MAY 02 1984 .

2

MEMORANDUM FOR: Chairman Palladino
Commissioner Gilinsky
Commissioner Roberts
Commissioner Asselstine
Commissioner Berntnal

FROM: William J. Dircks
Executive Director for Operations

SUBJECT: INTEGRATED DESIGN INSPECTION - SEABROOK UNIT 1

A copy of the inspection report for the third Integrated Design Inspection (IDI) performed for Seabrook Unit 1, is enclosed for your information. Development and implementation of a program of Integrated Design Inspections is one of the staff Quality Assurance Initiatives described in SECY 82-352. These team inspections expand the NRC's examination of quality of the design process by conducting multidisciplinary engineering examinations of design for selected systems at reactors under construction.

The first inspection was conducted at Callaway (a SNUPPS project) in November and December 1982. The second inspection for Byron Unit 1 was conducted in May and June 1983. The third inspection for Seabrook Unit 1 was conducted in November and December 1983. As in the second inspection, the Seabrook inspection was conducted with considerable contractor assistance (7 of 16 team members) which brought additional design experience to the inspection effort. The fourth inspection, at River Bend Unit 1, has been initiated.

(Signed) William J. Dircks
William J. Dircks
Executive Director for Operations

Enclosure:
Integrated Design Inspection
Report - Seabrook

cc w/enclosure:
SECY
OPE
OGC

CONTACT: J. N. Grace, IE
Ext. 29696

DISTRIBUTION:
DCS
QASIP Reading
QAB Reading
LLewis Reading
WDircks
JRoe
VStello
TRehm
RCDeYoung
JMTaylor
JNGrace
JGPartlow
TAnkrum
JMilhoan
EWenzinger, Region I
LLewis

SEE PREVIOUS CONCURRENCES*

IE:QAB*	IE:QAB*	IE:QAB*	IE:DD/QASIP*	IE:DIR/QASIP*	IE:DDIR	IE:DIR	EDO
LLewis:esp	JMilhoan	GTAnkrum	JGPartlow	JNGrace	JMTaylor	RCDeYoung	WDircks
4/ /84	4/ /84	4/ /84	4/ /84	4/ /84	4/ /84	4/6/84	4/ /84

A17

8405170306 XA

Shewmaker
1/31/84 5

FINDINGS CORRELATION TO WENZINGER'S TYPED TEAM LIST OF 1/10/84

SECTION III - CIVIL/STRUCTURAL

ED's No.	Original Team Finding No.	Draft Report Section	Draft Report Page	Sequence No.	Final Report Finding No & Page
1	4-5	4.7	4.7-4	(18)	
2	4-6	4.1	4.1-14	(2)	
3	4-8	4.3	4.3-11	(13)	
4	4-10	4.3	4.3-12	(14)	
5	4-16	4.4	4.4-2	(15)	
6	4-17	4.2	4.2-10	(7)	
7	4-18	4.2	4.2-8	(6)	
8	4-11	4.3	4.3-2	(8)	
9	4-21	4.7	4.7-16	(19)	
10	4-23	4.6	4.6-4	(17)	
11	(4-1)	(1.5)	1.5 -	[1]	1-1
12	(4-12)	(1.5)	1.5 -	[3]	1-3
13	4-3	4.1	4.1-17	(5)	
14	(4-14)	(1.5)	1.5-	[4]	1-4
15	4-15	4.1	4.1-16	(4)	
16	4-13	4.3	4.3-4	(10)	
17	(4-2)	(1.5)	1.5-	[2]	1-2
18	4-4	4.3	4.3-3	(9)	
19	4-19	4.3	4.3-6	(11)	
20	4-20	4.6	4.6-3	(16)	
21	4-7	4.3	4.3-8	(12)	
none	4-9	4.1	4.1-13	(1)	
none	4-22	4.1	4.1-15	(3)	

MAY 02 1984

2

MEMORANDUM FOR: Chairman Palladino
Commissioner Gilinsky
Commissioner Roberts
Commissioner Asselstine
Commissioner Bernthal

FROM: William J. Dircks
Executive Director for Operations

SUBJECT: INTEGRATED DESIGN INSPECTION - SEABROOK UNIT 1

A copy of the inspection report for the third Integrated Design Inspection (IDI) performed for Seabrook Unit 1, is enclosed for your information. Development and implementation of a program of Integrated Design Inspections is one of the staff Quality Assurance Initiatives described in SECY 82-352. These team inspections expand the NRC's examination of quality of the design process by conducting multidisciplinary engineering examinations of design for selected systems at reactors under construction.

The first inspection was conducted at Callaway (a SNUPPS project) in November and December 1982. The second inspection for Byron Unit 1 was conducted in May and June 1983. The third inspection for Seabrook Unit 1 was conducted in November and December 1983. As in the second inspection, the Seabrook inspection was conducted with considerable contractor assistance (7 of 16 team members) which brought additional design experience to the inspection effort. The fourth inspection, at River Bend Unit 1, has been initiated.

(Signed) William J. Dircks

William J. Dircks
Executive Director for Operations

Enclosure:
Integrated Design Inspection
Report - Seabrook

cc w/enclosure:
SECY
OPE
OGC

CONTACT: J. N. Grace, IE
Ext. 29696

DISTRIBUTION:
DCS
QASIP Reading
QAB Reading
LLewis Reading
WDircks
JRoe
VStello
TRehm
RCDeYoung
JMTaylor
JNGrace
JGPartlow
TAnkrum
JMilhoan
EWenzinger, Region I
LLewis

SEE PREVIOUS CONCURRENCES*

IE:QAB*	IE:QAB*	IE:QAB*	IE:DD/QASIP*	IE:DIR/QASIP*	IE:DDIR	IE:DIR	EDO
LLewis:esp	JMilhoan	GTAnkrum	JGPartlow	JNGrace	JMTaylor	RCDeYoung	WDircks
4/ /84	4/ /84	4/ /84	4/ /84	4/ /84	4/ /84	4/6/84	4/ /84

A17

8405170306

Shewmaker
1/31/84 5

FINDINGS CORRELATION TO WENZINGER'S TYPED TEAM LIST OF 1/10/84

SECTION III - CIVIL/STRUCTURAL

EO's No.	Original Team Finding No.	Draft Report Section	Draft Report Page	Sequence No.	Final Report Finding No & Page
1	4-5	4.7	4.7-4	18	
2	4-6	4.1	4.1-14	2	
3	4-8	4.3	4.3-11	13	
4	4-10	4.3	4.3-12	14	
5	4-16	4.4	4.4-2	15	
6	4-17	4.2	4.2-10	7	
7	4-18	4.2	4.2-8	6	
8	4-11	4.3	4.3-2	8	
9	4-21	4.7	4.7-16	19	
10	4-23	4.6	4.6-4	17	
11	4-1	1.5	1.5-	1	1-1
12	4-12	1.5	1.5-	3	1-3
13	4-3	4.1	4.1-17	5	
14	4-14	1.5	1.5-	4	1-4
15	4-15	4.1	4.1-16	4	
16	4-13	4.3	4.3-4	10	
17	4-2	1.5	1.5-	2	1-2
18	4-4	4.3	4.3-3	9	
19	4-19	4.3	4.3-6	11	
20	4-20	4.6	4.6-3	16	
21	4-7	4.3	4.3-8	12	
none	4-9	4.1	4.1-13	1	
none	4-22	4.1	4.1-15	3	

4

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

(NO need to cy this Report)

April 2, 1984

Docket No. 50-443

Public Service of New Hampshire
ATTN: Mr. D. N. Merrill
Executive Vice President
P. O. Box 330
Manchester, New Hampshire 03105

Gentlemen:

SUBJECT: INTEGRATED DESIGN INSPECTION 50-443/83-23

This letter conveys the results and conclusions of the integrated design inspection of the Seabrook, Unit 1, nuclear power plant. The inspection was conducted by the NRC's Office of Inspection and Enforcement. The team was composed of personnel from the NRC's Office of Inspection and Enforcement, Office of Nuclear Reactor Regulation, Region I and Region IV and consultants. The inspection took place at the Seabrook Station, Yankee Atomic Electric Company offices, United Engineers and Constructors, Inc., Westinghouse Electric Corporation and selected subcontractors. The inspection took place over the period from November 1, 1983 to December 21, 1983. The inspection examined activities authorized by NRC Construction Permit No. CPPR-135. The purpose of this inspection was to determine whether the design process used in constructing the plant has complied with NRC regulations and licensing commitments. The team inspected areas defining whether (1) regulatory requirements and design bases as specified in the license application had been correctly translated and satisfied as part of specifications, drawings, and procedures, (2) correct design information had been provided internally and externally to the responsible design organizations including selected off-site subcontractors, (3) design engineers had sufficient technical guidance to perform assigned engineering functions and (4) design controls, as applied to the original design, had also been applied to design changes, including field changes.

