NUREG-0578

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STATUS REPORT AND SHORT TERM RECOMMENDATIONS OF THE TMI-2 LESSONS LEARNED TASK FORCE

July 1979

OFFICE OF NUCLEAR REACTOR REGULATION

U.S. NUCLEAR REGULATORY COMMISSION

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1.0 GENERAL

1.1 Introduction

On March 28, 1979, the Three Mile Island Unit 2 (TMI-2) nuclear power plant experienced a loss of feedwater transient that led to a series of events resulting in a partially mitigated loss-of-coolant accident and significant core damage. On the basis of information available at this time, the sequence of events that led to core damage involved equipment malfunctions, design deficiencies and human errors that contributed to varying degrees to the consequences of the accident. The final evaluation of the TMI-2 accident is not complete. Activities have been established in the Office of Nuclear Reactor Regulation to assure the continued safe operation of licensed facilities while the TMI-2 evaluations and investigations proceed.

The Lessons Learned Task Force is one of several TMI-2 related activities now underway in NRR. The purpose of the Task Force is to review and evaluate safety concerns originating with the TMI-2 accident that require licensing action for presently operating reactors as well as pending operating licenses and construction permit applications. This includes the review and evaluation of investigative information, staff evaluations of responses to I&E Bulletins and Orders, Commissioners' recommendations, ACRS recommendations, staff recommendations, recommendations from NUREG-0560, and recommendations from outside of the NRC. In addition, the Task Force is to identify, analyze and recomm nd changes to licensing requirements and the licensing process for nuclear power plants based on the lessons learned. The range of areas of interest to the Task Force includes the following general technical areas:

(1) reactor operations, including operator training and licensing;

(2) licensee technical qualifications;

(3) reactor transient and accident analysis;

(4) licensing requirements for safety and process equipment, instrumentation, and controls;

(5) onsite emergency preparations and procedures;

(6) NRR accident response role, capability and management; and,

(7) feedback, evaluation, and utilization of reactor operating experience.

A related ongoing effort in NRR is the Bulletins and Orders (B&O) Task Force. That group is performing safety evaluations for the five B&W plants shut down by confirmatory Commission orders, and it is reviewing the responses to IE Bulletins by licensees with other operating plants designed by Westinghouse, Combustion Engineering and General Electric.

Actions recommended by the Lessons Learned Task Force and approved by the Director of NRR or the Commission, as appropriate, will be assigned to the Divisions of Project Management and Operating Reactors and the B&O Task Force for implementation on pending license applications and on operating plants. At that time, appropriate Licensing Boards will be formally notified of these licensing matters.

The short term actions recommended by the Lessons Learned Task Force in this report, when combined with the requirements flowing from implementation of the IE bulletins on TMI-2, are intended to constitute a sufficient set of short term requirements for operating plants as well as pending CP and OL applications with near term projected decision dates (remainder of calendar year 1979).

There may be additional licensing actions or requirements recommended by the Task Force within the next several months for backfit to operating plants and pending license applications. In addition, other longer term studies or research activities will be recommended by the Lessons Learned Task Force for action by the NRC Offices of SD, RES, or IE, as appropriate.

1.2 Task Force Operation and Coordination

The Task Force has established communications with the ACRS and its TMI-2 subcommittee, the B&O Task Force, the AIF Steering Committee, the EPRI Nuclear Safety Analysis Center, and various utility and vendor groups or owners groups, all having related interests in the lessons to be learned from the accident at TMI-2. Coordination with these groups will continue to be an ongoing activity of the Task Force. In addition the Task Force is coordinating some related NRR responses to Congressional inquiries and Commission information requests and work assignments concerning potential changes in reactor regulation resulting from the TMI-2 accident. The Task Force is also advising the Director of NRR on coordination and concurrence matters on the RES, SD and IE programs connected with TMI-2.

A very large number of issues has been raised by the accident. The initial efforts of the Task Force have been directed mainly to organize, screen and evaluate the licensing matters among this large set of issues so that they may be placed into various categories according to their importance to safety and their priority for implementation.

From its first month's work, the Task Force has culled a set of specific safety requirements that are recommended for prompt issuance in short term operating reactor licensing activities and near term CP and OL reviews. These issues have been chosen in the context of a general perspective and a continuing evaluation of the lessons from TMI-2 that can be derived from current understanding of the accident.

