NUCLEAR INFORMATION AND RESOURCE SERVICE

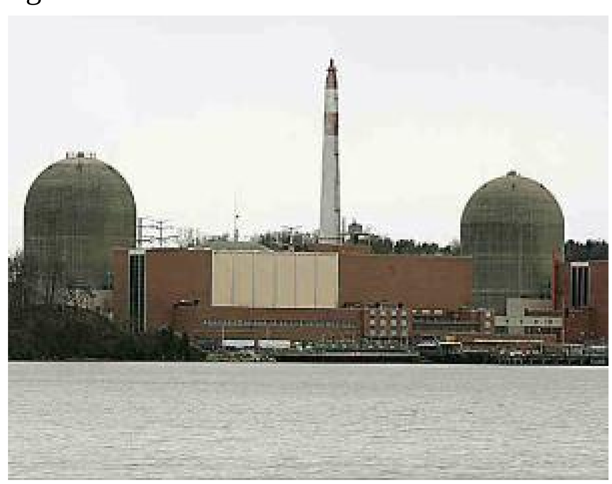
6930 Carroll Avenue, Suite 340, Takoma Park, MD 20912
301-270-NIRS (301-270-6477);

BRIEFING PAPER ON EMERGENCY PREPAREDNESS AT U.S. NUCLEAR REACTORS

About one-third, or roughly 120 million Americans, live within 50 miles of a nuclear power plant—the distance from the Fukushima reactors that the Chairman of the Nuclear Regulatory Commission (NRC) advised U.S. citizens to evacuate in March 2011. Yet only a small fraction of these Americans would be evacuated during a similar accident in the U.S., where NRC regulations call for Emergency Planning Zones of only 10 miles around nuclear reactors. Given the disasters at both Chernobyl (which also caused widespread evacuation) and Fukushima, the NRC can no longer reasonably state that its existing regulations, formulated after the Three Mile Island accident in 1979, are adequate to protect the public.

Emergency Planning History:

Concern about emergency planning zones has risen over the years, but has been heightened since the Fukushima disaster and the recommended evacuation of U.S. citizens within 50 miles of the nuclear power plant. In citing their rationale in implementing a 50-mile evacuation, U.S. officials stated that the recommendation reflects advice that the Nuclear Regulatory Commission would give if a similar accident were to occur in the U.S. This rationale seems puzzling given the fact that currently the evacuation plan for a nuclear disaster in the United States requires that only those areas within a 10 mile radius around a nuclear power plant must be evacuated.
After the accident at Three Mile Island the federal government established task forces and committees to determine the threat to residents living near nuclear reactors. The U.S. Nuclear Regulatory Commission and the U.S. Environmental Protection Agency determined that radiological emergency response plans should be implemented pursuant to any licensing of a new nuclear power plant. The regulations that were established as a result of the joint task force are outlined in 10 C.F.R. 50.47(c)(2), and created an Emergency Planning Zone (EPZ) of about 10 miles around U.S. reactor sites and an Ingestion Pathway Zone for the identification and interdiction of contaminated food and water within 50 miles of a nuclear reactor. These regulations have not be



Indian Point Nuclear Plant is 38 miles north of New York City--a Fukushima-sized disaster would have a direct effect on some 20 million people within 50 miles of the reactor.

amended or changed since its codification in 1980, and in the thirty plus years since the passage of the rulemaking several changes have occurred that necessitate expanding the emergency planning zones beyond their current respective radiuses.

Changes in population, the age of the reactors, differing weather patterns and increased incidents of natural disasters require that the rule take into consideration that the rulemaking has become antiquated and should be amended to reflect these changes.

<u>What History Has Taught Us: Nothing</u>

Two catastrophic nuclear disasters have demonstrated that evacuating a zone merely within 10 miles of a nuclear reactor would not be sufficient. Chernobyl and Fukushima both expelled radiation in large quantities and over long durations. Additionally, a recent rash of natural disasters has also caused concerns about nuclear emergency planning zones.

Chernobyl:

On April 26th, 1986 Chernobyl, a RBMK water cooled graphite moderated nuclear power station 80 miles north of Kiev, Ukraine, exploded causing a super-hot plume of radioactive smoke and gas to escape the reactor. The explosion resulted from a sudden power outage during a systems test, causing the reactor vessel to rupture and lead to a series of explosions. The effects of the explosion at Chernobyl have been severe and long lasting. The 18 mile radius surrounding the reactor has been labeled a “dead zone,” and is expected to remain uninhabitable for several hundred years. The explosion has caused increased incidents of cancer in the residents of Ukraine, Belarus and Russia. Evacuation for Chernobyl began on April 27, with 53,000 people vacating the 18 mile zone around the nuclear reactor. However, areas up to 500 kilometers away in neighboring Belarus remain uninhabitable. Between 1986 and 2000 more than 350,400 people were evacuated in the areas surrounding Chernobyl .

