Safety Evaluation Report By The
Office of Nuclear Reactor Regulation
Equipment Qualification Branch

For Baltimore Gas and Electric Company
Calvert Cliffs Units 1 and 2

Docket No. 50-317/318

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SAFETY EVALUATION REPORT BY THE
OFFICE OF NUCLEAR REACTOR REGULATION
EQUIPMENT QUALIFICATION BRANCH
FOR BALTIMORE GAS AND ELECTRIC COMPANY
CALVERT CLIFFS UNITS 1 AND 2
DOCKET NO. 50-317/318

ENVIRONMENTAL QUALIFICATION OF SAFETY-RELATED ELECTRICAL EQUIPMENT

1 INTRODUCTION

General Design Criteria 1 and 4 specify that safety-related electrical equipment in nuclear facilities must be capable of performing its safety-related function under environmental conditions associated with all normal, abnormal, and accident plant operation. In order to ensure compliance with the criteria, the NRC staff required all licensees of operating reactors to submit a reevaluation of the qualification of safety-related electrical equipment which may be exposed to a harsh environment.

2 BACKGROUND

On February 8, 1979, the NRC Office of Inspection and Enforcement (IE) issued to all licensees of operating plants (except those included in the systematic evaluation program (SEP)) IE Bulletin IEB 79-01, "Environmental Qualification of Class IE Equipment." This bulletin, together with IE Circular 78-08 (issued on May 31, 1978), required the licensees to perform reviews to assess the adequacy of their environmental qualification programs.

Subsequently, Commission Memorandum and Order CLI-80-21 (issued on May 23, 1980) states that the DOR guidelines and portions of NUREG-0588 (which were issued on January 14, 1980, as enclosures 4 and 5 to IEB-79-01B) form the requirements that licensees must meet regarding environmental qualification of safety-related electrical equipment in order to satisfy those aspects of 10 CFR 50, Appendix A, General Design Criterion (GDC)-4. This order also requires the staff to complete safety evaluation reports (SERs) for all operating plants by February 1, 1981. In addition, this order requires that the licensees have qualified safety-related equipment installed in their plants by June 30, 1982.

Supplements to IEB 79-01B were issued for further clarification and definition of the staff's needs. These supplements were issued on February 29, September 30, and October 24, 1980.

In addition, the staff issued orders dated August 29, 1980 (amended in September 1980) and October 24, 1980 to all licensees. The August order required that the licensees provide a report, by November 1, 1980, documenting the qualification of safety-related electrical equipment. The October order required the establishment of a central file location for the maintenance of all equipment-qualification records. The central file was mandated to be established by December 1, 1980. The order also required that all safety-related electrical equipment be qualified by June 30, 1982. In

response, the licensee submitted information through letters dated March 3 and 5, April 17, May 17, and October 31, 1980.

2.1 Purpose

The purpose of this SER is to identify equipment whose qualification program does not provide sufficient assurance that the equipment is capable of performing the design function in hostile environments. The staff position relating to any identified deficiencies is provided in this report.

2.2 Scope

The scope of this report is limited to an evaluation of the equipment which must function in order to mitigate the consequences of a loss-of-coolant accident (LOCA) or a high-energy-line-break (HELB) accident, inside or outside containment, while subjected to the hostile environments associated with these accidents.

3 STAFF EVALUATION

The staff evaluation of the licensee's response included an onsite inspection of selected Class IE equipment and an examination of the licensee's report for completeness and acceptability. The criteria described in the DOR guidelines and in NUREG-0588, in part, were used as a basis for the staff evaluation of the adequacy of the licensee's qualification program.

The NRC Office of Inspection and Enforcement performed (1) a preliminary evaluation of the licensee's response, documented in a technical evaluation report (TER) and (2) an onsite verification inspection (October 27-29, 1980) of selected safety-related electrical equipment. The condensate and feedwater systems were inspected at Unit 1; the compressed air system was inspected at Unit 2. The inspection at both units verified proper installation of equipment, overall interface integrity, and manufacturers' nameplate data. The manufacturer's name and model number from the nameplate data were compared to information given in the Component Evaluation Work Sheets (CES) of the licensee's report. The site inspection is documented for Units 1 and 2 in reports IE 50-317/80-20 and 318/80-18, respectively. No deficiencies were noted. For this review, the documents referenced above have been factored into the overall staff evaluation.

3.1 Completeness of Safety-Related Equipment

In accordance with IEB 79-01B, the licensee was directed to (1) establish a list of systems and equipment that are required to mitigate a LOCA and an HELB and (2) identify components needed to perform the function of safety-related display information, post-accident sampling and monitoring, and radiation monitoring.

The staff developed a generic master list based upon a review of plant safety analyses and emergency procedures. The instrumentation selected includes parameters to monitor overall plant performance as well as to monitor the performance of the systems on the list. The systems list was established on the

basis of the functions that must be performed for accident mitigation (without regard to location of equipment relative to hostile environments).

The list of safety-related systems provided by the licensee was reviewed against the staff-developed master list.

Based upon information in the licensee's submittal, the equipment location references, and in some cases subsequent conversations with the licensee, the staff has verified and determined that the systems included in the licensee's submittal are those required to achieve or support: (1) emergency reactor shutdown, (2) containment isolation, (3) reactor core cooling, (4) containment heat removal, (5) core residual heat removal, and (6) prevention of significant release of radioactive material to the environment. The staff therefore concludes that the systems identified by the licensee (listed in Appendix D) are acceptable, with the exception of those items discussed in Section 5 of this report.