The decision making process being followed by the Task Force in determining which safety issues require prompt licensing action, versus those that can be deferred for further evaluation by the Task Force or others, is based upon engineering evaluation and qualitative professional judgment of safety significance. In this regard the Task Force has selected items for "<u>short term action</u>" if their implementation would provide immediate, substantial, additional protection required for the public health and safety. Thus our recommendations for short term action are prompt, specific, and safety significant in their character and are not likely to be overturned or contradicted by continuing studies or investigations. In some cases an immediate action may not be amendable to precise description on the basis of information or analyses developed to date. Yet the item is judged to be of sufficient safety significance as to require an immediate commitment to get studies or testing underway. In this case the recommended action is to obtain a "<u>short term commitment</u>" for a longer term modification, study or test by affected licensees.

With two exceptions, the recommendations for short term actions or commitments so far identified are generally consistent with the existing design bases for nuclear power plants and the Commission's existing regulations. The two exceptions pertain to post-accident hydrogen contorl. In some of the other short-term recommendations our current judgment of the safety significance of a particular matter yields a somewhat different interpretation of existing regulations compared to previous interpretation.

The Task Force recommendations for short term actions or commitments were decided one at a time by a two-thirds majority vote of the Task Force members present. One item is included in this report as a minority recommendation; i.e., its short term implementation was supported by less than one-third of the Task Force. It is discussed in more detail, below.

There are several licensing issues raised by TMI-2 that are being worked by groups within the Commission's staff, but in close coordination with the Lessons Learned Task Force. These are operator training and licensing (OLB), licensee technical qualifications (QAB), instrumentation to follow the course of an accident (SD) and emergency preparedness (EDO Task Force). These activities can be expected to produce significant recommendations for regulatory improvements, some in the next several weeks, others by the end of the summer and beyond.

Having identified and characterized the short term action recommendations contained in Section 2 of this report, the Task Force will turn to the broader, more fundamental regulatory questions which must be addressed in the longer term (some of them likely to require evaluations that extend beyond the life span of this Task Force) before further regulatory actions are taken. It is the intent of the Task Force to develop, from its technical and engineering perspective, recommendations on how to proceed with decisions in these fundamental areas, along lines described in Section 3 of this report.

The Task Force intends to develop its final recommendations and issue a final report by about September 1, 1979. The most important topic to be addressed in that report will deal with issues that will affect the future structure and content of the licensing process to correct the deficiencies identified by the TMI-2 accident and to upgrade the level of safety in operating plants and plants under construction.

For several reasons many of the specific issues raised by TMI-2 cannot be evaluated narrowly. Some issues are inextricably tied to fundamental policy questions that require more thorough deliberation than can be accomplished in a few weeks. Some of the issues relate to degraded plant conditions or multiple failures that exceed the current design basis derived from existing regulations. Other items require a careful balancing of operations and design considerations in order to achieve a desired improvement. Finally, there are some issues that simply require more study to understand their safety significance.

The fundamental issues requiring work over the long term beyond the life of this Task Force will generally involve changes in the licensing basis for nuclear plants, and are of a broad scope, integrated or programmatic nature. It is anticipated that decisions on some of these items should await the results of ongoing investigations such as the President's Commission on TMI-2 and the NRC Special Inquery in order that the broader perspectives of these groups can be considered. The intent of the Lessons Learned Task Force is to make recommendations on the engineering and licensing considerations that should be factored into those decisions and possible regulatory approaches that could be followed in reaching and implementing the decisions.

1.3 Implementation of Short Term Licensing Requirements

The licensing requirements now being implemented by the B&O Task Force have come from the I&E Bulletins and Commission Confirmatory Shutdown Orders. Actions required by the Confirmatory Shutdown Orders on the B&W plants are being implemented before each plant is allowed to restart. Licensees' responses to the I&E Bulletins are presently being reviewed by the B&O Task Group which will issue status reports describing the detailed licensing requirements for the operating plants designed by Westinghouse, Combustion Engineering, and General Electric.

The Lessons Learned Task Force Less Established 12 broad areas in which changes in light water nuclear power plants are required (nine in the area of design and analysis and three in the operation area). They are described in Section 2, below.

These items identified by the Lessons Learned Task Force for short term licensing action were discussed with the Regulatory Requirements Review Committee on June 22, 1979, and were described to the Commission in a public meeting on June 25, 1979. Upon approval by the Director of NRR or the Commission, as appropriate, these short term licensing requirements will be transmitted to CP and OL licensees and license applicants by the B&O Task Force or DPM, as appropriate.

2.0 SHORT TERM RECOMMENDATIONS

The Lessons Learned Task Force has identified 23 specific requirements in 12 areas whose implementation is judged to provide immediate, substantial, additional protection required for public health and safety. Each requirement is described in detail Enclosure A. They are recommended for promulgation and implementation on the time scale described in the "implementation" section at the end of each writeup in Enclosure A. The requirements which are summarized and listed by general categories, below complete the short-term action of the Lessons Learned Task Foce.

