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Nuclear Security: General aviation is not a threat

Following the attacks of September 11th, the United States government has struggled to identify potential threats and targets for future terrorist activities. Potential targets identified by security officials have included shopping malls, banking institutions, water reservoirs, federal buildings, fairs, festivals, sporting events, and nuclear facilities. Some public officials have focused their attention on the potential use of light, general aviation aircraft to launch attacks against national assets. Specifically, claims have been made concerning the nation's nuclear power plants and their theoretical vulnerability to attacks from light aircraft.

As a result, the government and others continue to examine the issues surrounding both real and perceived weaknesses in nuclear security. One such example of these efforts is the study initiated by U.S. Representative Edward J. Markey titled *Security Gap: A Hard Look At the Soft Spots in Our Civilian Nuclear Reactor Security.* In this "study", Representative Markey, who has historically proven to be an opponent of nuclear energy, attempts to establish a supposition that general aviation poses a national threat based on its potential for use in strikes against nuclear power plants.

In reality, general aviation is a safe and important component of the United States transportation system. Moreover, light, general aviation aircraft do not pose a threat to domestic nuclear power plant security, and the facts presented in this report explain and illustrate this while refuting these accusations.

Nuclear Facility Design Standards

It has been suggested that the design standards of nuclear power plants offer inadequate protection in resisting airborne attacks. One point raised was the fact that few nuclear reactor facilities were designed specifically against threats from light, general aviation aircraft. This point is misleading, because it overlooks the fact that by their very design, nuclear power plants are inherently resistant to such strikes. For example, in the late 70's, the Japanese government conducted a test in which a 45,000-pound F-4 Phantom jet was impacted at over 450 miles per hour into a concrete wall about the thickness of the containment vessel of a nuclear power plant. The results were dramatic. While the aircraft was completely destroyed upon impact, the integrity of the wall remained uncompromised. To relate this to general aviation, it is important to note that the F-4 Phantom jet weighs 7 times as much as the average general aviation aircraft and was flown into the wall at speeds exceeding two and one half times that of a general aviation aircraft.

Parallels can also be drawn to one of the standard accident scenarios used in the design of nuclear power plants, the impact of tornado-propelled missiles such as power line

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poles. In a series of tests conducted by Sandia National Labs in the 1970s, wooden power poles were hurled into a concrete target (simulating a containment wall) at speeds up to 120 miles per hour. The power pole was, in each case, reduced to splinters. However, the thick concrete targets were merely polished at the point of impact. A power pole impacting perpendicular to the surface of the concrete is certainly as effective or a more effective missile than a light (aluminum), general aviation aircraft.

These tests serve to support a statement made by Chairman Richard Meserve of the U.S. Nuclear Regulatory Commission in which he remarked, “Nuclear power plants are among the most formidable structures in existence. Nuclear power plants are certainly far more capable to respond to an aircraft attack than other civilian facilities.” This is not to imply that such structures are indestructible but that they are indeed very robust hard targets.

The Markey report implied that a general aviation aircraft impact to the containment structure of a nuclear reactor could cause a full-scale core meltdown. However, engineering data, supported by “real-world” tests, refute these claims. The conclusions to be drawn are clear. Given that aircraft size and speed are two crucial elements in the damage equation, a light, general aviation aircraft weighing less than 6,000 pounds traveling at under 300 miles per hour simply lacks the energy to cause significant damage. In comparison, a commercial aircraft like the Boeing 757 weighs upwards of 250,000 pounds and travels at speeds in excess of 500 miles per hour. Most experts agree in the event an aircraft similar in size to a Boeing 757 airliner were to strike a nuclear power plant, in all likelihood, it would be unable to penetrate the outer containment vessel. But, even if it did manage to do so, the reactor vessel, which contains the nuclear fuel, would remain intact, eliminating the threat of public exposure to radioactive materials.