Display instrumentation which provides information for the reactor operators to aid them in the safe handling of the plant was not specifically identified by the licensee. A complete list of all display instrumentation mentioned in the LOCA and HELB emergency procedures must be provided. Equipment qualification information in the form of summary sheets should be provided for all components of the display instrumentation exposed to harsh environments. Instrumentation which is not considered to be safety related but which is mentioned in the emergency procedure should appear on the list. For these instruments, (1) justification should be provided for not considering the instrument safety related and (2) assurance should be provided that its subsequent failure will not mislead the operator or adversely affect the mitigation of the consequences of the accident. The environmental qualification of post-accident sampling and monitoring and radiation monitoring equipment is closely related to the review of the TMI Lessons-Learned modifications and will be performed in conjunction with that review.

The licensee identified 227 items of equipment which were assessed by the staff. Because Units 1 and 2 are nearly identical, the review can be performed as one. Differences in the units will be identified by a parenthetical expression, with the applicable unit number enclosed.

3.2 Service Conditions

Commission Memorandum and Order CLI-80-21 requires that the DOR guidelines and the "For Comment" NUREG-0588 are to be used as the criteria for establishing the adequacy of the safety-related electrical equipment environmental qualification program. These documents provide the option of establishing a bounding pressure and temperature condition based on plant-specific analysis identified in the licensee's Final Safety Analysis Report (FSAR) or based on generic profiles using the methods identified in these documents.

On this basis, the staff has assumed, unless otherwise noted, that the analysis for developing the environmental envelopes for Calvert Cliffs Units 1

and 2, relative to the temperature, pressure, and the containment spray caustics, has been performed in accordance with the requirements stated above. The staff has reviewed the qualification documentation to ensure that the qualification specifications envelope the conditions established by the licensee. During this review, the staff assumed that for plants designed and equipped with an automatic containment spray system which satisfies the single-failure criterion, the main-steam-line-break (MSLB) environmental conditions are enveloped by the large-break-LOCA environmental conditions. The staff assumed, and requires the licensee to verify, that the containment spray system is not subjected to a disabling single-component failure and therefore satisfies the requirements of Section 4.2.1 of the DOR guidelines.

Equipment submergence has also been addressed where the possibility exists that flooding of equipment may result from HELBs.

3.3 Temperature, Pressure, and Humidity Conditions Inside Containment

The licensee has provided the results of accident analyses as follows:

	Max Temp (°F)	Max Press (psig)	Humidity (%)
LOCA	276	50	100
MSLB	269	44.5	100

The staff has concluded that the minimum temperature profile for equipment qualification purposes should include a margin to account for higher-than-average temperatures in the upper regions of the containment that can exist due to stratification, especially following a postulated MSLB. Use of the steam saturation temperature corresponding to the total building pressure (partial pressure of steam plus partial pressure of air) versus time will provide an acceptable margin for either a postulated LOCA or MSLB, whichever is controlling, as to potential adverse environmental effects on equipment.

The licensee's specified temperature (service condition) of 276°F does not satisfy the above requirement. A saturation temperature corresponding to the peak profile (296°F peak temperature at 50 psig) should be used instead. The licensee should update his equipment summary tables to reflect this change. If there is any equipment that does not meet the staff position, the licensee must provide either justification that the equipment will perform its intended function under the specified conditions or propose corrective action.

3.4 Temperature, Pressure, and Humidity Conditions Outside Containment

The licensee has provided the temperature, pressure, humidity and applicable environment associated with an HELB outside containment. The following areas outside containment have been addressed:

(1) ECCC pump room (A119)
(2) Containment recirculation pipe tunnel (A122)

(3) West penetration room (A221)
(4) Piping area (A224 and A428)
(5) Radiation exhaust ventilation equipment room (A225)
(6) East penetration room (A227).
(7) Main steam piping penetration (A315)
(8) East piping penetration room (A316)
(9) Spent fuel filter room (A328)

The staff has verified that the parameters identified by the licensee for the MSLB are acceptable.

3.5 Submergence

The maximum submergence levels have been established and assessed by the licensee. Unless otherwise noted, the staff assumed for this review that the methodology employed by the licensee is in accordance with the appropriate criteria as established by Commission Memorandum and Order CLI-80-21.

The licensee's value for maximum submergence is 16 ft 4 in. Equipment below this level has been identified by the licensee, along with the proposed corrective action. The licensee identified five safety-related electrical components for Unit 1 and seven for Unit 2 as having the potential for becoming submerged after a postulated event. As a corrective action, the licensee proposes replacing these components; in some cases, the licensee is considering relocation of the components. The licensee has replaced the components in Unit 1 and has stated that the components in Unit 2 will be replaced before startup from the current outage. Based on its review of the licensee's submittal, the staff concurs with the proposed resolution.

In one instance, the licensee stated that the component in question--a solenoid valve in Unit 2--performs its function in less than 7 seconds, fails closed, and is not required to operate after a LOCA. In this case, the licensee should provide an assessment of the failure modes associated with the submergence of the solenoid valve. The licensee should also provide assurance that the subsequent failure of this component will not adversely affect any other safety functions or mislead an operator. Additionally, the licensee should discuss operating time, across the spectrum of events, in relation to the time of submergence. If the results of the licensee's assessment are acceptable, then the solenoid valve may be exempt from the submergence parameter of qualification.

It is not clear from the information submitted that submergence of safety-related electrical equipoment outside of containment was addressed. The licensee should address this area more specifically in the 90-day response and upgrade the CES as appropriate.

3.6 Chemical Spray

The licensee's FSAR value for the chemical concentration is 1700 ppm boric acid solution; the exact volume percent used by the vendor for qualification testing is being verified by the licensee. Therefore, for the purpose of this review, the effects of chemical spray will be considered unresolved. The staff will review the licensee's response when it is submitted and discuss the resolution in a supplemental report.