2.1 Design and Analysis

1. Emergency Power Supply Requirements for the Pressurizer Heaters, Relief and Block Valves,and

A general lesson from our review and others of the TMI-2 accident is that the frequency with which some safety systems, such as high pressure injection systems (part of the Emergency Core Cooling System provided pursuant to General Design Criterion 35 of 10 CFR Part 50, Appendix A), are called upon to function for reactor coolant system pressure control may exceed their generally understood and previously accepted design basis. Other actions pursuant to the Bulletins and Orders applied to B&W reactors have been aimed at increasing the overall performance reliability of the plant for feadwater transients (decreased re[illegible]ance on high pressure injection) by decreasing the sensitivity of the plant response, and work is underway in this area by the B&O Task Force in its review of Westinghouse and Combustion Engineering reactors. Over the long term additional work is likely to be required in a general review of the frequency of challenges to safety systems in past operating experience and possibly in the development of acceptable numerical criteria for past and future designs. For the short term, the Lessons Learned Task Force recommends that some specific changed be made current PWR designs to decrease the frequency of challenge to high pressure emergency core cooling systems upon loss of offsite power.

In some designs loss of pressurizer heaters due to a loss of offsite power requires the use of the high pressure emergency core cooling system to maintain reactor pressure and volume for natural circulation cooling. Similarly, in some design an inability to close power operated relieve valves due to loss of offsite powers could result in additional challenges to the high pressure energency core cooling system. Finally, proper functioning of the pressurizer level instrumentation is necessary in order to maintain satisfactory pressure control for natural circulation cooling using the pressurizer heaters.

There is also a general question raised by TMI-2 that involves the need to expand the scope of applicability of some of the existing reliability criteria (such as the single failure and diversity criteria and the other so called "safety grade" design criteria, such as seismic and environmental qualifications) to equipment not heretofore included in the licensing interpretation of the equipment "important to safety" described in General Design Criterion 1, and elsewhere in the Commission's regulations.

Pending longer term decisions on the need for and formulations of new safety classifications for such equipment, we recommend that the emergency power supply changes described below are a required step in that direction, in addition to the reason for these changes summarized in the preceding paragraphs.

Emergency Power Supply Requirements for the Pressurizer Relief and Block Valves and Pressurizer Level Indicators in PWRs

Provide the capability for emergency power supply to the minimum number of required pressurizer heaters to maintain natural circulation conditions in the event of loss of offsite power.

Also provide emergency power to the control and motive power systems for the PORV's and associated block valves and to the pressurizer level indication instrument channels.

2. Performance Testing for BWR and PWR Relief and Safety Valves

Although the Commission and the nuclear industry have had pump and valve operability standards and testing requirements under development for some years, they have nto been implemented for two important types of valves in the primary coolant boundary. Recognizing that some of this work will require much longer to complete and is not all of the same safety significance, the Task Force recommends that programs be promptly initiated and completed by January 1982 to establish the functional performance capability of PWR and BWR safety and relief valves. There is also a need over the longer term to provide reliability criteria for these and other valves in the primary coolant boundary in implementation of General Design Criterion 14. In summary form, the short term requirement in this area should be to:

Commit to provide performance verification by full scale, full flow prototypical testing, for all relief and safety valves. Test conditions shall include two phase slug flow and subcooled liquid flow.

3. Information to Aid Operators in Accident Diagnosis and Control

A widely accepted lesson from the TMI-2 accident is that the man-machine interface in some reactor control rooms needs significant improvement. Considerable long term research and development work in this area is already underway in industry and in the NRC research program. However, there is sufficient evidence from TMI-2 evaluations performed to date to conclude that the two following changes should be made as soon as practical, pending results from ongoing studies.

a. Direct Indication of Power Operated Relief Valve and Safety Valve Position for PWRs and BWRs

Provide in the control room either direct position indication for the valves or more reliable flow indication devices downstream of the valves.

b. Instrumentation for Detection and Mitigation of Inadegate Core Cooling for PWRs and BWRs

Perform analyses and implement procedures and training for prompt recognition of low reactor coolant level or core voiding using existing reactor instrumentation (flow, temperature, power, etc.) or short term modifications of existing instruments. Describe and provide analyses to provide more direct indication of core voiding such as reactor vessel water level instrumentation.

