POLICY ISSUE
(Information)

January 8, 1993

SECY-93-002

For: The Commissioners

From: James M. Taylor
Executive Director for Operations

Subject: REPORT ON THE JCCCNRS WORKING GROUP 8 MEETING, DECEMBER 7 - 12, 1992

Purpose: To inform the Commission of working group activities under the U.S.-USSR Joint Coordinating Committee for Civilian Nuclear Reactor Safety (JCCCNRS).

Discussion: This meeting of Working Group 8, "Exchange of Operational Experience," was part of a series of meetings approved in protocols between the U.S. and the U.S.S.R.

The U.S. delegation arrived in Moscow on December 5, 1992, for a week of working sessions spending two days at the VNIIAES office in Moscow, and four days at the Novovoronezh Nuclear Power Plant. Both sides reaffirmed their commitment to continue effective dialogue on items of mutual interest, even though this is the last meeting under the JCCCNRS.

James M. Taylor
Executive Director for Operations

Attachment:
12/28/92 Memorandum TMNovak to JMTaylor
"Report of Visit to the USSR,
December 7-12, 1992," w/enclosures

Contact:
Gordon Fowler, OIP
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NOTE: TO BE MADE PUBLICLY AVAILABLE IN 10 WORKING DAYS FROM THE DATE OF THIS PAPER

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

December 28, 1992

MEMORANDUM FOR: James M. Taylor, Chairman, JCCCNRS

FROM: Thomas M. Novak, Director
Division of Safety Programs
Office for Analysis and Evaluation
of Operational Data

SUBJECT: REPORT ON THE JCCCNRS WORKING GROUP 8 MEETING, DECEMBER 7 - 12, 1992

I. Background

This meeting of Working Group 8, "Exchange of Operational Experience," was part of a series of meetings approved in protocols between the U.S. and the U.S.S.R.

The U.S. delegation arrived in Moscow on December 5, 1992, for a week of working sessions spending two days at the VNIIAES office in Moscow, and four days at the Novovoronezh Nuclear Power Plant. The Russian side of the Working Group was headed by Vladimir Vitkov, Deputy Director, Nuclear Information Center, All Union Institute for Nuclear Power Plant Operation (VNIIAES). The U.S. side was headed by Thomas M. Novak.

II. Summary

The agenda and location for Working Group 8 meetings were planned so as to encourage attendance by operating plant personnel. With VNIIAES support, we were successful in having representatives from the Zaporozhe, Novovoronezh, Smolensk, Kalinin, and Kola power stations participate for the entire week of meetings.

The memorandum of the last meeting is enclosed. I would note the following particular interest.

1. It was agreed by both parties that Working Group 8 had fulfilled its commitment and while there was a need for continued exchange of information regarding operational experience, it should be considered under the "Lisbon Initiative." Dr. Vitkov was fully aware that it would be his Country's responsibility to set the priority for any future discussions under this initiative.

2. The attendance of several operating plant personnel contributed to the meeting. I had asked for their attendance to provide an opportunity for them to participate in discussion involving operating experience. They were particularly vocal in their view that all too often errors made by control room operators were used

as the cause for an event. They argued that design weaknesses were a major contributor to incidents.

3. The Russians have a development program underway intended to be an improvement to our Accident Sequence Precursor (ASP) Program. They expect to have this program ready for use in about one year. We indicated out interest in staying informed on the progress of these efforts.

4. During the previous two years, VNIIAES has distributed 468 operational event reports from Russian plants as well as IAEA-IRS reports to all of their operating plants. Based on feedback from the plants, about 30 percent of the information was considered important information and about 60 percent of the information was used by the plants. It was noted that those plants that were active participants in the reporting program appeared to have fewer failures.

As a final note, I would recommend a several day meeting with the Russians and Ukrainians about every two years to discuss operating experience and lessons learned, operator response to abnormal events, and developments in assessing risk from operational incidents.

The memorandum will be forwarded to the Commission as a SECY paper.

