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# MISSION REPORT

## WORKSHOP ON THE OPERATING EXPERIENCE ON ECCS STRAINER BLOCKAGE EVENTS

Wuhan, China  
14 – 16 October 2008

EXTRABUDGETARY PROGRAMME ON THE  
SAFETY OF NUCLEAR INSTALLATIONS IN SOUTH EAST ASIA,  
PACIFIC AND FAR EAST COUNTRIES

Department of Nuclear Safety and Security  
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## **Foreword**

Within the framework of Extrabudgetary Programme on the safety of nuclear installations in South East Asia, Pacific and Far East Countries (EBP Asia), a workshop was organized in China on the operating experience on ECCS strainer blockage events. The workshop took place in Wuhan city from 14<sup>th</sup> to 16<sup>th</sup> October 2008.

Lectures were provided by IAEA staff, Mr. T.Okamoto, and five international experts, Mr. J. Lehning (USNRC, USA), Mr. E.Wolbert (TRANSCO PRODUCTS INC., USA), Mr. N. Miller (TRANSCO PRODUCTS INC., USA), K.Takagawa (INSS, Japan) and Mr. Y.Matsumoto (NTC, Japan)

Personnel from different organizations in China (mainly from RINPO) attended the workshop.

The workshop aimed to provide good practices in other IAEA Member States to manage the ECCS strainer blockage issue on PWR.

Along with the objective, the experts and IAEA staff made presentations about the following subjects:

- Outline of representative events (Barseback NPP etc)
- Overview of US NRC's activities on ECCS strainer performance
- Current status of US activities on PWR strainer performance
- Current status of Japanese utilities
- Countermeasures for short term "Simulator training in Japan"
- Countermeasures for long term "Modification of ECCS strainer"

On the first day, experts from Chinese organizations also made presentations about the current status in China. The experts and participants discussed the future challenges on the last day.

The materials used for the presentations by the lecturers and by the national attendees are collected in this volume.

Workshop on the operating experience on ECCS strainer blockage events (EBP Asia)  
Organized by RINPO and IAEA at RINPO, Wuhan, China

RINPO Organizer:

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## 1. Objectives

Main objective of the workshop is to provide good practices in other IAEA Member States to manage the ECCS strainer blockage issue on PWR.

## 2. Workshop Programme

**Tuesday, 14<sup>th</sup> October 2008**

Opening course overview & administration (RINPO and IAEA); introduction of participants

No. 1 Mr. T.Okamoto:

Outline of representative events (Barseback NPP etc)

No.2 Mr. J. Lehning:

Overview of US NRC's activities on ECCS strainer performance

No.3 Mr. Lui Yu, Mr. Qingsong LIU, Mr. Ge Guoguang, Mr. Zhang de liang

Current status of Chinese activities

**Wednesday, 15<sup>th</sup> October 2008**

No.4 Mr. J. Lehning:

Current status of US activities on PWR strainer performance

No.5 Mr. K.Takagawa:

Current status of Japanese utilities

No.6 Mr. Y.Matsumoto:

Countermeasures for short term "Simulator training in Japan"

No.7 Mr. E.Wolbert, Mr. N. Miller:

Countermeasures for long term "Modification of ECCS strainer"

No.8 Wrap-up the workshop ( Incl. suggestions from Experts)

**Thursday, 16<sup>th</sup> October 2008**

Technical tour of RINPO

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#### 4. Discussions

##### (1) Outline of representative events (Barseback NPP etc)

The representative strainer blockage events such as Barseback-2 event, Grundremmingen event and Perry-2 event were explained. Especially, as for the Barseback-2 event, the detail of event including the description of related plant facility, debris generation and debris transportation.

Q1. Is there any PWR events?

A1. No, there are no similar events in PWR.

Q2. Consequence of Barseback event?

A2. They continued to operate after the event, although the plant was subsequently shut down for political and economic reasons.

Q3. What is the difference of Barseback and German plant? Why German plant was closed?

A3. As for the German plant, I have only limited information. However, I guessed it was economical reason.

##### (2) Overview of US NRC's activities on ECCS strainer performance

The experts explained the regulatory activities of the following main period.

