Task CH2: Design (Rev. 1)

The Chernobyl Unit 4 accident was a prompt critical reactivity excursion that occurred when the operators reduced power to well below the permissible safe operating level and, at the same time, neglected to follow low power operating procedures. Unit 4 shared a site with Units 1, 2, and 3 and was contiguous with Unit 3 with which it also shared some common elements. All three of the other units were exposed to some danger from the accident. Fires aggravated the accident and complicated its management and consequences. In this task,

outlined in Chapter 2 of NUREG-1251,[1] the staff will compare the design features of U.S. reactors with those of the Chernobyl 4 reactor in looking for possible regulatory changes implicit in the accident.

ITEM CH2.1: REACTIVITY ACCIDENTS

This item consists of one recommendation that is evaluated below.

ITEM CH2.1A: REACTIVITY TRANSIENTS DESCRIPTION

In light of Chernobyl, it is necessary to examine some of the multiple-failure reactivity transients using PRA tools to reconfirm previous judgments. This item called for the staff to perform a study to estimate probability levels

of certain reactivity transients. If any events appear to fall within the probability levels of NRC guidelines and involve a significant potential for extensive core damage, they might become a basis for changing design or operational limits. The study will include both probabilistic analyses to estimate the frequency of an event and deterministic analyses to assess the potential consequences. The events of interest are those in which there is a relatively large reactivity insertion and/or the response of the shutdown system may be inadequate. Identified events of interest are:

BWRs

- Multiple rod drop
- Control rod ejection
- Overpressurization with limited relief
- Boron dilution during anticipated transient without scram (ATWS)
- ATWS without recirculation pump trip
- Multiple rod bank withdrawal
- Reactivity events with more than one rod stuck out

PWRs

- Multiple rod blank withdrawal ATWS
- Multiple rod ejection (low power)
- Injection of cold, unborated emergency cooling water
- Injection of cold, unborated water due to SGTR
- Unlimited boron dilution
- Rod withdrawal, heatup or depressurization from low temperature with positive moderator temperature

[1] NUREG-1251, "Implications of the Accident at Chernobyl for Safety Regulation of Commercial Nuclear Power Plants in the United States," U.S. Nuclear Regulatory Commission, (Vols. I and II) April 1989.

coefficient

- ATWS with less negative moderator temperature coefficient
- Reactivity events with more than one rod stuck out

In addressing this issue, the staff will focus attention on sequences that might involve a positive void coefficient or moderator temperature coefficient, that might arise in connection with deliberate bypassing or disabling of any safety feature, and whose causes include human error (commission, omission, or misjudgment).

The six parts of this issue are as follows:

I.	**Establishment of Criteria:** Criteria will be established to judge whether a particular sequence needs further examination by the NRC.
II.	**Selection of Events:** Sequence of event trees will be developed for the events identified above and critical sequence paths will be determined for different modes of reactor operation in light of positive moderator temperature coefficient, deliberate bypassing or disabling of any safety feature and human errors including commission, omission, and misjudgments. One typical Westinghouse PWR (Byron) and one typical BWR (Peach Bottom) were chosen to be analyzed. If certain sequences in certain events are important, analyses will be extended to other types of plants.
III.	**Probabilistic Quantification of Events:** The accident sequences that emerge from Part II will be quantified to establish those that meet criteria in Part I above. The quantification process will involve a detailed search of various data bases to obtain failure rates and event probabilities. If the data base is not available, such as in the case of human errors, conservative assumptions will be made.
IV.	**Physical Assessment of Events:** For each sequence of events for which the frequency of occurrence is either unknown or expected to be significant according to the criteria of Part I, a deterministic analysis will be made. Key parameters will be determined and their limiting values quantified. The quantification will be done primarily by using results of analyses which have already been performed for other purposes.
V.	**Preparation of Report:** A draft report will be prepared integrating the above described tasks.
VI.	**Final Report:** A final report will be prepared after comments.

CONCLUSION

As a part of the improvements to NUREG-0933, the NRC staff clarified in SECY-11-0101, "Summary of Activities

Related to Generic Issues Program," dated July 26, 2011,[2] that the Generic Issues Program will not pursue any further actions toward resolution of licensing and regulatory impact issues. Because licensing and regulatory impact issues are not safety issues by the classification guidance in the legacy Generic Issues Program, these issues do not meet at least one of the Generic Issues Program screening criteria and do not warrant further processing in accordance with Management Directive 6.4, "Generic Issues Program," dated November 17,

2009.[3] Therefore, this issue will not be pursued any further in the Generic Issues Program.

