Comment to the proposed rule on the
AP1000 Design Certification Amendment
Docket ID NRC-2010-0131
As noticed in the Federal Register on February 24, 2011

Report Prepared for Friends of the Earth
By Chief Engineer Arnie Gundersen
Fairewinds Associates, Inc
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Introduction and Background

This report, prepared by Fairewinds Associates, Inc for Friends of the Earth, is being submitted as a comment to the proposed rule on the *AP1000 Design Certification Amendment*, Docket ID NRC-2010-0131 as noticed in the Federal Register on February 24, 2011[1]. Fairewinds' comments, which are of a technical nature and merit close scrutiny, support the position that issuance of a notice of rulemaking is premature and that approval of the design certification of the AP1000 reactor is not warranted.

Prior to the nuclear power plant accidents at Japan's Fukushima Boiling Water Reactors (BWR's), intervenors, NGO's, expert witnesses, industry insiders, and staff members within the Nuclear Regulatory Commission (NRC) had expressed significant doubts about the integrity and rigor of the proposed AP1000 design. To this date, the NRC has not adequately addressed the issues raised.

During the fall of 2009, Fairewinds Associates, Inc was retained by the AP1000 Oversight Group to independently evaluate the proposed design of the Westinghouse AP1000 nuclear power plant. Following six months of research and peer review, Fairewinds Associates prepared and submitted an expert report entitled *Post Accident AP1000 Containment Leakage, An Unreviewed Safety Issue*[2] to the AP1000 Oversight Group, which in turn submitted that report to the NRC. Subsequently, Fairewinds' Chief Engineer Arnie Gundersen and AP1000 Oversight Group Attorney John Runkle were invited to present their concerns to the NRC's Advisory Committee on Reactor Safeguards (ACRS) June 25, 2010. Subsequently, the AP1000 Oversight Group submitted the Nuclear Containment Failures: Ramifications for the AP1000 Containment Design supplemental report December 21, 2010. The two reports, the associated power point, and the June 25, 2010 presentation to the NRC coordinated with the NRC meeting audio may be found at Fairewinds Website under the reports and multi-media tabs.

Is Zero Percent Leakage Reasonable?

Both the NRC in its regulatory role and Westinghouse as the design engineer have declined to adequately scrutinize or calculate the reality of containment failure and leakage in the single-wall

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[1] *AP1000 Design Certification Amendment*, Docket ID NRC-2010-0131
http://edocket.access.gpo.gov/2011/2011-3989.htm

[2] Fairewinds Associates' website: fairewinds.com

containment structure upon which the proposed AP1000 design is predicated. Nuclear power industry operating experience during the past 40 years indicates repeated instances where containments have developed failures. Despite these repeated incidents, the Nuclear Regulatory Commission assumes that the probability of containment failure or leakage during operation of the AP1000 design is zero. In complete defiance of more than 40 years of actual nuclear power industry operating experience, the Nuclear Regulatory Commission perpetuates the myth that nuclear power plant containments do not fail and leak radioactivity. Thereby the regulatory agency continues to approve the faulty design features of the highly touted and fast-tracked AP1000 design by claiming that such containment failure never occurs.

Well before the proven inadequacy and even possible complete rupture of at least three separate nuclear power plant containment systems at Japan's troubled Fukushima nuclear power plant, the NRC's assumption of a zero failure rate diametrically opposes all historical data and sound engineering analysis on record. Fairewinds Associates has analyzed containment probabilities dating back more than 40 years and has detailed the history of containment failure and leakage in several reports submitted to the NRC and presented in person to the NRC Advisory Committee on Reactor Safeguards (ACRS). We have attached those reports to this filing, and while we will not currently review them in detail, we are submitting the following conclusions as part of this evidentiary report.

Five Containment Failure Modes:

1. There are numerous instances of containment failure where rust has developed on the outside of the containment building and progressed all the way from its outside origin through the wall to the inside of the containment. None of these failures were identifiable during any visual examination until the holes had propagated completely through the containment wall.

2. There are numerous instances of containment failure at which time rust developed on the inside and progressed from inside-out all the way through the wall to the outside of the containment. Once again, these actual containment breakdowns and failures could not be identified by any method of visual examination until the actual hole had propagated completely through the

containment system.

3. Fairewinds' analyses has shown that these phenomena are not just limited to through-wall rust and holes. The nuclear power industry data has numerous examples of containment failure where actual cracks have developed and propagated completely through the containment. These cracks were not identified by visual examinations, and instead were only uncovered when the actual crack propagated completely through the containment system.

4. Protective coatings are often touted by the nuclear power industry as a solution to containment cracking, holes, and leakage, but protective coatings do not perform as well as the nuclear power industry claims. Instead, there are numerous instances in which protective coatings have failed and were not identified by inspection personnel for significant periods of time, thus not protecting the public from containment leakage. Additionally, personnel who apply protective coating have been harassed and intimidated by industry executives for bringing their coating concerns to management's attention.