4. <u>Diverse and More Selective Containment Isolation Provisions for PWRs and BWRs</u>

The containment isolation provisions at TMI-2 proved to be inadequate in two respects. First, the lack of diverse actuation signals resulted in not isolating the containment until after a significant quantity of water had been pumped out of the containment sump into the auxiliary building. This is an important deficiency of some of the older designs that should be fixed, even if there was no radioactivity released from the TMI-2 containment by this route, as is now believed. Second, the sequence of events at TMI-2 illustrated the need for careful reconsideration of the isolation provisions of nonessential systems inside containment which should be isolated indefinitely and those systems which should be selectively isolated only after it is established that they are not essential to continued core cooling. Third, in some designs the resetting of the containment isolation signal may result in automatic reopening of some containment isolation valves. The following requirement is recommended to correct these deficiencies:

Provide containment isolation on diverse signals in conformance with Section 6.2.4 of the Standard Review Plan, review isolation provisions for nonessential systems and revise as necessary, and modify containment isolation designs as necessary to eliminate potential for inadvertent reopening upon reset of the isolation signal.

5. Post-Accident Hydrogen Control Systems for PWR and BWR Containments

The TMI-2 accident resulted in the production of quantities of hydrogen gas in excess of the amounts required by the Commission's Regulations to be considered in the design and analysis of nuclear power plants. The Task Force recommends one licensing change to improve the reliability of the hydrogen control systems currently installed in operating plants (or new OLs) and one regulation change to bring two operating BWRs and any newly licensed BWRs up to the same capability as the other operating BWRs for hydrogen control (containment inerting). A minority of the Task Force also recommends an immediate change in the Commission's Regulations to require that changes be made in the operating plants that currently rely upon containment venting as the only method of long term, post-accident hydrogen removal from the containment. The three specific recommendations are:

a. Dedicated Penetrations for External External Recombiner or Post-Accident External Purge System

For plants which have external recombiners or purge systems provide dedicated penetrations and isolation systems for which met the redundancy and single failure requirements of the Commission's regulations. Modify design as necessary so that these systems are not connected to or branch lines of the large containment purge penetrations.

b. Inerting BWR Containments

Provide inerting for all Mark I and Mark II BWR containments. This would require changes at Vermont Yankee and Hatch Unit 2 operating plants, as well as pending OL applications for Mark I and II BWRs.

c. Combustible Gas Control-Capability to Install Recombiner at Each Light Water Nuclear Power Plant

A minority of the Task Force recommends that all operating reactors, that do not already have the capability, be required to provide the capability to add, within a few days after an accident, a hydrogen recombiner system for post-accident hydrogen removal.

6. Post-Accident Control of Radiation in Systems Outside Containment of PWRs and BWRs

The systems containing radioactive material outside of containment at TMI-2 had several deficiencies. First there were inadequate leakage characteristics. Second, there were inadequate shielding or personnel access provisions. The difficulties arose in safety systems and in systems outside the scope of previous "safety grade" requirements (such as the makeup and letdown system). Pending long term consideration of this and other aspects of the degraded core consequences of the TMI-2 accident, the Task Force recommends the following intermediate steps to improve the systems in operating plants and pending applications so that operators would be in a better position to manage radiation control activities in the event of an accident of this nature.

a. Integrity of Systems Outside Containment Likely to Contain Radioactive Materials (Engineered Safety Systems and Auxiliary Systems)

Perform leakage rate tests on systems outside containment that process primary coolant and could contain high level radioactive materials, develop and implement a periodic testing program and preventive maintenance programs.

b. Design Review of Plant Shielding of Spaces for Post Accident Operations

Perform a design review of the shielding of systems that process primary coolant and could contain high level radioactive materials to determine any areas that are vital for post accident occupancy and assure that access will not be limited due to radiation from these systems.

7. Improved Auxiliary Feedwater System Reliability for PWRs

The need to provide an emergency feedwater system of high reliability is a clear lesson from the accident. The IE Bulletins and the Commission's Confirmatory Orders for the B&W designed plants deal with this aspect of the accident in some detail. In addition to the requirements already being implemented by the Bulletins and Orders Task Force, the Lessons Learned Task Force recommends that the following additional requirements be issued now for Westinghouse and Combustion Engineering designs.

a. Automatic Initiation of the Auxiliary Feedwater System

Provide automatic initiation of all auxiliary feedwater systems. The initiation signals and circuits shall be designed in such a manner that a single failure will not result in the loss of auxiliary feedwater system function. Testability of the initiating signals and circuits shall be a feature of the design. The initiating signals and circuits shall be powered from the emergency buses. Manual capability to initiate the auxiliary feedwater system from the control room must be retained and must be implemented in such a manner that a single failure in the manual circuits will not result in the loss of system function. The A-C motor driven pumps and valves in the auxiliary feedwater system must be included in the automatic sequence of the loads to the emergency buses. The design of the automatic initiating signals and circuits must be such that their failure will not result in the loss of manual capability to initiate the auxiliary feedwater system from the control room.

b. Auxiliary Feedwater Flow Indication to Steam Generators

Provide control room indication of auxiliary feedwater flow for each steam generator. The flow instrument channels shall be powered from the emergency buses consistent with satisfying the power diversity requirements for auxiliary feedwater systems.