/S/

Thomas M. Novak, Director
Division of Safety Programs
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of Operational Data

Enclosure: As stated

cc w/enclosure
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MEMORANDUM OF THE FIFTH MEETING OF WORKING GROUP NO. 8
OF THE U.S.-RUSSIA JOINT COORDINATING COMMITTEE
ON CIVILIAN NUCLEAR REACTOR SAFETY

December 7-12, 1992

The fifth meeting of Working Group No. 8, "Exchange of Operational Experience", of the U.S.-Russia Joint Coordinating Committee on Civilian Nuclear Reactor Safety (JCCCNRS) was held in Moscow, at the All Union Institute for Nuclear Power Plant Operation and in Novovoronezh, at the nuclear power station.

The Russian side of the Working Group was headed by Vladimir Vitkov, Deputy Director, Nuclear Information Center, All Union Institute for Nuclear Power Plant Operation. The U.S. side was headed by Thomas M. Novak, Director, Division of Safety Programs, Office for Analysis and Evaluation of Operational Data, U.S. NRC. A list of the participants in the Working Group sessions, as well as invited plant personnel, is provided in Appendix I. The invitees to the meetings included personnel from several nuclear power stations including Zaporozhje, Novovoronezh, Smolensk, Kalinin, and Kola. The documents exchanged during the sessions are listed in Appendix II.

This Memorandum of Meeting reports the recommendations for proposed future actions. Both sides reaffirmed their commitment to continue effective dialogue on items of mutual interest, even though this is the last meeting under the JCCCNRS.

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE ACTIVITIES

The agenda for the meeting was followed with the following conclusions:

a. Use of Markovian Methods. No firm conclusions were drawn with regard to possible benefits to be gained from use of Markovian methods to assess system reliability. It was agreed that the discussions identified differences between U.S. methods as used in NUREG-1150 and the Russian methods using Markovian models. It was concluded that these meetings have provided a good forum for discussion, but, it would not be useful to include this subject in any future agenda.

b. Accident Sequence Precursor Program. There was agreement that these discussions provided useful insights into a better understanding of risk from operating events. Each country described the development work in progress to improve the insights that could be gained from the ASP analyses. It was agreed that future discussions (either as part of Working Group 8 or in some other forum) should be held to exchange information on improvements in ASP type methodology.

c. Shutdown Risk. Each country provided a discussion of events which occurred during shutdown. The U.S. emphasized the importance of outage planning, the need for reliable decay heat removal systems, and additional instrumentation to assist the operators during reduced inventory operations. It was agreed that these discussions highlighted the importance of recognizing the risks during shutdown

and that any future discussions of operating experience should include events while in shutdown.

d. Performance Indicators (PI). Each country described uses made of PI to trend plant performance. Both countries described development efforts underway to better utilize PI data. It was agreed that these discussions covered the expected uses of PIs and that there was no need for further discussions on this topic. However, in the event that new indicators are developed which provide useful information regarding operating performance, they should be included in discussions covered by operating experience.

e. Human Factors. The discussions regarding human factors offered an opportunity for all participants to exchange views based on operational experience. Representatives from several operating plants in Russia and the Ukraine offered views on difficulties confronting operating crews when responding to abnormal events. It was agreed that any future discussions should be considered as part of the "Lisbon Initiative."

f. Common Cause Failures. Each country provided a discussion of operating events involving common cause failures. It was agreed that these discussions were beneficial and that any future discussion of operational experience should include common cause failures.

It was agreed that Working Group 8 had fulfilled its commitment and while there was a need for continued exchange of information regarding operational experience, it should be considered under the "Lisbon Initiative." Specific subjects for further discussion include:

Exchange of views between experts (including possible consultant meetings to provide directions for future developments) regarding the analytical methods and applications in the Accident Sequence Precursor (ASP) program.

Insights gained from evaluation of operator response (human factors and the trending of human error rates) to abnormal events.

Exchange of operational experience and lessons learned.