Others have speculated a light aircraft laden with explosives might be used to breach a reactor containment building, again implying this would result in a full-scale core meltdown. Again, the capabilities of light aircraft argue against such an attack being successful. Very few general aviation aircraft have a payload as high as 1,000 pounds, even if flown by a small pilot and carrying minimum fuel. Further, the explosives would be carried in the cabin placing them at a distance from the point of impact. Modern explosives must be detonated, and impact has a small probability of causing detonation. So, even if the terrorist rigged a contact fuse on the nose of the airplane to set off the explosives, there would be several feet between the reactor building and the detonation. That distance would reduce the damage to the point that, even should the containment building be breached, there would be little damage inside (and no aircraft fuel to cause a fire). Again, such an attack would be an exercise in futility as there would be no radiation release and no public involvement.

Hypothetically, a larger aircraft (not the typical general aviation aircraft) carrying thousands of pounds of explosives may be able to penetrate the outer containment vessel of a nuclear power plant, causing severe damage to systems inside. However, this would affect an immediate shutdown of the reactor, which would remain intact in such a scenario.

It has been asserted that, "NRC recognizes aircraft crashes may result in multiple-failure initiating events, and that non-safety system malfunctions could contribute to such events." The regulations for analyzing the safety of nuclear power plants require every conceivable element that could contribute to safety degradation must be considered a "safety system." Further, nuclear power plants must be designed to prevent "single failures," no matter how they propagate, to cause loss of critical safety systems. It is inconceivable that the crash of a general aviation aircraft could accomplish such broad safety problems in a nuclear power plant.

Others have postulated that it would only take two hours after loss of "on-site power" at a nuclear facility for core damage to begin. This assumes not only loss of on-site power but also loss of standby power and loss of emergency core cooling. Piling one miniscule probability on top of another quickly stretches the limits of believability. These entities have also proposed that support systems and auxiliary buildings as also vulnerable to a successful attack. This assertion assumes that all support systems are co-located at a single point, allowing an aircraft crash to destroy everything at once. This is a simplification that serves the alarmist argument, but it is simply untrue.

Spent Fuel Storage and Unsubstantiated Risk of Fire Resulting from the Ignition of Nuclear Materials

Another possibility discussed regarding nuclear power plants involves the scenario of an aircraft crash somehow igniting the Zirconium cladding on the nuclear fuel elements. Unlike Sodium, which burns on exposure to air, or Magnesium, which ignites at relatively low temperature, solid Zirconium will not burn. Zirconium doesn't melt until approximately 3,330 degrees Fahrenheit. However, fine Zirconium shavings or dust will burn. In order to cause a Zirconium fire, it would be necessary for a terrorist to fracture the nuclear fuel cladding into small pieces before subjecting it to a source of ignition. Even assuming that the Zirconium was fragmented into chips, the spent fuel elements are either under water (upwards to 50 feet in many cases) or contained in massive shielding systems. This means that it would take an incredibly large quantity of heat to raise the temperature of the Zirconium and the surrounding shielding to the point of ignition.

Moreover, since aviation gasoline burns at approximately 2,000 degrees Fahrenheit, it would take an extended period of time to achieve the temperatures needed to ignite Zirconium shavings. A fire that persists for a long time (twenty hours has been mentioned) requires a substantial fuel source. In an open configuration, such as might take place on the ground surrounding a dry storage facility, gasoline will burn at a rate close to 1/3 inch per minute (i.e., a large pan of gasoline burning will reduce the level of the fuel in the pan about 1/3 inch per minute). Given that even the largest light

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aircraft carries less than 300 gallons of fuel, the possibility of such a condition is practically non-existent.

Further, to provide an optically opaque fire and transmit as much heat as possible, the flames have to be at least ten feet thick. Thus, to engulf a dry storage cask in flames (one model is about 10 feet in diameter, others are larger) would require a pool at least 30 feet in diameter. At 1/3 inch a minute, this would consume almost 150 gallons a minute even if there were no runoff. At that rate, a 20-hour fire would consume 400 inches of fuel, or slightly over 176,000 gallons (equaling one million pounds). Not even the largest military tanker can transport that much fuel. Using the figure of 20,000 gallons of fuel mentioned in the Markey report, a fire 30 feet in diameter would burn for a maximum of about 2.3 hours. Since light general aviation aircraft carry only a fraction of the cited fuel volume plus, considering runoff, the resulting fire from a small airplane crash would be mere minutes. The possibility of a fuel explosion igniting the Zirconium is refuted by carefully reviewing the dynamics of such an event. The temperature of a fireball is again about 2,000 degrees, but the exposure lasts for only milliseconds. This would produce insufficient heat to raise the temperature of the Zirconium more than a degree or so even if directly exposed to the fireball.

