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DISTRIBUTION OF NUREG-1251, IMPLICATIONS OF THE ACCIDENT AT CHERNOBYL FOR SAFETY REGULATION OF COMMERCIAL NUCLEAR POWER PLANTS IN THE UNITED STATES, VOLUMES I AND II

The enclosed final report was prepared by the U.S. Nuclear Regulatory Commission (NRC) staff to assess the implications of the April 1986 accident at the Chernobyl nuclear power plant in the Soviet Union as they relate to commercial nuclear reactor safety regulation in the United States. You will recall receiving a draft of this report which was issued for public comment in September 1987. The comments received, together with further work within the NRC, were taken into account in preparing this final version. The changes (marked by vertical lines in the margin) correct or clarify specific items of information and modify assessments in some areas pertaining to specific issues; they do not substantially change the major aspects of the assessment.

The report consists of two volumes. Volume I is the main report. A separately bound appendix to this report, Volume II, contains the comments received, provides the staff's response to significant issues raised in the comments and identifies the nature and basis of the resultant changes to the draft report.

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EXCERPT

Implications of the Accident at Chernobyl for Safety Regulation of Commercial Nuclear Power Plants in the United States

Final Report

Main Report

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ABSTRACT

This report was prepared by the Nuclear Regulatory Commission (NRC) staff to assess the implications of the accident at the Chernobyl nuclear power plant as they relate to reactor safety regulation for commercial nuclear power plants in the United States. The facts used in this assessment have been drawn from the U.S. fact-finding report (NUREG-1250) and its sources.

This report consists of two volumes: Volume I, Main Report, and Volume II, Appendix - Public Comments and Their Disposition.

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INTRODUCTION

This report was prepared by the staff of the U.S. Nuclear Regulatory Commission (NRC) to assess the implications of the April 1986 Chernobyl accident in the Soviet Union as they relate to commercial nuclear reactor safety regulation in the United States. Most of the assessment focuses on light-water-reactor power plants. A final chapter addresses graphite-moderated reactors.

With respect to studying the Chernobyl accident, U.S. Government agencies have expended their energies on determining the facts, as well as on assessing those facts in terms of how the accident may affect U.S. policies and practices in the nuclear power field.

The work was divided into two major phases. The first phase, fact finding, was a coordinated effort among several U.S. Government agencies and some private groups; this phase was completed in January 1987 and has been reported in NUREG-1250, "Report on the Accident at the Chernobyl Nuclear Power Station." The second phase, an assessment of the implications of that accident with regard to U.S. policies and practices, is being pursued separately by each organization that participated in NUREG-1250. The present report, as part of this second phase, addresses the safety regulation of commercial nuclear reactors under NRC regulatory jurisdiction. (Department of Energy reactors, not subject to NRC regulation, are not addressed in this NRC study.)

In developing the assessments presented in this report (NUREG-1251), the NRC staff depended on NUREG-1250 and its two major source documents (USSR, 1986; INSAG, 1986) for the facts of the Chernobyl accident. The Soviet document (USSR, 1986) is an official Soviet report to the International Atomic Energy Agency (IAEA) Experts' Meeting held in Vienna August 25-29, 1986; the second (INSAG, 1986) is the report to the IAEA prepared by the International Nuclear Safety Advisory Group at a second meeting in Vienna on August 30 to September 5, 1986.

The assessment of the implications of the Chernobyl accident with regard to commercial nuclear reactor safety regulation in the United States is supported by detailed assessments of a number of particular issues, grouped in six subject areas. The particular issues selected for evaluation were those that are associated with significant factors that led to or exacerbated the consequences of the Chernobyl accident.

A draft of this report was issued for public comment in September 1987. The comments received, together with further work within the NRC, were taken into account in preparing this final version. The passages that have been changed (except for those with minor editorial changes, such as the spelling out of acronyms) are marked by vertical lines in the margin. A separately bound appendix to this report contains the comments received, provides the staff's response to significant issues raised in the comments, and identifies the nature and basis of the resultant changes to the draft report. The changes correct or clarify specific items of information and modify assessments in some areas pertaining to specific issues; they do not substantially change the major aspects of the assessment.

(4) The Chernobyl experience should remain as part of the background information to be taken into account when dealing with reactor safety issues in the future.

Conclusions About Specific Areas

The accident at Chernobyl suggests that the following specific areas be examined in direct response to that event. (Cross-references in parentheses refer to correspondingly numbered detailed assessments in the body of this report.)