8. Instrumentation to Follow the Course of an Accident

The NRC staff and the ACRS have for some years emphasized the need to install special features and instruments to aid in accident diagnosis and control. Although some instruments and capability of this sort were available at TMI-2, and exist on other plants, more is needed. The Lessons Learned Task Force has met with representatives of ONRR and OSD management where it was agreed to expedite the revision and early implementation of Regulatory Guide 1.97 for all operating plants and plants under construction. It is expected that the necessary revisions would be developed within a few months and implementation would follow subsequently. In the meantime, the following provisions are recommended for early implementation on all operating plants and new OLs to provide a uniform, minimum capability in this area.

a. Improved Post-Accident Sampling Capability

Review and upgrade as necessary the capability to obtain samples from the reactor coolant system and containment atmosphere under high radioactivity conditions. Provide the capability to do chemical and spectrum analysis of high level samples on-site.

b. Increased Range on Radiation Monitors

Revise or provide high range radiation monitors in plant effluent lines and a high radiation monitor in the containment. Provide instrumentation which monitors effluent release lines to the environment during accident conditions which is capable of directly or indirectly measuringand identifying radioiodine and particulate radioactive effluents.

c. Improved In-Plant Iodine Instrumentation

Provide portable instrumentation for accurately determining in-plant airborne radioiodine concentration to prevent unnecessary use of respiratory protection equipment.

9. Analysis of Design and Off-Normal Transients and Accidents

Further analyses are required to insure adequacy of operator training and operations procedures. The two NRR Task Forces have agreed upon a program of required generic analyses of small break LOCAs, loss of core cooling events, and multiple failure transients and accidents for completion over the next year and use in the revision of training programs and emergency procedures.

2.2 Operations

1. Improve Reactor Operations Command Function

The Task Force has concluded that the need for improved operations reliability is the most important lesson to be learned from the accident at TMI-2. One part of this overall lesson that is amenable to early implementation and appears to be necessary is more definite and clearly articulated operations command responsibilities and better administrative procedures and controls for normal and emergency conditions to support the command function. Required improvements in operator qualifications, training, and licensing; technical qualifications of overall reactor operations organizations; and display and system diagnostic equipment will be recommended by NRR and others in the coming months that will provide for significant improvements over the next several years. In the meantime, the Task Force recommends prompt implementation of the following administrative changes and controls to significantly improve existing operational capabilities.

a. Shift Supervisor Responsibilities

Review plant administrative and management procedures and revise necessary to assure that reactor operations command and control responsibilities and authority are properly defined Corporate management shall revise as necessary and promptly issue an operations policy directive which emphasizes the duties, responsibilities, authority, and lines of command of the control room operators, the shift safety engineer and the person responsible for reactor operating command in the control room (SRO).

b. Shift Safety Engineer

Provide a qualified person (the Shift Safety Engineer) at each nuclear power plant with university level engineering training in reactor systems performance and nuclear engineering. Provide training for shift safety engineers equivalent to that required of senior reactor operators. The Shift Safety Engineer shall be on shift and will report to the shift supervisor in the event of any emergency.

The routine responsibilties for this shift safefty engineer should include the review and evaluation of operating experiences at this particular facility as well as comparable facilities within the industry. The information derived from these efforts should be used to improve the safety of the plant. Each licensee should provide the necessary organizational framework to accommodate the addition of the Shift Safety Engineer to the shift complement.

c. Shift and Relief Turnover Procedures

Plant procedures should be reviewed and revised as necessary to assure that a shift turnover checklist is provided and required to be completed and signed by the on-coming and off-going individuals responsible for command of operations in the control room. Supplementary check lists and shift logs should be developed for the entire operations organization, including instrument technicians, auxiliary operators, and maintenance personnel.