5. The nuclear power industry also claims that the visual inspection technique upon which the industry relies assures complete containment integrity. In actuality, the inspection procedures heralded by the nuclear power industry have repeated failed to identify cracks, holes and containment coating deterioration until gross degradation has already occurred.

NRC Uses Flawed Data

Based upon a thorough analysis containment failure and degradation as delineated in this report in points 1 to 5 listed above, Fairewinds concludes that there is a finite probability of a containment failure or containment leakage in the AP1000 design. Fairewinds' conclusion was reported to the NRC and ACRS prior to the very real containment failure and leakage evidenced at Japan's Fukushima nuclear power plants. Yet, despite actual evidence to the contrary, the Nuclear Regulatory Commission continues to allow Westinghouse to assume and calculate a zero percent (0%) probability of containment degradation leading to failure or leakage even

without an accident scenario, let alone from additional stress during a LOCA (Loss of Coolant Accident). Such claims are not based upon sound scientific analysis and engineering review, but appear instead to be based upon the mythical dreaming of an aggressive industry and its captive regulator. Moreover, throughout the AP1000 docket there is no supporting documentation proving Westinghouse's SAMDA analysis and the NRC's endorsement of that SAMDA claiming that there is a zero percent probability of containment failure.

On June 28, 2010, three days after the ACRS meeting, Fairewinds Associates, Inc informed the ACRS of *yet another containment failure*, this time at the Fitzpatrick nuclear power plant in 2005. The photo below of the 4 ½" crack was taken in 2005 from the outside of the containment torus at the Fitzpatrick nuclear power plant in Oswego, NY.

As a result of questions during the ACRS discussion period relating to BWR thick containment designs like the through wall cracks at Hatch 1 and 2, Fairewinds researched additional failures

and found that the Fitzpatrick nuclear power plant developed a large though-wall leak that was not due to corrosion. Once again, here is a unique violation of the BWR containment system that is directly applicable to the Westinghouse design of the AP1000.

The Fitzpatrick crack is due to differential expansion in a thick containment that is of similar thickness to the proposed AP1000 design and like the cracks previously uncovered at Hatch 1 and Hatch 2. Thus to date, three thick containment systems have experienced complete through-wall failures that remained undetectable by ASME visual techniques until each through-wall crack actually appeared. Similar stresses resulting in cracks could also occur in an AP1000 nuclear power plant if it is constructed to the current inadequate specifications.

Immediately after Fairewinds provided these photos and detailed analysis of the AP1000 design to the ACRS and without detailed analysis of any kind, either the NRC staff or members of the ACRS itself leaked their opinion to pro-nuclear bloggers stating that Fairewinds analysis was incorrect. While Fairewinds has never had the privilege of a detailed NRC response, the NRC used its typical backchannel communications with its friends in the nuclear industry in an attempt to discredit the veracity of the Fairewinds report. When Fairewinds issued its report discussing the critical safety flaw of *the chimney effect,* Westinghouse immediately issued a press release ignoring all of Fairewinds peer-reviewed data and instead attempted to impugn integrity of Fairewinds Associates. And, rather than analyze the Fairewinds report, the NRC apparently read the Westinghouse press release and simply parroted those words to back to the pro-nuclear bloggers. The April 29, 2010 edition of *Nuclear Engineering International* quotes the Westinghouse cover-up:

> Westinghouse spokesman Vaughn Gilbert responded vigorously to the claims:
>
> We disagree completely and unequivocally with every conclusion that was put forward. We are certainly never surprised when an antinuclear group with an antinuclear agenda puts forth antinuclear comments. The reality is that the steel in question is 1.75 inches thick, it is corrosion-resistant, and it is highly unlikely corrosion would ever be an issue. Contrary to what they reported, if corrosion were to begin, it would be quickly discovered in a manner that is prompt and appropriate, and it would be remedied before it would come close to being a problem. The announcements were plain and simple wrong.[3]

[3] April 29, 2010 edition of *Nuclear Engineering International*
http://www.neimagazine.com/story.asp?storyCode=2056229

In its jaundiced statement to *Nuclear Engineering International,* Westinghouse attempts to ignore the real findings of Fairewinds' analysis by attempting to obfuscate the truth. By mischaracterizing accurate scientific analysis and thorough engineering review by trying to label it as anti-nuclear comments, Westinghouse follows the 60-year-old pattern of the nuclear industry. Whenever it is confronted with engineering errors and debacles, the industry shouts to the rooftops that whoever criticizes them is a rabid anti-nuke. The acceptance of such innuendo and slander by the NRC staff and the ACRS rather than doing what it is chartered to do by Congress and conduct a thorough overall safety analysis of the AP1000 design shows its industry bias and capitulation to industry pressure for a fast-tracked process of a new and inadequately reviewed AP1000 design.