ITEM CH2.2: ACCIDENTS AT LOW POWER AND AT ZERO POWER

DESCRIPTION

One of the unique aspects of the Chernobyl accident is that it occurred at relatively low power (<7%). This has caused some concern because low power operation is generally considered to be a safer condition than high or full power operation. The principal effect of low power on the Chernobyl accident was related to nuclear/

thermohydraulic stability and reactivity insertion. These effects were addressed in Item CH2.1. Another important aspect of low power or zero power operation is the availability of safety systems. Items CH1.3 and CH1.4 specifically address the subjects of bypassing and availability of safety systems. Different safety systems may be used to provide protection for low power and shutdown (zero power) events than are used for high power

[2] SECY-11-0101, "Summary of Activities Related to Generic Issues Program," July 26, 2011. [ML111590814]

[3] Management Directive 6.4, "Generic Issues Program," U.S. Nuclear Regulatory Commission, November 17, 2009.

events. TS prescribe the conditions for bypassing and activating the various systems and their completeness is also addressed in Items CH1.3 and CH1.4.

In pursuing this issue, the staff is expected to increase its knowledge, certainty, and understanding of safety issues in order to increase its confidence in assessing levels of safety. Therefore, this issue is considered to be a licensing issue.

CONCLUSION

Accident initiators at low power are covered in Item CH1.4 which is to be coordinated with the Severe Accident Program. The results of Item CH1.4 will be made available to the industry to help develop TS improvements if necessary.

ITEM CH2.3: MULTIPLE-UNIT PROTECTION

The radioactive gas and smoke released during the accident at Chernobyl Unit 4 spread to the other three operating units at the site. The airborne radioactive material was transported to the other units through a shared ventilation system as well as by way of general atmospheric dispersion paths. This raises the question of how accidents at one unit of a multi-unit site affect the remaining units and additional questions of how these effects may be compounded when structures, systems, and components are shared between units. This item consists of four recommendations that are evaluated separately below.

ITEM CH2.3A: CONTROL ROOM HABITABILITY DESCRIPTION

The objective of this issue is to estimate what effects an accident at one unit of a multi-unit site could have upon the ability of site personnel to maintain the remaining units in a safe condition, to identify potential new requirements that would decrease those effects, and to assess the safety advantages of such requirements in relation to the disadvantages of their imposition. Although identified as a multi-unit issue, the staff's work should include site emergencies such as fires and other potential causes of widespread damage that might not be directly related to a particular unit. By including control room habitability challenges not initiated by a reactor accident, single unit sites would also be included.

In pursuing this issue, the staff is expected to increase its knowledge, certainty, and understanding of safety issues in order to increase its confidence in assessing levels of safety. Therefore, this issue is considered to be a licensing issue.

CONCLUSION

All efforts to address this issue are included in the plans for the resolution of Issue 83, "Control Room Habitability." Included in these plans is a survey of a sample of U.S. control rooms at diverse plants and sites and an assessment of the capabilities of these control rooms and their habitability systems to meet GDC 5 and

19. In the event of deficiencies in the assessed capabilities, the costs and benefits of backfits needed to achieve those capabilities are to be assessed and, where justified, requirements specified.

ITEM CH2.3B: CONTAMINATION OUTSIDE CONTROL ROOM DESCRIPTION

The objective of this issue is to identify all plant areas to which human access would be necessary to either manage an accident at an affected unit or to maintain other units at a multi-unit site, to assess the dose consequences to personnel performing needed tasks within those areas, and to identify any potential measures for further reducing those consequences which could be justified by virtue of improved risk.

The necessary information to perform the work required by this issue includes identification of risk-dominant accidents and their corresponding accident management plans. For the identified accidents and the associated plant areas to which access is needed, generic estimates of contamination of those areas, in combination with generic measures of radiation shine from adjacent equipment and from other units,

need to be developed.

The identification of plant areas to which access is required occurred during resolution of TMI Action Plan[4] Item II.B.2. It will be confirmed that these plant identifications are consistent with the accident management considerations being proposed in conjunction with the IPE. This work is incorporated in existing efforts in accident management research.

[4] NUREG-0660, "NRC Action Plan Developed as a Result of the TMI-2 Accident," U.S. Nuclear Regulatory Commission, May 1980, (Rev. 1) August 1980.

In pursuing this issue, the staff is expected to increase its knowledge, certainty, and understanding of safety issues in order to increase its confidence in assessing levels of safety. Therefore, this issue is considered to be a licensing issue.

CONCLUSION

This item consisted of review and coordination to assure that Chernobyl lessons were taken into account in the Accident Management Research Plan. The results of this issue would constitute an input to the Accident Management Research efforts.

As a part of the improvements to NUREG-0933, the NRC staff clarified in SECY-11-0101, "Summary of Activities

Related to Generic Issues Program," dated July 26, 2011,[5] that the Generic Issues Program will not pursue any further actions toward resolution of licensing and regulatory impact issues. Because licensing and regulatory impact issues are not safety issues by the classification guidance in the legacy Generic Issues Program, these issues do not meet at least one of the Generic Issues Program screening criteria and do not warrant further processing in accordance with Management Directive 6.4, "Generic Issues Program," dated November 17,

2009.[6] Therefore, this issue will not be pursued any further in the Generic Issues Program.

