September 27, 1979

[PRELIMINARY] VALUE/IMPACT ASSESSMENT ON

RESIDUAL HEAT REMOVAL

I. The Proposed Action

A. Description

In the past, the safe shutdown of a nuclear power plant following an accident not related to a loss-of-coolant accident (LOCA) has been [typically] interpreted as a hot standby [shutdown]. Consequently, considerable emphasis has been placed on the ability to achieve and maintain hot standby [hot-shutdown of-a-power-plant] in case of an accident or abnormal occurrence. A similar degree of emphasis has been placed on long-term cooling of the reactor core, which is typically achieved by the residual heat removal (RHR) system. The RHR system may be [starts-to] operated when the reactor coolant pressure and temperature are substantially lower than their hot standby [-shutdown] condition values. The proposed action places the same degree of emphasis on the ability to achieve reactor cooldown over the entire range of reactor coolant temperatures and pressures. [including-the-range-between-hot-shutdown-and-RHR-operation-conditions.]

B. Need for the Proposed Action

In nuclear power plant operation, experience shows that there have been and [there] will continue to be accidental events that require [reactor-cooling to-permit] long-term cooling the reactor system [using-the-RHR-system-to-go] to cold shutdown for inspection and repairs. Consequently, the capability to achieve a cold shutdown under any accident conditions should be a safety-related function [maintained]. However, some systems and components required to perform this function are not currently designed as safety-related [grade] equipment. Current NPP designs do not meet all the recommendations presented in the proposed regulatory guidance. The need exists for criteria governing the design of systems and components required to achieve a cold shutdown. In particular, the Three Mile Island accident has reinforced the need for a safe and reliable method to achieve cold shutdown under any accident or environmental conditions.

C. Value/Impact of the Proposed Action

1. NRC

[~~It is estimated that use of the proposed action will not average more or less staff time than that being currently spent on licensing review, inspection, and other regulatory functions.~~]

The value of this proposed action will be to help ensure protection of the public health and safety for any credible accident or environmental condition at a nuclear power plant. The impact will be the increased time and manpower spent to ensure that the regulatory guidance is correctly implemented by the industry.

2. Other Government Agencies

Not applicable, unless the government agency is an applicant, such as TVA, in which case Value/Impact assessment is covered under "Industry".

3. Industry

The capability to achieve and maintain cold shutdown under any credible accident or environmental condition will reduce the risk of a significant release of radioactivity in the event of an accident which results in core damage.

The resulting value to the industry will be an increased plant reliability and consequently a long-term economic and safety advantage. The impact on the industry is primarily an increase in cost. For example, a rough estimate was made of the cost increase for a RESAR-3S NSSS and its balance of plant (BOP) (Ref. 2). It should be emphasized that the cost estimate thus generated is only a rough estimate and the actual cost may be substantially less or more depending on the particular system design. Comments received indicate that the monetary figures presented in this value/impact assessment are low by a factor of two. The cost estimate was broken down as follows:

(1) Chemical and Volume Control System (CVCS):

With full implementation (as described in Section II-B of this document), and if motor-operated valves were used, the NSSS portion would cost $150,000 and the BOP portion would cost $200,000. Higher costs are expected if fully qualified air-operated valves and a seismic Category I air system are used.

(2) Auxiliary Feedwater System (AFWS) and Steam Dump Valves:

a. AFWS

An adequate supply of feedwater to [cool] the steam generator for cooling the reactor primary system in case of a loss of offsite power (i.e., using only natural circulation) should be estimated. For example, an increase of condensate water storage tank capacity from a typical 200,000 to 400,000 gallons would permit cooling time at hot standby [shutdown] conditions to increase from 2 to 16 hours. The cost of this increased water capacity is about $150,000.

b. Steam Dump Valves

The cost of upgrading a single steam dump valve to safety-related [grade] standards is estimated at $15,000, giving a total of

$60,000 for the 4 valves of RESAR-3S. Those estimates are for fully qualified, motor-operated valves with Class 1E power and controls.

(3) Pressurizer and Connected Systems:
No estimate available.

(4) Residual Heat Removal System (RHRS):
No estimate available.

(5) Operational procedures:
Nonsignificant man-hours involved.

(6) Other costs would include those associated with additional testing, design, analysis, documentation, and licensing for system and component modifications. No estimate was available.

According to a letter from J.H. Taylor, B&W, to the NRC, dated August 4, 1978, brief studies were performed by B&W to assess the change in risk to the public health and safety by addition of the capability to achieve cold shutdown using only safety-related systems. The technical specification limit of 1 gpm was used for steam generator tube leakage. The results indicated that; if cold shutdown was achieved in 36 hours, the thyroid dose at the exclusion area boundary would be 0.963 rem (or 0.32 % of Part 100 guidelines) as compared to 1.68 rem (or 0.56% of Part 100 guidelines) if hot standby was maintained for two weeks. Further, these results were utilized to quantify risk. Initially, risk was quantified by considering the probability of equipment and operator success in achieving cold shutdown within 36 hours with the existing system. This probability was determined to be at least 95% based on a success path analysis.