The inspection focused on the Containment Building Spray System although other areas were also covered as delineated in the enclosed inspection report. Activities included examination of design, design procedures, records, design bases and inspection of the system as installed at the plant. Emphasis was placed on reviewing the adequacy of design details as a means of measuring how well the design process had functioned for the selected sample.

Findings regarding errors, procedural violations and inconsistencies are identified in the report. Unresolved items are identified where insufficient information was developed to allow final determinations on the adequacy of specific features or practices.

A15

8405160195

Other observations are identified where it was considered appropriate to call attention to matters for which there are no specific regulatory requirements, but which are recommended for your consideration.

Section 1 of the report provides a summary of the results of the inspection and the conclusions reached by the inspection team. The principal points from that summary are discussed below.

In the mechanical systems area, there were deficiencies in the method used by United Engineers to calculate available net positive suction head (NPSH) for the containment building spray pump. In addition, there is uncertainty as to the pressure drop across the inner screen of the containment recirculation sump and its effect upon NPSH. There is also uncertainty as to the required NPSH identified by tests because the pump was not tested with the motor to be used at Seabrook and United Engineers has not obtained test data establishing the torque capability of the Seabrook motor. The team independently calculated NPSH margin and determined that it may be less than required. The team also reviewed a Westinghouse calculation of NPSH for the residual heat removal pump and found deficiencies similar to those for the containment building spray pump. The team reviewed two NPSH calculations for the emergency feedwater pumps and found deficiencies with regard to the bases and validity of assumptions. Based on the number of deficiencies we found in NPSH calculations, involving three separate systems and two design organizations, there appears to be a systematic problem. Action needs to be taken to review NPSH calculations for other systems to determine if the designs are adequate and to determine the root cause of the deficiencies identified above. The team also found that work is being accomplished at a very late stage in assessing whether there is adequate protection of essential components from postulated pipe breaks and cracks in high and moderate energy piping. The design cannot be considered complete until the work is finished. In other respects, the design process in the mechanical systems area appeared to be controlled.

In the mechanical components area, there were items of technical significance which warrant additional design efforts. Waterhammer loads and modeling procedures should be addressed in certain piping reanalyses. Rapid closure of containment isolation valves during operation of containment building spray pumps should be reviewed taking into consideration the peak pressures that result. The functional adequacy of the containment building spray pump under specified thermal transient loadings should be confirmed. Bolted joints on certain valves should be assessed to be sure that their structural integrity is assured. In other respects, the design process in the mechanical components area is generally controlled.

In the civil-structural area, three areas of concern were found which warrant additional design efforts. Floor live loads are not included in load combinations which incorporate seismic loads. This is a violation of the basic structural design criteria approved for the plant. The classification of the structural elements of the tank farm structure with regard to seismic loadings and tornado loadings was found to be inconsistent within the project criteria and there were also inconsistencies between the project criteria and design calculations. Instances of improper modeling of the tank farm structure for both the reinforced concrete portions and the structural steel portions were also noted. In other respects, the design process in the civil-structural area appeared to be controlled.

In the electric power area, the design process appeared to be generally controlled. However, the seismic and environmental qualification had not been satisfactorily demonstrated for a number of electric components.

In the instrumentation and controls area, an adequate set of procedures is in place to assure that the design can be controlled in a satisfactory manner. Nevertheless, portions of the present instrumentation and controls design may not be adequate. Sufficient independence of certain control circuits that are essential to the operation of three engineered safety features has not been demonstrated. There is lack of automatic valve position control for certain valves in the Residual Heat Removal System to assure that the valves are in the proper position for automatic operation of the Emergency Core Cooling System during the recirculation phase. In addition, seismic and environmental qualification has not been satisfactorily demonstrated for certain instrumentation and control equipment. In spite of procedures in effect at Yankee Atomic and United Engineers, these deficiencies have not been found by the current quality assurance program.

The above items and many others are listed in the enclosed inspection report. In general, the problems found in the Seabrook design appeared to be confined to specific issues that did not seem to cross discipline boundaries. The overall design appeared to be adequately controlled.

In accordance with 10 CFR 2.790(a), a copy of this letter and the enclosures will be placed in the NRC Public Document Room unless you notify this office by telephone, within 10 days of the date of this letter, and submit written application to withhold information contained herein within 25 days of the date of this letter. Such applications shall be consistent with the requirements of 10 CFR 2.790(b)(1).

You are requested to respond in writing to the findings and unresolved items within 45 days after receipt of this letter. With respect to the deficiencies identified in findings, the response should address the cause, extent, corrective actions and any other information you consider relevant. For unresolved items, the response should provide information concerning acceptability of the specific feature or practice involved or indicate the extent to which corrective action is needed. In such cases the cause and corrective actions and any other information you consider relevant should also be included in the response. Finally, the response should include your position, and the bases therefore, with respect to the necessity for conducting additional audits of design implementation in areas other than those covered by our inspection so as to provide assurance that deficiencies of importance either do not exist or are corrected. The response should be addressed to this office.

As discussed in the report, the NRC's followup efforts will be managed by the Office of Inspection and Enforcement with assistance from the Region I Office or other NRC offices as needed. Some of the items identified in the report may provide bases for enforcement actions. The Office of Inspection and Enforcement will initiate any enforcement actions considered appropriate. Any decision in this regard will be held in abeyance pending review of the reply to this inspection.

Should you have any questions concerning this inspection, please contact me or Mr. Ted Ankrum (301-492-4774) of this office.

Sincerely,

R C DeYoung

Richard C. DeYoung, Director
Office of Inspection and Enforcement

Enclosure:
Inspection Report
50-443/83-23

cc w/enclosure:
Mr. William B. Derrickson
Senior Vice President, Nuclear Energy
Public Service of New Hampshire
P. O. Box 330
Manchester, New Hampshire 03105

Mr. Wendel P. Johnson
Vice President
Public Service of New Hampshire
P. O. Box 700
Seabrook, New Hampshire 03874

Mr. Bruce B. Beckley
Manager, Nuclear Projects
Public Service of New Hampshire
P. O. Box 330
Manchester, New Hampshire 03105

Mr. John DeVincentis
Project Manager, Seabrook Station
Yankee Atomic Electric Company
1671 Worcester Road
Framingham, Massachusetts 01701

Ms. Diane Tefft
Manager
Radiological Health Program
Department of Health and Welfare
Hazen Drive
Concord, New Hampshire 03301

Mr. E. P. Wilkinson
President
Institute for Nuclear Power Operations
1100 Circle 75 Parkway
Suite 1500
Atlanta, Georgia 30339

U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT
Division of Quality Assurance, Safeguards, and Inspection Programs
Quality Assurance Branch

Report No.: 50-443/83-23
Docket No.: 50-443
Licensee: Public Service of New Hampshire
P. O. Box 330
Manchester, New Hampshire
Facility Name: Seabrook Station, Unit 1
Inspection At: Yankee Atomic Electric Company, Framingham, Massachusetts
United Engineers and Constructors, Inc., Philadelphia, Pennsylvania
Westinghouse Electric Corporation, Pittsburg, Pennsylvania
Alden Research Laboratory, Holden, Massachusetts
Bethlehem Steel Corporation, Bethlehem, Pennsylvania
Bingham-Willamette, Portland, Oregon
Brown Boveri Electric, Springhouse, Pennsylvania
ITT Barton, City of Industry, California
ITT Grinnell, Providence, Rhode Island
Mercury Company of Norwood, Brockton, Massachusetts
PX Engineering, Boston, Massachusetts
Veritrac (Tobar), Tempe, Arizona
York Electric Panel Control, York, Pennsylvania
Inspection Conducted: November 1-4, November 14-22, and November 28-December 21, 1983
Inspection Team Members:

Team Leader	E. C. Wenzinger, Sr. Quality Assurance Engineer, IE
Mechanical Systems	D. P. Norkin, Construction Engineer, IE
	D. B. Breaux, Reactor Engineer (Systems), Region IV
	R. M. Young, Nuclear Engineer, IE
Mechanical Components	A. V. duBouchet, Consultant, Harstead Engineering Assoc.
	W. P. Chen, Consultant, ETEC-Rockwell International
	S. A. Gula, Consultant, Harstead Engineering Assoc.
Civil and Structural	R. E. Shewmaker, Sr. Civil Engineer, IE
	K. E. Lipinski, Structural Engineer, NRR
	G. A. Harstead, Consultant, Harstead Engineering Assoc.
Electric Power	L. Ahmed, Electrical Engineer (Systems), NRR
	K. Weise, Consultant, Westec Services
	R. Paolino, Lead Reactor Engineer, Region I
Instrumentation & Controls	L. Stanley, Consultant, Zytor, Inc.
	C. J. Crane, Consultant, Westec Services
	G. S. Lewis, Inspection Specialist, IE
Observers	P. Evans, INPO; W. Choudhury, INPO*
NRC Seabrook Resident Inspector	A. C. Cerne, Region I*

*Part Time

for Edward C. Wenzinger, Team Leader, IE — 3/20/84 Date

Approved By: James L. Milhoan, Section Chief, Quality Assurance Branch — 3/20/84 Date

8405160109

TABLE OF CONTENTS

LIST OF FINDINGS, UNRESOLVED ITEMS AND OBSERVATIONS

Civil and Structural

Organization and Procedures

LIST OF ABBREVIATIONS

ANSI	- American National Standards Institute
ASME	- American Society of Mechanical Engineers
CFR	- Code of Federal Regulations
FSAR	- Final Safety Analysis Report
IEEE	- Institute of Electrical and Electronics Engineers
LOCA	- Loss of Coolant Accident
NPSH	- Net Positive Suction Head
NRC	- U.S. Nuclear Regulatory Commission
SD	- System Description
GEDP	- General Engineering Design Procedure
AP	- Administrative Procedure
DCN	- Design Change Notice

1. INTRODUCTION AND SUMMARY

1.1 Objectives

In August 1982 the staff of the U.S. Nuclear Regulatory Commission (NRC) undertook a number of initiatives to improve assurance of quality in design and construction of nuclear projects. One of those initiatives was to develop and implement an integrated design inspection program to assess the quality of design activities, including examination of the as-built configuration. The objective was to expand the NRC examination of quality assurance into the design process. The approach is intended to provide a comprehensive examination of the design development and implementation for a selected system.

