilize a variety of medical and household products, from hip joint implants to bandaids and baby pacifiers.

Other technologies used to sterilize fruits, spices and medical devices use toxic chemicals, such as ethylene oxide. Use of irradiation can reduce the use of these other hazardous substances.

How can I tell if the food has been irradiated?

A distinctive logo has been developed for use on food packaging, in order to identify the product as irradiated. This symbol is called the "radura" and is used internationally to mean that the food in the package has been irradiated. A written description may also be present, such as "Irradiated to destroy harmful microbes". It is not required to label a food if a minor ingredient of the food, such as a spice, has been irradiated itself.

EXHIBIT M

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 BRIAN COULSON

I, Brian Coulson, declare that if called as a witness in this action I could testify of my own personal knowledge as follows:

1. I live at 95-920 Wikao Street in Mililani, Hawai'i.

2. I am a flight instructor at Moore Air, Inc., which is located at 90 Nakolo Place, Suite 24, off Lagoon Drive at the Honolulu International Airport. Moore Air is only about ½-mile from the Palekona Street site proposed for Pa'ina Hawaii's irradiator.

3. I am deeply concerned about Pa'ina Hawaii's proposal to construct and operate a Cobalt-60 irradiator in such close proximity to my place of business. A malfunction at the facility, hurricane, tsunami, airplane crash, or act of terrorism could cause the release of radioactive material that would threaten the health, safety and well-being of myself, my co-workers, my clients, and others in my community.

4. Even a minor accident at the Pa'ina Hawaii irradiator could shut down business operations at Moore Air, causing me significant financial harm from lost flight instruction time. In addition, I am concerned the mere presence of the Pa'ina Hawaii irradiator along Lagoon

Drive might drive away customers who might prefer to learn to fly somewhere else, where they would not have to worry about the risk of nuclear accident.

5. I am a member of Concerned Citizens of Honolulu, a grassroots environmental organization that was created to ensure the people who live and work in Honolulu will be adequately protected from potential public health and safety and environmental impacts associated with Pa'ina Hawaii's proposed irradiator and to ensure that a thorough environmental review of the proposal – including consideration of alternate technologies and alternate locations that could achieve the project's goals with less risk to the public and environment – is performed before any project approvals are issued. I have authorized Concerned Citizens of Honolulu to represent me in this proceeding, for the purpose of ensuring that the Nuclear Regulatory Commission's decision on Pa'ina Hawaii's license application includes adequate measures for the protection of my health and welfare and the quality of my environment.

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 Honolulu, Hawai'i, October 2, 2005.

[signature]

BRIAN COULSON

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE SECRETARY

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

DECLARATION OF MARIE-THERESE KNOLL

I, Marie-Therese Knoll, declare that if called as a witness in this action I could testify of my own personal knowledge as follows:

1. I live at 3015 Ala Napuaa Place in Honolulu, Hawai'i.

2. I am the office manager at Moore Air, Inc., where I work three days per week. Moore Air is located at 90 Nakolo Place, Suite 24, off Lagoon Drive at the Honolulu International Airport, only about ½-mile from the Palekona Street site proposed for Pa'ina Hawaii's irradiator.

3. On the days that I am not working, I regularly come down to Moore Air to go flying. Thus, in a typical week, I am at Moore Air five or six days.

4. About one day each week, I fly "cross-country" (more than 50 nautical miles). Before every such flight, I check the weather at the flight service station, which is located on Palekona Street, the short loop road on which Pa'ina Hawaii proposes to build and operate its irradiator.

5. I am deeply concerned about Pa'ina Hawaii's proposal to construct and operate a Cobalt-60 irradiator in such close proximity to the place where I work and spend much of my

free time. A malfunction at the facility, hurricane, tsunami, airplane crash, or act of terrorism could cause the release of radioactive material that would threaten the health, safety and well-being of myself, my co-workers, my clients, and others in my community.