The model considered delay in cooldown time for repairs necessitated by equipment failures which resulted in a distribution of cooldown times greater than 36 hours. Secondly, risk was quantified assuming a safety-related system and, therefore, no equipment failure. The difference between the two quantified risks was an estimate of the delta-risk resulting from the modification to a safety-related system. The result showed a delta risk of 5.2×10^{-3} rem thyroid at the exclusion area boundary. Using an estimate of $500,000 for equipment changes, the cost/risk ratio was calculated to be approximately $12,500/man-rem. These delta risk values would be substantially higher assuming a reactor coolant activity on the order of that reached after the Three Mile Island accident. Thus, the cost/risk ratio ($/man-rem) would be proportionally reduced.

4. Public

The value gained by the public is the inhanced safety in power plant design and operation. The impact on the public is [~~an eventual, additional, and~~] a small increase in energy cost [~~increase~~].

D. Decision on the Proposed Action

Guidance should be furnished on nuclear power plant residual heat removal.

II. Technical Approach

A. Technical Alternatives

The proposed action requires that systems and components necessary to achieve a cold shutdown in a power plant be designed as safety-related [~~grade~~]

equipment and that operational procedures to perform this function be developed. Current designs of BWRs do meet the majority of these conditions (Ref. 1), but current PWR designs do not; therefore, the following discussion will be limited to PWRs.

The proposed action addresses the following:

(1) CVCS.

(2) AFWS and steam dump valves.

(3) Pressurizer and auxiliary pressurizer spray, or pressurizer power-operated relief valves.

(4) RHRS.

(5) Operational procedures.

The different alternatives indicate the different ways in which the proposed action can be implemented. These alternatives are discussed in the following section.

B. Discussion and Comparison of Technical Alternatives

The alternatives for complying with the proposed action vary from full implementation to partial implementation. Full implementation requires the following (see footnote):

(1) For the CVCS:

Upgrading of existing [10] valves (for some designs, this would be 7 in the letdown path and 3 in the charging path) to meet safety-related equipment requirements.) Addition of [8] remotely operated valves

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*A study of the proposed action impact on standard plants RESAR-3S, B-SAR-205, and CESSAR-80 (see Ref. 2 & 3). The numbers of valves that appear in item (1) are approximate numbers for RESAR-3S. However, it was concluded that the impact is about the same on the three standard plants.

(5 in the letdown path and 3 in the charging path) and [3] manual valves (2 in the letdown path and 1 in the charging path) in order to meet the single failure criterion.

(2) For the AFWS and steam dump valves:

Increased capacity of [Conservative] AFW water supply or an alternate safety-related high-quality water supply and delivery system [with-a seismic-Category-I-storage-and-delivery-system]. Safety-related [grade] dump valves and diverse power supplies and controls so that manual action should not be required to operate these valves.

(3) For the pressurizer and connected systems:

Upgrading of existing valves to safety-related quality and addition of safety-related valves to ensure the operation of auxiliary pressurizer spray and meet the single failure criterion. Upgrading of the pressure control system to ensure the capability to achieve and maintain natural circulation within the primary system under all normal and credible accident conditions.

(4) For the RHRS:

Upgrading the system to be fully operational from the control room and meet single failure criterion. This may involve providing double drop line (or valves in parallel) to prevent a single valve failure from stopping the RHR cooling function. Upgrading of existing equipment to meet the safety-related equipment requirements. Provisions must be made for access to, and repair of, equipment outside containment which may fail during a post-incident recovery period. Examples of these provisions include measures such as proper shielding of redundant equipment, ability to flush compartments, ability to drain and flush radioactive lines within compartments where access is required, and provision of safe access routes to the equipment, assuming expected source terms. Upgrading of system to be capable of removing heat from reactor coolant with a high radioactivity level without release of radioactivity to the environment beyond accepted limits. This includes provisions to control and process leakage from valves and pump seals. Possible upgrading of the RHR cooling water supply system and RHR pump seal cooling water system to meet the position of the regulatory guide. [~~Providing double drop line (or valves in parallel) to prevent single valve failure from stopping the RHR cooling function.~~]

(5) For the operational procedures:
Preparation of detailed procedures and incorporation in the emergency operating procedures of the plant.

The partial implementation requires that the applicant can demonstrate that a cold shutdown can be achieved in a reasonable time with only a partial implementation of the proposed action. Partial implementation involves the following (Ref. 2, 3):

(1) For the CVCS:
Boration of the reactor coolant to the cold shutdown concentration without the letdown path may be acceptable. In that case, the letdown path need not be upgraded. Use of the emergency core cooling system (ECCS) for boration may be acceptable. Limited operator action outside the control room (CR) may also be acceptable if suitably justified.

(2) For the AFWS and steam dump valves:
Full implementation required.

(3) For the pressurizer and connected systems:

Use of the pressurizer power-operated relief valves which have been upgraded to safety grade level that meet the single failure criterion.

(4) For the RHRS:

Full implementation except limited operator action outside the CR, to meet the proposed action conditions, may be acceptable if suitably justified.

(5) For the Operational Procedures:

Full implementation required.

C. Decision on Technical Approach

Any one of the above mentioned alternatives or a combination of the two may be acceptable upon demonstration of its capability to achieve a cold shutdown under all credible accident conditions.