Chernobyl evacuations began on April 27, 1986 with Pripyat and the nearby village Yanov. On May 2, 1986 evacuations were ordered for villages beyond the 10 kilometer zone surrounding Chernobyl to include villages within 30 kilometers of Chernobyl. Eventually, evacuations spread over the years as far as 200 miles away from the reactor. Between the years 1986 and 2000 approximately 350,400 people were evacuated from the areas surrounding Chernobyl.

Fukushima:

On March 11, 2011 the Great East Japan Earthquake, a 9.0 magnitude rated earthquake, occurred 130 kilometers off the coast of Japan. Approximately 40 minutes after the earthquake initially occurred, the earthquake triggered a 27 foot tsunami which struck the Fukushima Dai-ichi Nuclear Power Plant. The tsunami inundated and flooded the site causing extensive damage and complete loss of ac electrical power at 5 out of the 6 reactor units. Evacuation efforts began first in a three-kilometer zone, which was quickly expanded to 10 kilometers and then a 20 kilometer radius around Fukushima Dai-ichi. By March 12, 2011, 140,000 people had been evacuated from the area. On March 15, 2011 U.S. NRC Chair Greg Jazcko urged Americans within 50 miles of the Fukushima Dai-ichi plant to evacuate. This was followed by a similar statement from the U.S. State Department. Over the following months, numerous hotspots have been found throughout north-central Japan, 100 miles and more from the Fukushima Dai-ichi site. On August 21, 2011 the New York Times published an article stating that a large zone immediately surrounding the plant will be labeled a dead zone and will be uninhabitable for decades.

On August 31, 2011 the Japanese government revealed that 34 locales surrounding Fukushima have higher levels of radiation than the Chernobyl threshold. The threshold for radioactive contamination in Chernobyl was 1.48 million becquerels per square meter, the

Japanese government found levels of deadly cesium-137 in excess of this threshold which renders these locations completely uninhabitable. The area surrounding Fukushima Dai-ichi is not becoming less dangerous, but appears to be only growing more dangerous.

Seven months after the Fukushima Dai-ichi accident 29 million cubic meters of soil remained contaminated and radiation levels had to be brought down in a 2,400 square kilometer radius around Fukushima.[1] The United States Department of Energy published projections of the radiation risks for the next year, and potential exposure is expected to exceed 20 mSv/year in some areas up to 50 kilometers away from the plant. At that level in the United States, relocation would be considered, and it is the level that would cause roughly one extra cancer case in 500 young adults.[2] The Japanese government has downplayed the risks and dangers associated with this disaster. Indeed, a new study that was issued in October 2011 demonstrated that high levels of radioactive contamination were found up to 60 kilometers from the plant.[3] The researchers, Friends of the Earth Japan and Citizens Against Fukushima Aging Nuclear Power Plants, urged the government to order evacuations in that area, stating that soil contamination measured more than 30 times higher than current government safety standards.

[1] http://www.guardian.co.uk/business/feedarticle/9877986

[2] "Radiological Assessment of effects fom Fukushima Daiichi Nuclear Power Plant". United States Department of Energy. 16 April 2011.

[3] http://www.voanews.com/english/news/asia/east-pacific/New-Study-Shows-High-Radiation-60-Kilometers-from-Japanese-Power-Plant----131136508.html

<u>Other Inadequacies:</u>

Better Understanding of Severe Accident Risks:

In the 30 years since the NRC promulgated the emergency planning regulations, government studies have demonstrated that the risk of severe reactor and spent fuel pool accidents is greater than previously considered by the NRC.

Beginning in 2006, the NRC began the State-of-the-Art Reactor Consequence Analyses (SOARCA) project to evaluate the "realistic consequences of a severe reactor accident."[4] In determining what the consequences of a severe accidents will be, the SOARCA team uses several accident modeling techniques, such as selection of the accident scenario, accident progression and mitigation measures, offsite release of radioactive materials, emergency response and health effects. The SOARCA process requires that an accident scenario is selected, and then the progression of the accident is modeled, if there is no core damage or release or alternatively if there is core damage but containment prevents release, then according to the process then there are no health consequences that should be modeled.[5] Alternatively, if the containment does not prevent the release of radioactive materials, then the dispersion of materials, emergency planning and health consequences must be modeled. Concerns have been voiced by NRC employees that some of the strategies employed by SOARCA modeling have not been reviewed to ensure that they actually mitigate severe accidents.[6] Specifically, that the post 9/11 procedures or B.5.b measures, as they are also known, which are believed to mitigate severe accident scenarios such as aircraft impact might not mitigate such severe accidents.[7]