It is hard to conceive that even a deliberate attempt to continuously provide additional combustible fuel to the fire over a prolonged time could ever ignite the Zirconium cladding on the reactor fuel elements. If the combustible fuel is to be delivered by an aircraft impacting the facility, the crash will disburse the fire over a wide area, and, thus, present absolutely no hazard to the spent fuel in either the fuel pool or the dry storage casks.

Anti-aircraft Defense Unwarranted and Ineffective

One of the most unreasonable ideas presented to the public calls for anti-aircraft capabilities around nuclear power plants. The idea begs careful analysis focused on the potential for the unintended consequences of shooting down an innocent civilian aircraft. The claim that other countries have adopted this strategy does little to quell the fears of general aviation pilots or the air traveler. The volume of general aviation traffic and the freedom with which it is utilized is unique to the United States, rendering such comparisons of little value. The entire concept is flawed for a more significant reason. The federal government has a finite amount of capital available to protect its citizens, and, when it is spent in support of irrelevant strategies (leaving the more critical considerations unprotected), the nation becomes far more vulnerable to terrorist threats.

Attack by Light General Aviation Aircraft Impractical

General aviation aircraft would prove ineffective in an attack, similar to those carried out on September 11th. The World Trade Center towers and the Pentagon were large, conspicuous landmarks and, as such, were more easily targeted in an aerial attack than would be a nuclear power plant. The success of these attacks was predicated on the use of large, turbine-powered commercial aircraft with immense fuel carrying capacity. A general aviation aircraft, at only a fraction of the weight, speed and fuel load, would be unable to inflict damage on the scale witnessed on that tragic day.

In spite of this fact, concerns have been raised regarding the perceived threat of general aviation to nuclear power plants. For example, it was reported that 21 power plants lay within five miles of an airport, implying that these airports present an inherent threat based on their proximity to nuclear power plants. Common sense would dictate that proximity is hardly the issue in such cases. It is unlikely that a terrorist would rule out a given target based on the travel time involved in reaching it. The reality is that the proximity of these power facilities to active airfields does not increase their exposure to terrorist threats.

However, since the point has been raised, these airports (many of which are small general aviation facilities) serve as excellent examples as to why general aviation is not a threat. The light aircraft flown into small general aviation airports throughout the United States are ill suited for terrorist use, given they lack the weight, speed, fuel and load carrying capacity to do significant damage to a target.

Of the 23 airports listed in the government study, five are so small that they do not even appear in AOPA's *Airport Directory, a comprehensive compendium of civil airport data.* Eleven of the airports are small private airstrips, most with turf (unpaved) runways. Five of the airstrips have runways too short to permit operations by large, turbine-powered aircraft. In reality, only two of the airports listed in the report have runways large enough to allow operation by large, transport-category aircraft. One of these is located proximate to the Three Mile Island facility in Harrisburg, Pennsylvania, which was specifically designed to sustain an impact from a large aircraft. The Markey report implies to a large degree that nuclear security concerns rest squarely with general aviation. However, scientific evidence to the contrary demonstrates that the concerns raised have no basis in fact and are completely unwarranted.

Conclusion

General aviation is a safe and important part of the United States transportation system. For the reasons cited in this report, it is unlikely that a terrorist would choose a light, general aviation aircraft to threaten a nuclear power plant. The result of such an endeavor would fail to produce the damage necessary to cause any radiological involvement of the public. Certainly, if a terrorist organization were inclined to undertake such an effort, a light aircraft would quickly be dismissed as a possible vehicle due to its impracticality.

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