ITEM CH2.3C: SMOKE CONTROL DESCRIPTION

This issue called for the staff to assess the risk significance of smoke propagation from one unit to an adjacent unit and to address the question of whether additional protection/requirements should be developed. The staff will use fire risk assessments from four LWRs to assess the risk significance of smoke propagation. Based upon the results, the need for further work will be determined. This issue could affect existing and future plants.

In pursuing this issue, the staff is expected to increase its knowledge, certainty, and understanding of safety issues in order to increase its confidence in assessing levels of safety. Therefore, this issue is considered to be a licensing issue.

CONCLUSION

As a part of the improvements to NUREG-0933, the NRC staff clarified in SECY-11-0101, "Summary of Activities

Related to Generic Issues Program," dated July 26, 2011,[7] that the Generic Issues Program will not pursue any further actions toward resolution of licensing and regulatory impact issues. Because licensing and regulatory impact issues are not safety issues by the classification guidance in the legacy Generic Issues Program, these issues do not meet at least one of the Generic Issues Program screening criteria and do not warrant further processing in accordance with Management Directive 6.4, "Generic Issues Program," dated November 17,

2009.[8] Therefore, this issue will not be pursued any further in the Generic Issues Program.

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[5] SECY-11-0101, "Summary of Activities Related to Generic Issues Program," July 26, 2011. [ML111590814]
[6] Management Directive 6.4, "Generic Issues Program," U.S. Nuclear Regulatory Commission, November 17, 2009.
[7] SECY-11-0101, "Summary of Activities Related to Generic Issues Program," July 26, 2011. [ML111590814]
[8] Management Directive 6.4, "Generic Issues Program," U.S. Nuclear Regulatory Commission, November 17, 2009.

ITEM CH2.3D: SHARED SHUTDOWN SYSTEMS DESCRIPTION

This issue called for the staff to determine whether sharing of systems required for safe shutdown among units at a multi-unit site should be prohibited and, if not, to what restrictions such sharing should be subjected. The staff is to determine requirements for shared systems and prepare guidance on the use of shared systems as part of the severe accident policy implementation. It is anticipated that only future plants will be affected by this issue.

In pursuing this issue, the staff is expected to increase its knowledge, certainty, and understanding of safety issues in order to increase its confidence in assessing levels of safety. Therefore, this issue is considered to be a licensing issue.

CONCLUSION

As a part of the improvements to NUREG-0933, the NRC staff clarified in SECY-11-0101, "Summary of Activities

Related to Generic Issues Program," dated July 26, 2011,[9] that the Generic Issues Program will not pursue any further actions toward resolution of licensing and regulatory impact issues. Because licensing and regulatory impact issues are not safety issues by the classification guidance in the legacy Generic Issues Program, these issues do not meet at least one of the Generic Issues Program screening criteria and do not warrant further processing in accordance with Management Directive 6.4, "Generic Issues Program," dated November 17, 2009.[10] Therefore, this issue will not be pursued any further in the Generic Issues Program.

ITEM CH2.4: FIRE PROTECTION

This item consists of one recommendation that is evaluated below. **ITEM CH2.4A: FIREFIGHTING WITH RADIATION PRESENT DESCRIPTION**

This issue called for the staff to determine: (1) whether there is a significant risk that radiation released during a fire or from the initiating event could limit firefighting capability; and (2) what additional measures, if any, such

risk might necessitate. The staff will use existing representative fire risk studies from four LWRs to estimate risk. This issue could affect existing and future plants.

In pursuing this issue, the staff is expected to increase its knowledge, certainty, and understanding of safety issues in order to increase its confidence in assessing levels of safety. Therefore, this issue is considered to be a licensing issue.

CONCLUSION

As a part of the improvements to NUREG-0933, the NRC staff clarified in SECY-11-0101, "Summary of Activities

Related to Generic Issues Program," dated July 26, 2011,[11] that the Generic Issues Program will not pursue any further actions toward resolution of licensing and regulatory impact issues. Because licensing and regulatory impact issues are not safety issues by the classification guidance in the legacy Generic Issues Program, these issues do not meet at least one of the Generic Issues Program screening criteria and do not warrant further processing in accordance with Management Directive 6.4, "Generic Issues Program," dated November 17,

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[9] SECY-11-0101, "Summary of Activities Related to Generic Issues Program," July 26, 2011. [ML111590814]

[10] Management Directive 6.4, "Generic Issues Program," U.S. Nuclear Regulatory Commission, November 17, 2009.

[11] SECY-11-0101, "Summary of Activities Related to Generic Issues Program," July 26, 2011. [ML111590814]

2009.[12] Therefore, this issue will not be pursued any further in the Generic Issues Program.

[12] Management Directive 6.4, "Generic Issues Program," U.S. Nuclear Regulatory Commission, November 17, 2009.