Irradiated fuel pools also pose serious threats and can cause severe accidents. When fuel rods in a nuclear reactor are "irradiated" or no longer usable, they are removed from the reactor core and replaced with new fuel rods.[8] However, these rods continue to generate heat for many years and are placed in pools of water to cool. In theory, this form of storage is meant to be temporary.[9] But, because offsite storage of irradiated fuel is currently unavailable, high density storage of this material has been permitted to occur. [10] These densely packed pools create a situation where cooling them would be incredibly difficult. In the case of a loss of water in the pool, convective air cooling would be relatively ineffective in such a "dense-packed" pool.[11] Irradiated fuel recently discharged from a reactor could heat up relatively rapidly to temperatures at which the zircaloy fuel cladding could catch fire and the fuel's volatile fission products, including 30-year half-life 137Cs, would be released.[12] The fire could well spread to older irradiated fuel.[13] The long-term land-contamination consequences of such an event could be

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[4] The SOARCA Process, updated Mar. 31, 2011, http://www.nrc.gov/about-nrc/regulatory/research/soar/soarca-process.html

[5] http://www.nrc.gov/public-involve/conference-symposia/ric/past/2011/docs/abstracts/santiagop-h.pdf

[6] UCS FOIA Request, http://www.ucsusa.org/assets/documents/nuclear_power/foia-1.pdf

[7] Id.

[8] "Safer Storage of Spent Nuclear Fuel, The Problems with Spent Fuel Pools," last revised Mar. 24, 2011. http://www.ucsusa.org/nuclear_power/nuclear_power_risk/safety/safer-storage-of-spent-fuel.html

[9] Id.

[10] Alvarez, Robert. "Reducing the Hazards from Stored Spent Power Reactor Fuel in the United States," http://www.ips-dc.org/reports/reducing_the_hazards_from_stored_spent_power-reactor_fuel_in_the_united_states at pg. 2

[11] Id.

[12] Id.

[13] Id.

significantly worse than those from Chernobyl. Aside from concerns associated with the dense packing of a pool, the pools themselves are located outside of the primary containment which is designed to keep radiation which is released during an emergency event from escaping in to the environment.[14] Because they are outside of the primary containment structure, they are more vulnerable than the core to natural disasters and terrorist attacks.

In October 2010 the NRC drafted a report discussing a hypothetical severe accident at a nuclear power plant in Pennsylvania very similar to the one at Fukushima Dai-ichi. The report was part of a study called the State of the Art Reactor Consequence Analyses (SOARCA). The goal of SOARCA was to provide "realistic analysis of severe reactor accidents." The study determined that in a 50 mile radius of an accident, nearly 1000 cancer deaths would occur on average. This study only looked at the best case scenario of a nuclear power plant accident and failed to take into consideration differing weather patterns and worst case scenario situations. If weather was worse or the worst case scenario was to occur, then results could be 10 times ~~at~~ that average value or higher. Additionally, the figures on cancer deaths were largely based on the assumption that everyone would evacuate within 20 miles of a nuclear reactor—an unsupportable assumption given the current 10 mile Emergency Planning Zone. However, if not everyone could evacuate from the region in time, then cancer figures would be increased again.

Failing to Take into Account Human Evacuation Behavior:

During emergencies, human behavior will deviate from the plans have been established. Not everyone will follow the explicit instructions delineated in the REPs, and some people will evacuate beyond an EPZ, even if they are told not to. By having two separate zones of plume exposure pathway emergency areas, the evacuation could be staggered. Additionally, sirens would only be located within the Emergency Evacuation Zone, and they would be evacuated first. Subsequent evacuations beyond that will have significantly more time to evacuate after the Emergency Evacuation Zone has left.

Currently as it stands, children and elderly individuals are bussed from schools or nursing homes to the evacuation centers. These individuals are in a fragile class because they cannot transport themselves without the aid or assistance of others. If bus drivers wait too long before mobilizing and moving these people, they risk greater harm. Because the dangers of exposure to radiation can be very high within 30 minutes of release, bus drivers should be ready to mobilize quickly and early when the alert is given. Seasonal changes for schools and day care centers should be considered. This may increase the time to evacuate a facility if return trips are necessary. Other considerations should be given to the fact that these personnel are not trained emergency personnel in the same manner as a police officer or firefighter. More training of these personnel and/or exploring having dedicated emergency personnel assigned to the task should be considered.