3.7 Aging

Section 7 of the DOR guidelines does not require a qualified life to be established for all safety-related electrical equipment. However, the following actions are required:

(1) Make a detailed comparison of existing equipment and the materials identified in Appendix C of the DOR guidelines. The first supplement to IEB-79-01B requires licensees to utilize the table in Appendix C and identify any additional materials as the result of their effort.

(2) Establish an ongoing program to review surveillance and maintenance records to identify potential age-related degradations.

(3) Establish component maintenance and replacement schedules which include considerations of aging characteristics of the installed components.

The licensee identified a number of equipment items for which a specified qualified life was established (for examples, 5 years, 15 years, or 40 years). In its assessment of these submittals, the staff did not review the adequacy of the methodology nor the basis used to arrive at these values; the staff has assumed that the established values are based on state-of-the-art technology and are acceptable.

For this review, however, the staff requires that the licensee submit supplemental information to verify and identify the degree of conformance to the above requirements. The response should include all the equipment identified as required to maintain functional operability in harsh environments.

The licensee indicated that this phase of the response is outstanding and that the review is in progress. The staff will review the licensee's response when it is submitted and discuss its evaluation in a supplemental report.

3.8 Radiation (Inside and Outside Containment)

The licensee has provided values for the radiation levels postulated to exist following a LOCA. The application and methodology employed to determine these values were presented to the licensee as part of the NRC staff criteria contained in the DOR guidelines, in NUREG-0588, and in the guidance provided in IEB-79-01B, Supplement 2. Therefore, for this review, the staff has assumed that, unless otherwise noted, the values provided have been determined in accordance with the prescribed criteria. The staff review determined that the values to which equipment was qualified enveloped the requirements identified by the licensee.

The value required by the licensee inside containment is an integrated dose of 1×10^8 rads. This value envelopes the DOR guideline requirements and is therefore acceptable.

A required value outside containment of greater than 10^{-1} rads has been used by the licensee to specify limiting radiation levels within the ECCS pump room of the auxiliary building. This value does not appear to consider the radiation levels

influenced by the source term methodology associated with post-LOCA recirculation fluid lines. The licensee must correct this along with the associated equipment summary sheets. The licensee stated that this review was in progress and will be completed by February 1, 1981, and the results submitted to the staff.

4 QUALIFICATION OF EQUIPMENT

The following subsections present the staff's assessment, based on the licensee's submittal, of the qualification status of safety-related electrical equipment.

The staff has separated the safety-related equipment into three categories: (1) equipment requiring immediate corrective action, (2) equipment requiring additional qualification information and/or corrective action, and (3) equipment considered acceptable if the staff's concern identified in Section 3.7 is satisfactorily resolved.

In its assessment of the licensee's submittal, the NRC staff did not review the methodology employed to determine the values established by the licensee. However, in reviewing the data sheets, the staff made a determination as to the stated conditions presented by the licensee. Additionally, the staff has not completed its review of supporting documentation referenced by the licensee (for example, test reports). It is expected that when the review of test reports is complete, the environmental qualification data bank established by the staff will provide the means to cross reference each supporting document to the referencing licensee.

If supporting documents are found to be unacceptable, the licensee will be required to take additional corrective actions to either establish qualification or replace the item(s) of concern. This effort will begin in early 1981.

An appendix for each subsection of this report provides a list of equipment for which additional information and/or corrective action is required. Where appropriate, a reference is provided in the appendices to identify deficiencies. It should be noted, as in the Commission Memorandum and Order, that the deficiencies identified do not necessarily mean that equipment is unqualified. However, they are cause for concern and may require further case-by-case evaluation.

4.1 Equipment Requiring Immediate Corrective Action

Appendix A identifies equipment (if any) in this category. The licensee was asked to review the facility's safety-related electrical equipment. The licensee's review of this equipment has not identified any equipment requiring immediate corrective action; therefore, no licensee event reports (LERs) were submitted. In addition, in this review, the staff has not identified any safety-related electrical equipment which is not able to perform its intended safety function during the time in which it must operate.

4.2 Equipment Requiring Additional Information and/or Corrective Action

Appendix B identifies equipment in this category, including a tabulation of deficiencies. The deficiencies are noted by a letter relating to the legend (identified below), indicating that the information provided is not sufficient for the qualification parameter or condition.

Legend

R - radiation
T - temperature
QT - qualification time
RT - required time
P - pressure
H - humidity
CS - chemical spray
A - material-aging evaluation; replacement schedule; ongoing equipment surveillance
S - submergence
M - margin
I - HELB evaluation outside containment not completed
QM - qualification method
RPN - equipment relocation or replacement; adequate schedule not provided
EXN - exempted equipment justification inadequate
SEN - separate-effects qualification justification inadequate
QI - qualification information being developed
RPS - equipment relocation or replacement schedule provided

As noted in Section 4, these deficiencies do not necessarily mean that the equipment is unqualified. However, the deficiencies are cause for concern and require further case-by-case evaluation. The staff has determined that an acceptable basis to exempt equipment from qualification, in whole or part, can be established provided the following can be established and verified by the licensee:

(1) Equipment does not perform essential safety functions in the harsh environment, and equipment failure in the harsh environment will not impact safety-related functions or mislead an operator.

(2a) Equipment performs its function before its exposure to the harsh environment, and the adequacy for the time margin provided is adequately justified, and

(2b) Subsequent failure of the equipment as a result of the harsh environment does not degrade other safety functions or mislead the operator.

(3) The safety-related function can be accomplished by some other designated equipment that has been adequately qualified and satisfies the single-failure criterion.

(4) Equipment will not be subjected to a harsh environment as a result of the postulated accident.