6. Even a minor accident at the Pa'ina Hawaii irradiator would likely shut down business operations at Moore Air, causing me significant financial harm from lost wages. In addition, even a minor release of radiation would undoubtedly shut down access to the flight service station on Palekona Street, preventing me from taking cross-country flights, an activity I love.

7. I am a member of Concerned Citizens of Honolulu, a grassroots environmental organization that was created to ensure the people who live and work in Honolulu will be adequately protected from potential public health and safety and environmental impacts associated with Pa'ina Hawaii's proposed irradiator and to ensure that a thorough environmental review of the proposal – including consideration of alternate technologies and alternate locations that could achieve the project's goals with less risk to the public and environment – is performed before any project approvals are issued. I have authorized Concerned Citizens of Honolulu to represent me in this proceeding, for the purpose of ensuring that the Nuclear Regulatory Commission's decision on Pa'ina Hawaii's license application includes adequate measures for the protection of my health and welfare and the quality of my environment.

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 Honolulu, Hawai'i, September 30, 2005.

Marie-Therese Knoll

MARIE-THERESE KNOLL

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE SECRETARY

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

DECLARATION OF DARRYN NG

I, Darryn Ng, declare that if called as a witness in this action I could testify of my own personal knowledge as follows:

1. I live at 1490-A Kohou Street in Honolulu, Hawai'i. My home lies approximately three and one-half miles from the Palekona Street site proposed for Pa'ina Hawaii's irradiator.

2. I am a father of two boys, a ten-year old who attends Kapalama Elementary School (1601 North School Street) near our house and a three-year old who is cared for by his grandmother at our home on Kohou Street.

3. I regularly spend time in areas near the proposed irradiator site. I enjoy recreational fishing and, about once a month, launch my boat from the Ke'ehi Lagoon Boat Harbor, which is located less than two miles across the lagoon from Palekona Street. When I motor out the Kalihi Channel to reach open water, I pass the end of the Reef Runway and can clearly see the buildings along Lagoon Drive where the irradiator would be located.

4. With my wife and children, I often go to watch canoe races at Ke'ehi Lagoon Park, which is only about 1 ¾ miles from the irradiator site. We also regularly go to the beach at Sand Island, driving along the Access Road across the lagoon from the irradiator site.

5. I am concerned that, if approved, Pa'ina Hawaii's Cobalt-60 irradiator would threaten the health of myself and my family, since the facility is proposed for a site near my home and close to places where my children study and play and where I like to go to fish and relax. A malfunction at the irradiator, hurricane, tsunami, airplane crash, or act of terrorism could cause the release of radioactive material that would threaten the health, safety and well-being of myself, my family and others in my community.

6. Living with the threat of a catastrophic accident at the Pa'ina Hawaii irradiator would upset my and my family's peace of mind and would interfere with our enjoyment of activities we love, forcing us to abandon our favorite places and go elsewhere to fish, enjoy the beach, and watch sports to minimize our exposure to the dangers the facility would pose.

7. I am also concerned about the reduction in the property value of our house since no one wants to live near a nuclear facility.

8. I am a member of Concerned Citizens of Honolulu, a grassroots environmental organization that was created to ensure the people of Honolulu will be adequately protected from potential public health and safety and environmental impacts associated with Pa'ina Hawai'i's proposed irradiator and to ensure that a thorough environmental review of the proposal – including consideration of alternate technologies and alternate locations that could achieve the project's goals with less risk to the public and environment – is performed before any project approvals are issued. I have authorized Concerned Citizens of Honolulu to represent me in this proceeding, for the purpose of ensuring that the NRC's decision on Pa'ina Hawai'i's license application includes adequate measures for the protection of my health and welfare and the quality of my environment.

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 Honolulu, Hawai'i, September 29, 2005.