Additionally, current REPs require that parents with school aged children refrain from picking up their children directly from a school facility. Rather, REPs state that to "avoid further confusion" parents should pick up their children from a pick up center that the school will transport them to. This requirement fails to take into consideration the fact that most parents will disregard these instructions, and will choose to be with their children, and pick up their children personally in the event of an emergency.

In many, perhaps most cases, emergency evacuation centers are located too close to existing reactor sites, which could force people to receive unnecessary radiation doses in order to

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[14] "Safer Storage," http://www.ucsusa.org/nuclear_power/nuclear_power_risk/safety/safer-storage-of-spent-fuel.html

pick up their children and loved ones. At Fukushima, for example, some residents close to the reactor site were evacuated to an area outside the initial evacuation zone (near the town of Iitate) that actually had higher radiation readings than the area they had left. Emergency evacuation centers must be located outside the 25-mile EPZ.

Failing to taking into Account Increased Populations:
Limiting the radius of evacuation fails to take into account large scale accidents, such as Chernobyl and Fukushima, and would cause more confusion, gridlock and injuries than if plans were already in place to evacuate a larger area. Large and rapid development has spread closer to the areas around nuclear power plants which would further complicate evacuation. In some instances population growth in these areas has increased exponentially. According to a report by the Associated Press[15], the most explosive growth occurred around the two-reactor Saint Lucie complex near Fort Pierce, Fla., where the 10-mile population of 43,332 in 1980 grew 366 percent to 202,010 in 2010. Others in the top five: the two-unit Brunswick complex near the North Carolina coast, which increased 326 percent from 8,164 to 34,782; Monticello, 35 miles from Minneapolis, where population rose 314 percent from 14,130 to 58,538; the two-unit Turkey Point site, 20 miles south of Miami, up 302 percent; and the two-unit San Onofre facility in San Clemente, Calif., up 283 percent.

In 2004, the NRC issued a study created by Sandia Laboratories relating to NUREG/CR-6863 entitled “Development of Evacuation Time Studies for Nuclear Power Plants.”[16] The suggestions made in the report discussed ways in which evacuation times could be enhanced. One of the concerns expressed in the report related to commuters and transient populations that may not live in the 10 mile EPZ but may nevertheless be there for work or other purposes. The report found that in addition to the three defined population groups, returning commuters and vehicles traveling through the area during the event should also be considered. Returning commuters include permanent residents who work outside the EPZ and return home before evacuating as a family group. Residents of the EPZ who are not at home (i.e., shopping, at parks, etc.) at the time of the evacuation notice may also return home prior to evacuating. The ability of the road network to service vehicle demand is a major factor in determining how rapidly an evacuation can be completed. The capacity of a road is defined as the maximum rate at which vehicles can be expected to traverse a section of a lane of roadway during a given time period under prevailing roadway, traffic, and control conditions.

In response to the burgeoning populations around nuclear power plants, the NRC announced that it would be utilizing information gathered every ten years through United States Census surveys. This rule has not been promulgated fully yet, but Radiological Emergency Preparedness (REP) plans should take into account changes in population by using the 2010 census in emergency preparedness exercises and quickly updating emergency plans with every census. By using more current population data emergency planning could determine the best roads possible to be used in the event of an evacuation, rather than roads that may be clogged or jammed due to excessive traffic.

Failing to take into account variable scenarios during drills/exercises.
Offsite accidents are regulated by the NRC and FEMA. All nuclear power facilities are required to participate in full scale emergency exercises every two years. In the off years when exercises are not conducted, drills are given to determine how plants are complying with federal

[15] http://www.msnbc.msn.com/id/43529122/ns/us_news-environment/t/us-nuclear-evacuation-plans-havent-kept-population/
[16] http://pbadupws.nrc.gov/docs/ML0502/ML050250240.pdf

regulations. As part of the current regulations, utilities in conjunction with state and local governments must undertake safety exercises which the NRC and FEMA oversee under the Radiological Emergency Preparedness (REP) program. When an exercise is conducted, the power plant operators and personnel are given a scenario requiring emergency response and are graded for their response to the emergency. Little information is available about whether a respective plant varies the emergencies or if they are given the scenarios in advance. If plants do not provide operators with a full spectrum of possible accidents or give them the scenario in advance to aid in preparation, a plant will not be adequately prepared for an emergency.