The following topics were discussed at the Moscow meeting:

Topic 1. Application of Markovian Processes in Plant System Reliability Estimation

The Russian are using a computer code based on the Markov process to examine the reliability of nuclear plants. Specifically, they are examining strategies for performing plant maintenance by varying the frequency of surveillance tests and the allowed time for recovering inoperable safety trains. Results were presented for the analysis of the boron injection system for the Khmelnitskaya plant which has a three train system. The trains are tested on a staggered monthly basis. If one train is inoperable, the other trains are tested to insure their operability. They want to

extend the allowable recovery time from 72 to 96 hours. The analysis provides a dynamic picture of the system reliability over the monthly surveillance cycle.

The Russians analyzed the auxiliary feedwater system for the Surry plant based on the system description and component failure data provided in NUREG-1150 documents. The available Surry data were not sufficiently detailed for the full utilization of Markov methods which consider the timing of specific actions associated with the system. However, results of the analysis based on available data were provided. This is a more refined analysis compared to the traditional fault tree analysis used in the U.S. where average failure values are used. An analysis was presented showing the impact of various testing and outage strategies for the Surry auxiliary feedwater system.

The Russians have performed level 1 probabilistic analyses of several plants including Rostov, Kalinin, and Loviisa. The dominant accident sequences noted in the Rostov (new plant design) analysis are small break LOCA, loss of feedwater, and loss of offsite power. These sequences are similar to those noted in analyses of U.S. plants. The Russians plan to perform level 1 and level 2 probabilistic analyses of the Zaporozhje and Balacovo plants.

The U.S. described the evolution of the probabilistic analysis of the auxiliary feedwater system in American pressurized water reactors from WASH-1400 to a recent evaluation based on operational data. It was noted that the major contributor to system unavailability was estimated common cause failures. The evaluation of recent data shows that the unavailability associated with independent failures of the three trains is higher than previously estimated, but still within the overall estimated system unavailability.

Topic 2. Severe Accident Sequence Precursor Program

The U.S. described the results of the evaluation of the 1991 review of operating events at American plants. The Accident Sequence Precursor program identified 27 events that had a conditional core damage probability greater than 1E-6 and 14 events that had a conditional core damage probability greater than 1E-4. The most severe event was the delayed observation of stuck open relief valves in the high pressure injection system. The importance of this event was not recognized until the ASP analysis indicated a conditional core damage probability of 6E-3. A discussion of the 14 most significant events was provided.

Future activities in the Accident Sequence Precursor program include examination of the uncertainties associated with the evaluations and use of more detailed models to evaluate the events. Licensee review of the analyses for their plants, creation of an oversight group, and some statistical analysis will be used to reduce the uncertainties in the conclusions drawn from the results. Component level fault trees will be used in the future to perform the ASP analyses.

The Russians described an accident severity analysis program that they are developing using the Markov process and event trees. They believe that this approach will provide added insight to degrading plant conditions and their impact on the dynamic severity of an event. The output from such

a program will show the degree of severity and the length of time the plant is exposed to these conditions. Three indicators are being considered: an instantaneous conditional probability of core damage, an integrated value, and a rate of change in the value. Because of the extensive effort required to analyze all potential core damage at each point in the path, an interactive program is being developed so the analyst can direct the scope of the analysis as it progresses. They expect to have a production version ready in one year.

Topic 3. Shutdown Risk

The Russians described 19 events that occurred during shutdown in 1992. Although none of these events posed significant risk, they did indicate a need for improved administrative control under these conditions. At one plant, they observed swelling and cracking in various guide tubes in the upper head region. Extensive investigations ultimately hypothesized that these failures were caused by an earlier hydrogen detonation in the upper head when the plant was started up a year earlier. The explosive mixture was attributed to radiolysis, the use of ammonia and hydrozine for water chemistry, and inopportune venting of the upper head. This event has received wide dissemination in Russia and has been provided to IAEA and WANO.