This was the third inspection in that program. It had a dual objective -- evaluating the design process for the Seabrook Station and continuing development of the methodology for conducting future inspections. This report covers only the first objective, evaluating the design process based on examination of the containment building spray system.

1.2 Definitions

(1) Findings

In our evaluation we found many design actions that were being well executed. Some of these positive findings are described in the text of the following sections. They are not flagged and numbered in the text nor listed at the front of this report since followup is not required.

Negative findings are described in the text of the following sections. The negative findings are flagged and numbered in the text since followup action is required for licensee resolution and NRC evaluation of the resolutions.

The NRC's Region I Office is normally responsible for inspection of the Seabrook Station. However, due to the developmental nature of the Integrated Design Inspection, NRC management of follow-on actions resulting from this inspection will initially be handled by the Office of Inspection and Enforcement with assistance, as required, from the Region I Office.

Some of the items identified may form the bases for enforcement action. Any decision in this regard will be held in abeyance pending review of the reply to this inspection report.

(2) Unresolved Items

Unresolved items are questions for which the inspection team did not develop enough information to reach a conclusion. These items could become findings or be dropped from consideration, depending on the nature of further information. Unresolved items are described in the text of the following sections.

They are flagged and numbered since licensee response and NRC evaluation are required. As with the findings, the NRC followup will be managed by the Office of Inspection and Enforcement with assistance as required from other offices.

(3) Observations

The report contains a number of observations that are flagged and numbered. These represent cases where it is considered appropriate to call attention to matters that are not specific findings or unresolved items. They include items recommended for licensee consideration but for which there is no specific regulatory requirement.

1.3 Inspection Effort

The containment building spray system was selected for this inspection. This is a safety-related system designed by United Engineers. The components, functions and interfaces involved are typical of those found in a number of other safety systems.

The inspection was an interoffice NRC effort conducted with contractor assistance. Team members were selected to provide technical expertise and design experience in the disciplines listed. Many of the team members had previous experience as employees of architect-engineering firms or reactor manufacturers working on large commercial nuclear power plants. The others had related design experience on commercial nuclear facilities, test reactors or naval reactors.

A date of August 17, 1983 was established as the cut-off date for evaluation purposes and the team examined the design as it existed on that date. For example, if a document contained an error on August 17, that error formed the basis for a finding even if the document was later corrected. This policy has been adopted to ensure representativeness of the selected system. Public Service of New Hampshire was notified of the specific system to be inspected on that date. To ensure that subsequent "polishing" of the selected system does not impair NRC's ability to form conclusions about the entire design process, changes or additions to the design subsequent to August 17, 1983 were generally not considered. In some cases, more recent information which developed during the inspection was also reviewed to help understand the significance of an item. For instance, a subsequent analysis might show whether or not an error had any effect on the design. Where such information is used in this report it is described as more recent work done during the inspection.

Beginning on October 17, 1983 the inspection team devoted 2 weeks to the initial study of background information and preparation of plans for the inspection. The week of October 31 to November 4 was spent becoming more familiar with the project organization, inspecting at the Yankee Atomic engineering offices and gathering additional background material. The week of November 7 was spent completing study of background information and plans for the inspection. Approximately 5 weeks of direct inspection activities were conducted at Yankee Atomic, United Engineers, Westinghouse Electric Corporation, the Seabrook Station and ten subcontractors (equipment suppliers and companies providing design assistance), concluding on December 21, 1983.

The inspection team reviewed the organizations' staffing and procedures and interviewed personnel to determine the responsibilities of and the relationships among the entities involved in the design process. Primary emphasis was placed upon reviewing the adequacy of design details (or products) as a means of measuring how well the design process had functioned in the selected sampling area. In reviewing the design details the team focused on the following items:

(1) Validity of design inputs and assumptions

(2) Validity of design specifications

(3) Validity of analyses

(4) Identification of system interface requirements

(5) Potential indirect effects of changes

(6) Proper component classification

(7) Revision control

(8) Documentation control

(9) Verification of as-built condition

The team inspected five engineering disciplines within the project in addition to organization and procedures (see Section 7). The five disciplines were mechanical systems (see Section 2), mechanical components (see Section 3), civil and structural (see Section 4), electric power (see Section 5), and instrumentation and controls (see Section 6).

In some areas the sample was narrowed to include only a part of the containment building spray system. In other areas the sample was broadened into areas that were not related to the containment building spray system. More detailed descriptions of the review are provided in following sections of this report.

1.4 Major Conclusions

Although the inspection sampled a very small part of the design effort, the team did review hundreds of specific items. The findings and conclusions are described in subsequent sections of this report. The most significant items are summarized below.

In the mechanical systems area, there were deficiencies in the method used by United Engineers to calculate available net positive suction head (NPSH) for the containment building spray pump (Findings 2-4 through 2-7). In addition, there is uncertainty as to the pressure drop across the inner screen of the containment recirculation sump and its effect upon NPSH (Finding 2-12). There is also uncertainty as to the required NPSH identified by tests because the pump was not tested with the motor to be used at Seabrook (Finding 2-16), and United Engineers has not obtained test data establishing the torque capability of the Seabrook motor (Finding 2-18). The team independently calculated NPSH margin based on Findings 2-4 through 2-7, and determined that it may be less than required. Additional uncertainties are covered by Findings 2-12, 2-16, and 2-18.

The team also reviewed a Westinghouse calculation of NPSH for the residual heat removal pump, and found deficiencies similar to those for the containment building spray pump (Findings 2-8 and 2-9). Since both pumps draw from the containment recirculation sump, Findings 2-4 through 2-7 and 2-12 also apply to the residual heat removal pumps and need to be resolved to confirm there is adequate NPSH for those pumps. The team reviewed two NPSH calculations for the emergency feedwater pumps and found deficiencies with regard to the bases and validity of assumptions (Findings 2-10 and 2-11). Based on the number of deficiencies we found in NPSH calculations, involving three separate systems and two design organizations, there appears to be a systematic problem. Action needs to be taken to review NPSH calculations for other systems to determine if the designs are adequate and to determine the root cause of the deficiencies identified above.

We reviewed analyses of the effects of high and moderate energy line breaks and cracks upon essential systems and components, and were unable to obtain documented evidence of analyses for jet impingement, pipe whipping envelopes and moderate energy fluid spraying (Findings 2-19, 2-21, and 2-22). These findings were generic since they apply to all 100 Seabrook zones currently being reviewed by United Engineers. The design cannot be considered complete until the effects of the postulated breaks and cracks have been systematically examined and appropriate protection provided where needed.

In the mechanical components area the team found items of technical significance that could possibly necessitate significant additional efforts. Waterhammer loads, modeling procedures and documentation of assumptions should be addressed in needed piping reanalyses (Findings 3-12, 3-14, and 3-16). Rapid closure of containment isolation valves during operation of containment building spray pumps, considering the peak pressures that result, should be reviewed (Finding 3-11). The functional adequacy of the containment building spray pump under specified thermal transient loadings (Finding 3-22) should be confirmed. Bolted joints on the valves reviewed should be assessed to be sure that their structural integrity is assured (Finding 3-6).

In the civil-structural area three areas of concern were found which could possibly require significant effort on the part of the licensee and its contractors. The team found that the treatment of floor live loads is to not include them in load combinations which incorporate seismic loads. The team found this to be a violation of the basic structural design criteria approved for the plant (Findings 4-2 and 4-18). The classification of the structural elements of the tank farm structure with regard to seismic loads and tornado loads was found to be inconsistent within the project criteria (Findings 4-1 and 4-3) and there were also inconsistencies between the criteria and the design calculations (Finding 4-8). Encompassed in the application of criteria were instances of improper modeling of the tank farm structure for both the reinforced concrete portions and the structural steel portions (Findings 4-6 and 4-7). The team was concerned that no final load checking program exists on the project for the structural elements made of reinforced concrete (Observation 4-8). However, the team found an adequate program for final load checks for structural steel. Aside from these items the team found that the criteria defined in the FSAR had been integrated into project design documents and seemed to have been properly implemented. Design interfaces were numerous, but in the team's judgment were well defined and controlled in an adequate manner. Calculations were easy to follow and easily retrievable. The team also found that the controls were in place to integrate changes (into the original designs), whether from the field or the engineering office.