III. Procedural Approach

A. Procedural Alternatives

Potential SD procedures that may be used to promulgate the proposed action include the following:

- Regulation
- Regulatory Guide
- ANSI Standard, endorsed by a Regulatory Guide
- Branch Position
- NUREG

B. Value/Impact of Procedural Alternatives

A NUREG is not a viable alternative because the guidance will contain positions. Preparation of an ANSI standard on the subject has been initiated; however, [No-ANSI-standard-on-the-subject-is-under-preparation.] because of the time (2 to 3 years) for preparation of an ANSI standard, this alternative was eliminated. The matter can be addressed more fully in a Regulatory Guide or a Branch Position than in [is-not-of-sufficient-importance-to-justify-issuance-of] a regulation. Only a Regulatory Guide or a Branch Position are viable alternatives.

Currently, there is a Branch Position for guidance on RHR. However, since Branch Positions have limited distribution, a Regulatory Guide is recommended [required] to better inform the public and industry and to get their comments.

C. Decision on Procedural Approach

A Regulatory Guide should be prepared.

IV. Statutory Considerations

A. NRC Authority

This guide would fall under the authority and safety requirements of the Atomic Energy Act.

B. Need for NEPA Assessment

The proposed action is not a major action, per 10 CFR 51.5(a)(10), and does not require an environmental impact statement.

V. Relationship to Other Existing or Proposed Regulations or Policies

When Regulatory Guide 1.70 (Standard Format and Content) is revised, [mention-of] the necessity that the nuclear power plant be capable to go to cold shutdown using only safety-related [grade] equipment should be included. It is not necessary to include in Regulatory Guide 1.70 all of the material which is contained in the proposed guide.

VI. Summary and Conclusions

A proposed Regulatory Guide on residual heat removal [should-be] has been prepared and contains guidance and criteria acceptable to the NRC for design of systems and components required to achieve a plant cold shutdown.

REFERENCES

1. Letter from R. E. Heineman, Director, DSS, to E. G. Case, Chairman, Regulatory Requirements Review Committee, titled "Request for RRRC Consideration - Proposed Revision to Standard Review Plan 5.4.7, Residual Heat Removal System," dated 3-9-1976.

2. Memo from R. J. Mattson, Director, DSS, to E. G. Case, Acting Director, NRR, titled "Request for RRRC Consideration - Proposed Revision to Standard Review Plan 5.4.7, Residual Heat Removal System," dated 11-8-1977.

3. Memo from R. J. Mattson, Director, DSS, V. Stello, Director, DOR, to E. G. Case, Acting Director, NRR, titled "Revised Implementation Schedule of Task A-31, RHR Shutdown Requirements," dated 1-19-1978.

Resolution

of

Public Comments

on Regulatory Guide 1.139

15 Letters

Commenters:

1.	T. M. Anderson (Westinghouse)	8/17/78
2.	J. E. Arthur (Rochester Gas and Electric)	7/21/78
3.	A. L. Cahn (Bechtel Power Corp.)	8/16/78
4.	M. P. Ferrante (American Nuclear Insurers)	7/12/78
5.	J. E. Gilleland (TVA)	6/20/79
6.	W. P. Johnson (Yankee Atomic)	7/6/78
7.	B. L. Lex (Bechtel Power Corp.)	8/16/78
8.	J. E. McEwen, Jr. (KMC)	10/2/78
9.	J. C. Peters (U.S. Dept. of Interior)	7/7/78
10.	A. E. Scherer (CE)	9/12/78
11.	G. G. Sherwood (GE)	7/27/78
12.	T. J. Sullivan (Consumers Power Co.)	7/27/78
13.	D. C. Switzer (Northeast Utilities)	4/10/78
14.	J. H. Taylor (B&W)	8/4/78
15.	J. E. Ward (Atomic Industrial Forum)	11/21/78
16	R. E. Uhrig (Florida Power & Light)	7/14/78

General Comments

1. Mr. McEwen, Mr. Switzer, Mr. Arthur, Mr. Johnson, and Mr. Taylor submitted comments concerning the regulatory position limiting operator action outside of the control room. The comments stated that limiting operator action was unjustified since sufficient time would be available to comple... any necessary repairs or obtain additional personnel. Mr. Johnson stated that additional guidance for suitable justification of operator action was necessary.

   Resolution:
   It is agreed that limited operator action should be allowed outside of the control room provided this action can be accomplished such as to achieve shutdown within the time limitations and will not result in personnel radiation exposure beyond the allowed limits. The guide has been revised to incorporate this additional guidance.

2. Mr. Ward, Mr. Sullivan, Mr. Taylor, Mr. Arthur, Mr. Gilleland, and Mr. McEwen submitted comments concerning the 36-hour time limitation on achieving cold shutdown. The comments stated that the 36-hour time limitation was arbitrary and no justification for this limitation could be conceived. Mr. McEwen commented that the requirement to bring the plant to cold shutdown within 36 hours under any accident condition was a substantial change in NRC policy.

Resolution:

The time span has been expanded to 36 hours for the attainment of hot shutdown at which point the RHR system is capable of being operated. This time limit is reasonable to allow for preparation of the long-term cooling systems for operation.

3. Mr. Lex, Mr. Cahn, Mr. Gilleland, and Mr. Sherwood commented that guidance was necessary concerning the definition of a safe shutdown plant condition. Mr. Cahn stated that safe shutdown should be defined in a general manner to take into account the unique characteristics associated with each initiating event.

Resolution:

The guide has been revised to include the definitions of hot standby, hot shutdown, and cold shutdown.