Darryn D. Ng
DARRYN NG

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 DAVID PAULSON

I, David Paulson, declare that if called as a witness in this action I could testify of my own personal knowledge as follows:

1. I live at 3254 Hoolulu Street in Honolulu, Hawai'i.

2. I am an attorney with the law firm of Bickerton Saunders Dang & Sullivan. Our offices are located at 745 Fort Street, Suite 801, in Honolulu, approximately three and one-half miles from the Palekona Street site proposed for Pa'ina Hawaii's irradiator.

3. About twelve times per year, I fly in or out of Honolulu International Airport, using runways immediately adjacent to the proposed irradiator site. Another approximately twelve times annually, I drive to the airport to pick up or drop off friends and relatives who are visiting.

4. I am deeply concerned about Pa'ina Hawaii's proposal to construct and operate a Cobalt-60 irradiator in such close proximity to my place of work and to the airport on which I rely to maintain contact with family and friends. A malfunction at the facility, hurricane, tsunami, airplane crash, or act of terrorism could cause the release of radioactive material that would threaten my health, safety and well-being and that of others in my community.

5. I am a member of Concerned Citizens of Honolulu, a grassroots environmental organization that was created to ensure the people who live and work in Honolulu will be adequately protected from potential public health and safety and environmental impacts associated with Pa'ina Hawaii's proposed irradiator and to ensure that a thorough environmental review of the proposal – including consideration of alternate technologies and alternate locations that could achieve the project's goals with less risk to the public and environment – is performed before any project approvals are issued. I have authorized Concerned Citizens of Honolulu to represent me in this proceeding, for the purpose of ensuring that the NRC's decision on Pa'ina Hawaii's license application includes adequate measures for the protection of my health and welfare and the quality of my environment.

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 Honolulu, Hawai'i, October 3, 2005.

DAVID PAULSON

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 GRACE SIMMONS

I, Grace Simmons, declare that if called as a witness in this action I could testify of my own personal knowledge as follows:

1. I live at 1486 Kohou Street in Honolulu, Hawai'i. My home lies approximately three and one-half miles from the Palekona Street site proposed for Pa'ina Hawai'i's irradiator.

2. I am an environmental health specialist with the State of Hawai'i Department of Health's Solid and Hazardous Waste Branch. As part of my job, I conduct inspections of facilities at Honolulu International Airport, including facilities located along Lagoon Drive in close proximity to the Palekona Street site. I also routinely inspect facilities located on Sand Island, which is located immediately across Ke'ehi Lagoon from the airport. To get to Sand Island, I drive along Sand Island Access Road, passing within two miles of the proposed irradiator site.

3. Approximately four times per year, I fly in and out of Honolulu International Airport, using runways immediately adjacent to the proposed irradiator site. Another approximately eight times annually, I drive to the airport to pick up or drop off friends and relatives visiting from neighbor islands or the mainland.

4. I am deeply concerned about Pa'ina Hawaii's proposal to construct and operate a Cobalt-60 irradiator in such close proximity to my home and to places I regularly visit as part of my professional responsibilities and personal life. A malfunction at the facility, hurricane, tsunami, airplane crash, or act of terrorism could cause the release of radioactive material that would threaten the health, safety and well-being of myself, my family and others in my community. It is outrageous that the Nuclear Regulatory Commission (NRC) has refused to conduct any analysis of the threats to public safety and health and to the environment posed by Pa'ina Hawaii's proposed irradiator.

5. I am a member of Concerned Citizens of Honolulu, a grassroots environmental organization that was created to ensure the people of Honolulu will be adequately protected from potential public health and safety and environmental impacts associated with Pa'ina Hawai'i's proposed irradiator and to ensure that a thorough environmental review of the proposal – including consideration of alternate technologies and alternate locations that could achieve the project's goals with less risk to the public and environment – is performed before any project approvals are issued. I have authorized Concerned Citizens of Honolulu to represent me in this proceeding, for the purpose of ensuring that the NRC's decision on Pa'ina Hawai'i's license application includes adequate measures for the protection of my health and welfare and the quality of my environment.

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 Honolulu, Hawai'i, September 29, 2005.