Our review in the electric power area disclosed a number of findings that involved noncompliance with FSAR commitments, specification and procedural requirements, inconsistencies and errors. We found that seismic and environmental qualification has not been satisfactorily demonstrated for a number of electric components as discussed in Findings 5-10 and 5-13 through 5-18, inclusive. From our review of the sample equipment, specifications, procedures and other documents, the design in the electrical areas appeared to be generally controlled.

Our inspection in the instrumentation and controls area concluded that an adequate set of procedures is in place to assure that the design can be controlled in a satisfactory manner. Nevertheless, based on six individual findings (6-12 to 6-17) the team concluded that portions of the present instrumentation and controls design may not be adequate. Sufficient independence of certain control circuits that are essential to the operation of three engineered safety features has not been demonstrated. This lack of independence results in failure to meet the Single Failure Criterion of IEEE Standard 279. One of the findings (6-13) concerns lack of automatic valve position control in violation of IEEE Standard 279 and General Design Criteria. In addition, we found that seismic and environmental qualification has not been satisfactorily demonstrated by vendors of Seabrook instrumentation and control equipment. In spite of procedures in effect at Yankee Atomic and United Engineers, these deficiencies have not been found by the current quality assurance program. If left uncorrected, the licensee will not have adequate assurance of the satisfactory operation of safety related systems. See Findings 6-7, 6-8, and 6-19 through 6-29.

The remainder of the findings in the instrumentation and control area were, except for conduit marking (Finding 6-30), the result of apparently isolated errors, inconsistencies, and omissions. We note that corrective action has already been taken in a number of cases based on our discussions with United Engineers personnel during and after the inspection.

This inspection was the first Integrated Design Inspection to include a significant number of subcontractors, ten in all. The most significant findings in this area involved qualification of instrumentation and control equipment and findings related to the adequacy of the containment building spray pump design with regard to NPSH and thermal transients. Except for these findings, the design process at the subcontractors, based on the samples examined, appeared to be controlled.

In summary, in the mechanical systems area, the team recommends a systematic review and corrective action program to assure that (1) pumps are provided with sufficient NPSH and (2) design work in the area of postulated failures of high and moderate energy lines is complete, adequate and controlled. In the instrumentation and control area a systematic review of control circuits that are essential to the operation of safety related systems should be performed to determine if other non-safety-related equipment, such as the current-to-pneumatic converters, could be the source of common cause failure of safety-related systems. In addition, the licensee should take appropriate action to assure that equipment supplied by vendors is adequately qualified. In other respects, the problems found in the Seabrook design appeared to be confined to specific issues that did not seem to cross discipline boundaries.

2. MECHANICAL SYSTEMS

The objective of this portion of the inspection was to evaluate the mechanical systems aspects of the design with emphasis on the exchange and control of interface information. The team reviewed the system design and a number of sample areas of work, which focused primarily upon the United Engineers Nuclear/Mechanical Engineering Department.

2.1 Design Information

This section summarizes the mechanical systems design information reviewed.

Design commitments to the NRC are contained in the FSAR and related correspondence submitted in support of the operating license application. The basic system design, design bases, functional requirements, failure analyses, and components data are described in these documents along with more general information, such as relevant accident analyses, high-energy line break analyses, and seismic requirements. These licensing commitments were prepared and submitted by Public Service of New Hampshire with considerable assistance from Yankee Atomic, United Engineers, and Westinghouse Electric Corporation. An area of emphasis in our inspection was to determine whether or not the actual design met the licensing commitments.

United Engineers is the designer for the containment building spray system, which includes design of the refueling water storage tank and containment recirculation sump and screen. (Westinghouse is responsible for some related instrumentation.) The refueling water storage tank and containment recirculation sump also provide water sources for the emergency core cooling system, which is designed by Westinghouse. In addition, several subcontractors are involved in designing components. For example, Bingham-Willamette has design responsibility for the containment building spray pump. These divisions of responsibility required a substantial amount of communications. One aim of our inspection was to evaluate the use of information which is the output from one organization and the input to another, e.g., United Engineers calculated containment water levels which are used by Westinghouse in the net positive suction head (NPSH) calculation for the residual heat removal pumps.

The Nuclear/Mechanical Engineering group at United Engineers has overall system responsibility for the containment building spray system. This group is responsible for the system description, piping and instrumentation diagrams, piping isometrics, various component procurements, and system calculations, e.g., on hydraulics, determination of sump flow velocities and refueling water storage tank capacity. The Nuclear/Mechanical Engineering group interacts internally with other groups such as Fluids Analysis and Structural Analysis in accomplishing these responsibilities. The governing standards for the containment building spray system are listed in SD-20, "System Design Description for Containment Building Spray System" (Reference 2.15). For purposes of this inspection, the most significant Regulatory Guides are 1.1 and 1.82 (References 2.1 and 2.13), which pertain to pump NPSH and sump design, respectively.

The mechanical systems review, as it pertained to the containment building spray system, focused on the Nuclear/Mechanical Engineering group. We also reviewed high and moderate energy pipe break analyses as they pertained to all systems under United Engineers responsibility. This work is being accomplished by the Failure Modes and Effects Analysis group, and involves considerable interactions with others, e.g., the Pipe Stress Analysis group.

United Engineers procedure GEDP-0033 (Reference 1.107) states the requirements for the originators of documents to solicit and resolve comments from others on the documents they have prepared. The responsible engineer for the document is required to designate which other design groups should review the document. It is then the responsibility of the responsible engineer to assure that all review comments from the other design groups are resolved. Appendix A to GEDP-0033 provides a format for documenting comment resolutions.

The inspection team reviewed several revisions to the System Description SD-20, "Containment Building Spray System." We reviewed 15 comment resolution forms, and determined that in 1 case (for Revision 6) the responsible engineer did not complete the form to indicate how the comments were resolved. The team also evaluated the file for the internal review which resulted in changes to System Description SD-3, "Main and Auxiliary Steam System", Revision 1 (References 3.54). We identified three examples where changes to Revision 1 (for inclusion in Revision 2) requested by the Electrical group were not implemented as requested. There was no documented record as to why the comments were not implemented as requested. For example, the Electrical group had requested that reference information on a manufacturer's pump performance curves be clarified by additional data. Instead, Revision 2 completely eliminated any reference to the performance curves. (Finding 2-1)

GEDP-0032 (Reference 1.106) states the requirements for using Design Change Notices to inform affected personnel of design changes and to give them an opportunity to evaluate the impact of the change on their areas of responsibility. Administrative Procedure No. 46 (Reference 1.118) provides details for implementing GEDP-0032 on the Seabrook project. Based on these requirements, the team reviewed Revisions 6 and 7 of the containment building spray system description, SD-20 (Reference 2.15), and identified 25 changes affecting the system design which are indicated in SD-20, Revision 7, but were not handled by the Design Change Notice process. These changes involved details on changing from the injection mode to the recirculation mode as well as revisions to design parameters, such as available and required pump net positive suction head, maximum calculated recirculation flow, spray additive tank usable volume and maximum temperature, and sump screen dimensions. In addition, the team reviewed SD-3, Revisions 0, 1, and 2 (References 3.53 through 3.55), and identified 19 changes made from Revision 0 to Revision 1 and 12 made from Revision 1 to Revision 2 for which Design Change Notices should have been originated, but were not. The most significant changes involved addition of equipment design data as the system design evolved. (Finding 2-2)

Revision 7 to the containment building spray system description, SD-20 (Reference 2.15) states that the containment building spray system is actuated by a high-high containment pressure signal (18 psig). Table 7.3-1 in the FSAR indicates that the system is actuated by high-high-high containment pressure. The team determined that revisions 5, 6, and 7 to SD-20 indicate changes from high-high to high-high-high and back to high-high. We discussed this with the responsible systems engineer, and determined that high-high-high represented 25.3 psig while high-high represented 18 psig. The 25.3 psig signal was eliminated, and there was confusion as to whether the 18 psig signal should be termed high-high or high-high-high. Action needs to be taken to resolve the inconsistency between the system description and the FSAR. (Finding 2-3).

It is noted that the change to high-high-high in Revision 7 to SD-20 was not handled by a Design Change Notice. AP-46 states that one of the functions of the Design Change Notice is to determine if the FSAR is affected by the change. The team considers that failure to use a Design Change Notice was a contributing factor to the above inconsistency. In addition, Finding 5-7 (Section 5.4) concerns the fact that a Design Change Notice, which changed a relaying scheme, did not reference the associated equipment specification and system description, as required by United Engineers procedure. These matters should be addressed in resolving Findings 2-2 and 2-3.