(1) Administrative Controls Over Reactor Operations (Chapter 1)

In general, regulatory provisions at nuclear plants in the United States, if properly implemented, are adequate with respect to administrative controls to ensure that reactor operations are conducted within a safe range of operating conditions. These controls address procedural adequacy and compliance, approval of tests and other unusual operations, bypassing of safety systems, availability of engineered safety features, operating staff attitudes toward safety, management systems, and accident management.

However, the benefits of the following additional provisions should be examined:

(a) Programs for accident management, including training and the development of procedures for coping with severe core damage and for the effective management of the containment. This provision will be addressed and resolved as part of the implementation of the Commission's Severe Accident Policy.

(b) The review of administrative controls to seek ways of strengthening technical reviews and the approval of changes, tests, and experiments.

(c) The review of safety system status displays and the availability of engineered safety features for potential worthwhile improvements.

(d) The review of current NRC testing requirements for balancing benefits versus risks.

(e) Measures that might further increase assurance that violations of procedures that could be instrumental in causing an accident or emergency situation or compromising safety margins will not occur.

(2) Reactivity Accidents (Section 2.1)

Positive void reactivity coefficients, which are a characteristic of the RBMK graphite-moderated water-cooled reactors, played a central role in determining the severity of the Chernobyl accident. Commercial reactors in the United States are designed very differently from the RBMK reactor at Chernobyl, and have generally a negative void reactivity coefficient. This provides assurance that the kind of superprompt critical excursion that took place at Chernobyl will not occur. However, the NRC should reconfirm that vulnerabilities and risks from possible accident sequences have been adequately factored into safety analysis reports on which design approvals are based.

protective actions outside it if necessary, continues to be viewed as adequate. However, in light of new research information (NUREG-0956, "Reassessment of the Technical Bases for Estimating Source Terms," and NUREG-1150, "Reactor Risk Reference Document"), the planning bases for relocation and decontamination and for protective measures for the food ingestion pathway are being reexamined in cooperation with the Federal Emergency Management Agency.

(8) Severe-Accident Phenomena (Chapter 5)

The phenomena of the Chernobyl accident were greatly influenced by the design features and materials in the RBMK reactor, which differ in many respects from those of U.S. reactors. The only radionuclide release aspects identified to date that are not currently considered in U.S. analytical models involve two mechanisms of fission-product release from fuel debris. These are mechanical dispersal and chemical stripping (removal of the fuel surface layer, as through chemical change of the uranium oxide). Although it is not clear that these mechanisms will have any effect on accident sequences relevant to U.S. reactors, it is recommended that the need for additional research be assessed.

(9) Graphite-Moderated Reactors (Chapter 6)

The Fort St. Vrain high-temperature gas-cooled reactor (HTGR) is the only licensed and operating commercial graphite-moderated reactor in the United States. A study of the potential for a Chernobyl-type fire and explosion at Fort St. Vrain was initiated immediately after the Chernobyl accident. It should be noted, however, that the licensee for Fort St. Vrain, the Public Service Company of Colorado, has notified the NRC that it will discontinue operations on or before June 30, 1990.

Although the only shared features between the HTGR concept and the Chernobyl design are the use of a graphite moderator and gravity-driven control rods, the 330-MWe Fort St. Vrain HTGR and a proposed modular HTGR concept were reviewed against the Chernobyl candidate issues and the conclusions presented in this document for light-water reactors. This assessment confirms that the concept of the HTGR (because it uses helium coolant in a fully ceramic core, has an overall negative reactivity coefficient, and has completely diverse alternate shutdown and cooling systems) has no direct association with the identified weaknesses of the Chernobyl design. In the areas at issue of operations, design, containment, emergency planning, and severe-accident phenomena, NRC assessments conclude that the implications of the accident at Chernobyl generate no new licensing concerns for HTGRs and both the overall and specific-area conclusions are the same as for light-water reactors. The assessment did not raise any new concerns regarding HTGR severe-accident phenomena. It did reinforce the desirability of undertaking a limited probabilistic risk assessment of Fort St. Vrain. It also suggested consideration of the merits of the possible reinitiation of experiments in graphite thermal stress to enhance confidence in the long-term integrity of the Fort St. Vrain structural graphite. However, no work with respect to Fort St. Vrain is now warranted, in view of the imminent termination of operations.