Despite historical data and reams of analysis indicating that containment failures do in fact occur, the NRC has repeatedly ignored these facts and has not responded to Fairewinds' analysis delineating existing containment failures. Fairewinds requests a complete and thorough review of this critical design-basis safety flaw.

As Fairewinds has already stated, the NRC has not adequately analyzed the *unreviewed safety issue* Mr. Gundersen identified on the AP1000 regarding containment leakage. The current AP1000 design is not consistent with very basic "defense in depth" and "multiple barrier" principles to which the NRC must adhere by statute. Information available to Fairewinds shows that the NRC appears not to understand that unlike on current PWRs, the shield building on the AP1000 *does NOT* function as a secondary containment. Quite simply, the AP1000 shield building does not prevent the release of radiation to the environment; it is not a secondary containment building.

The December 10, 2010 *Nuclear Engineering International*, indicates just how widespread the false belief is throughout the entire nuclear industry that the AP1000 has both a primary and a secondary containment system.

> The amended design includes a redesigned AP1000 Shield Building, a massive armored structure made of concrete and steel that protects the containment vessel from external forces, such as tornado-driven objects, earthquakes and aircraft

impact. It also acts as a secondary radiation barrier… [4]

The *Nuclear Engineering International* article emphasizes the factually incorrect conclusion that the shield building "also acts as a secondary radiation barrier".

As Fairewinds stressed to the NRC more than one year ago, not only does the shield building not serve as a secondary radiation barrier during a severe accident, which is when it would be critically needed to perform that function, but also through the "chimney effect", it actually aids dispersal of any radioactivity that leaks from the primary containment.

That this prestigious nuclear magazine could so visibly misunderstand the purpose of the shield building is an indication why so many engineers working on this project or reviewing the AP1000 for licensure have not understood this basic safety flaw. Once again, for the record, the AP1000 shield building does not function as an additional radiation barrier in the event of an accident.

Issues Proven by Fukushima Accidents

Given the failure of three containment systems at Japan's stricken Fukushima nuclear power plants, it is imperative that the NRC reevaluates the new AP1000 design in light of its potential for containment failure. The AP1000 shield building vents directly to the outside environment and was never designed to be a secondary containment system. As Fairewinds Associates notified the NRC more than one year ago, the AP1000 shield building was never designed as a secondary containment system. Moreover, not only will the shield building not contain any radioactivity in the case of an accident, the shield building creates what Fairewinds has named *the chimney effect*, and actually wafts radiation out into the environment, which will significantly compromise the surrounding population during an accident.

Although final data from the multiple Fukushima nuclear power plants are not yet available, it is readily apparent that the Fukushima nuclear plants, which are the same BWR Mark 1 model as many US plants, are suffering cataclysmic containment failure and leakage.

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[4] December 10, 2010 *Nuclear Engineering International*
http://www.neimagazine.com/story.asp?storyCode=2058414

- Fukushima Unit 2 has a containment system that has failed completely and is allowing highly radioactive releases from inside the containment to freely enter the environment.

- Fukushima Unit 1 has also suffered a loss of containment integrity as evidenced by Tokyo Electric Power Company's (TEPCO's) continuous addition of gaseous nitrogen in an effort to reestablish containment integrity and pressure without success.

- While data from Fukushima Unit 3 is inconclusive, there is also evidence that Unit 3's containment has also been breached.

Consequently, during just the last two months, three allegedly robust nuclear containment systems have failed entirely. If such a containment breach, failure, or leakage were to occur in the new AP1000 design, the results would be catastrophic for the surrounding communities. In prior reports and testimony, Fairewinds Associates has already identified the AP1000 chimney effect that would waft enormous amounts of radiation out of the reactor and into the surrounding communities. Given that there is 40 years of data indicating a bevy of containment failures in nuclear power plants operating within the United States, and given that there are now three Japanese nuclear power plants that have failed containment systems in Fukushima, it is obvious that the NRC's acceptance of a zero percent (0%) probability of containment failure is not only mathematically and historically incorrect, but appears to prove that the NRC is failing in its regulatory role.

Furthermore, it is now evident that a detonation shock wave (not deflagration) occurred at Fukushima Unit 3, destroying much of the structure. The AP1000 containment is not designed to withstand a detonation shock wave. Until the cause of the detonation is determined, design approval of the AP1000 containment should not be granted. Once again, Fairewinds reiterates that the "issuance of a notice of rulemaking is premature and that approval of the design certification of the AP1000 reactor is not warranted".

AP1000 Is Only A Simulated Design

Fairewinds has great concern regarding the AP1000 design that has only been simulated on a limited Computer Aided Design (CAD) program. Neither the shield building nor the containment building have been constructed in verification of the their computer simulated

design analysis. In fact, the AP1000 shield building technique has never been used in the United States on any comparable structure. Previously, the NRC demanded full scale testing of the Mark 3 BWR containment in the mid-1970's due to its unique design. However, the NRC has required no full-scale tests on the unique AP1000 containment design. Furthermore, Fairewinds Associates' review has uncovered analytical problems with the containment design computer codes applied to both the AP1000 containment analysis and the analysis of the AP1000 shield building.