The licensee is, therefore, required to supplement the information presented by providing resolutions to the deficiencies identified; these resolutions should include a description of the corrective action, schedules for its completion (as applicable), and so forth. The staff will review the licensee's response, when it is submitted, and discuss the resolution in a supplemental report.

It should be noted that in cases where testing is being conducted, a condition may arise which results in a determination by the licensee that the equipment does not satisfy the qualification test requirements. For that equipment, the licensee will be required to provide the proposed corrective action, on a timely basis, to ensure that qualification can be established by June 30, 1982.

4.3 Equipment Considered Acceptable or Conditionally Acceptable

Based on the staff review of the licensee's submittal, the staff identified the equipment in Appendix C as (1) acceptable on the basis that the qualification program adequately enveloped the specific environmental plant parameters, or (2) conditionally acceptable subject to the satisfactory resolution of the staff concern identified in Section 3.7.

For the equipment identified as conditionally acceptable, the staff determined that the licensee did not clearly

(1) state that an equipment material evaluation was conducted to ensure that no known materials susceptible to degradation because of aging have been used,

(2) establish an ongoing program to review the plant surveillance and maintenance records in order to identify equipment degradation which may be age related, and/or

(3) propose a maintenance program and replacement schedule for equipment identified in item 1 or equipment that is qualified for less than the life of the plant.

The licensee is, therefore, required to supplement the information presented for equipment in this category before full acceptance of this equipment can be established. The staff will review the licensee's response when it is submitted and discuss the resolution in a supplemental report.

5 DEFERRED REQUIREMENTS

IEB 79-01B, Supplement 3 has relaxed the time constraints for the submission of the information associated with cold shutdown equipment and TMI lessons-learned modifications. The staff has required that this information be provided by February 1, 1981. The staff will provide a supplemental safety evaluation addressing these concerns.

6 CONCLUSIONS

The staff has determined that the licensee's listing of safety-related systems and associated electrical equipment whose ability to function in a harsh environment following an accident is required to mitigate a LOCA or HELB is complete and acceptable, except as noted in Section 3 of this report. The staff has also determined that the environmental service conditions to be met by the electrical equipment in the harsh accident environment are appropriate, except as noted in Section 3 of this report. Outstanding information identified in Section 3 should be provided within 90 days of receipt of this SER.

The staff has reviewed the qualification of safety-related electrical equipment to the extent defined by this SER and has found no outstanding items which would require immediate corrective action to ensure the safety of plant operation. However, the staff has determined that many items of safety-related electrical equipment identified by the licensee for this review do not have adequate documentation to ensure that they are capable of withstanding the harsh environmental service conditions. This review was based on a comparison of the qualification values with the specified environmental values required by the design, which were provided in the licensee's summary sheets.

Subsection 4.2 identified deficiencies that must be resolved to establish the qualification of the equipment; the staff requires that the information lacking in this category be provided within 90 days of receipt of this SER. Within this period, the licensee should either provide documentation of the missing qualification information which demonstrates that such equipment meets the DOR guidelines or NUREG-0588 or commit to a corrective action (requalification, replacement, relocation, and so forth) consistent with the requirements to establish qualification by June 30, 1982. If the latter option is chosen, the licensee must provide justification for operation until such corrective action is complete.

Subsection 4.3 identified acceptance and conditional acceptance based on noted deficiencies. Where additional information is required, the licensee should respond within 90 days of receipt of this SER by providing assurance that these concerns will be satisfactorily resolved by June 30, 1982.

The staff issued to the licensee Sections 3 and 4 of this report and requested, under the provisions of 10 CFR 50.54(f), that the licensee review the deficiencies enumerated and the ramifications thereof to determine whether safe operation of the facility would be impacted in consideration of the deficiencies. The licensee has completed a preliminary review of the identified deficiencies and has determined that, after due consideration of the deficiencies and their ramifications, continued safe operation would not be adversely affected.

Based on these considerations, the staff concludes that conformance with the above requirements and satisfactory completion of the corrective actions by June 30, 1982 will ensure compliance with the Commission Memorandum and Order of May 23, 1980. The staff further concludes that there is reasonable assurance of continued safe operation of this facility pending completion of these corrective actions. This conclusion is based on the following:

(1) that there are no outstanding items which would require immediate corrective action to assure safety of plant operation

(2) some of the items found deficient have been or are being replaced or relocated, thus improving the facility's capability to function following a LOCA or HELB

(3) the harsh environmental conditions for which this equipment must be qualified result from low-probability events; events which might reasonably be anticipated during this very limited period would lead to less demanding service conditions for this equipment.

APPENDIX A

Equipment Requiring

Immediate Corrective Action

(Category 4.1)

Equipment Description	Manufacturer	Component No.

No equipment in this category for Calvert Cliffs Units 1 and 2.

APPENDIX B

Equipment Requiring Additional Information

and/or Corrective Action

(Category 4.2)

LEGEND:

Designation for Deficiency

R - Radiation
T - Temperature
QT - Qualification time
RT - Required time
P - Pressure
H - Humidity
CS - Chemical spray
A - Material aging evaluation, replacement schedule, ongoing equipment surveillance
S - Submergence
M - Margin
I - HELB evaluation outside containment not completed
QM - Qualification method
RPN - Equipment relocation or replacement, adequate schedule not provided
EXN - Exempted equipment justification inadequate
SEN - Separate effects qualification justification inadequate
QI - Qualification information being developed
RPS - Equipment relocation or replacement schedule provided

