NUCLEAR POWER PLANT SAFETY

SUMMARY

A primary responsibility of the NRC is the safety of nuclear power plants. This responsibility is implemented through a licensing process that provides for the issuance of licenses for construction and operation of these plants only after a thorough and multi-level agency review that includes public participation and input at its key stages. The licenses issued in accordance with this process specify the framework and necessary details of actions that builders and operators of nuclear power plants must follow in order to protect public health and safety. Compliance with these licenses conditions is enforced by NRC inspectors during both plant construction and operation.

Licenses are issued only for those nuclear power plants which, based on careful and independent reviews by the NRC, can meet the stringent safety standards and criteria required by our regulations within the bounds of conservative engineering practice. These safety standards include requirements for considerable margins between design and operating conditions and for redundancy in primary and backup equipment in order to compensate for the fact that no body of knowledge can ever be complete enough to reduce uncertainties and risks to zero. Thus, although the operation of nuclear power plants is not completely risk-free, the safety objective of the NRC, as implemented through this licensing process, is to

require plant builders and operators to take all those actions considered necessary to assure that the risk to the public ~~and safety~~ is and continues to be very small.

One of the primary methods for achieving this safety objective is the use of a defense-in-depth concept for protecting public health and safety. This concept, which is required by NRC regulations, results in the provision of multiple physical barriers in nuclear power plants between the radioactivity contained in the reactor fuel and the plant environment. These regulatory requirements are supplemented by a comprehensive quality assurance program that is designed to assure their proper implementation. Further assurance of achieving our safety objective is provided by the comprehensive safety reviews carried out by the NRC Staff during plant design, construction, and operation, and by the independent safety reviews conducted by the Commission's Advisory Committee on Reactor Safeguards and Atomic Safety and Licensing Boards.

Operating experience provides another important contribution to the assurance of nuclear power plant safety. Design improvements, based on this experience, can be and are being incorporated into new plants, and mistakes in design and construction of operating plants can be and are being corrected in order to further minimize public risk. The results to date

of this operating experience have shown in the most practical way the wisdom of requiring the defense-in-depth concept for nuclear plants with ample conservatisms in order to compensate for the existing lack of complete knowledge. Operating results have also provides a basis in experience for improvements in the design and operation of features important to continued plant safety.

Based on these considerations and without prejudice to the conclusions we might reach in any individual licensing proceeding, we believe that nuclear power plants that have been designed, constructed and licensed to operate in accordance with these NRC regulations and practices are safe; that is, they present no undue risk to the health and safety of the public.

It would be nice to be able to also say that there are absolutely no problems with respect to the safety of nuclear power plants, that perfection has been achieved, and that all risks have been eliminated. This is not the case. Nevertheless, we believe that nuclear power plants are safe and that the risk to the public health and safety from their operation is very small. The Commission's intention is to assure that this risk remains at or below this level so that nuclear power can continue to represent a suitable and safe alternative for satisfying the nation's energy needs.

NUCLEAR POWER PLANT SAFETY

DEFENSE-IN-DEPTH

The defense-in-depth concept is a principal means of assuring a small risk to public health and safety from the operation of nuclear power plants. This concept calls for the incorporation of three levels of safety in the design of these plants. The three levels concern different design considerations, but they necessarily intermesh and overlap, so that certain design features can be assigned to more than one of these levels.

The First Level of Safety

A simplified statement of the first level philosophy is to design and build a nuclear power plant so it will, with a high degree of reliability, operate without failures that could lead to accidents. The first level of safety involves designing a plant to conservative standards so that it will be safe in all phases of operation and has a maximum tolerance for errors, off-normal operation and component malfunction.

The Second Level Of Safety

Despite the care that is taken in the first level of safety to avoid equipment failures or operating errors that could lead to safety problems, the NRC believes it is prudent to anticipate that some incidents will occur during the service life of a nuclear power plant and to provide measures

to cope with them. This second level of protection for the reactor operating staff and the public is provided by reliable protection devices and systems designed to assure that expected occurrences and off-normal conditions will be detected and either arrested or accommodated safely. The requirements for these protection systems are based on a consideration of a spectrum of events that could lead to off-normal operations which the plant design must safely accommodate. In addition, extensive testing programs are carried out to verify that the protection systems will function as designed.