Careful analysis by Fairewinds of significant containment defects at Progress Energy's Crystal River nuclear power plant (NPP) illustrate the deficiencies in its similar containment analysis via state-of-the-art computer programs simulating containment performance. Beginning in 2009, in order to uprate the power (increase the power output) at the Crystal River NPP, contractors cut into the containment in order to replace the steam generators so that the power output could be increased. The contractors at the Crystal River NPP used concrete-cutting saws to cut into the nuclear power plant's containment, and in the process unwittingly created a 60foot long delamination (splitting apart into layers) of the containment.

Fairewinds notes that this was allegedly a carefully analyzed quality-assured process. In spite of the fact that the CAD simulation program had allegedly thoroughly analyzed containment design at the Crystal River NPP prior to any concrete cuts by contractors, the simulation erroneously predicted no damage to the containment structure.

Following the erroneous CAD analysis and subsequent damage to the nuclear power plant's vital containment system in 2009, Crystal River NPP and the NRC have proclaimed that Crystal River engineers and contractors have applied sophisticated computer codes to thoroughly reanalyze Crystal River's containment building in order to create a new methodology for rebuilding and resealing the nuclear power plant's containment in order to seal up and restart the nuclear power plant.

Despite assurances by the NRC and Progress Energy regarding the veracity of the computer code analysis the CAD program once again failed dramatically leaving the Crystal River containment building with a new and large delamination. Allegedly, thousands of hours of analysis by

Progress Energy and review by the NRC occurred before these repairs were implemented. Yet once again the Crystal River containment repair was a failure and the plant remains shutdown.

Fairewinds believes that this second failure of the allegedly rigorous CAD program proves the total inadequacy of the current computer code in analyzing and predicting containment integrity. The Crystal River containment analysis and design was likely the most heavily analyzed containment design in the world, yet sophisticated computer programs specifically built to analyze containment structures failed to prevent not only one but two significant delamination to Crystal River's containment building. The containment integrity debacle evidenced at Progress Energy's Crystal River NPP establishes and validates the complete failure of the nuclear industry computer code and computer aided design programs to accurately assess or calculate shield building and containment integrity.

Dr. John Ma, the NRC's lead structural engineer for the AP1000 has already been rebuffed when he stated his concerns about the NRC's analysis of the AP1000 shield building. The evidence of the marked failure of the containment integrity computer code analysis and CAD programs at Crystal River unequivocally proves the weakness in the fast-track design and analysis of both the AP1000 Shield and Containment buildings. The evidence shows that the computer models created to conceptualize and design the nuclear power plant containment system are undeniably flawed.

Moreover, the NRC is given its authority to regulate and license nuclear power plants based upon its primary responsibility to protect public health and safety as it grants permits for the design, construction and operation of all U.S. nuclear power plants. The utter failure of the CAD computer code to correctly analyze containment integrity at Crystal River and other operating nuclear plants clearly demonstrates the inability of the computer code and CAD program to analyze even the rudimentary containment integrity and shield building stability of the proposed AP1000.

Numerous Single Points of Vulnerability in the AP1000 Design

Historically the Nuclear Regulatory Commission has evaluated single points of vulnerability on active, not passive, containment systems. However, the three accidents at Fukushima clearly

indicate the need to evaluate all single points of vulnerability. Fairewinds review shows that the AP1000 design has at least two such single points of vulnerability and that given the tragedy at Fukushima, a viable airtight secondary containment system is vital to any new reactor design.

1. The first single point of vulnerability is the possibility of a leak or failure in large water tank balanced atop the reactor's shield building.

    - Should this tank fail to perform its intended function, the AP1000 design will not adequately remove heat from the containment building during a design basis accident that would lead to a meltdown. This single source of cooling water perched atop the shield building is unique to the AP1000 design and Westinghouse's reliance upon it creates a single point of vulnerability that has not been thoroughly evaluated by industry regulator NRC due to the rush for AP1000 certification and licensure.

    - While Westinghouse, the AP1000 nuclear power plant vendor, has allegedly completely evaluated the 8-million-pound water tank perched atop the containment and claims the design is robust, the computer codes used to analyze this tank are similar to the codes used to repeatedly analyze the Crystal River 3 containment that has repeatedly failed despite NRC review and approval.

    - The tragic nuclear plant accidents at Fukushima prove the travesty of an inadequate design like the Mark 1 BWR that GE pressured regulators to approve[5]. Westinghouse is applying the same pressure to the NRC in 2011. Events at Fukushima corroborate the necessity of proactive design integrity of mechanical structures designed to withstand anticipated and unanticipated forces of nature.