The U.S. gave an overview of the risk associated with events during shutdown and low power operations at U.S. nuclear power plants. The need for improved outage management (better maintenance planning), the necessity to have adequate procedures to cover loss of decay heat during mid-loop operation (Diablo Canyon event), and risk associated with reactivity addition for a pressurized water reactor was emphasized. The Accident Sequence Precursor program was extended to include events that occur during shutdown. Several plants have extended their probabilistic risk assessments to include shutdown. The U.S. is also reviewing the adequacy of 1) fire protection, 2)operating procedures and training, 3) available instrumentation, 4) emergency planning, and 5) limiting conditions for operation in the technical specifications for shutdown conditions.

The following topics were discussed at Novovoronezh:

Topic 4. Nuclear Power Plant Performance Indicators

The U.S. described how AEOD regularly performs independent assessments of the current seven performance indicators plus cause codes to identify plants whose performance trends warrant in-depth analyses. The results of these analyses are compared with the results of special inspection teams, Abnormal Occurrence reports, Accident Sequence Precursor events, and SALP scores to obtain an overall understanding of licensee strengths and weaknesses. These plant evaluations are then used by AEOD management in preparation for the NRC senior management meetings.

NRC has developed short term enhancements which include the division of the nuclear power plants into nine peer groups (by reactor vendor, vintage of the reactor, the licensing date and the number in that group). Thus, each plant can be compared to a peer group, enhancing the interpretation of observed trends.

The U.S. also discussed the long-term plans that would completely overhaul the performance indicator program.

The Russians described their annual reporting system for each plant and for all plants considered together. These reports focus on several parameters related to plant chemistry and radiation exposures. There are internal disagreements concerning the inferences drawn from these parameters because they impose an unfavorable bias on certain types of plants. There is an ongoing evolution in this area to obtain a useful indicators.

An evaluation of all the Russian plants using the present indicators concluded that their performance is acceptable. However, it was noted that there were a large number of forced power reductions or shutdowns and a large number of personnel errors.

Technical personnel from the Kola power plant described the extensive review of equipment failures that has been performed at the plant since 1980. These data are analyzed by plant personnel and the results used to initiate corrective action on those components showing an increase in unavailability. It was agreed that this was a good practice. In discussion with management from the Novovoronezh plant, it was also stated that similar analysis is performed. These data will also be used in a future probabilistic assessment of the plant.

Another Russian paper proposed using the variance associated with core damage probabilities calculated for sequential events at a given plant as a performance indicator. Three examples were presented that showed stable, unstable, and self-correcting plant performance.

Based on operating experience and new safety requirements with more stringent safety limits, the Russians described the design limits for their new VVER-1100NP series reactor that is currently being designed. It will have a double containment and passive safety systems among other features. The new regulatory guides have a core melt limitation of 1E-5.

Topic 5. Human Factors

The U.S. described the human factors studies initiated in 1990 to evaluate the impact of human performance during selected power reactor events. To date, AEOD has conducted 16 such studies, which represent a wide variety of situations at both pressurized and boiling water reactors, for events that occurred at power as well as during shutdown.

These studies have identified positive and negative aspects of important issues, such as: control room staffing and organization; the role of the shift technical adviser; use of shift resources during an emergency; operator control of engineered safety features; simulator training; crew teamwork during stressful situations; task awareness; knowledge-based operator performance; use of procedures; and licensee followup of events.

The findings of these studies provide many examples of good industry practices which could be applied to help human performance.

The GAN representative from its research center presented a paper regarding monitoring was useful and provided insights into the safety aspects of plant operation.

The Russians described a simple operator error performance indicator that sums the observations for each plant type. Within the limitation of the reporting system, for each plant type within the former Soviet Union 20 events were associated with human errors. There appeared to be differences in the types of errors and frequency of errors among the three types of reactors.

The operator training center at Novovoronezh is engaged in training operators in the new symptom oriented procedures. The Novovoronezh plant will be the first to implement these procedures. An extensive training program is underway with the usual difficulties associated with totally revamping the way the operators respond to plant scrams, with or without complications. Previously the operators committed the event oriented procedures to memory, instead of following a text step-by-step. There is a significant commitment of operator involvement in removing the defects in the procedures.