2. Improved In-Plant Emergency Procedures and Preparations

The Lessons Learned Task Force has confined its initial evaluation of emergency preparedness to the in-plant responsibilities of NRC licensees. Our current understanding of the response of the licensee to the events that occurred during the first 16 hours of the accident at Three Mile Island show a need to improve operations procedures and preparations for accident conditions. We recommend that pending our further evaluation of these matters and the investigations by others, the following requirements should be issued now for consistency with and in augmentation of the recommendations listed above for improving the reactor operations command function.

a. Control Room Access

Review plant emergency procedures and revise as necessary to assure that access to the control room under normal and accident conditions is sufficient for and rigidly restricted to the safe command and control of operations.

b. Onsite Technical Support Center

A separate technical support center should be provided for plant management, technical and engineering support personnel. In an emergency, this center shall be used for assessment of plant status and potential offsite impact without interfering with and in support of the control room command and control function. The center should also be used in conjunction with implementation of site and offsite emergency plans, including an offsite emergency response center. Provide at the Onsite Technical Support Center the as-built drawings of general plant arrangements and piping, instrumentation, and electrical systems. Photographs of as-built system layouts and locations may be an acceptable method of satisfying some of these needs.

c. Each operating nuclear power plant should establish and maintain a separate emergency response center outside the control room. Shift support personnel (e.g. auxiliary operators and technicians) other than those required and allowed in the control room shall report to one center for further orders and assignment by the shift supervisor in the event of an emergency.

3. Revised Limiting Conditions for Operation of Nuclear Power Plants Based Upon Safety System Availability

The examples of deficiencies at TMI-2 that demonstrate a need to significantly increase operations reliability include the shutting of isolation valves in the auxiliary feedwater system and chronic leakage of relief or safety valves in the primary system. Another more general indicator of this need is the several thousand of LERs per year from the 70 plants now operating. The Task Force recommends prompt action to significantly change the trend of reactor operating experience in this area.

We believe there are two basic approaches for obtaining better operational reliability - find new ways to effectively require it of the licensees (the requirements have been there, but the implementation has been unsatisfactory) or find new ways to assure it by more effective review and inspection by the NRC staff. In the second approach the staff could, for example, begin to review and inspect in detail the procedures at each plant for routine operations, preventative maintenance, surveillance, operations management, and so on. The resource implications for the NRC are enormous in view of the sizeable improvement that is indicated as necessary by TMI-2 and the fresh view it affords of previous operating experience. Furthermore, the time required for this approach to effect any significant change in operations reliability is long.

The Task Force recommends the first approach of finding a new way of assuring that licensees effectively meet their primary responsibility for reliability of safe operations. To this end we recommend the following immediate action, having considered several threshhold levels for its actuation and several alternatives for effecting the NRC decisions it would require.

> Require that the Technical Specifications for each reactor provide that the reactor be placed in a hot shutdown condition within 8 hours and in a cold shutdown condition by the licensee within 24 hours of any time that it is found to be or have been in operation with a loss of safety function (e.g., loss of emergency feedwater, high pressure ECCS, low pressure ECCS, containment, emergency power or other prescribed safety function). Require that an assessment of the cause of the loss of safety function be made (e.g., maintenance, operations error) and that an evaluation of alternative corrective actions be made and documented by the licensee. Require that the senior corporate officer responsible for operation of the facility present his recommendation for corrective action and his evaluation of the alternatives at a public meeting with senior NRC officials. Require that the senior NRC officials issue their decision at that public meeting, or a subsequent public meeting if time is required for staff evaluation, concerning the adequacy of the changes to improve operational reliability proposed by the utility. Allow the facility to return to power only after

successful completion of the changes proposed by the utility and approved by the NRC.

3.0 Future Work by the Lessons Learned Task Force

The short term licensing requirements dscussed in the previous sections of this report will improve safety, but they are intended to address only those issues where an immediate improvement in safety should be made. These requirements are therefore necessarily specific, narrow in scope and generally consistent with existing regulations, Regulatory Guides and staff's Standard Review Plans. The accident at the Three Mile Island nuclear power has raised a number of significant questions and policy issues. The Task Force iwll continue its evaluation of the accident at Three Mile Island by considering broader ad more fundamental changes in both the design and operation of nuclear power plants and in the licensing process.

The accidenat at Three Mile Island was not the result of any one or two easily identified design deficiencies or operator errors, but a consequence of many factors in the design, operation and licensing of the plant. The Task Force Believes that an orderly, comprehensive evaluation of the causes of the accident considering the many causative factors and their iterrelationship is required. Our evaluation will start with the broad, fundamental questions before further specific changes to current requirements are recommended. For convenience the issues to be considered have been grouped into four areas; general safety criteria, system design requirements, nuclear power plant operations and nuclear power plant licensing.