    - Therefore, the evidence collected from the Fukushima accidents clearly demonstrate the absolute necessity of the Nuclear Regulatory Commission to reevaluate the unique and unprecedented AP1000 NPP design that uses a single water tank perched atop the shield building design as its primary and only source

[5] NRC Internal Memo: *Joseph Hendrie to John O'Leary,* September 22, 1972.

of emergency cooling. Should there be a design basis accident and the tank fails, all capacity for cooling the AP1000 nuclear power plant will be lost as emergency cooling capacity was lost at Fukushima by the single point of vulnerability of the weather-caused destruction of the intake cooling pumps. Computer codes approved by the NRC predicted the Crystal River containment would be robust and were proven wrong. Computer codes claim to show that the AP1000 water tank will be robust as well. In light of Crystal River and Fukushima, that trust has no basis in the actual record.

- Moreover, this tank is subject to wind loads from hurricanes or tornadoes as well as seismic loads. Fairewinds believes that the Fukushima nuclear power plant accidents clearly show that what was previously identified as a maximum credible design basis accident must be reevaluated.

- Furthermore, this 8-million-pound water tank must be refilled within 3days after an accident. The nuclear accidents at Fukushima have also publically unveiled the nightmare of water demand during a design basis accident caused by hurricanes, tornadoes, floods, tsunamis, or earthquakes. It is scientifically impossible to suggest that such an unreasonably short time frame could be fulfilled in the midst of a national disaster that has damaged access to the nuclear power plant. The evidence reviewed clearly reveals this single point of vulnerability inherent in the AP1000 shield building design, and such a significant safety flaw demands regulatory attention and AP1000 redesign.

2. Second, Fairewinds is not alone in its belief that the new AP1000 design features must be reevaluated in light of the three Fukushima nuclear power accidents. To date, Dr. Akira T. Tokuhiro, Associate Professor of Nuclear Engineering at the University of Idaho, has identified *at least* five vulnerable areas that must be reevaluated prior to any new reactor design certification following the Fukushima tragedy. These single points of vulnerability include, but are not limited to:

   2.1. **Zirconium-based fuel cladding.** The use of zirconium-based fuel cladding has created hydrogen explosions 5 times during the past 40 years. The Three Mile Island nuclear

power plant accident in 1979 and four of the six Fukushima nuclear reactors have had experienced hydrogen explosions as a direct result of zirconium-based fuel cladding.

2.1.1. Yet the AP 1000 design once again relies upon the flawed and accident-prone zirconium-based fuel cladding.

2.1.2. Given the likelihood that a hydrogen-induced explosion will occur, as now has happened 5 times during the past 35 years, it should be mandatory that non-zirconium-based fuel cladding be evaluated for any new reactor design prior to design certification and licensure.

2.2. **The Danger of Multiple Nuclear Power Plants on the Same Site.** Events at the Fukushima nuclear power plant site have shown the dangerous implication of placing multiple reactors on the same site. Should a design basis event occur, Fukushima demonstrates the necessity for reevaluating all multi-reactor sites for their ability to withstand multiple design basis accidents and for the region's ability to sustain services and power in the event of a natural disaster like a hurricane, tornado, earthquake, or flood.

2.2.1. Currently operating nuclear reactors on a multi-unit nuclear power plant site have not been evaluated in terms of how a multi-unit site functions during an accident or LOCA. This process must be expanded to evaluate how a multi-unit site operates during an accident or LOCA for the new AP1000 design. Fairewinds believes this is especially important for multi-unit sites for which the new AP1000 is under consideration on the same site as multi-unit older generation reactors.

2.2.2. Two AP1000 nuclear power plants are already proposed for construction and licensure at the Vogtle site, and separately two AP1000 reactors are proposed for the Turkey Point site both of which already have other nuclear reactors presently in operation. Additionally, at V.C. Summer, two AP1000 reactors are planned for that single reactor site. The older reactors have different, lower design basis event designs that could fail before the AP1000 yet increase the likelihood of an AP1000 failure as part of a sequence of cascading failures similar to Fukushima. For

example Fukushima Unit 1 had lower design bases than the other reactors and was the first to explode. This compounded recovery efforts at the other reactors.

2.2.3. The multi-nuclear power plant accident scenario that played out in Japan at the Fukushima multi-unit site demonstrates the critical importance of evaluating the real vulnerability of multi-unit sites as part of any new power plant licensing process.

2.3. **Abandonment of Reactor Control.** The Fukushima accident has also demonstrated the necessity of standby control rooms that are accessible during accidents in which reactor containment leakage and high radiation releases have compromised normal operating control room designs. While costly backfits should be examined for all currently operating reactors, it is imperative that the new AP1000 design be corrected to reflect control room compromise in the event of a design basis accident by locating a standby control room at some distance from the plant within a filtered hermetically sealed containment building so that reactor operators are protected from radiation and may continue to monitor and operate the reactor in the event of a design-basis accident.

