Supplemental Information for NRC Chairman Gregory Jaczko:

Key Items Concerning NFPA 805 Fire Protection Transition at Shearon Harris, Oconee and other US Nuclear Power Plants

by Beyond Nuclear and NC WARN **EXCERPTS***
March 16, 2010

This paper is a supplement [excerpts] to the letter dated February 19, 2010 to NRC Chairman Jaczko from Beyond Nuclear's Paul Gunter and NC WARN's Jim Warren, and reflects a number of verbal and email communications. Note that where report excerpts are used, they are representative of similar references in multiple parts of those documents. All highlights are by Beyond Nuclear and NC WARN.

RELIANCE ON UNTESTED FIRE MODELS: Being able to predict how quickly cables can catch fire, and how fast a fire spreads to secondary fire sources, are central elements of NFPA 805, Performance-Based Standard for Fire Protection for Light Water Reactor Electrical Generating Plants 2001 Edition. Please note the following passages from NFPA 805:

- Sections 2.4.1.2.2 and 2.4.1.2.3 state that fire models shall be applied only within the limitations of the given model … and "The fire models **shall be verified and validated**." (emphasis added)
- Section 2.7.3.2 Verification and Validation. "Each calculation model or numerical method used **shall be verified and validated** through comparison to test results or comparison to other acceptable models."

However, NRC Staff is directing pilot programs Harris and Oconee to use guidance document NUREG 6850, Fire PRA Methodology for Nuclear Power Facilities, to calculate cable ignition and flame spread. **The authors of 6850, which include Sandia National Labs, NRC and the Electric Power Research Institute, emphasize that it has not been verified or validated, that it reflects only experimental conditions, and that it cannot be relied on in real world conditions.** They also note in the first sentence to Appendix R, Cable Fires, that **"Cables are probably the most common combustible in nuclear power plants."**

The NRC has also admitted that not every aspect of fire modeling could be tested before the 805 program started, and that it would be a few years before the models could be validated. The regulations clearly require verification and validation prior to applying for transition to NFPA 805. **Moreover, the models indeed *had been tested* for their ability to predict cable ignition and flame spread along cables – and they all failed**. The test is described in this report by the National Institute of Standards and Technology, http://fire.nist.gov/bfrlpubs/fire08/PDF/f08039.pdf . See, for examples, "Conclusions" on page 88, which opens:

> *At the time being, none of the codes applied in Benchmark Exercise No. 5 for calculating the ignition, pyrolysis and flame spread of realistically routed cables work at a level such that it is possible to use them as a reliable predictive tool for predicting such phenomena.*

NUREG 685O: http://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr6850/

BROADER MODELING PROBLEMS; PIRT PANEL, NUREG 6978, November 2008: As noted in the report, this panel of "seven international fire science experts … facilitated by Sandia National Laboratories" was convened to evaluate the NRC's fire modeling efforts. The panel's results identified "a number" of "those phenomena that are of the highest potential importance relative to fire modeling improvement. In particular, those phenomena that were ranked as having high importance and a low state of knowledge adequacy… Some were specific to individual fire scenarios, while others were more universal, being identified as Level 1 phenomena for two or more scenarios." The identified Level 1 phenomena included the following:

• Performance of fire detection systems under complex geometries (e.g., highly congested spaces),
• Performance of incipient detection systems,
• Performance of fire sprinkler systems under highly obstructed conditions,
• Performance of fire sprinkler systems against a large oil pool fire,
• Fire behaviors, such as plume development, in the presence of obstructions such as pipes, drop ceilings, and open grating floors,
• Characterizing/predicting cable fire behaviors including fire spread and total heat release rates,
• Characterizing/predicting electrical cabinet fires including fire spread, total heat release rates, ventilation effects, and HEAF behaviors,
• Modeling the response of damage targets, such as cables, to the fire environment, and
• Human performance issues such as human detection of fires and the performance of fire fighters.