Grace Simmons

GRACE SIMMONS

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE SECRETARY

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

DECLARATION OF LIA YOUNG HUNT

I, Lia Young Hunt, declare that if called as a witness in this action I could testify of my own personal knowledge as follows:

1. I live at 2026 Dole Street, Honolulu, Hawai'i 96822.

2. I am the owner of Goldwings Supply Service, Inc., the largest aviation parts supplier in the Pacific Basin. Goldwings Supply has been in the same location for thirty years: 120 Kapalulu Place, off Lagoon Drive at the Honolulu International Airport, which is less than ¾ of a mile from the Palekona Street site proposed for Pa'ina Hawaii's irradiator.

3. I am deeply concerned about Pa'ina Hawaii's proposal to construct and operate a Cobalt-60 irradiator in such close proximity to my business. A malfunction at the facility, hurricane, tsunami, airplane crash, or act of terrorism could cause the release of radioactive material that would threaten the health, safety and well-being of myself, my employees, my clients, and others in my community.

4. Even a minor accident at the Pa'ina Hawaii irradiator may well shut down my business operations, causing me significant financial harm.

5. I am a member of Concerned Citizens of Honolulu, a grassroots environmental organization that was created to ensure the people who live and work in Honolulu will be adequately protected from potential public health and safety and environmental impacts associated with Pa'ina Hawaii's proposed irradiator and to ensure that a thorough environmental review of the proposal – including consideration of alternate technologies and alternate locations that could achieve the project's goals with less risk to the public and environment – is performed before any project approvals are issued. I have authorized Concerned Citizens of Honolulu to represent me in this proceeding, for the purpose of ensuring that the Nuclear Regulatory Commission's decision on Pa'ina Hawaii's license application includes adequate measures for the protection of my health and welfare and the quality of my environment.

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 Honolulu, Hawai'i, October 3, 2005.

LIA YOUNG HUNT

CERTIFICATE OF SERVICE

The undersigned hereby certifies that, on October 3, 2005, a true and correct copy of the foregoing document was duly served on the following as indicated:

Pa`ina Hawaii, LLC P.O. Box 30542 Honolulu HI 96820 [For Applicant]	FIRST CLASS MAIL
Office of the General Counsel U.S. Nuclear Regulatory Commission Washington, DC 20555-0001 [For NRC Staff]	FIRST CLASS MAIL
Office of the General Counsel U.S. Nuclear Regulatory Commission Fax No.: (301) 415-3725	FACIMILE TRANSMISSION

Dated at Honolulu, Hawai`i, October 3, 2005.

DAVID L. HENKIN
Attorney for Petitioner
Concerned Citizens of Honolulu

EARTHJUSTICE

BOZEMAN, MONTANA DENVER, COLORADO HONOLULU, HAWAII
JUNEAU, ALASKA NEW ORLEANS, LOUISIANA SAN FRANCISCO, CALIFORNIA
SEATTLE, WASHINGTON TALLAHASSEE, FLORIDA WASHINGTON, D.C.
ENVIRONMENTAL LAW CLINIC AT UNIVERSITY OF DENVER
ENVIRONMENTAL LAW CLINIC AT STANFORD UNIVERSITY

TRANSMITTAL LETTER

TO: Office of the Secretary
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
Attention: Rulemakings and Adjudications Staff

FIRST CLASS MAIL

FROM: David L. Henkin

DATE: October 3, 2005

RE: NRC Docket No. 030-36974
Pa'ina Hawaii, LLC, Irradiator in Honolulu, HI

Enclosures (original and two copies of each):

10/3/05 NOTICE OF APPEARANCE BY DAVID L. HENKIN

10/3/05 REQUEST FOR HEARING BY CONCERNED CITIZENS OF HONOLULU

COPIES	DATE	DESCRIPTION

[ ] For Your Information.
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[ ] Per Our Conversation.
[ ] Per Your Request.
[ ] For Review and Comments.
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