

September 28, 2010

MEMORANDUM TO: Eric J. Leeds, Director
Office of Nuclear Reactor Regulation

THRU: William H. Ruland, Director **/for/ Sher Bahadur**
Division of Safety Systems
Office of Nuclear Reactor Regulation

FROM: Benjamin T. Parks **/RA/**
Reactor Systems Branch
Division of Safety Systems
Office of Nuclear Reactor Regulation

SUBJECT: FOREIGN TRIP REPORT ON THE 3RD JOINT US – EUROPEAN
FLUIDS ENGINEERING SUMMER MEETING

Enclosed is a foreign travel trip report to Montreal, Quebec, Canada. The purpose of the trip was to participate in the subject meeting, which was sponsored by the American Society of Mechanical Engineers. The meeting, held August 1-5, 2010, was comprised of 35 different symposia on various topics in the fluids engineering arena, mostly focused on advances in computational simulation and analysis of fluids problems.

The content of this report is not likely to be of interest to the Commission.

Enclosure:
As stated

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Trip Report

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NRC FOREIGN TRIP REPORT

3rd Joint US – European Fluids Engineering Summer Meeting
August 1- 5, 2010 – Montreal, Quebec, Canada

Benjamin T. Parks, Reactor Systems Branch
Office of Nuclear Reactor Regulation

Background

The purpose of this trip was to participate in the subject meeting, which was sponsored by the American Society of Mechanical Engineers. The meeting, held August 1-5, 2010, was comprised of 35 different symposia on various topics in the fluids engineering arena, mostly focused on advances in computational simulation and analysis of fluids problems.

I attended this meeting for training. In particular, the meeting contained a symposium on best-estimate plus uncertainty (BEPU) analytic methods that was expected to provide a valuable training opportunity, since the Reactor Systems Branch is reviewing an increasing number of licensing requests to implement BEPU analyses as a means for licensees to demonstrate compliance with Title 10 of the *Code of Federal Regulations* (10CFR) 50.46.

The expected outcome of this trip was to gain knowledge regarding BEPU analyses to improve review capabilities regarding licensing action requests that are supported by such analyses. This outcome was achieved. In addition, the information obtained suggests that further The U.S. Nuclear Regulatory Commission (NRC) engagement and research in the BEPU safety analysis arena should be considered.

Abstract

Presentations during the BEPU symposium were given mostly from the nuclear power industry and academia. Representatives from the nuclear power industry discussed recent applications of and progress in best-estimate analytic methods. Faculty from academic settings delivered presentations regarding newly developed approaches to estimate valid and meaningful uncertainties to accompany BEPU analyses. Most notably, an individual from the Spanish nuclear regulatory authority presented a paper on establishing rigorous review approaches for determining the validity of a given uncertainty evaluation, relative to regulatory requirements, such as Technical Specifications.

No policy matters or items of likely interest to the Commission were discussed; however, some of the advances discussed during the symposium warrant management attention. Particularly, the material presented by the Spanish regulator warrants consideration by the NRC in its review activities associated with BEPU analytic methods.

Although the expected outcome – gaining knowledge to improve review capabilities – was achieved, not all symposium participants who provided papers came to the symposium to present and discuss their papers. In consideration of the information exchanged at this meeting, but also in consideration of the unexpectedly high number of no-shows, I recommend continued NRC participation in exchanging information about BEPU analytic methods, but find that this particular forum may not be the best vehicle to that end.

ENCLOSURE

Discussion

The ASME Fluids Engineering Summer Meeting was a collection of symposia following different topics in the area of fluids engineering. Most symposia were focused on computational methods; however, several were based on experimental measurement.

While my primary purpose was to gain knowledge at the BEPU symposium, I took advantage of the opportunity to drop in on other symposia while the BEPU symposium was not in session. I attended a session of a general computational fluid dynamics symposium. The papers presented here focused on very large applications, such as modeling tidal flows in the Gulf of Mexico. The author of one paper discussed a computational method he had devised to simplify two-phase (liquid and solid) flow approximations by modeling the flow as a single-phase, non-newtonian fluid. I believe that advances in this area may be meaningful to the NRC's ongoing work to resolve Generic Safety Issue 191, where current focuses appear to be on understanding the effect that debris have on recirculated reactor coolant flow.

