

December 16, 2002

MEMORANDUM TO: Nilesch C Chokshi, Chief  
Materials Engineering Branch  
Division of Engineering Technology  
Office of Nuclear Regulatory Research

FROM: Robert L Tregoning */RA/*  
Materials Engineering Branch  
Division of Engineering Technology  
Office of Nuclear Regulatory Research

SUBJECT: FOREIGN TRIP REPORT - MPA Seminar and Meeting  
with Dr. Helmut Schulz

Attached is the trip report for Dr. Gery Wilkowski's trip to Stuttgart Germany to present a paper at the 28<sup>th</sup> MPA seminar. There was also a separate meeting with Dr. Helmut Schultz of GRS to discuss the conditional pipe break probability model that was used in NUREG/CR-5750 to develop medium and large LOCA estimates; the upcoming LOCA reevaluation effort using expert elicitation, the susceptibility of German plants to PWSCC, and the Brunsbuettel hydrogen rupture event.

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December 2, 2002

MEMORANDUM TO: Robert L Tregoning  
Division of Engineering Technology  
Office of Nuclear Regulatory Research

FROM: Gery Wilkowski  
Engineering Mechanics Corporation of Columbus  
3518 Riverside Drive - Suite 202  
Columbus, OH 43221

SUBJECT: FOREIGN TRIP REPORT - MPA Seminar

Attached is my trip report for the visit to Stuttgart, Germany to attend the 28<sup>th</sup> MPA Seminar. At the seminar I presented a paper jointly prepared by Rob Tregoning, Paul Scott of Battelle and staff at Engineering Mechanics Corporation of Columbus (including myself). Additionally I chaired a session at the conference.

As a separate activity, I arranged to have a meeting with Dr. Helmut Schulz of GRS. The discussions were on:

1. Limitation of the relationship he and his colleagues have published on leak to break failure probabilities of piping from historical service data,
2. Internal explosion failures in Germany, in particular the recent one at Brunsbuettel, and
3. PWSCC cracking history in Germany.

Details are given in the attachment.

## NRC FOREIGN TRIP REPORT

### Subject

Presentation of LB-LOCA Redefinition paper at the 28<sup>th</sup> MPA Seminar and discussions with Helmut Schultz of GRS on probabilistic piping analyses, recent pipe failures in Germany from internal hydrogen explosion, and PWSCC cracking history in Germany.

### Author, Title, and Agency Affiliation

Dr. Gery Wilkowski  
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### Dates of Travel and Countries/Organizations Visited

Left Columbus, Ohio for Germany on October 8<sup>th</sup>. Left Germany on October 12<sup>th</sup> and went on to SMiRT planning conference. (Note, airfare was entirely paid for by the SMiRT committee.

### Sensitivity

Not applicable.

### Background/Purpose

The purpose of the travel was to present a paper on the LB-LOCA redefinition program at the MPA seminar, and to separately meet with Helmut Schulz of GRS. This was the first presentation of this new effort in Germany and Europe. The meeting with Helmut Schulz was intended mainly to determine the limits of the simplistic multiplier on the leak probability to determine a failure probability that was used in NUREG/CR-5750. As an addition discussion item, Dr. Schulz also gave details of the recent hydrogen internal explosion failure at Brunsbuettel and PWSCC cracking history in Germany.

### Abstract

G. Wilkowski attended the MPA seminar held in Stuttgart, Germany. He presented a paper on the LB-LOCA program. The title of the paper was "Status of Efforts to Evaluate LOCA Frequency Estimates Using Combined PRA and PFM Approaches," by G. Wilkowski, R. Tregoning, P. Scott, and D. Rudland. A copy of the paper and viewgraphs was separately e-mailed to NRC and Battelle. The paper was well received, and viewed as a significant new direction of structural integrity assessment. Unfortunately, since Germany is leaning towards early decommissioning of all nuclear power plants there is probably little incentive for parallel work in Germany.

G. Wilkowski also met with H. Schulz of GRS and discussed two items. The first item was relative to his co-authored paper with Beliczey where they presented the concept that the probability of a break is related to the probability of a leak as an inverse function of the pipe diameter. Schulz said that the relationship should only be used for fatigue cracks, and not flaws like erosion-corrosion, IGSCC or PWSCC (i.e., it is not valid for degradation mechanisms that might produce long surface flaws without leaking). This is an important aspect that was not

considered in the NUREG/CR-5750 statistical analysis of pipe events. Schultz also noted that most German bimetallic welds with Alloy 82/182 were heat-treated after welding, and they have no occurrences of PWSCC. In only the Obrigheim Plant, were there bimetallic welds that were not heat treated, that had no occurrences of PWSCC in that plant. This information has been previously sent to the NRC International Office.

Another aspect that was discussed with Schulz was the Brunsbuettel plant internal hydrogen combustion failure. This was a 4-inch diameter line that had been replaced 5-6 years earlier. The failure was in an isolated section of a spray line for cooling down the top of the RPV to decrease the time to shutdown. The water comes from a bypass line for warm-up from a steam line that had radioanalysis of water to produce the hydrogen (and oxygen). The flow rate was very slow during normal plant operation. After the failure, a temperature difference was noticed in the spray line, which was used for the fatigue analysis (not determining if gas was in the line). During the last cycle prior to the failure, they changed the valve tightening procedure that gave a high gas build-up in the failed section of pipe. The failure was detected when there was a peak pressure in the containment building, but that was thought to be a gasket failure. This occurred just before Christmas last year, and was not checked until after the Christmas holidays. The German plants have a nitrogen atmosphere in the containment building (due to using hydrogen water chemistry for IGSCC control) so it was not a trivial effort to have personal enter the containment for visual inspection. There were no cameras in that area to detect the failed pipe section. About 1.5 meters of pipe had ruptured into about 20 pieces. The concern was about collateral damage to other safety related equipment. There was also deformation about 10 inches away from the valve, which was suspected to be due to a prior event. About three years ago, there was a similar hydrogen internal explosion event in a 1.5-inch diameter turbine line. There were a total of 6 internal hydrogen explosions to date in German plants, 4 of them were at Brunsbuettel (2 pipe breaks, one pipe deformation, and 1 at a warm-up heater). The other 2 events occurred at two other plants. Due to this failure, the Brunsbuettel plant was still closed as of the middle of October.

Finally, G. Wilkowski also attended a planning meeting for the SMiRT conference. An option is to have a workshop at the SMiRT conference on LB-LOCA and RI-ISI. N. Chokshi is aware of this possibility.

### **Discussions**

The discussion with H. Schulz suggests that the simple leak versus break probabilistic multiplier used in the NUREG/CR-5750 Appendix J analysis should ***not*** have been used for all degradation mechanisms.

### **Attachments**

The technical paper presented at the MPA meeting is provided as an attachment to this trip report.

### **Pending Actions/Planned Next Steps for NRC**

The pending issues resulting from the meeting with Helmut Schulz is to incorporate this discussion into the LOCA frequency reevaluation effort which is ongoing as part of the 10 CFR 50.46 risk-informed revision. The LOCA reevaluation will be performed using expert elicitation. Dr. Schulz is currently planned to be on the expert panel. However, the NRC must follow-up to ensure his participation so that limitations in the original conditional pipe break probability are properly

discussed and evaluated during panel deliberations. Steps are being followed to ensure Dr. Schulz's involvement in this effort.

**Points for Commission Consideration/Items of Interest**

No points are raised for commission consideration as a result of this travel.

**"On the Margins"**

There is no additional information of probable interest to report.