Finding 2-1 concerns the failure to provide documented evidence of how comments pertaining to system description revisions were resolved. In the case for SD-20 this is minor because the comments were in fact implemented as requested. However, for SD-3 since the comments were not implemented as requested and there is no record of how they were resolved, the comments were effectively nullified. Finding 2-2 concerns the failure to comply with Administrative Procedure 46 in using Design Change Notices as the method for providing justification and obtaining appropriate reviews and approval for technical design changes. We reviewed two revisions to SD-20 and three revisions to SD-3, and identified a significant number of design changes which did not have supporting Design Change Notices. Finding 2-3 is related to finding 2-2 in that it involved an inconsistency between the system description and the FSAR which would have been identified by United Engineers had a Design Change Notice been used to support revision 7 to SD-20.

Due to the significant number of cases we identified where the Design Change Notices were not used when required and since this problem applied to three different system description revisions and two different system descriptions, the team concluded that this problem is pervasive. Action needs to be taken to review other system descriptions to determine the scope of the problem and to identify the root cause.

The results of our review of the mechanical systems of the Seabrook design are described in subsequent sections.

2.2 System Design

The objective of this portion of the inspection was to evaluate the adequacy and control of basic containment building spray system design.

The team reviewed the basic containment building spray system design information contained in the FSAR, the system description and the piping and instrumentation diagrams for the containment building spray system and its interfacing systems.

Containment building spray is supplied by two automatically initiated, full-capacity safety trains. Each train is composed of a connection to the refueling water storage tank, a containment recirculation sump, pump, heat exchanger, spray header and nozzles, along with interconnecting piping, valves, and associated instrumentation and controls. The system will start and run without operator action when needed. High-high containment pressure is the initiating signal. The supply of borated water during the injection mode is from the refueling water storage tank and the spray additive tank. Automatic transfer functions are provided to switch the pumps' suctions to the containment recirculation sumps upon receipt of a low low water level signal from refueling water storage tank instrumentation.

The basic system design, as documented in the licensing submittals, had been previously reviewed and found acceptable by the NRC staff (Reference 1.76). In the areas reviewed during this inspection, acceptability of the basic design in accordance with regulatory guidance was generally confirmed. Two areas were identified, with respect to net positive suction head and sump screen design, where further work may be necessary to confirm acceptability of the design.

The team reviewed the determination of net positive suction head (NPSH) available for the containment building spray pumps. The major variables in calculating NPSH available are temperature of the water, static head of the water, containment pressure, and friction losses and other pressure drops due to piping, valves, reducers/increasers, bellmouths, and other fittings in the suction line to the pump. For the Seabrook containment building spray pump, the limiting NPSH condition is the recirculation mode, due to the increased water temperature (86°F vs. 280°F) and the fact that the sump is at a lower elevation (-26 feet) than the refueling water storage tank (+20.75 feet).

Regulatory Guide 1.1 (Reference 2.1), to which the licensee committed without exception in the FSAR for the containment building spray pumps states in the Discussion section: "It is important that the proper performance of emergency core cooling and containment heat removal systems be independent of calculated increases in containment pressure caused by postulated loss of coolant accidents in order to assure reliable operation under a variety of possible accident conditions .... Changes in NPSH for emergency core cooling and containment heat removal system pumps caused by increases in temperature of the pumped fluid under loss of coolant accident conditions can be accommodated without reliance on the calculated increase in containment pressure." The corresponding Regulatory Position (Section C) is as follows: "Emergency core cooling and containment heat removal systems should be designed so that adequate net positive suction head (NPSH) is provided to system pumps assuming maximum expected temperatures of pumped fluids and no increase in containment pressure from that present prior to postulated loss of coolant accidents." NRC Standard Review Plan 6.2.2, "Containment Heat Removal Systems", (Reference 2.41) clarifies Regulatory Guide 1.1 by stating that the NPSH analysis "should be based on the assumption that the containment pressure equals the vapor pressure of the sump water. This ensures that credit is not taken for containment pressurization during the transient."

The team reviewed United Engineers calculation 4.3.5.11, "Containment Spray Pump NPSH Calculations", (Reference 2.2), which concluded that 23.5 feet of NPSH is available at pump runout flow conditions of 3300 gpm. Section 6.2.2.3.d of the FSAR states that the pump requires an NPSH of 21 feet at 3300 gpm. This calculation makes the assumption that the sump water will be 212°F. The specification for the containment building spray pumps (Reference 2.3), section 3.1.2.1, states that the pumped fluid can range from 40 to 280° F. In fact, United Engineers letter SBU 13320 to Yankee Atomic Electric (Reference 2.4) recommended performing a thermal test covering a thermal transient over that range of temperature to ensure the adequacy of the various containment building spray pump components. Therefore, calculation 4.3.5.11 is inconsistent with Regulatory Guide 1.1 by not assuming the maximum expected temperature of pumped fluids. (Finding 2-4)

During the inspection, United Engineers performed calculation 4.3.5.10F, "CBS Hydraulic Analysis," (Reference 2.5), a new calculation of the NPSH available, which considered sump temperatures up to 260°F and assumed that containment pressure equaled the vapor pressure of the sump water, as indicated by Standard Review Plan 6.2.2. This calculation also increased the pressure drops due to friction losses. The result is a calculated NPSH of 21.68 feet at the maximum calculated runout flow of 3300 gpm (based on interpolation by the team of calculated values for 3260 and 3400 gpm). This new calculation indicates that NPSH available is 0.68 feet greater than NPSH required at the maximum calculated runout flow.

Calculation 4.3.5.11 (Reference 2.2) assumes a minimum water level in the sump of -23.33 ft., which represents a water level of 2 feet, 8 inches above the containment floor elevation (-26 feet) adjacent to the sump. The response to NRC question RAI 440.52 (6.3) states, in FSAR Amendment 48 (January 1983) that "there are drain lines equipped with strainers which permit a flow path between the reactor cavity and refueling canals to elevations above the water level in the rest of the containment. Should the strainers on these lines become blocked, an additional volume of 5760 cubic feet of water would be trapped. The resulting reduction of water height would be 5.76 inches." This height reduction has not been factored into the above referenced NPSH calculation. This is contrary to Standard Review Plan 6.2.2 (Reference 2.41) which states that "the quantity of water that may be trapped by the reactor cavity and the refueling canal should be factored into the calculation of the suction head." Calculation 4.3.22-F07 (Reference 2.6) was performed during the inspection, and determined the sump water level would be either -23.78 or -23.30 feet depending on whether credit is allowed for the entrapped water above the -26 feet elevation (5760 cubic feet). Calculation 4.3.5.10F was performed during the inspection, and assumes -23.29 feet without justifying the assumption that water could not be entrapped above the -26 feet elevation. After this was pointed out by the team, United Engineers performed Revision 2 to calculation 4.3.5.10F (Reference 2.7) and determined that the blockage of drain lines from the refueling canal would result in a reduction in NPSH available of 0.46 feet. (Finding 2-5)

Alden Research Laboratory performed tests on a Seabrook containment sump model to evaluate the inlet pressure head losses of the bellmouth entrance to the suction pipe. The inlet loss coefficients for both of the suction pipes were evaluated for a range of pipe Reynolds numbers. Alden observed in their report of the tests (Reference 2.8) that no significant changes of loss coefficient occurred within the wide range of Reynolds numbers tested. The average values of the loss coefficients for both of the pipe inlets was 0.37 with 50% sump screen blockage. The value of the loss coefficient includes losses due to screens and gratings. The tests also determined that the worst case loss coefficient was 0.53. United Engineers' NPSH calculations (References 2.2 and 2.5) assume the average loss coefficient (0.37) as opposed to the worst case observed in the tests (0.53) without providing any justification for using the average test result. This is contrary to GEDP-0005 (Reference 1.93), which states that "All assumptions should be noted with their justifications". (Finding 2-6)

The team considers it prudent to have used the most conservative value to ensure pump operation during worst case conditions. The effect upon calculation 4.3.5.11 of using an inlet loss coefficient of 0.53 (instead of the 0.37 value which was used) is to increase the pressure drop due to friction losses by 0.54 feet. This results in reduction of NPSH available by 0.54 feet.

Hydraulic model tests on a 1:4 scale model of the Seabrook containment sump, conducted by Alden, showed the existence of small amounts of swirl in the flow within the suction pipes when operating with partially blocked vertical sump screens. The effect of this swirl on the entrance loss and pipe friction loss and ultimately on the calculated available NPSH was indicated as a concern in Alden's report (Reference 2.8). An investigation of the effect of swirl on pipe friction losses was conducted by Alden. Alden's report (Reference 2.9) stated: "The effect of swirling flow on the friction loss is dependent on swirl intensity. For an average indicated swirl angle of 5 degrees (normally encountered in suction pipes due to inlet rotational flow), the increase in the frictional loss would be approximately 15% compared to that for non-swirling flow at the same Reynolds number. For a higher swirl angle, the increase in friction factor would be greater". The team found no documented evidence that this effect upon NPSH available had been evaluated by United Engineers. Failure to evaluate all factors affecting NPSH is contrary to the "Discussion" section of Regulatory Guide 1.82 (Reference 2.13), which states that "a significant consideration is the potential for degraded pump performance which could be caused by a number of factors, including NPSH." After this was identified by the team, United Engineers performed calculation 4.3.5.41F (Reference 2.10) which determined that the swirl flow effect results in the reduction of the NPSH available by 0.092 feet. (Finding 2-7).