Emergency preparedness drills and exercises should include incidents relating to natural disasters. In recent years weather patterns have grown increasingly more extreme and dangerous. Examples of this include droughts, flooding, blizzards, earthquakes and hurricanes. The earthquake and subsequent tsunami that destroyed the Fukushima plant demonstrate that natural disasters can cause serious nuclear emergencies. The United States is not immune to similar natural disasters. In the month of August 2011 alone both an earthquake and a hurricane caused damage to U.S. nuclear reactors, demonstrating the need to reconsider and expand emergency planning zones. Indeed, information has come to light from individuals who work and live in Fukushima that the cause of the reactor meltdown may not have been inundation of water as previously assumed, but rather from the earthquake.[17] Given the fact that the earthquake at North Anna exceeded design capabilities, the NRC can no longer state that such events are unlikely to occur here in the U.S.

In addition, natural disasters complicate effective evacuation: roads may be inundated or otherwise impassable, communications may be disrupted, mass transit may be closed when needed most. Adverse weather conditions can significantly reduce not only roadway capacity but also operating speed resulting in increased emergency evacuation time. The Highway Capacity Manual (HCM) provides a means to calculate reduction in capacity for adverse weather using speed flow curves for differing weather conditions. Development of the ETE should include local or regional data available on traffic congestion during adverse weather (e.g., rain, snow, ice, and fog) and the known or anticipated traffic congestion that occurs during these events.

Health Risks from Staying in the 50 mile reactor zone:

There is no "safe" dose of radiation. The National Research Council of National Academies' BIER VII Report in 2005 confirmed that any exposure to radiation – including background radiation – increases a person's risk of developing cancer.[18] For example, Japan has been criticized internationally for increasing its allowable radiation exposure levels for the general public twenty-fold from pre-Fukushima standards to 20 MilliSieverts/year (2 rems/year), apparently to avoid much larger evacuations/relocations than already undertaken.

Even so, this 2 rems/year level is considerably lower than the Protective Action Guide (PAG) of an emergency response goal of preventing exposure to 5 rems/year. Given BEIR VII, this PAG is hopelessly outdated and indefensible. For example, BEIR VII clarifies that women and children are much more susceptible to radiation exposure than the "average man," which is what the PAG considers.[19] Indeed, according to BEIR VII, exposure to 2 rads in a single year (roughly equivalent to the new Japanese standard of 20 MilliSieverts or 2 rems in one year) will cause cancer in about 1 in 200 juvenile males, and the same exposure will cause 1 cancer in

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[17] http://www.independent.co.uk/news/world/asia/the-explosive-truth-behind-fukushimas-meltdown-2338819.html

[18] http://www.psr.org/assets/pdfs/fukushima-and-chernobyl.pdf

[19] Biological Effects of Ionizing Radiation (BEIR) VII, Phase 2 report, "Health Risks from Exposure to Low Levels of Ionizing Radiation" Table 12D-3 on pg. 312, Published by the National Academy Press in 2006, Washington D.C.

about 100 juvenile females.[20] Given the Linear No-Threshold model adopted by BEIR VII, the PAG guideline of 5 rems would cause cancers at more than double those rates for children.[21]

Radiation exposure would be significantly worse if there were to be an irradiated fuel pool accident in addition to a reactor accident. The irradiated fuel pools can hold 5 to 10 times more long lasting radioactive material than the reactor core. The NRC has already stated that the effects of radiation could be felt as far away as 500 miles.[22] According to former Department of Energy official Robert Alvarez, nearly 40 percent of the radioactivity in U.S. spent fuel is cesium-137 (4.5 billion curies) — roughly 20 times more than released from all atmospheric nuclear weapons tests. U.S. spent pools hold about 15-30 times more cesium-137 than the Chernobyl accident released.[23]

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[20] BEIR VII, Phase 2 Report, Table 12D1-12D2, pg. 311. BEIR VII, page 311, Tables 12D-1 (incidence) and 12D-2 provides conclusions on the exposure of various age groups to .1Gy of radiation, reported per 100,000 exposed. Because of the clear difference in gender response to radiation, NIRS finds it important to report the findings for both males and females. The most vulnerable require the greatest protection, so we report the numbers for the youngest, most vulnerable age group, adjusted for the 20 mSv comparison.

[21] Id.

[22] http://www.washingtonpost.com/wp-dyn/content/article/2011/03/17/AR2011031701214.html (The figure is derived from a study issued in 2000 by the NRC regarding a hypothetical event).

[23] Alverez, Robert. “Spent Nuclear Fuel Pools in the U.S.: Reducing the Deadly Risks of Storage.” http://www.ips-dc.org/reports/spent_nuclear_fuel_pools_in_the_us_reducing_the_deadly_risks_of_storage