- Unresolved Safety Issue A-43 (1979-1985)
- Boiling Water Reactor ECCS strainer blockage issue (1992-2001)
- Generic Safety Issue 191(GSI-191), Pressurized Water Reactor sump performance (1996-Present)

GSI-191 includes a number of aspects, including the following items: Break selection, Debris Generation, Debris transport to the sump strainer, Characterization of debris, Head loss testing, Head loss correlation development, Chemical effects,.

NRC staff is currently working to complete GSI-191 activities and is considering whether follow-on work for BWRs is justified. The adequacy of ECCS strainer designs for new reactor applications is also being reviewed.

Q1. At this moment, how does industry handle the chemical issue?

A1. Industry developed a methodology to evaluate chemical effects documented in WCAP-16530. Many plants are using this approach.

Q2. Is the WCAP-16530 acceptable for USNRC?

A2. Yes, it's acceptable and conservative.

Q3. As for downstream effects, how should it be dealt with?

A3. About the ex-vessel effects, industry has developed the methodology, WCAP-16406.

However, it's proprietary. Therefore, only owners' group members can use it.

As for the in-vessel effects, industry is currently revising WCAP-16793 to address NRC staff concerns.

Q4. About the design of AP-1000, do they have any feedback to plant design?

A4. The NRC staff recently requested that Westinghouse company provide additional information concerning the strainer issue. The NRC staff will evaluate the response when it is received.

##### (3) Current status of Chinese activities

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- 4 Chinese experts explain the following status.
- Regulatory strategy & requirements of the issue of NPP recirculation sump screens blockage in China
  - Operation Experience on ECCS strainer in China Daya Bay Base Nuclear Power Plants
  - Current status of ECCS sump strainer issue in CANDU reactors
  - Characteristic design of the AP1000 containment recirculation Screens

(from Chinese experts to US and Japanese experts)

Q1. Generally, how many years does it take to finish modification in the United States?

A1. In the US, for BWR plants it takes about 3-5 years, and for PWR it takes 5 years. For PWR plant, at the moment of 2007 Dec. they have additional activities such as chemical effect issue and down stream effects issue.

Q2. As for the verification tests for sump screen, how many qualification tests should we do?

A2. It depends on the plant situations and purpose of the test. In the United States, licensees need to perform a sufficient number of tests to demonstrate adequate sump performance. The regulatory body will verify whether there is reasonable assurance of adequate sump performance. A typical series of tests generally may involve five or more individual test runs.

Q3. To complete the modifications, which type of documents do we have to prepare?

A3. In the US, utilities have to answer to the USNRC based on the requests of Generic Letter 2004-02 and the NRC Content Guide for supplemental responses to the Generic Letter. You can see the results of Generic Letter Response Reviews on the USNRC website.

(4) Current status of US activities on PWR strainer performance

The expert explained the progress of NRC staff reviews of PWR licensees' responses to Generic Letter 2004-02 and also showed the example topics of NRC staff Requests for Additional Information (RAIs) such as Break Selection, Debris Generation, Debris Characteristics, Latent debris, Debris Transport, Head Loss, Net Positive Suction Head (NPSH), Chemical Effects, Coating, Upstream Effects, Downstream Effects and Structural Analysis.

At this moment, all US PWRs have installed significantly larger ECCS sump strainers and made other plant improvements in response to GL 2004-02. That's why vulnerability to post-LOCA debris effects is substantially reduced. However, outstanding technical issues remain for most plants, for example additional head loss testing may be necessary for some plants to demonstrate adequate strainer performance.

Q1. How does NRC evaluate the testing method or scaling method?

A1. NRC developed the guidance (see P25 of previous NRC presentation). This guidance includes those methods and it has enough conservatism to account for uncertainties.

Q2. Do the replacement strainers in the U.S. include a trash rack? A trash rack provides additional defense-in-depth.

A2. Many of the replacement strainer designs do not include a trash rack. The replacement strainer designs typically do not require a trash rack. Licensees inspect the strainer integrity, and avoid locations where break jets, missiles, and other hazards can affect the strainer. Also, much of the larger debris that a trash rack would stop will typically tend to settle in the containment pool.