Equipment Description	Manufacturer	Component No.	Deficiency
Solenoid valve	ASCO	1SV1412	A,CS
Solenoid valve	ASCO	1SV1411	A,CS
Solenoid valve	ASCO	1SV1410	A,CS
Solenoid valve	ASCO	1SV641	A,CS
Solenoid valve	ASCO	1SV631	A,CS
Solenoid valve	ASCO	1SV621	A,CS

Equipment Description	Manufacturer	Component No.	Deficiency
Solenoid valve	ASCO	1SV611	A,CS
Solenoid valve	ASCO	1SV661	A,CS
Soleonid valve	ASCO	1SV648	A,CS
Solenoid valve	ASCO	1SV638	A,CS
Solenoid valve	ASCO	1SV628	A,CS
Solenoid valve	ASCO	1SV618	A,CS
Solenoid valve	ASCO	1SV2085	A,CS
Solenoid valve(1)	ASCO	1SV5465	A,S,RPN
Solenoid valve(1)	ASCO	1SV5466	A,S,RPN
Solenoid valve(1)	ASCO	1SV5467	A,S,RPN
Solenoid valve(2)	ASCO	2SV5465	A,S,RPN
Solenoid valve(2)	ASCO	2SV5466	A,S,RPN
Solenoid valve(2)	ASCO	2SV5467	A,S,RPN
Solenoid valve(2)	ASCO	2SV506	A,S,RPN
Connector	Bendix	CONXXX-3902-1	R,T,QT,RT, CS,A,QM,QI
Connector	Kings	CONXXX-KC59-503	R,T,QT,RT,H CS,A,QM,QI
Connector	Kings	CONXXX-KM5905	T,QT,RT,H, CS,A,S,M,QI
Connector	AmPhenol	CONXXX-82-320-1004	R,T,QT,RT,H, CS,A,QM,QI
Connector	ITT CANNON (GREMAR)	CONXXX-19457	R,T,QT,RT, H,CS,A,QM,QI
Connector	ITT CANNON (GREMAR)	CONXXX-279-75	T,QT,RT,CS,A QM,M,QI
Connector	AmPhenol	CONXXX-531000	R,T,QT,RT, CS,A,QM,QI

(1) Unit 1
(2) Unit 2

Equipment Description	Manufacturer	Component No.	Deficiency
Motor-Operated Valve	Limitorque	1MOV5463	QT,A,QM
Motor-Operated Valve	Limitorque	1MOV5462	QT,A,QM
Motor	Johnson	1MO5439	QT,RT,A,QM
Motor	Reliance	1MO448	QT,RT,A,QM
Motor	General Electric	1MO403	T,QT,RT,H A,QM
Motor-Operated Valve	Limitorque	1MOV6903	QT,RT,A
Motor-Operated Valve	Pratt	1MOV6902	T,QT,RT,A,QM
Motor-Operated Valve	Limitorque	1MOV6901	QT,RT,A
Motor-Operated Valve	Limitorque	1MOV6900	T,QT,RT,A,M
Heater	Westinghouse	1Q04	QT,RT,CS,A
Heater	Westinghouse	1Q08	QT,RT,CS,A
Motor	Johnson	1MO5437	QT,RT,A,QM
Motor	Reliance	1M1448	QT,RT,A,QM
Motor-Operated Valve	Limitorque	1MOV644	QT,RT,A,M
Motor-Operated Valve	Limitorque	1MOV634	QT,RT,A,M
Motor-Operated Valve	Limitorque	1MOV624	QT,RT,A,M
Motor-Operated Valve	Limitorque	1MOV614	QT,RT,A,M
Motor-Operated Valve	Limitorque	1MOV656	QT,RT,A,QM
Motor-Operated Valve	Limitorque	1MOV660	QT,RT,A,QM
Motor-Operated Valve	Limitorque	1MOV659	QT,RT,A,QM
Motor-Operated Valve	Limitorque	1MOV4145	QT,RT,A
Motor-Operated Valve	Limitorque	1MOV4144	QT,RT,A

Equipment Description	Manufacturer	Component No.	Deficiency
Motor-Operated Valve	Limitorque	1MOV652	QT,RT,A,M
Motor-Operated Valve	Limitorque	1MOV651	QT,RT,A
Motor-Operated Valve	Limitorque	1MOV625	QT,RT,A
Motor-Operated Valve	Limitorque	1MOV615	QT,RT,A
Motor	General Electric	1MA404	QT,RT,A,QM
Motor	General Electric	1MA104	QT,RT,A,QM
Motor-Operated Valve	Limitorque	1MOV626	QT,RT,A,QM
Motor-Operated Valve	Limitorque	1MOV616	QT,RT,A,QM
Motor-Operated Valve	Limitorque	1MOV627	QT,RT,A,QM
Motor-Operated Valve	Limitorque	1MOV617	QT,RT,A,QM
Motor	General Electric	1MA110	QT,RT,A,QM
Motor	General Electric	1MA408	QT,RT,A,QM
Motor	General Electric	1MA108	QT,RT,A,QM
Motor-Operated Valve	Limitorque	1MOV654	QT,RT,A,QM
Motor-Operated Valve	Limitorque	1MOV655	QT,RT,A,QM
Motor-Operated Valve	Limitorque	1MOV653	QT,RT,A,QM
Motor	Allis-Chalmers	1MA407	QT,RT,A,QM
Motor	Allis-Chalmers	1MA107	QT,RT,A,QM
Solenoid Valve	ASCO	1SV4151	RT,A
Solenoid Valve	ASCO	1SV4150	RT,A