The working group toured the training center at Novovoronezh. They have simulators for the VVER 440 and 1000 MW plants which are used for training russian operators as well as those from other countries using these model plants. The training center issues four year operator certificates after the applicants complete the classroom and simulator training and pass the qualifying exams. The center is also active in disseminating information on nuclear power to the public.

Another paper, prepared jointly by VNIIAES and Zaporozhje power plant personnel, discussed a review of the control room layout in the V230 series plants. It was noted that the instrumentation does not facilitate operator response to plant transients. As a result of this review, they are considering using computers to monitor the plant parameters during all modes of operation and aid the shift supervisor in making timely decisions. The lack of adequate feedback in the control room was noted by several of the operating personnel at the meeting. The Novovoronezh representative provided separate comments on the subject.

Topic 6. Analysis of Separate Events. Common Cause Failures.

The U.S. described a review of potential or actual common cause failures at American plants in 1990. The results show that a majority of the situations observed are associated with design, fabrication, and installation errors that occurred when the plant was built. Potential corrective actions for eliminating these types of flaws are comprehensive system tests which cover the potential operating regions of the system and component replacement with equipment having larger design margins. Exposure to those situations caused by maintenance errors may be partially reduced by staggered surveillance testing.

The Russians described 13 actual or potential common cause failure events that occurred in the past year. The failures involved valve erosion, flooding, poor maintenance, biofouling of service water systems,

condensation in electrical cabinets, corrosion in air systems, and blockage of impulse lines. Corrective actions were recommended for each of these events.

At one plant, the Russians experienced diesel failures because of resin deposits in the turbocharger from low load operation. These deposits caused excessive vibrations and ultimate failure of the turbochargers. Test programs were revised to ensure that the resins will be burned off during testing.

During the previous two years, VNIIAES has distributed 466 operational event reports from Russian plants as well as IAEA-IRS reports to all of their plants. Based on feedback from these plants, about 30% of the reports were considered important information and about 60% of the information was used by the plants. It was noted that those plants that were active participants in the reporting program appeared to have fewer failures.

FOR THE RUSSIAN COMMITTEE FOR
THE UTILIZATION OF ATOMIC ENERGY

Vladimir M. Vitkov
12 December, 1992

FOR THE US NUCLEAR
REGULATORY COMMISSION

Thomas M. Novak
12 December, 1992

APPENDIX I - LIST OF PARTICIPANTS

RUSSIA

All Union Institute for Nuclear Power Plant Operation (VNIIAES)

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Nuclear Regulatory Commission

Thomas M. Novak, Director, Division of Safety Programs, Office for Analysis and Evaluation of Operational Data

Sanford Israel

APPENDIX II - LIST OF PRESENTATIONS

RUSSIA

Estimation of Reliability Indicators for Auxiliary Feedwater System (based on US plant system example) Using Markovian Models. Estimation of Integrated Reliability Indicators for HPSI System.

Development of a Program to Identify Severe Accident Sequence Precursors.

Analysis of NPP Events that Occurred During Planned Shutdowns.

Damage to Reactor Internals While Planned Shutdown. Corrective Actions.

Work Practice to Assess the Status which Describes NPP Operational Safety. Indicators Describing Balakovo Operational Safety.

In-service Monitoring of Balakovo NPP Safety.

Human Factor Impact on NPP Operational Event Origination and Progression. Major Corrective Actions.

Problems of Operator Training While Introducing Symptom Based Procedures.

Plant Layout and Analysis and Proposals to Modify VVER-1000 Control Rooms Resulting from Operational Experience.

Analysis of NPP Operational Events Due to Common Cause Failures.

Analysis of Kola NPP Safety System Reliability While in Operation. Corrective Actions.

Design Limits for VVER-1100 NG New Generation Nuclear Steam Supply System

Some Results of Using IAEA-IRS Reports in Russia's Nuclear Power Industry.

U.S.

Auxiliary Feedwater System Reliability.

Accident Sequence Precursor Program, 1991 Events.

Performance Indicators.

Trending of Individual Plant Performance Indicators.