We see no evidence that this broad array of problem areas has been solved. [Another passage] by the PIRT experts supporting our concerns, from part 3. SUMMARY OF LEVEL 1 PHENOMENA ORGANIZED BY INDIVIDUAL FIRE SCENARIOS:

> ***The general consensus of the panel was that incorporating such transitional models into fire modeling tools would be an exceedingly complex and difficult undertaking, but that it was feasible given enough time and money.*** *p. 30*

Scenario 2a involved a slowly developing cabinet fire leading to the **ignition of cables in cable tray** above and to the side of the initiating cabinet. … *"The flame spread rate along the cable tray located above the cabinet fire"* is one of the Level 1 phenomena identified for Scenario 2a. The panel all agreed the phenomena was important given that fire spread was assumed necessary to damaging the specified target cables:

> ***This was considered a fire modeling problem for which models were currently "nonexistent to, at best, inadequate".*** *p. 32*

http://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr6978/

RADIANT HEATING BEING IGNORED: NRC's public relations staff confirmed twice, in writing, that licensees Shearon Harris and Oconee are being directed to ignore radiant heating as a factor in predicting damage to critical equipment such as electrical cables. This contradicts the government agency that performed the fire research for NRC, the **National Institute of Standards and Technology**. NIST indicates that radiant heat from a fire can indeed impact targets, and its fire model uses calculations to determine how much radiant heat should be attributed to a fire under varying conditions – instead of ignoring radiant heating as the NRC does.

NRC Staff's position on radiant heating also contradicts the findings of a joint report by the **International Collaborative Fire Modeling Project,** another panel of fire science experts from prestigious European institutions, along with experts from NIST and NRC. The ICFMP conducted a series of benchmark experiments upon which NRC based the verification and validation of its fire models. The ICFMP also says that radiant heating should be taken into account by fire models. In fact, Dr. Marina Rowekamp, the lead author of the joint ICFMP/NIST/NRC report, said that based on the group's experiments, "**it can be estimated that radiative heat transfer provides a relevant contribution to the thermal load of possible targets."** Also, from that report:

> *The ICFMP has also identified where fire models should be applied with caution or may at present not be appropriate. Of particular relevance to nuclear power plants is the task of predicting the response of cables and cable trays to fire conditions.* ***Benchmark Exercise No. 5 demonstrated that cable heating and pyrolysis models are currently at an elementary stage****.*
>
> ***Perhaps most important here is the task of predicting the heating and failure of safety critical items such as cables.*** [p. 8 of the pdf cited at end of this section]

The NRC was joint author of the ICFMP report, which states, "There clearly remains a useful role for the ICFMP as an independent and open forum for engineers, scientists, model developers, regulators etc. to advance the application of fire models for nuclear power plants." However, after we and others began questioning the radiant heating issue, NRC Staff sought to discount the importance of the ICFMP by maintaining that it was not an official entity.

ICFMP/NIST/NRC report, September 2008:
http://fire.nist.gov/bfrlpubs/fire08/PDF/f08039.pdf

CONTINUING INDICATIONS OF PROBLEMS: NUREG 1934, Nuclear Power Plant Fire Modeling Application Guide - DRAFT. A number of the detailed examples have problematic results, including Appendix E, which describes attempts to model a trash fire in the cable spreading room. **This is a vital area of any nuclear power plant, yet the authors cannot predict whether the cables were damaged or not.** This is the NRC's best and latest effort to predict if essential cables would survive a fire, but the authors admit they do not know. From NUREG 1934 E.7 Conclusions:

> *The analysis have shown that a 130 kW trash can fire beneath a vertical array of cable trays is unlikely to damage cables in the trays three and six levels above the fire. … However, this analysis has not included any consideration of the ignition and burning of the cables themselves.* ***Depending on the duration of the fire, it is possible that cables in the first two trays from the bottom could add to the HRR and consequently damage cables above.*** *Because of the uncertainty in the smoke detector activation prediction of all the models and the uncertainty associated with the possible ignition of cables in the trays just above the fire,* ***it is difficult to predict whether or not the CO2 suppression system would be activated in time to prevent possible cable ignition."*** (emphasis added)

http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1934/sr1934.pdf
(Appendix E begins on p. 169)

NUREG 6850 "PEER REVIEW": Also, under questioning, NRC Staff has changed its explanation regarding verification and validation of fire models. The NRC Staff agrees that the calculations in NUREG 6850 governing flame spread are fire models. NRC Staff agrees that fire models must be verified and validated. NRC Staff then claimed that, in the absence of verification and validation, NUREG 6850 had been "peer reviewed" and that this is equal to verification and validation. However, there is a standard that NRC has already used for verification and validation of fire models, called ASTME 1355, and "peer review" is quite different.

Nonetheless, the very first page of NUREG 6850, Appendix R (the section dealing with cable fires) says **"No verification and validation has been conducted for the correlations included in this appendix."** So regardless of NRC protestations about "peer review" or "special models," the authors of NUREG 6850 understand engineering standards and they emphasize that the fire models have not been verified and validated.

* For a full copy of the March 16, 2010 Supplemental Information for NRC Chairman Gregory Jaczko, contact NC WARN or Beyond Nuclear.