The guide states in the Discussion section that the plant should have the capability to proceed to cold shutdown when this is determined to be the safest course of action. Cold shutdown would be a safe and stable plant condition regardless of the initiating event.

4. Mr. Ward, Mr. Sullivan, Mr. Taylor, Mr. McEwen, and Mr. Anderson submitted comments stating their opinion that hot standby is a safe and stable plant plant condition which can be maintained for an extended period of time. Mr. Taylor considered hot shutdown (standby) to be a more stable condition than a cooldown maneuver following a postulated DBA. Mr. Sullivan cited

the Reactor Safety Study (WASH-1400) as concurring that hot standby is a stable plant condition.

Resolution:

It is agreed that hot standby is a safe and stable plant condition (as stated in WASH-1400) for a temporary period of time. However, in the interest of public health and safety, the ability must exist to achieve cold shutdown under any credible accident condition in a reasonably short amount of time.

In regard to Mr. Taylor's comment, the guide does not require proceeding to cold shutdown under any accident condition, but only when this manuever is deemed the safest course of action.

5. Mr. Arthur, Mr. Anderson, Mr. Ward, Mr. Taylor, Mr. McEwen, and Mr. Sullivan commented that nonsafety-grade systems are capable of bringing the plant to a cold shutdown condition. Mr. Ward commented that design or hardware changes required to achieve cold shutdown using only safety-grade equipment are undesirable, counterproductive to the standardization effort, and disruptive to the design stability within the industry.

Resolution:

It is agreed that nonsafety-related systems are capable of bringing the plant to cold shutdown under normal plant conditions. However, nonsafety-related systems cannot be relied upon to perform this function under all credible accident conditions.

In regard to Mr. Ward's comments, the modifications necessary to obtain the capability to proceed to cold shutdown under any credible accident condition are desirable in order to ensure protection of the public health and safety. The ability to achieve cold shutdown under any credible accident condition should be beneficial to the standardization effort in that all plants would have this basic capability. With the numerous variations in plant design, the modifications should not adversely effect the design stability within the industry.

6. Mr. Arthur and Mr. Scherer commented that the safety significance of having sufficient inventory to permit operation at hot standby conditions for at least 4 hours was not apparent. They recommended that if there was no safety significant basis for the 4-hour time period, then this limitation should be deleted.

Mr. Gilleland commented that the 4-hour time limit in Section C.6 appeared arbitrary. He commented that the guide implied that the seismic Category I cooling water source must be of secondary side (e.g., condensate) or better quality and he considered such a requirement unnecessary. He recommended that this section be modified to permit the design philosophy in Draft 5 of ANSI Standard 637 on Auxiliary Feedwater System for Pressurized Water Reactors. He stated that this concept permits the use of a primary AFW source which does not meet safety-grade, seismic, and secondary side quality requirements. As a backup source, for those low probability events when the preferred AFW source is not available, such a philosophy does require a safety-grade, seismically qualified AFW supply but it does not require that this source be of a secondary side quality. He believes that this philosophy yields the most economical AFW supply design while maintaining a fully adequate safety margin.

Resolution:

The time span of 4 hours is recommended to ensure that adequate cooling water inventory is available while any necessary preparations are made to commence cooldown.

The regulatory position does not propose any additional requirements on the quality of the auxiliary feedwater beyond those already enforced. The regulatory position does not dictate whether the seismic Category I supply is the primary or secondary source. However, if the seismically qualified source is utilized as the backup supply, no delay in delivery of water to the steam generators must occur when the seismically qualified source is required.

7. Mr. Cahn, Mr. Anderson, Mr. Ward, Mr. Gilleland, and Mr. Arthur commented that this regulatory guide should not be backfit to existing power plants. Mr. Ward commented that if the NRC proceeded to impose safety-grade cold shutdown requirements solely to "improve the designs" and without an in-depth value/impact assessment, then the guide should be implemented as forward fit only. Mr. Cahn commented that the operating history of nuclear power plants has shown existing systems required to attain cold shutdown provide an adequate level of safety.

Mr. Gilleland commented that full implementation of this guide on plants either in operation or for which a major portion of the equipment has been purchased is not warranted unless major safety flaws are discovered.

Resolution:

This regulatory guidance has been carefully considered by the NRC staff to ensure protection of the public health and safety under all credible accident or environmental conditions. Due to the safety significance of this issue, backfitting decisions will be made by the NRC staff on a case-by-case basis.

In regard to Mr. Ward's comments, the value/impact assessment has been revised to improve the discussion of possible impact. The backfitting decisions will not be made to solely improve the designs, but to ensure sufficient protection of the public health and safety.

In regard to Mr. Cahn's comment, one example of the problem is the delay in achieving a cold shutdown condition caused by the concern over the inability of the RHR system at Three Mile Island Unit 2 to prevent the release of highly radioactive primary coolant.

8. Mr. Arthur and Mr. Switzer submitted comments concerning overpressurization protection of the RHR system. Mr. Arthur commented that there is no need for automatic isolation if proper relief capacity is provided. Mr. Switzer commented that double isolation valves are unnecessary, and only a single

isolation valve and a pressure relief system is all that is required to protect the RHR system against overpressurization assuming a single failure.