3.1 General Safety Criteria

The underlying philosophy of nuclear reactor safety is the need to provide multiple levels of protection against the release of radioactivity, i.e., the concept of defense-in-depth. It includes diversity and redundancy of various safety functions and systems and multiple physical barriers (the fuel, the cladding, the primary coolant boundary and the containment). The Task Force concludes that the defense-in-depth concept is sound and not fundamentally challenged by the occurrence of the accident. However, the Task Force has concluded there is a need to improve the complementation of this concept in determining safety requirements.

The functions and general characteristics of the system required to provide this defense-in-depth are specified in the General Design Criteria of the Commission's regulations. (Appendix A to 10 CFR 50). The specific design and performance requirements of these systems are determined, generally by analysis, such that the consequences of specified events like anticipated operational transients and design basis accidents are within specific acceptance criteria. At Three Mile Island the safety systems were challenged, in some cases, to a greater extent and differently than anticipated in their design basis. Many of the events that occurred were forseen, as possible they were not previously judged to be likely enough to require consideration in the design basis. Incorrect operator actions, extensive core damage, and the production of a large quantity of hydrogen from the reactor of the zircaloy cladding and steam were forseen but excluded from the design basis since plant safety, features are provided to prevent such consequences even with failure of equipment design basis. The Task Force will consider whether revisions or additions to the General Design Criteria or other requirements are necessary in light of these unexpected consequences. A central issue to be considered is whether to modify or extend the current design basis events or to depart from the concept. For example, design basis accidents could be modified to include multiple equipment failures and more explicit consideration of operator actions or inaction rather than the tradiational single failure criterion. Alternatively, design basis accidents could be extended to include core uncovery or core melting scenarios. Risk asessment and explicit consideration of accident probabilities and consequences might also be used instead of the analysis of design accidents. In this regard consideration will be given to the need or desirability to institute quantitative safety goals in lieu of or in addition to the existing diversity and single failure criteria.

3.2 System Design Requirements

The specification of design basis events has resulted in the classification of systems into two types, safety and nonsafety. The reliability and quality of saety systems are controlled through NRC requirements for their design, construction and operation. No NRC requirements are placed onthe nonsafety systems. However, nonsafety systems may initiate transients and lead to accidents. Conversely some nonsafety systems can be and have been effective in terminating transients and in mitigating the consequences of accidents.

Both circumstances occurred at Three Mile Island. Problems with the condensate purification system caused a loss of feedwater and initiated the sequence of events that eventually resulted in damage to the core. Other nonsafety systems such as the reactor coolant pumps, the reactor coolant letdown system and the main steam system were used at various teims in the mitigation of the accident. The present classification system does not adequately recognize the effect that nonsafety systems can have on the safety of the plant. Thus, for example, requirements for non-safety sysatems may be recommended to reduce the frequency of occurrance of events that could initite or adversely effect transients and accidents. Other requirements may be desirable to improve the current capability to use nonsafety systems during transient or accident situations. The Task Force intends to study the desireability of additonal safety classifications of systems between safety and nonsafety grade levels with appropriate requirements for each class. Included will be a reevaluation of current requirements, a more realistic assessment of interaction of the operators with the systems and a better understanding of the consequences of a failure in a nonsafety system.

The TMI-2 accident involving design, equipment and human failure, was a combination of events clearly outside the current design basis requirements. It suggests the need to leave considerable capability and flexibility to respond to these events to ensure public health and safety. It now needs to be decided to what extent and for what purspose the ractor designers, operations, and regulations should go beyond the current design operational requirements.

3.3 Nuclear Power Plant Operations

Current regulations place the responsibility for safety on the utility which operates a nuclear power plant. To assure that thus responsibility is met, minimum for standards the organization, qualification and training of the utility staff that operate a plant. At Three Mile Island the actions of the operating staff, both directly and indirectly, were significant in the cause, course and consequence of the accident. The Task Force will consider changes that could improve both the day-to-day operation of the plant and the response of the plant operating staff to anticipate transients and accidents. Means of reducing human errors and improving the quality of operations during normal operation so as to reduce the frequency of occurrence of situations that could result in or contribute to accidents will be evaluated.

The accident also has raised the question as to whether basic changes are needed in the role of the control room operators in response to off-normal events. The amount of reliance placed on operator action; the ability o operators to assess the status of the reactor and take corrective action when presented with unusual circumstances; the methods of organization, selection and training of the operator; and improvements in the type, quantity and method of display of information provided to the operators will also be studied

The accdient also revealed the need to provide specialized technical and other support to the operating staff during the course of an accident.

The Task Force will evaluate how such support might be made available and the planning and preparation necessary to assure that it will be available when necessary, short term actions in this regard were discussed in Section 2.2.