2.4. **Additional Power Supplies Necessary.** The Fukushima accidents also reveal the necessity of adding the evaluation of alternating current and direct current power supplies to the AP 1000 design and licensure process.

2.5. **Spent Fuel Pool.** Finally, since the AP1000 design calls for a spent fuel pool to be built within the containment, Fairewinds recommends that no spent fuel should be stored within the reactor containment due to the obvious risk of heat, fire, and explosion as well as the extensive radioactive dose risk to personnel attempting to operate the reactor itself during a natural disaster and subsequent design-basis accident. Additionally, all spent fuels pools should be required to have back-up control and moderating systems in the event that a natural disaster creates a rack distortion and inadvertent criticality. Fukushima clearly shows that fuel should be moved to dry cask storage as soon as possible, which eliminates the need for high-density racks for the AP1000 design.

The net effect of all these non-conservative assumptions in the Westinghouse AP1000 design is that post accident radiation doses to the public could be several orders of magnitude higher (one hundred to one thousand times higher) than those assumed by Westinghouse in its AP1000

design. Such calculational flaws quite seriously impact emergency planning over a much broader area than that presently assumed in the Westinghouse SAMDA analysis and NRC staff review.

Safety Concerns Submitted by AP1000 Engineer Never Addressed

In addition to the specific concerns expressed by Fairewinds Associates and submitted to the NRC, Dr. Susan Sterrett, a former Westinghouse design engineer assigned to the AP1000 project, made repeated attempts to discuss AP1000 design concerns and apprehensions with both the NRC staff and the ACRS from 2003 to 2005.

The AP1000 design is similar in many respects to the AP600. While Dr. Sterrett was employed by Westinghouse, she determined that Westinghouse had ignored its own internal quality assurance design procedures created to ensure design integrity by maintaining a database of similarities and differences for reactor designs receiving upgraded power levels. These specific internal monitoring procedures were created by Westinghouse to address the unexpected consequences of power increases, and they were not applied to the AP1000 design analysis.

More specifically, the Power Capability Working Group is an organization in place at Westinghouse whose purpose it is to analyze and address such unexpected consequences, yet Westinghouse did not apply the expertise of this group for its new AP1000 reactor design. Furthermore, Westinghouse also has in place additional processes and procedures designed as an oversight process for new reactor design, and Westinghouse also did not implement these internal procedures during its development of the fast-tracked AP1000 design.

Presentations and design submissions by Westinghouse to the NRC and the ACRS clearly lay out the firm's engineering reliance upon the AP600 design in the conception and development of the AP1000 nuclear power plant. Moreover, a significant number of Design Control Documents (DCD's) presented by Westinghouse to the Nuclear Regulatory Commission claim to be based upon NRC AP600 approval. Dr. Sterrett first brought her concerns to the NRC ACRS in 2003, and instead of giving such serious allegations a thorough review, the ACRS discounted and ignored considerable sound scientific and engineering analysis, and continues to do so eight years later. It appears that the ACRS and NRC have done a woefully inadequate review of both

Dr. Sterrett's and Fairewinds Associate AP1000 legitimate safety and engineering concerns in order to meet industry demand for an accelerated review process and fast-track licensure of a woefully unreviewed and untested new reactor design.

In her thorough engineering analysis for the NRC ACRS, Dr. Sterrett noted several other considerations in need of critical analysis and thorough engineering review. For example, Dr. Sterrett observed numerous conditions under which the AP1000 design was inappropriately based upon the previous AP600 design calculations. Astonishingly, the NRC never required proof of design calculations from Westinghouse during the design certification process. Instead of calculation proof during the design evaluation and sufficiency assessment process, the NRC has delayed such rudimentary engineering requirements until the actual Construction Operating License (COL) stage of the AP1000 licensing process.

- Specifically, Dr. Sterrett informed the NRC that post-accident steam pressures would be lower on the AP1000 than in the AP600 design because pipe size would be bigger. The NRC chose not to review this legitimate engineering safety concern.

- More specifically, Dr. Sterrett also outlined problems with the temperature of the ultimate heat sink. In AP600 and AP1000 design the ultimate heat sink is ambient atmosphere. However, as Dr. Sterrett acknowledged, the impact of solar radiation on the slanted roof and on the water tank perched on atop the shield building have not been adequately addressed by the Nuclear Regulatory Commission it its design review of the AP1000.

- Additionally, the effect of a heat wave upon the AP1000 cooling system has not been calculated, especially in view of global warming compared to the historical record of temperatures.

- Furthermore Dr. Sterrett believes that the concerns expressed by Dr. John Ma in his non-concurrence should also receive further consideration by the Nuclear Regulatory Commission in light of the temperature of the ultimate heat sink and the effect of solar radiation on the top of the shield building.