Resolution:

In regard to Mr. Arthur's comment, automatic isolation is not only for protection of RHR system piping but, also, to provide protection against a loss of primary coolant pressure boundary. In the event that only one valve in the series was shut and the reactor coolant system was increased to normal operating pressure, a failure of the single valve could result in an uncontained LOCA.

In regard to Mr. Switzer's comments, double isolation valves are required by General Design Criterion 55 for piping which is part of the reactor coolant pressure boundary that penetrates containment. Two isolation valves are necessary to maintain reactor coolant pressure boundary integrity under the single failure criterion.

9. Mr. Arthur and Mr. Scherer commented that additional methods of depressurization of the primary system of a PWR were available beyond those discussed in the guide. Mr. Arthur commented that depressurization due to cooldown was available via secondary heat removal. Mr. Scherer commented that depressurization was possible via a drain-and-fill technique.

Resolution:

The guide has been revised to incorporate these comments.

10. Mr. Lex, Mr. Scherer, Mr. Sullivan, and Mr. Taylor submitted comments concerning the production of a quantitative risk assessment for the proposed changes in regulatory guidance. Mr. Lex commented that the value/impact assessment was indequate in its present form. Mr. Lex suggested reconsideration in the areas of plant reliability improvement and man-rem reduction, and he and Mr. Taylor considered the monetary expenditure to be low by at least a factor of 2. Mr. Scherer commented that the anticipated reduction in risk should be quantified in the value/impact assessment. Mr. Taylor stated that a brief study performed to quantify the effect on dose and risk resulting from a safety-grade RHR system showed slight reduction in dose and a slight increase in risk. Mr. Taylor stated that a cost/benefit ratio calculation produced a figure in the area of $12,500/man-rem which he indicated was substantially greater than the NRC guideline for ALARA of $1000/man-rem.

Resolution:

The value/impact assessment has been revised in an effort to reflect these comments.

11. Mr. McEwen and Mr. Ward commented that the value/impact assessment should be available for public comment prior to implementation.

Resolution:

This regulatory guide was issued for public comment prior to initiation of the NRC policy to concurrently issue the value/impact assessment with each regulatory guide.

12. Mr. Anderson, Mr. McEwen, and Mr. Sullivan submitted comments concerning the maintenance of hot shutdown for a long period of time. Mr. Anderson commented that the guide should be revised to offer two options: (1) provide safety-grade systems to maintain the plant in hot shutdown for 72 hours, and (2) provide safety-grade systems to take the plant to cold shutdown. Also, the section on auxiliary feedwater should be revised to reflect these two options. Mr. McEwen commented that the guide should be rewritten to require the availability of cooling water which is the true safety requirement for long-term cooling.

Mr. Sullivan commented that a nonsafety-grade and nonsingle failure cooldown design should be acceptable if the plant has the capability to maintain a hot shutdown condition until it is possible to cool down the plant.

Resolution:
Maintenance of a hot shutdown condition for a PWR plant would utilize the auxiliary feedwater system with the release of steam to the atmosphere during a loss of offsite power or when only safety-grade systems can be assumed operational. Steam generator tube integrity, which is unreliable, would be the primary barrier between the reactor coolant and the environment. In the event of an accident which led to core damage, a high activity level would result in the reactor coolant. This high activity level could lead to excessive radioactive release beyond acceptable limits via the steam generator atmospheric relief valves. Therefore, no change has been made to the guide.

Specific Individual Comments

1. Mr. Anderson commented that the NRC staff has not presented a valid legal or technical basis for the regulatory guide. Mr. Anderson commented that GDC 19 and 34 do not constitute a legal basis for the guide. (Introduction)

   Resolution:
   Even though GDC 19 and 34 do not explicitly require the capability to achieve cold shutdown through the use of only safety-related systems, the NRC's mission to provide protection for public health and safety dictates that each nuclear power plant be capable of attaining a safe plant condition under any credible accident or environmental condition.

2. Mr. Anderson commented that the title of the guide and its contents are not consistent. He stated that the title should be revised and unrelated topics deleted from the guide.

   Resolution:
   The guide has been revised to reflect this comment.

3. Mr. Anderson commented that there is no justification for requiring diverse interlocks for the RHR isolation valves. He stated that redundant valves and interlocks from independent pressure transmitters are sufficient to comply with the single failure criterion. (Section C.2)

Resolution:

The guide has been revised to reflect this comment.

4. Mr. Arthur commented that the loss of all residual heat removal capability requires a large number of failures and is beyond a credible design basis.

   Resolution:

   Since the normal RHR system presently utilized is designed as a nonsafety-related system, this system cannot be relied upon under any credible accident or severe environmental conditions. Therefore, numerous failures could result from a single initiating event.

5. Mr. Arthur commented he sees no connection between the usefulness of eventually proceeding to cold shutdown and the ability to achieve cold shutdown under any accident conditions. He commented that no reason for not allowing reestablishment of offsite power while maintaining a hot condition has been given.

   Resolution:

   The guide indicates that a plant must have the capability to proceed to cold shutdown under any credible accident or environmental condition where only safety-related systems can be relied upon to perform their function. The ability to reestablish offsite power and the time required for this action cannot be determined reliably since each would be dependent on the initiating event. Therefore, no changes have been made to the guide.