The potential decrease in available NPSH associated with findings 2-4 through 2-7, inclusive, indicate that the NPSH available may be approximately 20.59 feet as opposed to a required NPSH of 21 feet (for the calculated maximum runout flow of 3300 gpm.) This 0.41 foot NPSH deficit does not include the effects of (1) 280°F sump water indicated in the pump specification vs. 260°F water on which the 20.59 feet is based, or (2) questions with respect to the adequacy of NPSH tests conducted by the pump manufacturer (See Section 2.3., Findings 2-16 and 2-18), or (3) questions with respect to the pressure drop across the sump screen caused by blockage due to insulation. (See Section 2.2., Finding 2-12) The team considers that these effects must be considered together with Findings 2-4 through 2-7 in evaluating whether there is adequate NPSH available. (Unresolved Item 2-1)

NPSH calculations for the containment building spray and residual heat removal pumps are similar because they have a common 16 inch suction line emerging from the sump; for both pumps the recirculation mode is the limiting NPSH case. The team reviewed the residual heat removal pump NPSH calculation because it offered a basis of comparison (Westinghouse performed the residual heat removal pump calculation and United Engineers the containment building spray pump calculation) and it involved interfaces between Westinghouse, United Engineers and Yankee Atomic.

The Alden work had been performed under a contract with Yankee Atomic. The results were apparently not made available to Westinghouse even though bellmouth loss coefficients and swirl flow affect residual heat removal pump NPSH, just as they do for the containment building spray pump. The Alden data is not reflected in Westinghouse calculation SD/SA-NAH-114 (Reference 2.11). The residual heat removal pump calculation assumes a bellmouth loss coeffient of 0.5 (without explaining the basis), which is more conservative than the 0.37 assumed in the containment building spray pump calculation and approximately equal to the 0.53 worst case value determined by Alden. The residual heat removal pump calculation assumes a minimum sump water level of -23 feet, which is less conservative than the -23.33 value in the containment building spray pump calculation (Reference 2.2). The residual heat removal pump calculation does not consider entrapped water above the -26 feet level, the effect of which had been calculated by United Engineers calculation 4.3.22-F07 (Reference 2.6). There is no documented evidence that the Westinghouse calculation considered the swirl flow effect identified by Alden Labs. The inconsistencies between the residual heat removal and containment building spray pumps NPSH calculations should be corrected. In that respect, Findings 2-4 through 2-7 should be evaluated for their applicability to the residual heat removal pump NPSH calculation. (Finding 2-8)

The FSAR is inconsistent with Westinghouse calculation SD/SA-NAH-114 in that FSAR Table 6.3-1 indicates that the NPSH available for the residual heat removal pumps is 20 feet, whereas the calculation indicates it is 22.3 feet. Also FSAR Table 6.3-1 is misleading by indicating that the NPSH required is 13.5 feet at 3800 gpm, which results in an NPSH margin of 6.5 feet. However, Westinghouse's calculated runout flow is 4691 gpm, in which case the NPSH required is 19.5 feet based on pump performance curves included with calculation SD/SA-NAH-114. Therefore, for the limiting design situation, the NPSH margin is actually 0.5 foot, based on the FSAR and the pump performance curves (Finding 2-9).

Based on calculations by United Engineers (References 2.7 and 2.10), the team estimated that the Westinghouse calculated NPSH should be approximately 21.4 feet to account for the correct water level and the swirl flow effect. However, the team is unable to conclude that there is adequate NPSH available for the residual heat removal pumps because of the discrepancy between the FSAR and calculation, the inconsistencies with the containment building spray pump NPSH calculation, the issue of sump screen pressure drop (see Section 2.2., Finding 2-12 and Unresolved Item 2-3), and the potential applicability of findings 2-4 through 2-7 to the residual heat removal pump NPSH calculation. All of these factors need to be evaluated to ensure there is adequate margin between required and available NPSH for the residual heat removal pumps. (Unresolved Item 2-2)

Due to the above identified concerns with NPSH calculations, the team selected for review an NPSH calculation for a system independent of the containment sump, the emergency feedwater system. Calculation 737-05 dated 2/29/74 (Reference 2.39) determined that the minimum NPSH available was 27.6 feet. The team reviewed the calculation and found that the temperature of the feed-water is assumed to be 60°F, whereas FSAR Table 6.8-1 indicates it can reach 100°F. The temperature difference equates to a vapor pressure increase and corresponding NPSH decrease of about 2.5 feet. The length of pipe and the specific fittings assumed in the calculation do not represent the latest design. For example, reducers, branching tees, and elbows are omitted from the calculation. The minimum water level in the condensate storage tank is indi-cated as 2.5 feet below the pump suction centerline, for purposes of calculating static head. There is no justification for this assumption in the calculation (Finding 2-10).

During the inspection, United Engineers completed calculation 737-15 (Reference 2.12), which superseded calculation 737-05. Calculation 737-15 improved upon 737-05 with respect to accuracy by assuming a feedwater temperature of 104°F and by accounting for friction losses representative of all fittings and piping in the emergency feedwater system (the latest calculation increased the equivalent length of piping from 233 to 539 feet). Calculation 737-15 changed the minimum water level in the condensate storage tank to 4.6667 feet below the pump suction centerline, but, as in the case of the earlier calculation, did not justify the basis for the assumed water level. (Finding 2-11)

In summary, we found that calculation 737-05 on emergency feedwater pump NPSH did not reflect the actual design, and it was contrary to United Engineers procedure GEDP-0005 by not justifying the assumed water level. Calculation 737-15 changed the assumed water level, but also did not justify the assumption or the reason for the change. The later calculation (737-15) lowered available NPSH to the emergency feedwater pump from 27.6 to 23.24 feet. However, this has minimal technical impact since both values are well in excess of the actual required NPSH (17 feet) indicated in SD-1, "System Design Description for Condensate, Feedwater and Heater Drain System," (Reference 2.40).

The team reviewed the containment sump design with respect to its effect on NPSH available to the containment building spray pump. The containment recirculation sumps are designed to limit the amount of insoluble corrosion products and debris in the recirculated spray solution. Heavy particles are prevented from reaching the sumps by sloping the surrounding floor away from the sumps. A vertical trash rack around the periphery of the sump protects a fine inner screen from large floating particles. A horizontal missile shield is provided on top of the sumps. A fine inner vertical screen is designed to exclude particles which could potentially plug the spray nozzles. A significant consideration is the potential for diminished NPSH available to the residual heat removal and containment building spray system pumps due to increased pressure drop across the inner screen as a result of blockage caused by debris. The source of this debris is primarily thermal insulation on primary and secondary system piping, the reactor pressure vessel, steam generators, the pressurizer, and reactor coolant pumps. All of these components, which can become targets of jet impingement from high energy line breaks, are of importance in assessing debris generation. If the sump location can be directly targeted by an expanding jet, insulation may be "promptly" transported to the sump. Other debris may be transported in a "long-term" mode depending on the characteristics of the insulation, e.g., fibrous or reflective metallic, flow path to the sump and the flow velocity at the sump screen.

Regulatory Guide 1.82 (Reference 2.13), to which the licensee committed without exception in the FSAR, states that, at a recommended design coolant velocity at the inner screens of 0.2 ft/sec, debris with a specific gravity of 1.05 or more will settle to the floor level before reaching the screen surface. Therefore, a negligible pressure drop across the screen would be expected at this velocity. Regulatory Position C.7 of Reg. Guide 1.82 states, in part, "The design coolant velocity at the inner screen should be approximately 6 cm/sec (0.2 ft/sec). The available surface area used in determining the design coolant velocity should be based on one-half of the free surface area of the fine inner screen to conservatively account for partial blockage."