The broad issues delineated above are discussed in some detail below, but Dr. Sterrett has

informed Fairewinds that she believes that none these concerns received adequate review and assessment by either the NRC or the ACRS. A chronology of Dr. Sterrett's concerns with references to the ADAMS database follows:

1. Prior to the first meeting of the ACRS at which Dr, Sterrett's concerns were discussed in April of 2003, she provided the ACRS with written material concerning the level of design detail and design control for the power output increase from the AP600 design the AP1000 design.[6]

2. Prior to approaching the NRC's ACRS, Dr. Sterrett had tried to work directly with NRC staff in order to remedy these AP1000 design deficiencies. It appears that the project manager for the AP1000 review, Larry Burkhart, finally understood Dr. Sterrett's apprehension regarding design detail, and he had promised to get back to her to further discuss her concerns. After not hearing back from Mr. Burkhart, Dr. Sterrett was informed that Mr. Burkhart had been removed as the AP1000 review manager and was unavailable for contact. After Mr. Burkhart left, there was no more correspondence by NRC regarding the design flaws enumerated by Dr. Sterrett.

3. According to the transcript of the *501st Summary Report 4/10-12/03*[7]

> 5. Subcommittee Report on AP1000 Design Certification Matters
> The Vice Chairman of the Thermal-Hydraulic Phenomena Subcommittee provided a report to the Committee highlighting the matters associated with AP1000 that were discussed at the Subcommittee meeting on March 19-20, 2003. Also, Dr. Susan G. Sterrett (Assistant Professor, Department of Philosophy/Duke University) presented and submitted a statement regarding the level of detail of the AP1000 design review. Dr. Sterrett expressed concern regarding whether the NRC verifies or asks for proof that the system fluid parameters reported in the AP1000 design certification application (and used in the analyses reported in topical reports) are actually justified by design details, as opposed to the system designs [being] at the conceptual stage.

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[6] *Meeting Minutes of the 501st ACRS Meeting, April 10 - 12, 2003* ML081820102. See the Meeting Handout that is attached to the minutes: *Draft of Remarks by Dr S. G. Sterrett 501st ACRS Meeting April 11, 2003, Rockville, MD*.

[7] *501st Summary Report 4/10-12/03*, Pages 4-5, ML031270683

4. Next, in July 2003, Dr. Sterrett met with the ACRS Future Plant Designs Subcommittee where she raised the issues of AP1000 Design and Quality Assurance Procedures and the Heat of solar radiation and the AP1000 Ultimate Heat Sink.[8] *Meeting Minutes of the ACRS Future Plant Designs Subcommittee, July 17-18, 2003*, ML081630184. The two letters written by Dr. Sterrett and attached to those minutes are import evidentiary reference points. At this meeting the ACRS asked the staff how they would respond to Dr. Sterrett's earlier concerns about the level of design detail, and Ms Joelle Starefos, one of the NRC's AP1000 co-project managers, replied that the staff would reply in a letter in some sort of public forum. However, shortly thereafter Ms. Starefos transferred to another position within the NRC, and the NRC never fulfilled its commitment for a review and public comments.

5. On January 28, 2004, Dr. Sterrett received a voicemail[9] alerting her to the NRC response to some of her concerns. Dr. Sterrett had requested a formal reply to her earlier discussions with the ACRS and the NRC staff had committed to a formal reply in a letter in a public forum. Instead it appears that the NRC attempted to respond to these critical safety issues by using an undocumented phone call.

6. On February 11, 2004, Dr. Sterrett then appeared before the ACRS. Fairewinds has excerpted some key points in Dr. Sterrett's testimony before the Thermal-Hydraulic Phenomena Subcommittee Meeting[10].

   On pages 641–645 of the 2/11/04 transcript, Dr. Sterrett's previously referenced concerns regarding the inadequacies of the AP1000 Quality Assurance design process were discussed. At this time, the ACRS explicitly stated that the NRC is NOT treating the AP1000 as an uprating of the AP600, but as a NEW design. Westinghouse and the NRC have repeatedly relied upon the fact that the AP1000 grew out of and is an extension of the AP600 design process. Fairewinds believes that NRC has made a critical analytical

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[8] *Meeting Minutes of the ACRS Future Plant Designs Subcommittee, July 17-18, 2003*, ML081630184. The two letters written by Dr. Sterrett and attached to those minutes are import evidentiary reference points.

[9] ML090820064 *Email from Dr. S. Sterrett - Your Voice Mail Re: AP1000 Design Certification*

[10] ML040760488 *Transcript of ACRS Thermal-Hydraulic Phenomena Subcommittee Meeting in Rockville, MD*, pp 639 – 661.

error in basing the AP1000 design upon the AP600 calculations, and never reviewing the AP600 calculations and determining their application as those calculations have been carried forward and applied to the AP1000 design and certification process.