In light of recent issues regarding ultrasonic flow meters, I decided to attend a session of a symposium on non-invasive flow measurement. A significant portion of the papers presented in this session focus on the uses and uncertainty characterization of particle image velocimetry to measure the behavior of two-phase flows. This technique involves the use of a high-quality imaging device to take visual images and analyzing the images to track particles or bubbles in the flow to obtain information about the flow field. One author characterized the uncertainties associated with this technique as very difficult to approximate, and estimated that they could reach 50-percent in some cases.

There was a single session on experiments, modeling and analysis that included presenters exclusively related to nuclear power plant applications. A slight majority of the presenters in this session were providing results of large-scale experiments and computer code validations for eastern reactors, including a Japanese test facility and simulating some startup tests for the newly online Monju plant. One paper, presented by Richard Schultz of the Idaho National Laboratory, discussed experimental results of stratified flow in horizontal pipes that would arise from initiating injection, for example, into a reactor vessel through a pipe that is half-filled with water, with a steam or air volume above it.

The BEPU symposium was quite interesting, provided for an excellent educational opportunity, and included some very relevant papers and discussions. While the symposium featured presenters speaking about a variety of topics and applications at many varied plant designs, I'd like to highlight three topics of heightened significance to the NRC. The first presentation of interest concerned the development of a BEPU loss-of-coolant-accident analysis tool for use at the Pickering B Nuclear Generating Station in Ontario. The second was a combination of two presentations related to a novel BEPU approach; the first presentation described the uncertainty characterization technique, and the second described its application to the Atucha plant in Argentina. Finally, a Spanish regulator presented a paper on the relation between BEPU safety analyses and TS. I believe that these three discussions demonstrate the state-of-the art with respect to application of BEPU analyses, and illuminate some areas where further NRC engagement in the BEPU community of practice may be necessary.

The two papers presented on power plant safety analyses demonstrated some differing approaches with regard to quantifying uncertainties in the BEPU analysis. The paper presented about the Pickering safety analysis described a modeling approach that is fairly similar to the NRC's own Code Scaling, Applicability and Uncertainty (CSAU) approach described in NUREG/CR-5249. By contrast, the papers related to the Atucha analyses relied on the Code with capability of Internal Assessment of Uncertainty (CIAU – Given the developers' affiliations with the University of Pisa, this is most likely pronounced, "chow"). The CIAU approach appears quite different from the CSAU approach. It is difficult, however, to compare the two approaches because they are applied to power plants with significantly different design and safety principles. Some follow-on assessment may benefit the NRC in understanding the strengths and weaknesses of the two methods, and provide useful information to (1) potentially improve or update the CSAU methodology, and (2) identify areas where NRC bi- or multilateral cooperation could help to improve the various BEPU uncertainty quantification methods in use in the international community.

The Spanish regulator presented a paper asserting that input parameter uncertainty distributions affect the uncertainty about the analytic results of BEPU analyses, and that the regulator should give due consideration to the ranges of parametric inputs and their relation to plant TS. I think that this is an excellent observation, and that the NRC should work to improve its understanding of the philosophy asserted in this paper, and consider whether to adopt some of its regulatory practices in our own review activities that are associated with BEPU analyses. Currently, there is no NRC guidance regarding how BEPU analyses relate to TS ranges. Current NRC-approved BEPU methods typically require that parametric ranges bound the TS-allowable operating range, but the implementation of this requirement is quite varied from plant to plant. While some plants assume the TS-allowed operating ranges only, others assume parametric ranges that exceed the permissible range by as much as 60-percent. Based on the Spanish regulator's observations, I recommend further study in this area.

In conclusion, I found that this symposium provided an excellent training opportunity to learn about the state of the art in BEPU safety analyses for nuclear power plants, and thus this was a successful trip. In addition, I used the opportunity to learn about additional advances in other areas in computational fluids engineering, particularly with regard to observing experiments and validating analytic techniques against observable data. Finally, the information obtained through this symposium demonstrates that further NRC engagement in the BEPU arena may be beneficial, as discussed in the preceding paragraphs.