6. Mr. Arthur commented that the requirement for clean feedwater is unnecessary since heat removal can be accomplished by any sort of feedwater. Mr. Arthur commented that the discussion of unequal natural circulation cooling is unclear. (Discussion)

Resolution:
The guide has been revised to reflect these comments.

7. Mr. Arthur commented that valves should fail to a safe position and not as stated in the guide. (Section C.2.a)

Resolution:
The guide has been revised to reflect this comment.

8. Mr. Arthur commented that the guidance concerning system testing rewrites the referenced document, Regulatory Guide 1.68. (Section C.5)

Resolution:
The guide has expanded the guidance concerning testing of the RHR system and the natural circulation cooling mode. No change to the guide has been made as a result of this comment.

9. Mr. Cahn commented that the guide implied that proceeding immediately to cold shutdown is always the safest procedure following a hazardous event.

Resolution:

The guide states in the Discussion section that the plant should have the capability to proceed to cold shutdown when this is determined to be the safest course of action.

10. Mr. Ferrante commented that Section C.2.b, Item (2), concerning power-operated valve position, was ambiguous. He suggested wording to clarify that only the power-operated valve must have position indication.

Resolution:

The guide has been revised to reflect this comment.

11. Mr. Ferrante suggested the addition of the words, "to the reactor coolant system," in Section C.4, Item (a), between the words "added" and "prior."

Resolution:

The guide has been revised to reflect this comment.

12. Mr. Gilleland commented that clarification was necessary as to whether the guide is applicable only to the events addressed by Chapter 15 of Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," or is intended to cover these events plus others such as fires, non-Chapter 15 pipe failures, etc.

Resolution:

This regulatory guide provides guidance for complying with the Commission's regulations with regard to the removal of decay heat after a reactor shutdown. Those structures, systems, or components indicated to be important to safety according to the regulatory guide must meet the design criteria of Appendix A to 10 CFR Part 50.

13. Mr. Gilleland commented that allowing operator action outside the control room only after a single failure, when combined with the safety-related equipment requirements of Section C.1.a and the loss-of-power condition of Section C.1.6, does not seem to have a logical basis, is unduly restrictive, and places undue economic penalties on plant control design for little, if any, increased safety margin.

    He suggested the following design philosophy:

    a. Remote control of those systems necessary to reach cold shutdown must be provided within the control room, but

    b. These systems and controls could use normal power supplies and be nonredundant, nonsafety-related if:

        (1) Emergency powered, redundant safety-related backup system are provided; and

        (2) All necessary controls for these s ety-related systems are located in close proximity to the control room and separated from any possibly contaminated fluid system areas, while meeting all operator protection and operator time limitations.

Resolution:

The object of the recommendation for remote operability from the control room for systems utilized in achieving cold shutdown is to ensure that operator action is performed in a controlled environment which will remain habitable under most accident or environmental conditions. It is agreed that limited operator action outside of the control room is acceptable if all operator protection and operator time limitations are met. If all controls for the safety-related backup systems were outside of the control room, the ability of the operator to perform all necessary correct actions within time limits and without excessive radioactive exposure under accident conditions would be suspect.

The present position of the guide allows for nonsafety-related systems to be utilized for normal conditions. However, the capability to achieve and maintain cold shutdown using only safety-related systems should be present.

14. Mr. Gilleland commented that several conflicting functional requirements on the RHR system suction isolation valves need to be clarified. He suggested meeting the requirements by use of a combination of passive relief devices, four-channel actuation, and remotely operable isolation valves. He commented that use of these eliminated the need for automatic valve closure and its potential for causing undesirable pump damage. In addition, he commented that the diversity in pressure sensors used in valve interlocks may not be necessary if the passive relief devices are relied

on for the main overpressurization protection with the backup being remote operability of the valves. (Section C.2.a)

Resolution:

The basic functional requirements which must be met for the RHR suction isolation valves are as follows:

a. Close when system pressure rises toward the design limit for the RHR system (600 psig).

b. Remain closed until RCS pressure drops below 450 psig.

c. Be capable of remote operation from the control room.

The RCS should not be dependent on the RHR system to prevent low temperature overpressurization. The RHR system pumps should have a low suction pressure trip to prevent pump damage in the event of an inadvertent RHR suction valve closure.

15. Mr. Gilleland commented that Section C.4 implied that automatic protection against conditions such as thermal overheating and low NPSH should be included in any RHR system design for any operating mode including emergency core cooling. He commented that this appears to be in conflict with other NRC requirements that do not permit automatic equipment protection to be employed on equipment used for accident mitigation. He believes that bypasses of this protection should not be employed.

Resolution:

The prohibition of automatic equipment protection for emergency core cooling equipment arises from the concern of a delay in providing cooling flow. The safety margin concerning a time delay is much smaller for an ECCS initiation than for the removal of decay heat. A short delay in decay heat removal would be preferable to continuous operation resulting in a total loss of decay heat removal capability.

Therefore, no change has been made to the guide.

16. Mr. Gilleland commented that, in order to meet the testing requirements of Section C.5, detailed measurements for core hot spots and boron mixing would be imposed. He recommended that gross measurements, in combination with supporting calculation, be deemed acceptable to meet the requirements.

Resolution:

This section has been revised to provide more concise guidance in this area.

17. Mr. Gilleland commented that Section C.7 implied that the operational procedure requirements need be taken only to the RHR system initiation. He commented that such procedures need to be defined to full shutdown conditions.