Dr. Sterrett gets to the heart of the matter regarding the design inconsistencies and lack of appropriate QA on page 648 of the transcript

> Hence, the question identified above about whether there was a procedure and if so, which procedure it was that covered the overarching process of determining which features, calculations, and documents of the AP600 apply to the AP1000 unchanged and which are impacted by the new design, shall we say, remains. The reason I focus on this is that it can't be done piecemeal. Many calculations use the results of other calculations, either directly by using values of parameters that are computed by other calculations or indirectly by involving design features or values of parameters based upon other design calculations. The order in which things are done matters. [lines 7-21]

This essential process of knowing the exact history of calculations and building upon those calculations in a scientific manner is a basic tenet of engineering mathematics. This process has never been adequately reviewed or acknowledged by the NRC Staff or the ACRS.

7. On April 20, 2004, the NRC finally provided a written response to Dr, Sterrett entitled *Response to Dr Susan Sterrett Concerns on AP1000 Design Certification*[11]. In an interview with Fairewinds, Dr Sterrett stated that the NRC reply simply did not address the referenced concerns she had raised during the previous year. What this NRC letter did do was acknowledge that the NRC planned to implement such a review process after design certification and during the Combined Operating License (COL) stage, concerning what the NRC would do when a license application (e.g., for a COL) referencing the AP1000 was received.

8. Both Dr. Sterrett and Fairewinds Associates agree that the structural integrity of the shield building is a significant issue for the upcoming rulemaking due to Dr. John Ma's non-concurrence report. More importantly, it is possible that the distribution of temperatures in

[11] *Response to Dr Susan Sterrett Concerns on AP1000 Design Certification* (dated April 20, 2004) ML040550366.

the shield building due to the heat of solar radiation that originally worried Dr. Sterrett so much that she contacted the NRC in 2004 might have an even larger importance given Dr. Ma's analysis. As Dr. Sterrett notified the NRC, temperature differences in a structure can induce stresses, depending upon how the building is constrained.

9. On July 7, 2004, Dr. Sterrett again attended an ACRS meeting on the AP1000. The transcript[12] beginning on Page 97 details Dr. Sterrett's discussion with the ACRS during which she called into question the lack of NRC staff response regarding the AP1000 design issues and concerns she had raised previously and that those specific issues and concerned still remained unaddressed and unresolved.

10. According to Dr. Sterrett, following the July 7, 2004 ACRS meeting, Jim Lyons of the NRC informally discussed Dr. Sterrett's concerns with her. When Fairewinds spoke with Dr. Sterrett, she recalled two important statements from that conversation:

    10.1 Lyons was adamant that the surface of the concrete could not exceed the surrounding air temperature. Dr. Sterrett notes that this NRC statement is unquestionably false, as any good engineering reference on roof design will reveal.

    10.2 Lyons stated that if an AP1000 plant had to shut down during a heat wave because of temperature constraints on the ultimate heat sink, and thousands of people died as happened in France in 2003, that that would be a great human tragedy, but that it was not the NRC's role to prevent such incidents.

    10.3 Lyons stated that the NRC licenses plants along with setting limits for plant operation.

11. Lastly, on July 8, 2004 Dr. Sterrett again met with the ACRS[13] where only one of her issues was reviewed because it was determined that two of the three issues Dr. Sterrett had raised belonged to the NRC staff for review and were outside purview of the ACRS. The one issue the ACRS did discuss at this meeting was the technical issue that the heat of solar radiation had not been considered as part of the design and analysis of the AP1000 safety systems and

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[12] *Transcript of 514th ACRS Meeting*, July 7, 2004. ML042080082.
[13] *Transcript of 514th ACRS Meeting, July 8, 2004,* Pages 104 ff. ML042080030.

structures. Dr. Sterrett was not asked to participate in the discussion of the concerns she had raised, and when the findings of the meeting were reported, she did not concur with the comments made or the conclusions drawn by the ACRS.

The AP1000 safety and design concerns remain unaddressed. Fairewinds believes these legitimate safety concerns must be fully addressed by the NRC staff prior to any licensing review and design certification moving forward. Furthermore, given the gravity of these safety issues, the NRC must hold a public meeting to discuss these concerns and publicly issue its technical resolution.

Fairewinds Associates' Conclusion

This report delineates that four reputable engineers with significant experience in reviewing and analyzing the AP1000 design (Dr. Ma, Dr. Sterrett, Dr. Tokuhiro, and Mr. Gundersen) have approached the NRC with significant design-basis safety problems. Those problems have been completely ignored by the NRC it its headlong rush to meet industry demands and satisfy Westinghouse's pursuit of fast-track licensure for its AP1000 design. The publication of the rulemaking notice is completely premature. The review of the AP1000 design must be completely suspended until all the prior safety issues have been resolved and the impact of the tragic Fukushima accidents are analyzed and incorporated into this untested design. A new rulemaking may commence only when successful resolution of these design-basis dilemmas has been completed. Without complete and successful resolution to these design-basis safety issues, the AP1000 certification will be vulnerable to legal challenge and the AP1000 itself will be a veritable safety threat to public health and safety.

Arnie Gundersen, Chief Engineer
Fairewinds Associates, Inc
May 10, 2011