The Third Level Of Safety

The third level of safety supplements the first two through features that provide additional margins in the plant design to protect the public even in the event of the occurrences of very unlikely accidents. These margins are assessed primarily by evaluating the response of the plant to a number of assumed accidents, involving in some instances the assumption of an independent failure of a redundant protective system simultaneously with the occurrence of the accident it is intended to control. From analyses of these postulated accidents, a number of sequences called design basis accidents are selected as a basis for the design of additional plant features and equipment that are provided to further protect public health and safety. One of the third-level systems provided on all modern nuclear

plants is the reactor containment. Another third-level system is the emergency core cooling systems that is designed to cool the core in the event of a major instantaneous rupture of all norma. plant cooling systems.

NRC SAFETY REVIEWS

The safety reviews and inspections conducted by the NRC are designed to assure the proper and conservative application of the Commission's siting, design, construction, and operation regulations which implement the defense-in-depth concept for nuclear power plants. The purpose, scope and effect of these reviews in minimizing public risk can best be shown by relating them to the siting, design, construction and operation phases of nuclear power plants.

Siting Reviews

The principal NRC requirements for the siting of nuclear plants are found in 10 CFR Part 100 and its Appendix A, Geologic and Seismic Siting Criteria for Nuclear Power Plants. The siting reviews carried out by the staff in implementing this regulation play an important role in assuring that the likelihood of severe reactor accidents due to siting considerations is very low. For example, the requirements of this regulation, supported by the independent evaluations of seismic and geologic conditions at and

near reactor site by the NRC staff and its consultants, provide the basis for establishing the likelihood of severe accidents from seismic events. The objective in the development of these requirements was to specify investigations and procedures such that the likelihood of occurrence of an earthquake more severe than required to be used for design purposes would be low and the possibility of a severe accident resulting from such an earthquake even lower. Similarly, NRC regulations require that other environmental considerations at or near a reactor site that have the potential to cause a severe reactor accident, such as flooding, tornadoes, and overflying aircraft, be evaluated and to the extent necessary designed against, pursuant to the requirements of Criterion 2 of the NRC General Design Criteria, to assure that the likelihood of accidents from these causes is comparable to the likelihood of accidents caused by earthquakes.

Design Reviews

There are many NRC regulations that require the implementation of the defense-in-depth concept in the design of nuclear power plants. These include the majority of the present 64 General Design Criteria, other Appendices of 10 CFR Part 50, and Section 50.55a, of Part 50, Codes and Standards for Nuclear Power Plants. A large fraction of the effort involved in NRC design reviews is for the purpose of determining whether these requirements are being properly and conservatively implemented. These detailed reviews of proposed reactor deisgns are relied upon to a

considerable degree in helping form a considerable portion of the basis for achieving our safety objective of assuring that the risk to the public from nuclear power plants is very small.

In addition to the reviews of design adequacy conducted by the NRC staff, AEC regulations require license applicants to perform analyses of various postulated equipment, system and personnel failures. Independent evaluations of these events on a selective basis are then performed by the NRC to assure that equipment and personnel performance under the assumed conditions are properly described and the accident consequences conservatively calculated. These independent accident analyses provide further assurance of the design adequacy of licensed nuclear power plants.

Construction and Operation Reviews

Appendix B to 10 CFR Part 50 of the NRC regulations establishes quality assurance criteria required for all phases of nuclear power plant design, construction and operation. These criteria, as implemented by licensees' quality assurance programs and enforced by field reviews and inspections by the NRC staff, provide assurance that the as-built plant structures, systems and components important to safety reflect those features required as a result of NRC design reviews and accident analyses. In addition, NRC inspections during operation provide further assurance that plant operations are conducted in accordance with license conditions. These

license conditions are conservatively established so as to maintain the very low risk to public health and safety from plant operation.

OPERATING EXPERIENCE

The siting, design, construction and operating reviews previously described have been designed to provide the necessary and sufficient conditions needed to assure, in conjunction with the NRC regulations, that nuclear power plants present no undue risk to public health and safety. The over 300 reactor years of successful nuclear power plant operation in this country provide added support for such a judgment. Of course, this amount of experience does not provide an adequate statistical basis for definitively quantifying the probability of reactor accidents or the risk to public health and safety. Within, these limitations, however, the safety record of licensed nuclear power reactors speaks for itself.

Operating experience provides another important contribution to the assurance of nuclear power plant safety. Design improvements, based on experience, can be and are being incorporated into new plant designs, and mistakes in design and construction of operating plants can be and are being rectified to further improve plant safety. The results to date of this operating experience have shown in the most practical way the wisdom of implementing the defense-in-depth concept for nuclear plants with ample conservatisms

in order to compensate for the existing lack of complete knowledge. Operating results have also provided a basis in experience for improvements in the design and operation of plant features important to continued plant safety.