Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions
issue brief

Indian Point-less

On Thursday, December 6, 2001, representatives of Entergy Nuclear Operations met with Roger Witherspoon, a reporter for the Gannett newspaper *The Journal News*, to present their reasons for concluding that the public living around the Indian Point nuclear plant would not be in jeopardy even if a fully-loaded 767 aircraft hit the plant. By arrangement with Entergy, Mr. Witherspoon took two experts with him: Christian Meyer, Professor of Civil Engineering at Columbia University to assess structural analyses, and David Lochbaum, nuclear safety engineer for the Union of Concerned Scientists to assess system capability analyses. Michael Kansler, Senior Vice President at Entergy, led the briefing team and explained that it was the same presentation that Entergy recently provided for Senators Schumer and Clinton and other elected officials.

As UCS understood it, Entergy's position was that the 3½-feet thick, reinforced concrete containment dome would not be breached by the impacting aircraft with the possible exception of its engines. Even if engine parts penetrated the containment, Entergy repeatedly stated that the public would be protected because the reactor vessel would remain intact. Entergy maintained that as long as the reactor vessel remained intact, installed safety systems or ad hoc emergency measures (such as workers using fire hoses[1]) would cool the reactor fuel and prevent the release of radioactivity to the atmosphere.

Simply put, Entergy's position was pointless. Their contrived "success criterion" that the public would be protected as long as the reactor vessel remained intact contradicted experience spanning four decades, illustrated by the following summary of nuclear plant accidents:

- October 9, 1989: 480 fuel rods were damaged at the Connecticut Yankee nuclear plant (USA) by metal chips in the primary coolant system. The reactor vessel was undamaged.
- November 22, 1988: 191 fuel rods were damaged at Pickering Unit 1 (Canada) by an abnormal control rod pattern. The reactor vessel was undamaged.
- April 25, 1986: Two steam explosions destroyed the reactor and containment structures at Chernobyl Unit 4 (Ukraine) with more than 100 million curies of radioactivity released to the atmosphere. The reactor vessel remained intact until the explosions. The severity of the accident would not have been appreciably reduced had the reactor vessel remained intact.
- December 19, 1984: 44 fuel assemblies at the Oyster Creek nuclear plant (USA) were damaged due to an error in the reactor core monitoring program. The reactor vessel was undamaged.
- September 26, 1983: Fuel assemblies at Arkansas Nuclear One Unit 1 (USA) were damaged with a control rod was inadvertently misaligned 90 inches for nearly two weeks. The reactor vessel was undamaged.
- September 20, 1981: Fuel assemblies at Hatch Unit 1 (USA) were damaged following a reactor core power transient. The fuel damage caused the radiation level of the steam leaving the reactor to peak at 0.3 curies per second. The reactor vessel was undamaged.
- March 28, 1979: The reactor core at Three Mile Island Unit 2 (USA) suffered a partial meltdown following a minor system transient complicated by equipment failure and operator mistakes. The reactor vessel was slightly damaged by the molten core, but remained intact.
- October 31, 1974: Many fuel assemblies at Dresden Unit 3 (USA) were damaged by a control rod pattern adjustment that resulted in local power "hot" spots. The reactor vessel was undamaged.

[1] Entergy's notion that its workers would successfully handle this dire emergency, for which they have had no formal training, seems contradicted by the recent failure of 4 out of 7 of its operating crews during simulated emergencies for which they had considerable specific training.

- October 17, 1969: Nearly 400 pounds of fuel melted at Saint Laurent (France) when the on-line refueling machine malfunctioned. Radioactivity was released to the atmosphere. The reactor vessel remained intact.
- October 5, 1966: Fuel assemblies melted at Fermi Unit 1 (USA) when flow through cooling channels was blocked. The reactor vessel was undamaged.
- January 3, 1961: The reactor core was destroyed at SL-1 (USA) by a steam explosion that killed every worker at the site. The reactor vessel remained intact until the explosion. The severity of the accident would not have been appreciably reduced had the reactor vessel remained intact.
- July 26, 1959: Twelve fuel elements melted at the Sodium Reactor Experiment (USA) after the organic compound being used as a coolant decomposed and blocked the cooling flow channels. The reactor vessel was undamaged.
- October 7, 1957: Fuel elements were damaged at Windscale Unit 1 (United Kingdom) when energy stored in the graphite moderator overheated and caught on fire. Approximately 20,000 curies of I-131 were released to the atmosphere resulting in the contamination of milk. The reactor vessel remained intact.
- January 5, 1955: One or more fuel elements overheated and ruptured at the Hanford production reactor (USA) when flow through cooling channels was blocked. The reactor vessel was undamaged.

It is abundantly clear that significant fuel damage with release of radioactivity to the atmosphere can occur even when the reactor vessel remains intact. Thus, Entergy's assertion that the reactor vessel remains intact following an aircraft impact has little or no relevance to the question of whether the public will be harmed.

The irrelevance of Entergy's analysis cannot be explained. They know better. Safety studies performed by Indian Point's former owner evaluated many scenarios with the potential outcome being reactor core damage. (UCS assumes that Entergy acquired the Owner's Manuals along with Indian Point.) For example, those scenarios included:

- Large loss-of-coolant accident (LLOCA)
- Medium loss-of-coolant accident (MLOCA)
- Small loss-of-coolant accident (SLOCA)
- Steam generator tube rupture (SGTR)
- Steam line break inside containment
- Steam line break outside containment
- Loss of main feedwater
- Inadvertent closure of Main Steam Isolation Valve
- Loss of primary flow
- Turbine trip
- Loss of DC Bus 21
- Loss of DC Bus 22
- Reactor trip
- Loss of component cooling water[2]

Each of these scenarios was calculated to have some probability of producing reactor fuel damage at Indian Point Unit 2. Yet NONE of these scenarios assumed that the reactor vessel was damaged in any way at any time. However, these analyses concluded that fuel damage could occur nonetheless.