United Engineers calculation CI-2, page 15, (Reference 2.14) assumes a total pump capacity of 7800 gpm (1 residual heat removal pump plus 1 containment building spray pump). With 50% screen blockage, the inner screen area available for flow is 49 ft^2. The velocity through the 50% blocked screen was calculated as a function of these two parameters, and the result was 0.36 ft/sec. The calculation also indicates that, when the screen is not blocked, the screen area doubles and hence the velocity is halved, i.e., 0.18 ft/sec. This (0.18 ft/sec) is termed the "approach velocity" (as indicated below, United Engineers determined after the inspection that this is not a correct calculation of "approach velocity".) The team was informed by United Engineers that this calculated parameter is the basis for statements in both the FSAR (Section 6.2.2.2.j) and the system description, SD-20 (Reference 2.15) that the sump flow velocity complies with Regulatory Guide 1.82. The system description was changed from revision 5 to revision 6 to substitute "approach" velocity for velocity "through the screens". Design Change Notice 68/168 (Reference 2.59) provided approval for the change. In addition, the question of whether the velocity "approaching" the screen or "through" the screen should be the basis for Regulatory Guide 1.82 compliance was raised at a conference between United Engineers, Westinghouse, and Yankee Atomic on September 27, 1978. The conference report (Reference 2.16) indicated that the velocity limit in Regulatory

Guide 1.82 should be interpreted as "approach" velocity to the screens since the intent of limiting the velocity is to permit debris to settle out before reaching the inner screens. Most of this settling should occur at a reasonable distance from the fine screens, and therefore it is logical that the "approach" velocity and not the velocity "at" the screens is critical. The conference report also indicated that tests by Alden labs would confirm that debris would not deposit on the inner screens based on an "approach" velocity of 0.2 ft/sec. The team found no evidence that these tests were ever conducted.

A United Engineers memorandum produced after the inspection dated 1/18/84 (Reference 2.42), states that the calculated number for approach velocity, 0.18 ft/sec, was in error. The 0.18 number represented a flow velocity through the unblocked screen openings and not an approaching velocity. At the time of our inspection there was no documented evidence that the coolant velocity at the sump inner screen complied with the recommended velocity in Regulatory Guide 1.82, i.e., 0.2 ft/sec. (Finding 2-12)

The approach velocity reflected in the FSAR and system description is inappropriate for demonstrating compliance with Regulatory Guide 1.82 because it does not consider 50% blockage of the screen. The 1/18/84 United Engineers memorandum provides a new approach velocity of 0.214 ft/sec, which is also inappropriate because it includes screen material as part of the free flow screen area. Based on Regulatory Guide 1.82, the team consider the aforementioned 0.36 ft/sec value calculated by United Engineers (calculation CI-2-reference 2.14) to be the most valid indicator of potential deposit of debris on the screen, because it is the only calculation provided by United Engineers which addresses the free flow area of a 50% blocked screen. In resolving Finding 2-12, if it is determined that the 0.2 ft/sec design coolant velocity at the inner screen recommended by Regulatory Guide 1.82 is exceeded, then evaluations need to be made of the resultant pressure drop across the screen and the ultimate effect on NPSH for all affected pumps (Unresolved Item 2-3).

A proposed revision to Regulatory Guide 1.82, addressed by NUREGs 0869 and 0897 (References 2.17 and 2.18), has received public comment and revisions are currently undergoing staff review. The Regulatory Guide 1.82 proposed revision recognizes that debris assessments must be plant specific based on types, location, and quantities of insulation used, postulated high energy pipe breaks, the estimation of quantities of debris generated by postulated high energy pipe breaks, and the migration of such debris to the sump screen.

Alden's report on the sump study (Reference 2.8) cites an article in the literature titled, "The Prevention of Vortices and Swirl at Intakes", (Reference 2.37), which states that air concentrations in pump suction pipes as low as 3 to 5% can lower pump efficiency considerably. Alden Labs testing of the sump found, during their tests, that considerable quantities of air were caught underneath the top cover of the sump while the sump was filled. Alden recommended that holes be drilled in the top cover to vent the entrained air. We found no documented evidence that United Engineers has evaluated this potential problem. RG 1.82 (Reference 2.13) states that a significant consideration with respect to the sump is degraded pump performance. Failure to evaluate all potential problems, including entrained air, affecting pumps suctioning from the sump, i.e., containment building spray and residual heat removal pumps, is inconsistent with RG 1.82. (Finding 2-13)

After the entrained air problem was identified by the team, the United Engineers Nuclear group wrote an internal memorandum to the United Engineers Power Engineering group (Reference 2.38) which requested that action be initiated to add 1/8 inch diameter holes on three inch centers (providing equal venting area per square foot) to the sump cover plates and walkways. The holes are to be uniformly spaced to cover the entire surface area with at least 16 holes per square foot. We consider that Finding 2-13 has no further technical significance since action has been taken to evaluate the potential problem and implement a design change. We found no other similar examples to indicate this is a pervasive design control problem.

The refueling water storage tank is designed to supply water for refueling operations, and to the containment building spray and residual heat removal systems. The containment building spray system and residual heat removal system have two phases of operation, injection and recirculation. For the recirculation phase, the containment building spray and residual heat removal pumps are automatically switched from the refueling water storage tank to the containment recirculation sump when a predetermined low low water level in the tank is reached.

On September 28, 1978, the Region I Office of the NRC was informed by Yankee Atomic of a design deficiency associated with the refueling water storage tank involving an undersizing of the tank. The undersizing was discovered in a routine design review of the NPSH for the containment building spray and residual heat removal pumps. The design review verified proper NPSH, but also showed that there did not appear to be sufficient water in the refueling water storage tank to complete the transfer of pump suctions from the refueling water storage tank to the containment sump before the refueling water storage tank was emptied. Refueling water storage tank capacity is based upon ensuring that 350,000 gallons of borated water will be available for injection by containment building spray and residual heat removal pumps, and that there is sufficient margin to ensure that these pumps can be switched to the containment sump prior to reaching the water level in the refueling water storage tank at which vortexing and consequential air entrainment by the pump occurs. The 375,000 gallon design submitted in the Preliminary Safety Analysis Report was judged not to provide sufficient capacity to account for all factors affecting this margin. The refueling water storage tank was re-designed such that its storage capacity was increased from 375,000 gallons to 475,000 gallons, and a proportional size increase was made to the spray additive tank. This larger size proved adequate for all design considerations and left margin for possible future changes. Based on the sample reviewed, the team found that the refueling water storage tank re-design appeared to have been implemented satisfactorily on the design drawings.

The team reviewed United Engineers Calculation 4.3.5.30, Revision 0, (Reference 2.44), which established the refueling water storage tank volume allowances and associated alarm setpoints for tank water levels. The setpoints provide for alarm actuation when, because of changes in the water level, certain volume allowances are approached or expended. We found examples where the calculation did not provide justification for assumptions, which is contrary to United Engineers procedure GEDP 0005 (Reference 1.93). These assumptions are the refueling water storage tank vortexing level, working allowance, alarm separation allowance, transfer allowance, and a shutoff allowance to allow the pumps to shutoff if the transfer is not made before reaching the vortex level. Calculation 4.3.5.30 (Rev. 0) indicates a 2.07 inch allowance for temperature changes, but does not indicate how the total working allowance of 4 inches, to account for evaporation, was determined. In addition, a transfer allowance of 27.5 inches is indicated to account for actions to switch residual heat removal and containment building spray pumps to the sump before the vortex level in the refueling water storage tank is reached. However, there is no calculation to confirm the assumed vortex level (72 inches) or that this transfer allowance is adequate. (Finding 2-14).

During the inspection United Engineers performed calculations which demonstrated that there is adequate volume in the refueling water storage tank to carry out all required operations. A memorandum dated August 24, 1983 (Reference 2.43) and calculation 4.3.5.37F dated November 4, 1983 (Reference 2.46) demonstrate, respectively, the levels at which vortexing will occur in the refueling water storage tank and that vortexing in the refueling water storage tank will not occur before the operator can complete his actions to switch the pumps to the sump. The team reviewed the calculations and determined they provided adequate technical support for their conclusions. Revision 2 to Calculation 4.3.5.30 dated October 20, 1983 (Reference 2.45) concerning set points for the refueling water storage tank is more comprehensive and inclusive than revision 0. Revision 2 reflects a change in the refueling water storage tank and spray additive tank level monitoring by incorporating temperature compensation, which allows the setpoints for upper tank water levels to "slide" as a function of temperature, while the error band about any particular setpoint remains constant. This precludes the need to have a fixed allowance to account for temperature changes. To enhance instrumentation accuracy, this design change includes a standpipe in conjunction with narrow range instruments for monitoring the setpoints for tank upper water levels. This instrumentation includes a level transmitter attached to the standpipe and a thermocouple located at the base of the tank. These design changes are covered in Design Change Notice 65/205 (Reference 2.47).