Resolution:

The regulatory position on operational procedures states that procedures for bringing the plant from normal operating power to cold shutdown should be in conformance with Regulatory Guide 1.33.

The guide has been revised to provide a more clear statement of this regulatory position.

18. Mr. Johnson commented that, for two check valves providing RHR isolation, the first acts as a thermal barrier and will have a higher leak rate. He indicated that gross leakage should be the only concern.

Resolution:

Under equilibrium conditions, each check valve may achieve the same leakage rate. No change has been made to the guide as a result of this comment.

19. Mr. Johnson commented that, in Section C.3.a, the inadvertent operation of a charging pump "in the normal charging mode" is used as a basis for sizing an RHR relief valve. He also commented that, since this can occur only when the RHR is open to the RCS, the low temperature overpressure protection relief capacity can be considered as protection for the RHR in this case.

Resolution:

The guide has been revised to clarify that the charging pump is considered in the normal charging mode for this design basis.

With regard to the second comment, overpressure protection for the RHR system piping is necessary under all situations and, therefore, a relief valve is required.

20. Mr. Johnson commented that, in Section C.3 where criteria for a relief valve are delineated, Item (a) should be revised to read "Result in flooding of any safety-related equipment required to maintain the reactor in a safe shutdown condition." In addition, he suggested the following addition to Item (b): "...assuming the LOCA occurs during the shutdown cooling mode."

Resolution:
The flooding of safety-related equipment is unacceptable since this could have a possible detrimental effect on the ability to maintain the reactor in a safe condition.

With regard to the second comment, the lifting of a relief valve during any operational state of the reactor should not adversely effect the ECCS. No change has been made as a result of these comments.

21. Mr. Lex commented that a draft guide should be reformatted to provide safety criteria rather than design details. He also commented that references to alternate system designs should be deleted.

Resolution:
The guide has been formatted to provide as much regulatory guidance as might be considered usual to users of the guide. This guide describes one method which is acceptable to the NRC staff for complying with the

Commission's regulations with regard to the removal of decay heat and sensible heat after a reactor shutdown.

22. Mr. Lex commented that the guide should be revised to expand the bases for the added emphasis on systems required to operate between hot shutdown and normal operating condition of the plant.

Resolution:
The guide has been revised to reflect this comment.

23. Mr. McEwen commented that the justification for a safety-related RHR system based on the WASH-1400 study was in error since that study considered a loss of all electric power coupled with the loss of the turbine-driven auxiliary feed system (or RCIC). He considered this event to have no direct relationship to additional RHR system requirements. (Page 1, 3rd paragraph)

Resolution:
The justification for this regulatory guide based on the WASH-1400 study has been deleted as unnecessary.

24. Mr. McEwen commented that the first paragraph on page 2 was unclear as to what plant experience made the requirement to go to cold shutdown essential. He commented that the example of a safe shutdown earthquake was inadequate to provide an explanation. (Page 2, 1st paragraph)

Resolution:

The guide has been revised to clarify the intent of this paragraph. The Three Mile Island accident would be an applicable example.

25. Mr. McEwen commented that boration is not necessary during hot standby conditions. Therefore, a safety-related CVCS was unnecessary. He stated that if natural circulation did not provide adequate mixing of the boron solution, then it would be equally ineffective during a cooldown required by the Guide. (Page 2, 3rd paragraph, item 1)

Resolution:

Boration is necessary as a PWR plant is taken to cold conditions. Therefore, the ability to provide boration and letdown via a safety-related system will be necessary.

With regard to the second comment, guidance for the achievement and maintenance of natural circulation has been added to the guide.

26. Mr. McEwen commented that the statement "Heat rejection... is the only way to avoid a core melt..." was inappropriate. He stated that the speculation concerning natural circulation flow leading to hot spots was unrelated to the guide and technically questionable. (Page 2, 3rd paragraph, item 2)

Resolution:

The subject statements have been deleted from the guide.

27. Mr. McEwen commented that the use of pressurizer relief valves to achieve RHR conditions was contrary to good operating practice. (Page 2, 3rd paragraph, item 3)

Resolution:
The guide has been revised to reflect this comment.

28. Mr. McEwen commented that heat accumulation is normally accomplished at hot standby through the use of steam relief and auxilary feedwater, so the statement that "long-term cooling is necessary to prevent heat accumulation" is not clear. (Page 2, 3rd paragraph, item 4)

Resolution:
The guide has been revised to reflect this comment.

29. Mr. McEwen commented that the option of three check valves without testability might compromise safety, and should be deleted. (Page 4, Item C.2.b(3))

Resolution:
It is agreed, and this option has been deleted.

30. Mr. McEwen commented that the phrase "fluid discharge... should be collected and contained" should be modified to state "fluid discharged... should be routed." He stated that Item C.3.b was irrelevant since the

safety injection mode of the RHR system must meet this single failure. (Page 4, Item C.3)

Resolution:
The phrase "collected and contained" expresses the concern that this fluid might have a high activity and must be processed accordingly.

It is agreed that, for those RHR systems which serve multipurpose functions, the design should be such as to prevent this occurrence. However, in the interest of complete coverage of safety considerations, the item has been retained.