Equipment Description	Manufacturer	Component No.	Deficiency
Radiation Monitor	Westinghouse	1RE5316 D	R,T,QT,RT,P, CS,A,QM
Radiation Monitor	Westirghouse	1RE5316 C	R,T,QT,RT,P, CS,A,QM
Radiation Monitor	Westinghouse	1RE5316 B	R,T,QT,RT,P, CS,A,QM
Radiation Monitor	Westinghouse	1RE5316 A	R,T,QT,RT,P, CS,A,QM
Motor-Operated Valve	Limitorque	1MOV6579	QT,A
Proportional Counter	Reuter Stokes	1NI004 (P)	R,QT,RT,CS,A,QM
Proportional Counter	Reuter Stokes	1NI002 (P)	R,QT,RT,CS,A,QM
Proportional Counter	Reuter Stokes	1NI001 (P)	R,QT,RT,CS,A,QM
Preamplifier	Gulf Atomic	1PA604	R,T,QT,RT,H,CS, A,QM
Preamplifier	Gulf Atomic	1PA603	R,T,QT,RT,CS, A,QM
Fission Chamber	Westinghouse	1NI001 (F)	R,QT,RT,H,CS,A, QM
Fission Chamber	Westinghouse	1NI002 (F)	R,QT,RT,H,I
Fission Chamber	Westinghouse	1NI003 (F)	R,QT,RT,H,CS,A, QM
Fission Chamber	Westinghouse	1NI004 (F)	R,QT,RT,H,CS,A, QM
Preamplifier	Gulf Atomic	1PA601	R,T,QT,RT,H,CS, A,QM
Preamplifier	Gulf Atomic	1PA602	R,T,QT,RT,H,CS, A,QM

Equipment Description	Manufacturer	Component No.	Deficiency
Connector	AmPhenol	CONXXX-30576-A	QT,RT,CS,A,M
Terminal Lug	Thomas & Betts	LUGXXX-53000 Series	R,QT,RT,P,H,CS, A,QM
Terminal Lug	Thomas & Betts	LUGXXX-34000 Series	QT,RT,CS,A,QM
Terminal Block	Buchanan	TBXXXX-B112	QT,RT,CS,A, QM
Terminal Block	Westinghouse	TBXXXX-542247	R,QT,RT,CS,A, QM,M
Terminal Block	Marathon	TBXXXX-1600 Series	QT,RT,CS,A,M
Cable	Rockbestos		QT,RT,CS,A
Cable	Hatfield		QT,RT,CS,A,M
Cable	Lewis Engrg. Co.		QT,RT,A,M
Cable	Kerite		QT,RT,CS,A,M
Cable	Cerro		QT,RT,A,
Cable	Boston Insul., Wire		QT,RT,CS,A,M
Cable	Continental		QT,RT,CS,A,M
Cable	Boston Insul., Wire		QT,RT,CS,A
Cable	Raychchem		QT,RT,H,CS,A
Cable	Okonite		QT,RT,CS,A
Cable	Anaconda		QT,RT,CS,A
Cable	Anaconda		QT,RT,A

Equipment Description	Manufacturer	Component No.	Deficiency
EPA Type 3A Penetration Assembly	AmPhenol SAMS	1ZWE9	QT,RT,CS,A,M
EPA Type 3A Penetration Assembly	AmPhenol SAMS	1ZWE3	QT,RT,CS,A,M
EPA Type 3A Penetration Assembly	AmPhenol SAMS	1ZEE9	QT,RT,CS,A,M
EPA Type 3A Penetration Assembly	AmPhenol SAMS	1ZWE4	QT,RT,CS,A,M
EPA Type 3D Penetration Assembly	AmPhenol SAMS	1ZWE7	QT,RT,CS,A,M
EPA Type 3D Penetration Assembly	AmPhenol SAMS	1ZWG1	QT,RT,CS,A,M
EPA Type 3D Penetration Assembly	AmPhenol SAMS	1ZEE1	QT,RT,CS,A,M
EPA Type 3D Penetration Assembly	AmPhenol SAMS	1ZEE1	QT,RT,CS,A,M
Solenoid Valve	ASCO	1SV3830	QT,RT,A,QM
Solenoid Valve	ASCO	1SV3828	QT,RT,A,QM
Solenoid Valve	ASCO	1SV4160	RT,A
Solenoid Valve	ASCO	1SV4159	RT,A
Motor	Reliance	1MB414	QT,RT,CS,A,M
Motor	Reliance	1MB402	QT,RT,CS,A,M

Equipment Description	Manufacturer	Component No.	Deficiency
Motor	Reliance	1MB114	QT,RT,CS,A,M
Motor	Reliance	1MB102	QT,RT,CS,A,M
Motor	Reliance	1MB121	QT,RT,CS,A,M
Motor	Reliance	1MB405	QT,RT,CS,A,M
Motor	Reliance	1MB105	QT,RT,CS,A,M
Motor-Operated Valve	Limitorque	1MOV2080	H,A
Motor-Operated Valve	Limitorque	1MOV4516	QT,RT,A
Motor-Operated Valve	Limitorque	1MOV4517	QT,RT,A
EPA Type 2D Penetration Assembly	AmPhenol SAMS	1ZEC4	QT,RT,CS,A,M
EPA Type 2C Penetration Assembly	AmPhenol SAMS	1ZEC1	QT,RT,CS,A,M
EPA Type 2B Penetration Assembly	AmPhenol SAMS	1ZEB6	QT,RT,CS,A,M
EPA Type 2B Penetration Assembly	AmPhenol SAMS	1ZEB3	QT,RT,CS,A,M
EPA Type 2B Penetration Assembly	AmPhenol SAMS	1ZEB1	QT,RT,CS,A,M
EPA Type 2A Penetration Assembly	AmPhenol SAMS	1ZEA7	QT,RT,CS,A,M
EPA Type 2A Penetration Assembly	AmPhenol SAMS	1ZEA4	QT,RT,CS,A,M
EPA Type [illegible] Penetration Assembly	AmPhenol SAMS	1ZWC6	QT,RT,CS,A,M