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[2] Consolidated Edison Company, "Individual Plant Examination for Indian Point Unit No. 2 Nuclear Generating Station," August 1992, Table 3.3-1, "Initiating Event Frequencies."

According to the former owner of Indian Point Unit 2, the most likely scenarios leading to fuel damage are:[3]

Scenario	Contribution to Overall Risk of Core Damage
General transients	41.40 percent
Loss-of-coolant accidents	33.30 percent
Station blackout	14.26 percent
Steam generator tube rupture	5.98 percent

The former owner of Indian Point Unit 3 made it explicitly clear that fuel damage can occur without the reactor vessel being compromised. For example:

> *Plant damage state group 2 represents 40.9 percent of the total internal core damage frequency. It results from long- and short-term accident sequences initiated by a transient. The long-term sequences involve a loss of AFW [auxiliary feedwater] secondary cooling and subsequent failure of either bleed and feed core cooling or long-term recirculation core cooling. The short-term accident sequences involve an ATWS [anticipated transient without scram] plant damage state with failure to provide adequate reactivity control. Their behavior is assumed to be similar to that of a total loss of heat sink event. Without adequate secondary cooling, steam generator dryout occurs and high or low-high RCS [reactor coolant system] pressure results Unable to reduce RCS pressure, high and low-head safety injection are precluded. RCS boil-off ensues and core damage.*
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> or
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> *Plant damage state group 3 represents 29.8 percent of the total core damage frequency. It results from short-term LOCA [loss-of-coolant accident] ant ATWS-induced large LOCA accident sequences and long-term small break LOCA accident sequences. In most cases, RCS boiloff ensues because of a failure to align long-term recirculation cooling or random mechanical faults in the recirculation and RHR [residual heat removal] systems. All of the large LOCA sequences proceed to core damage at low RCS pressure (<675 psia): the intermediate and small LOCAs proceed to core damage at low-high RCS pressure (>675 psia, ≤2350 psia). In certain scenarios, initial core cooling injection is lost and thus the only means of providing water from the RWST [recirculation water storage tank] into the containment sumps is by containment spray system operation or gravity drain from the RWST. Otherwise, long-term recirculation core cooling fails because of operator error or random mechanical faults.*[4]

Damage to the reactor vessel was therefore not assumed to be a factor in the majority of scenarios leading to significant fuel damage at Indian Point. Entergy purchased Units 2 and 3 and acquired these safety studies along with the keys to operate the reactors. Yet Entergy opted to focus on reactor vessel integrity when considering the potential consequences from an aircraft crash.

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[3] Consolidated Edison Company, "Individual Plant Examination for Indian Point Unit No. 2 Nuclear Generating Station," August 1992, Table 1.4-1, "Comparison of Core Damage Frequency by Initiator Group."

[4] New York Power Authority, "Indian Point 3 Nuclear Power Plant Individual Plant Examination," June 1994, Section 1.5.1.2, "Plant Damage States."

Can a fully-loaded 767 aircraft impacting Indian Point cause a transient? Yes.

Can a fully-loaded 767 aircraft impacting Indian Point cause a loss-of-coolant accident? Yes.

Can a fully-loaded 767 aircraft impacting Indian Point cause a station blackout? Maybe.

Can a fully-loaded 767 aircraft impacting Indian Point cause a steam generator tube rupture? Yes.

Can a fully-loaded 767 aircraft impacting Indian Point cause reactor fuel damage? Yes.

Did Entergy mislead Senators Schumer and Clinton and reporter Witherspoon when it claimed that the public could not be harmed even if a fully-loaded 767 aircraft hit Indian Point? Yes.

Entergy knew, or should have known, they fabricated a bogus scenario. Nearly two decades earlier, Indian Point's prior owners looked at the risk from aircraft crashes. They did not limit their evaluation to the potential damage caused by engine parts penetrating the containment dome. Nor did they restrict their analysis to things that might damage the reactor vessel. After examining the consequences from a small aircraft hitting various site structures, they concluded: "*The control building is the only single building which, if hit, could lead to core melt.*"[5] They did not postulate that a small aircraft hitting the control building would damage the reactor vessel — they recognized that the damage to the control building could disable the equipment needed to cool the fuel in the reactor vessel and prevent meltdown. Entergy conveniently omitted those facts in its presentations to United States Senators and Mr Witherspoon.

Entergy is absolutely wrong to claim that the public could not be harmed even if a fully-loaded aircraft hit Indian Point. But it is equally wrong to claim that the public would be harmed if such an attack were to occur. The truth lies somewhere in the middle — an aircraft hitting Indian Point increases the chance of fuel damage and the release of radioactivity to the atmosphere. The responsible course of action would be to define areas of the plant vulnerable to aircraft impact and jet fuel fires and then take all reasonable measures needed to reduce these vulnerabilities. Recognizing that completion of all these measures can only reduce rather than eliminate the risk, the responsible course of action would also ensure that all reasonable measures are taken to protect the public if radioactivity is released.

Will Entergy and the NRC take responsible courses of action? Fortunately, it's too soon to say No. Unfortunately, it's time to say Not Yet.

[5] Consolidated Edison Company and the Power Authority of the State of New York, "Indian Point Probabilistic Safety Study," Section 7.6, Spring 1982.