3.4 Nuclear Power Plant

Although the plant operator has the primary responsibility for the safety of a nuclear power plant the NRC has the responsibility for setting the requirements necessary to provide reasonable assurance by auditing the design, construction and operation of plants. The type, depth and frequency of these audits have varied with time, among plants and among technical disciplines. The Task Force intends to study means of improving the quality of the licensing review process by considering increases in the depth an detail of review; improvements in the interaction of the staff reviewers in making an integrated and comprehensive review of the licensing applications; reorientation of the licensing review from a component level to a system level of audit, thus resulting in the need for licensees to obtain independent verification and validation of design details; the evaluation and application of operating experience and safety research. One significant issue that will be addressed is that of backfit, that is the method of determining the need for new requirements and implementing these requirements in a timely manner on reactors under construction and in operation.

Although the primary purpose of the licensing process is to assure no undue risk to public health and safety by accident prevention and mitigation, the NRC will necessarily be involved, as was the case at TMI, when accidents occur in assuring that public safety consequences are minimized. The accident at TMI has shown that the responsibilities and functions of the NRC when an accident occurs must be reevaluated in light of the demonstrated weaknesses of the agency in this area and the expectations of the public. The Task Force intends to review the NRR role in the current incident response plan and suggest modifications to improve the definition of responsibilities and integration of NRR actions with other organizations within the Commission. This effort will be coordinated with efforts ~~will be coordinated~~ with efforts ongoing in other offices. The Task Force understands that the relationships of licensee, vendor, State, local authorities, and NRC will be examined by others with broader perspectives than this Task Force to determine an effective and feasible interaction and appropriate responsibilities and authorities for each party. However, technical recommendations on the content, organization and training of NRC and licensee accident response personnel and facilities will be considered by the Task Force.

Preliminary Thadani Views On
Three Mile Island Impact on ATWS

1. No more argument on frequency of transients.

2. Auxiliary Feedwater System

   a) Significant differences in auxiliary feedwater system designs.
   b) Forget about using AFWS injection time of 15 seconds.
   c) How about the impact of limitations on AFWS injection rate from water hammer considerations.
   d) How about the impact of flow restrictors on AFWS injection rate.

3. How many plants are operating with isolation PORVs?

   Cannot take credit for PORVs for these plants.

4. Behavior of PORVs of Safety Valves to two phase of subcooled discharges.

   Need experimental verification.

5a. Correctness of analysis of ATWS and Stick Open Valve.

b. Why not more valves stuck open?

c. What codes were used and why are they OK?

6. Several plants HPSI shut off head is low (e.g. 1200 1700 psi).

   Cannot manually inject flow of HPSI? How is this considered in the analyses?

7. Instrumentation

   With one or more valves stuck open what would the operator see? Operator actions, info. displayed, system design limitations? Instrumentation errors?

8. Long Term Shutdown

   a) Do we need RCPs?

   b) What equipment available for LOOP?

   c) What happens to instrumentation (e.g. containment level, transmitter locations).

d) Would natural circulation take place? Any reflux boiling? Any non-condensables?

e) Boron precipitation problems. Would letdown line (or other areas) give problems like TMI-2.

f) Equipment outside containment. Leakage problems, how addressed?

I. Reviewer: Tel No:

BACKGROUND

PWRs	BWRs	BOTH	FIELD e.g. Systems Physics Etc.

Section Leader, If any:

Branch Chief:

II. What specific areas are you reviewing:

III. What do you think is the impact of TMI-2 on ATWS?

IV. What is your reaction to the GE report?

V. Percent of your time devoted to ATWS.

ENCLOSURE

5

General Areas of ATWS Review:

Analysis Methods
Systems Review, Transient Analysis
Containment Considerations
Component Integrity & Operability
Fuel Behavior
Radiological Behavior
Systems - Electric Considerations
Physics Characteristic
Operator Actions - Long Term Shutdown
Environmental Appraisal
ATWS Rule
ATWS RG
S/R Valve Research (PWRs)
Value Impact

Encl 5 p2

A. Need someone to look at Physics Parameters.

   1. Reactivity Coefficients
   2. PPM Boron for Hot Shutdown
   3. PPM Boron for Cold Shutdown

B. Need someone to consider Boron Precipitation - if it is a problem. Look at needed Boron PPM and SLCS storage tank capability.

C. Need someone to assess the possible stability problems in a BWR.

D. Need someone to review Boron mixing model of efficiency.

E. Need someone to gather plant specific data (perhaps B&O is a good source).

F. Need someone to consider Instrumentation Capability.