Q3. If the plant does not have enough space to install large strainers, what should they do?

A3. There are several solutions such as compact type strainer, debris interceptor and insulation modification. U.S. PWR licensees are required to ensure that their plant designs provide adequate ECCS strainer performance.

Q4. There are many kinds of strainers, does NRC have any problem to evaluate them?

A4. Typically, there are several kinds of strainers. The NRC staff evaluates each plant's strainer individually. Examples of some differences in strainer design are as follows. One type of strainer has an interior orifice that encourages uniform flow; others are non-uniform. Some strainers are located in a pit; others are located on the containment floor.

Q5. How does NRC track the corrective actions which are done by licensees?

A5. NRC staff will track which licensees have corrective actions that have not been completed when the GL 2004-02 review is closed for a given plant. Licensees will report to us when all corrective actions are complete. Then the NRC will perform verification of these corrective actions as applicable through the normal plant inspection process.

Q6. I (Chinese participant) think that PWRs in the US have similar design. Why does NRC evaluate each plant?

A6. They have their own conditions such as kind of debris, amount of debris, containment vessel design and flow rate of pump. That's why NRC evaluates each plant on an individual basis.

**(5) Current status of Japanese utilities**

Progress of the response to the ECCS strainer blockage events by Japanese regulatory body and utilities was explained. It includes the investigation of insulations in containment vessel, interim compensatory measures, the evaluation method for effectiveness of strainer and future plan in Japanese utilities.

In Japan, PWR utilities continue implementing interim compensatory measures, until the evaluations are finished and specific measures are complete.

Q1. As for the BWRs in Japan, did they change the strainers or insulations or both of them?

A1. They planed the change of strainers, and at this moment most BWRs are finished the modification of strainers. I'm sorry I'm not sure about insulations.

**(6) Countermeasures for short term "Simulator training in Japan"**

Development for simulator training of ECCS sump screen blockage event, and implementation & evaluation of the training were showed. The expert explained the observations regarding trainee's habit which he realized in his simulator training and their provisions. They were also beneficial for simulator training in China.

No questions.

**(7) Countermeasures for long term "Modification of ECCS strainer"**

Key attributes for strainer performance, long-term countermeasure options and elements of a strainer replacement project were showed. As for the strainer performance, experts used the movie of the experiments regarding debris generation and debris loading, therefore, the participants were easy to understand. In addition, experts showed the concrete example of modification options and some suggestions to each Chinese NPPs. It was also very beneficial

for Chinese participants.

**Q1. How is seismic qualification of the strainer performed (by calculation or by testing) If we (Chinese participant) change to use metallic reflective insulation, we have to implement the seismic calculation because metal reflective insulation can be heavier than the fiber insulation currently installed. In that case, how should we implement it?**

**A1. The seismic qualification of a strainer system is done by calculation using finite element analysis. Metal reflective insulation is also qualified by calculation, although physical testing as a baseline has been performed in the past to establish benchmark values.**

**Q2. How effective is the debris interceptor?**

**A2. The interceptor can catch or divert a significant amount of the debris, therefore the load for strainer can be decreased. Crediting the debris interceptor with the capture of large debris is straightforward because testing has been done to confirm curb lift velocity metrics. However, crediting the capture of fine debris on debris interceptors, although it would occur to some degree, is very complicated and difficult to model using existing analytical methods.**

**Q3. About how many plants use the debris bypass eliminator to capture very small particles that would otherwise pass through the strainer?**

**A3. Approximately one fourth of US PWR's that installed the Transco strainer have incorporated the debris bypass eliminator option.**

#### **Comments and suggestions from experts**

Followings are the Remarks from experts except above Q&A.

##### **Remark1**

If you are interested in the simulator training concerning ECCS blockage event, please refer the contents that Mr. Matsumoto explained. (from Mr. Yoshio Matsumoto)

##### **Remark2**

The expert suggested that Chinese regulators and plant operators might consider an evaluation of strainer performance and associated risks for operating plants before making a final determination of the schedule for implementing modifications to ensure adequate strainer performance for these plants. (from Mr. John Lehning)