Human Factor Analysis of 17 Events at U.S. Plants During 1990 - 1991.

Insights from Common Cause Failure Events.

JOINT RUSSIAN-AMERICAN COORDINATION COMMISSION FOR SAFETY OF CIVILIAN NUCLEAR REACTORS (JCCSCNR)

VNIIAES

PROGRAMME
of WG-8 meeting "Exchange of Operational Experience"
JCCSCNR
Moscow, Novovoronezh

7-14 December 1992

WG-8 Co-Chairman from Russian Side: V.Vitkov (VNIIAES)
WG-8 Co-Chairman from US Side: T.Novak (NRC)

7 December VNIIAES

9-30 Opening of the meeting Topic: Application of
10-00 Markovian Processes in Plant System Reliability Estimation. VNIIAES paper: "Estimation of Reliability Indicators for Auxiliary Feedwater System (based on US plant system example) Using Markovian Models. Estimation of Integrated Reliability Indicators for HPSI system."

12-00 NRC paper: "Use of Markovian Process to Measure System Reliability Compared to the US Approach on Example of Surry NPP Auxiliary Feedwater System." Topic summing up.
Topic: Severe Accident Precursor Programme

14-30 NRC paper: "Severe Accident Sequence Precursor Programme":
- review of significant precursors
- changes to the programme.

8 December VNIIAES

VNIIAES paper: "Development of a Programme to Identify Severe Accident Sequence Precursors". Topic summing up.

Topic: Shutdown risk.
"Rosenergoatom" papers:
"Analysis of NPP Events That Occurred During Planned Shutdowns".
Kalinin NPP paper:
"Damage to Reactor Internals While Planned Shutdown. Corrective Actions..."

NRC paper:
"Discussion of Actions Being Considered to Reduce Risk During Shutdown".
Topic summing up.
Evening: Departure to Nov voronezh.

9 December NV NPP

14-00 Topic: NPP Performance Indicators
NRC papers:
"Review of Current Effectiveness of US PIs Considering Recent Changes in Method of Presentation". Planned Short-Term Development to Improve Usefulness of Current PIs. Long-term Plans for Complete Overhauling of the PI Programme.

16-00 Balakovo plant and VNIIAES paper:
"Work Practice to Assess the Status which Describes NPP Operational Safety. Indicators Describing Balakovo NPP Operational Safety".
Paper by Russian Nuclear Power Indpectorate's Research Centre: "In-Service Monitoring of Balakovo NPP Safety".

18-00 NRC paper:
"Programs for Trending Individual Plant Performance to Identify Declining Plant Performance"
Topic summing up.

10 December NV NPP

9-00 Topic: Human factor
NRC paper:
"Human Factor Analysis of 17 Events at US Plants During 1990-1991".

13-00 VNIIAES paper:
"Human Factor Impact on NPP Operational Event Origination and Progression. Major Corrective Actions."
Paper by NV NPP Training Centre:
"Problems of Operator Training While Introducing Symptom-Based Procedures".
Paper by VNIIAES and Zaporozhye NPP:
"Plant Layout Analysis and Proposals to Modify VVER-1000 Control Rooms Resulting from Operational Experience".

11 December	NV NPP
9-00	Topic: Analysis of Separate Events. Common Cause Failures NRC paper: "Discussion of Significant Events Which Occurred at US Operating NPPs as a Result of Common Cause Failures in Redundant Trains of Safety-Related Equipment".
11-00	Paper by Nuclear Inspectorate's Research Centre: "Analysis of NPP Operational Events Due to Common Cause Failure". Kola NPP paper: "Analysis of Kola NPP Safety System Reliability While in Operation. Corrective Actions". Paper by "Hydropress" Design Bureau: "Use of NPP Operational Experience to Improve VVER Type Plant Reliability". Topic summing up.
15-00	Tour of the NV NPP Training Centre.
12 December	NV NPP
9-00	Visit to NV NPP.
13-00	Concuding remarks on the meeting. Preparation and signing of the Minutes. Evening: departure to Moscow.