31. Mr. McEwen commented that the reference to IEEE Std 338 and Regulatory Guide 1.22 was inappropriate since these documents concerned protection systems. He stated that the natural circulation testing requirements were too vague to be useful. The phrase "limits specified in emergency procedures" was not clear since none presently exist. (Page 5, Item C.5)

Resolution:
Regulatory Guide 1.118 and IEEE Std 338 have been referenced since these documents provide a suitable program for system testing. The guidance concerning natural circulation testing is intended to note the general areas which must be addressed by such tests.

The guide has been revised to provide additional guidance concerning emergency procedures.

32. Mr. Peters commented that this guide should be applied to existing plants on a case-by-case basis.

Resolution:

The guide currently states that backfit decisions will be made on a case-by-case basis.

33. Mr. Scherer commented that Section C.1 did not address accident conditions while these conditions were addressed in the Discussion section. Revision of these sections was suggested to provide consistency. (Section C.1)

Resolution:

The capability to remain operational under accident conditions is required for safety-related systems in GDC 1 through 5.

34. Mr. Scherer commented that a single failure should be clarified to mean single active failure. (Section C.1.b and C.1.c)

Resolution:

The definition of single failure is presented in Appendix A to 10 CFR Part 50, and usage of the term within the guide is intended to be consistent with the definition. Therefore, the guide has not been modified as a result of this comment.

35. Mr. Scherer commented that the design and operating procedures of the RHR system should be such that no single active failure, or single operator error, can result in loss of the RHR function due to damage of all RHR

system pumps. He commented that suitable separation and redundancy should be allowed, rather than requiring the designer to "prevent" certain single failures. (Section C.5)

Resolution:

The guide has been revised to reflect this comment.

36. Mr. Scherer commented that the need for analysis or confirmatory testing does not necessarily warrant a need for repetitive full scale testing of operating plants. He stated that because of the costs associated with additional plant testing, there should be alternatives allowed or the need for full-scale testing justified by a value/impact assessment. (Section C.5)

Resolution:

Testing is necessary to ensure proper operation of any system which is relied upon for safety.

The value/impact assessment has been revised to address system testing.

37. Mr. Scherer submitted several comments concerning the value/impact assessment. Mr. Scherer commented that the evaluation of need does not adequately address why a change in policy is desired. He stated that current RHR designs are not assessed to evaluate whether or not they meet or exceed this need for an RHR capability. Mr. Scherer commented that the direct value or impact of the regulatory guide to the NRC staff was not indicated.

Mr. Scherer commented that the cost of additional testing, design, analysis, documentation, and licensing for component changes was not evaluated.

Resolution:

The value/impact assessment has been revised to reflect these comments.

38. Mr. Sherwood commented that the requirement for alarms in the control room when the RHR isolation valves are open and RCS pressure exceeds RHR system pressure should be removed. He reasoned that since indicators are provided alarms are not necessary.

Resolution:

Indicators are not always noticed by operating personnel; therefore, due to the importance of having correct valve position, the guide has not been changed.

39. Mr. Sherwood commented that Section C.2.a, RHR System Isolation, requires separate power sources and automatic closure initiation for each of two redundant valves. He stated that redundant valves with separate power and closure initiation logic for each valve is adequate.

Resolution:

The guide has been revised to clarify the regulatory guidance in this area.

40. Mr. Sullivan commented that it was not clear why slow cooling required a larger clean feedwater inventory.

Resolution:

The subject statement has been deleted from the guide.

41. Mr. Sullivan commented that additional guidance for the testing of natural circulation boration should be included in the guide.

Resolution:

Additional guidance on the achievement and maintenance of natural circulation has been included in the guide.

42. Mr. Switzer commented that pressure interlocks on isolation valves should be independent, but diverse interlocks are not practical because all pressure switches work on the same general principle. (Section C-2.B(1))

Resolution:

The guide has been revised to reflect this comment.

43. Mr. Switzer commented that relief valves to protect the RHR from overpressurization should not be required if the RCS has low temperature overpressurization protection system that operates at a lower pressure than the RHR design pressure. (Section C.3.B)

Resolution:

The relief valves are necessary to prevent the design limits of the RHR piping from being exceeded by any credible system overpressurization event. Therefore, the guide has not been changed as a result of this comment.

44. Mr. Switzer commented that pump protection is simply good engineering practice and should not have to be specified in a regulatory guide.

Resolution:

The guide has been revised to express the single failure requirement for the design of plant systems.

45. Mr. Ward suggested that the regulatory positions be clarified in regard to initiating events and subsequent criteria that must be met. In particular, the initiating event which requires safety-related cooldown needs to be more clearly defined. As an example of criteria, he stated single failures should be considered single active failures and limited operator action should include corrective maintenance and actions inside containment.

Resolution:

The guide states the plant should be capable of achieving cold shutdown by a method which utilizes safety-related systems. The initiating events which must be considered are those which safety-related systems must satisfy as described in GDC 1 through 5.

The definition of single failure corresponds to that stated in Appendix A to 10 CFR Part 50. Limited operator action inside the containment would not be possible with high activity in the reactor coolant or containment atmosphere. No changes have been made to the guide as a result of these comments.

46. Mr. Uhrig commented that Section C.2.b, Item (4), RHR System Isolation, applies a burdensome testing frequency on the discharge check valves. He suggested a leak test that is required during each refueling outage.

Resolution:

The guide has been revised to reflect this comment.