Equipment Description	Manufacturer	Component No.	Deficiency
EPA Type 2D Penetration Assembly	AmPhenol SAMS	1ZWC4	QT,RT,CS,A,M
EPA Type 2C Penetration Assembly	AmPhenol SAMS	1ZWC1	QT,RT,CS,A,M
EPA Type 2B Penetration Assembly	AmPhenol SAMS	1ZWB7	QT,RT,CS,A,M
EPA Type 2B Penetration Assembly	AmPhenol SAMS	1ZWB2	QT,RT,CS,A,M
EPA Type 2B Penetration Assembly	AmPhenol SAMS	1ZWB1	QT,RT,CS,A,M
EPA Type 2A Penetration Assembly	AmPhenol SAMS	1ZWA6	QT,RT,CS,A,M
EPA Type 2A Penetration Assembly	AmPhenol SAMS	1ZWA3	QT,RT,CS,A,M
EPA Type 2C Penetration Assembly	AmPhenol SAMS	1ZEC9	QT,RT,CS
EPA Type 2D Penetration Assembly	AmPhenol SAMS	1ZEC6	QT,RT,CS,A,M
Solenoid Valve	Dragon	1SV6540F	R,T,QT,RT,CS, A,QM,RPN
Solenoid Valve	Dragon	1SV6540E	R,T,QT,RT,CS, A,QM,RPN
Solenoid Valve	Dragon	1SV6540D	R,T,QT,RT,CS, A,QM,RPN
Solenoid Valve	Dragon	1SV6540C	R,T,QT,RT,CS, A,QM,RPN

Equipment Description	Manufacturer	Component No.	Deficiency
Solenoid Valve	Dragon	1SV6507B	QT,RT,A,QM,RPN
Solenoid Valve	Dragon	1SV6507C	QT,RT,A,QM,RPN
Solenoid Valve	Dragon	1SV6507D	QT,RT,A,QM,RPN
Solenoid Valve	Dragon	1SV6507E	QT,RT,A,QM,RPN
Solenoid Valve	Dragon	1SV6507F	QT,RT,A,QM,RPN
Solenoid Valve	Dragon	1SV6507G	QT,RT,A,QM,RPN
Solenoid Valve	Dragon	1SV6540A	R,T,QT,RT,CS, A,QM,RPN
Solenoid Valve	Dragon	1SV6540B	R,QT,RT,CS,A, QM,RPN
Solenoid Valve	Dragon	1SV6507A	QT,RT,A,QM, RPN
Solenoid Valve	Dragon	1SV6540G	R,T,QT,RT,CS, A,QM,RPN
Flow Transmitter	Fischer & Porter	1FT6901	QT,RT,A,QM,RPN
Solenoid Valve	ASCO	1SV5292	R,T,QT,A,QM,RPN
Pressure Transmitter	Fischer & Porter	1PT102D	QT,RT,CS,A,QM,RPN
Pressure Transmitter	Fischer & Porter	1PT102C	QT,RT,CS,A,QM,RPN
Pressure Transmitter	Fischer & Porter	1PT102B	QT,RT,CS,A,QM,RPN
Pressure Transmitter	Fischer & Porter	1PT102A	QT,RT,CS,A,QM,RPN
Pressure Transmitter	Fischer & Porter	1PT103-1	QT,RT,CS,A,QM,RPN
Pressure Transmitter	Fischer & Porter	1PT103	QT,RT,CS,A,QM,RPN
RTD*	Rosemount	1TE122CD	R,QT,RT,CS,A,QM, M,RPN
RTD	Rosemount	1TE122CB	R,QT,RT,CS,A,QM, M,RPN

Equipment Description	Manufacturer	Component No.	Deficiency
RTD	Rosemount	1TE122CC	R,QT,RT,CS,A,QM, M,RPN
RTD	Rosemount	1TE122CA	R,QT,RT,CS,A,QM, M,RPN
RTD	Rosemount	1TE122HD	R,QT,RT,CS,A,QM, M,RPN
RTD	Rosemount	1TE122HC	R,QT,RT,CS,A,QM, M,RPN
RTD	Rosemount	1TE122HB	R,QT,RT,CS,A,QM, M,RPN
RTD	Rosemount	1TE122HA	R,QT,RT,CS,A,QM, M,RPN
RTD	Rosemount	1TE112CD	R,QT,RT,CS,A,QM, M,RPN
RTD	Rosemount	1TE112CB	R,QT,RT,CS,A,QM, M,RPN
RTD	Rosemount	1TE112CC	R,QT,RT,CS,A,QM, M,RPN
RTD	Rosemount	1TE112CA	R,QT,RT,CS,A,QM, M,RPN
RTD	Rosemount	1TE112HD	R,QT,RT,CS,A,QM, M,RPN
RTD	Rosemount	1TE112HC	R,QT,RT,CS,A,QM, M,RPN
RTD	Rosemount	1TE112HB	R,QT,RT,CS,A,QM, M,RPN
RTD	Rosemount	1TE112HA	R,QT,RT,CS,A,QM, M,RPN
Pressure Transmitter	Fischer & Porter	1PT1023D	QT,RT,CS,A,QM,RPN
Pressure Transmitter	Fischer & Porter	1PT1023C	QT,RT,CS,A,QM,RPN

Equipment Description	Manufacturer	Component No.	Deficiency
Pressure Transmitter	Fischer & Porter	1PT1023B	QT,RT,CS,A,QM,RPN
Pressure Transmitter	Fischer & Porter	1PT1023A	QT,RT,CS,A,QM,RPN
Pressure Transmitter	Fischer & Porter	1PT1013D	QT,RT,CS,A,QM,RPN
Pressure Transmitter	Fischer & Porter	1PT1013B	QT,RT,CS,A,QM,RPN
Pressure Transmitter	Fischer & Porter	1PT1013A	QT,RT,CS,A,QM,RPN
Solenoid Valve	ASCO	1SV4013	R,T,QT,RT,P,H,CS, A,QM,RPN
Solenoid Valve	ASCO	1SV4012	R,T,QT,RT,P,H,CS, A,QM,RPN
Solenoid Valve	ASCO	1SV4011	R,T,QT,RT,P,H,CS, A,QM,RPN
Solenoid Valve	ASCO	1SV4010	R,T,QT,RT,P,H,CS, A,QM,RPN
Solenoid Valve	ASCO	1SV1589	R,T,QT,RT,P,H,A, QM,RPN
Solenoid Valve	ASCO	1SV1591	R,T,QT,RT,P,H,A, QM,RPN
Solenoid Valve	ASCO	1SV1581	R,T,QT,RT,P, H,A,QM,RPN
Solenoid Valve	ASCO	1SV1583	R,T,QT,RT,P, H,A,QM,RPN
Solenoid Valve	ASCO	1SV1590	R,T,QT,RT,P, H,A,QM,RPN
Solenoid Valve	ASCO	1SV1582	R,T,QT,RT,P, H,A,QM,RPN
Solenoid Valve	ASCO	1SV3833	R,T,QT,RT,P, H,A,QM,RPN
Solenoid Valve	ASCO	1SV3832	R,T,QT,RT,P, H,A,QM,RPN

Equipment Description	Manufacturer	Component No.	Deficiency
Level Transmitter	Fischer & Porter	1LT1113A	R,QT,RT,CS,A QM,RPN
Level Transmitter	Fischer & Porter	1LT1113B	T,QT,RT,CS,A QM,RPN
Level Transmitter	Fischer & Porter	1LT1113C	R,QT,RT,CS,A QM,RPN
Level Transmitter	Fischer & Porter	1LT1113D	R,QT,RT,CS,A QM,RPN
Level Transmitter	Fischer & Porter	1LT1123A	R,QT,RT,CS,A QM,RPN
Level Transmitter	Fischer & Porter	1LT1123B	R,QT,RT,CS,A QM,RPN
Level Transmitter	Fischer & Porter	1LT1123C	R,QT,RT,CS,A QM,RPN
Level Transmitter	Fischer & Porter	1LT1123D	R,QT,RT,CS,A QM,RPN
Solenoid Valve	Republic Teldyne	1SV4042	R,T,QT,RT,H,A, QM,RPN
Solenoid Valve	Republic Teldyne	1SV4045	R,T,QT,RT,H,A, QM,RPN
Solenoid Valve	Republic Teldyne	1SV4043	R,T,QT,RT,H,A, QM,RPN
Solenoid Valve	Republic Teldyne	1SV4044	R,T,QT,RT,H,A, QM,RPN
Solenoid Valve	Republic Teldyne	1SV4046	R,T,QT,RT,H,A, QM,RPN
Solenoid Valve	Republic Teldyne	1SV4052	R,T,QT,RT,H,A, QM,RPN
Solenoid Valve	Republic Teldyne	1SV4047	R,T,QT,RT,H,A, QM,RPN

APPENDIX C

Equipment Considered Acceptable Or Conditionally Acceptable

(Category 4.3)

Equipment Description	Manufacturer	Component No.	Deficiency
Solenoid Valve	ASCO	1SV1413	A
Solenoid Valve	ASCO	1SV517	A
Solenoid Valve	ASCO	1SV5291	A
Solenoid Valve	ASCO	1SV643	A
Solenoid Valve	ASCO	1SV633	A
Solenoid Valve	ASCO	1SV623	A
Solenoid Valve	ASCO	1SV613	A
Solenoid Valve	ASCO	1SV516	A
Solenoid Valve	ASCO	1SV515	A
Solenoid Valve	ASCO	1SV519	A
Solenoid Valve	ASCO	1SV518	A

APPENDIX D

Safety-Related Systems List[1]

Function	System
Emergency Reactor Shutdown	Chemical Volume and Control
	Reactor Coolant
	Safeguards Actuation (Part of Reactor Coolant)
Containment Isolation	Chemical and Volume Control
	Compressed Air
	Condensate and Feedwater
	Cooling Water
	Main Steam
	Plant Heating
	Reactor Coolant and Waste Process Sample
	Safety Injection and Containment Spray Sampling
	Waste Processing
Reactor Core Cooling	Safety Injection and Containment Spray
Containment Heat Removal	Safety Injection and Containment Spray
	Containment Air Recirculation and Cooling

[1]The NRC staff recognized that there are differences in nomenclature of systems because of plant vintage and engineering design, consequently, some systems performing identical or similar functions may have different names. In those instances, it was necessary to verify the function of the system(s) with the responsible IE regional reviewer and/or the licensee.

Function	System
Core Residual Heat Removal	(Residual Heat Removal[3])
	Auxiliary Feedwater[2]
	Condensate and Feedwater
	Main Steam
	Cooling Water
	Safety Injection and Containment Spray
Prevention of Significant Release of Radioactive Material to Environment	Containment Air Recirculation and Cooling
	Radiation Monitoring
	Sampling
Supporting Systems	Electrical
	Ventilation

[2]Covered as part of TMI-2 Lessons Learned; does not appear in systems list.
[3]Residual heat removal is performed by a number of systems. Some components are being addressed as part of TMI-2 Lessons Learned.