The working allowance (to account for temperature changes) calculated in United Engineers calculation 4.3.5.30, Rev. 0, determines the thermal expansion of the refueling water storage tank inventory (475,000 gallons) when the temperature changes from 50°F to 86°F. This temperature variation translates into a tank water level change of 2.07 inches according to the calculation. Section 6.3.2.8 of the Seabrook FSAR states that a temperature change from 90°F to 40°F will lower the tank water level by about 2.4 inches. Based on the equation for working allowance in calculation 4.3.5.30, Rev. 0, the team calculated a water level change of 2.88 inches for the 50° temperature difference indicated in the FSAR, as opposed to the 2.4" value stated in the FSAR. The United Engineers systems engineer agreed that the FSAR was in error. (Finding 2-15)

In summary the team found numerous deficiencies with respect to the manner in which available NPSH was calculated by United Engineers for the containment building spray pump. Finding 2-4 concerns the fact that the calculation did not assume the maximum expected temperature of pumped fluids, as required by Regulatory Guide 1.1 and Standard Review Plan 6.2.2. Finding 2-5 concerns the fact that the static head assumed in the calculation did not factor in all volumes of water which could potentially be trapped and precluded from flowing to the sump. Finding 2-6 concerns the fact that the assumed inlet loss coefficient for the bellmouth entrance to the sump suction pipe was based on the average of test results. We found no documented basis for using the average loss coefficient as opposed to the worst case observed in the tests. Finding 2-7 concerns the fact that there was no documented evaluation of the effect upon NPSH of pressure drops due to a swirl flow effect, which had been identified in Seabrook sump model tests. Finding 2-12 concerns the fact that United Engineers has not provided confirmation that the inner screen design for the containment recirculation sump can comply with Regulatory Guide 1.82 by limiting the design coolant velocity at the inner screen to approximately 0.2 ft/sec. The calculation provided the team indicates the design coolant velocity at the inner screen for Seabrook may exceed 0.2 ft/sec, in which case an evaluation of the increased pressure drop and effect upon NPSH is necessary.

Findings 2-4 through 2-7 and 2-12 need to be considered together to properly calculate available NPSH for the containment building spray pump. Based on calculations developed by United Engineers during the inspection and the team's independent calculations, it appears that there may be insufficient margin between available and required NPSH. In addition, Findings 2-16 and 2-18 in Section 2.3 raise questions as to the adequacy of tests conducted by the pump manufacturer to determine required NPSH. These latter findings must be addressed with those affecting available NPSH to determine whether the available NPSH is adequate.

Due to the problems found in calculating NPSH for the containment building spray pump, the team reviewed two other NPSH calculations for Seabrook, one performed by Westinghouse for the residual heat removal pump and the other by United Engineers for the emergency feedwater pumps. Finding 2-8 concerns the fact that the residual heat removal pump calculation assumed a water level which was inconsistent with water levels calculated by United Engineers, and provided no documented evidence that consideration was given to the swirl flow effect identified in the sump model tests (see Finding 2-7). Finding 2-9 concerns the fact that the available NPSH for the residual heat removal pump indicated in the FSAR is inconsistent with that in the Westinghouse calculation. As in the case of the containment building spray pump, available NPSH is affected by pressure drop across the inner sump screen which needs to be evaluated based on Finding 2-12 with respect to design coolant velocity. The uncertainties discussed in Findings 2-8, 2-9, and 2-12 indicate that available NPSH may be lower than calculated by Westinghouse. The team considers that all of these factors need to be evaluated together to confirm there is adequate NPSH. Findings 2-10 and 2-11 concern the fact that the emergency feedwater pump NPSH calculations did not reflect the correct water temperature and arrangement of piping and fittings and did not justify the assumed water level.

However, we concluded there was adequate NPSH margin for the emergency feedwater pump.

Findings 2-4 through 2-12 indicate deficiencies for NPSH calculations pertinent to three different Seabrook pumps, one under Westinghouse cognizance and two under United Engineers cognizance. This is indicative of a systematic trend for the project as a whole, and we therefore consider that action is required to review pump NPSH calculations for other systems to determine if the designs are adequate and to identify the root cause of the deficiencies covered by Findings 2-4 through 2-12.

Finding 2-13 concerns the failure of United Engineers to evaluate a potential problem identified during sump model tests, that of pump intake of air entrained just underneath the sump top cover. Findings 2-14 and 2-15 concern the failure to justify the basis for assumed volume allowances in the set point calculation for the refueling water storage tank and an incorrect volume allowance for temperature changes stated in the FSAR. We did not review similar calculations for other systems. However, Finding 2-14 is consistent with Findings 2-5, 2-6, 2-10, and 2-11 with respect to the failure to justify assumptions in calculations. Action needs to be taken to review other systems to determine whether this weakness is pervasive and to identify the root cause.

2.3 Equipment

The team performed a multi-discipline review of the pump procurement. See Section 3-2 for results of the Mechanical Components review and Section 5-3 for results of the Electrical Power Systems review. In addition, two team members from the Mechanical Systems and the Mechanical Components disciplines visited the containment building spray pump supplier, Bingham-Willamette, and inspected activities there.

A letter dated June 26, 1974 from Public Service Company of New Hampshire, SM-603 (Reference 2.19) indicates that United Engineers had initially recommended purchase of the containment building spray pumps from Ingersoll-Rand and then switched to the less expensive Bingham-Willamette pump. The Bingham pumps were not originally evaluated because of unacceptable NPSH requirements. A larger flow requirement for the residual heat removal pumps resulted in an increased pipe size from the containment sump, which increased the available NPSH to the containment building spray pumps sufficiently to satisfy the pump NPSH requirement for the Bingham-Willamette pumps (22 feet required NPSH vs. 23.5 available NPSH, based on Public Service letter SM-603). The narrow NPSH margin indicated in Public Service letter SM-603 is significant with respect to the findings in Section 2.2 on available NPSH for the containment building spray pump, as well as to Finding 2-16 on the performance test which established the required NPSH.

United Engineers letter SBU-57133 (Reference 2.20) to Bingham-Willamette states that the seal cooler had originally been hydro-tested using the incorrect shell side design pressure, and as a result the coolers were being retested. The problem occurred because the United Engineers procurement specification, 9763-006-238-3 (Reference 2.3) originally did not specify the design temperature and pressure for the cooling water pressure boundary. Bingham-Willamette performed the hydro-test at room temperature and 45 psia, in the absence of any specified parameters. Revision 6 (9/1/82) to the pump specification added paragraph 3.1.3 which states that the cooling water pressure boundary shall have a design temperature and pressure of 200°F and 150 psig respectively. The seal coolers were successfully retested at these values (see Section 3.2, Finding 3-4). The team considers that this is a problem that was identified and corrected by United Engineers. However, United Engineers should determine why this specification oversight was not identified either in reviewing the specification or the hydro-test procedure, rather than after the initial test was conducted (Observation 2-1).

Bingham-Willamette's seismic analysis (Reference 2.22)) calculates overturning moments and shears for support loads, as required by Section 3.5.2 of the United Engineer's pump procurement specification (Reference 2.3) and indicates that required bolt areas are acceptable. The seismic analysis also includes calculations, as required by Section 3.2.3.2 of the procurement specification to confirm that the bearings, shaft, couplings, and impeller will remain operational during the Operational Basis Earthquake and the Safe Shutdown Earthquake. In these cases, Bingham-Willamette analyses provided design confirmation as required by the procurement specification.

United Engineers letter dated February 17, 1983 to Bingham-Willamette (Reference 2.24) increased the nozzle loads on the pump as a result of a revised piping analysis due to a seismic input change. Bingham-Willamette letter dated 4/26/83 (Reference 2.23) informed United Engineers that it was not possible for Bingham-Willamette to accept the increase in nozzle loads without revising the seismic analysis and design calculations. After the inspection, United Engineers revised the nozzle loads to ensure they remain within the envelope of the existing seismic analysis, and sent a letter, SBU-83667 dated 1/31/84 (Reference 2.60), to Bingham-Willamette confirming this.

Section 5.2 of United Engineers specification 9763-006-238-3 (Reference 2.3) states that the containment building spray pumps are required to be tested for balance, operation and performance in accordance with Hydraulic Institute Standard for Rotary, Reciprocating and Centrifugal Pumps (reference 2.61). Data is required to be furnished showing horsepower, efficiency, head capacity and NPSH required for flows ranging from shutoff to runout. The specification states "each pump shall be individually tested in the as-built configuration. Any modification to test configuration must be approved by the Purchaser." Contrary to this requirement, tests on containment building spray pumps 14210479 and 14210480 were performed by using motor HM-21 (a motor used for testing at Bingham-Willamette) instead of the as-built Seabrook motor (supplied by Westinghouse) which drives the pump in actual plant operation. There is no record of this modification to the test configuration indicated in the specification having been reviewed or approved by United Engineers (Finding 2-16).

The team considers that testing with the as-built motor would provide greater confidence in the test results. The alternative used by Bingham-Willamette may have been acceptable. A documented evaluation of this alternative and its effect on the tests would provide a basis for determining if it were acceptable. Even though the motor used in the test was the same rated horsepower (600 hp) as the as-built motor, any slight difference in NPSH test data caused by switching motors is of concern due to the questions in NPSH margin raised by Findings 2-4 through 2-7 and 2-12. These matters should be addressed in resolving Finding 2-16.

United Engineers specification 9763-006-128-1 (Reference 2.26) was used by Bingham-Willamette as the procurement specification for the 600 horsepower motors supplied by Westinghouse to drive the containment building spray pumps. Section 3.2.12 of this specification provides seismic criteria for the motor and states motor design capabilities which must be shown to be qualified by testing and/or analysis. These specifically include motor shaft deflection, motor bearing overload, stress in the motor mounting flange or support, stress in the stator end turn insulation support system, and stress in bolts used for anchoring, assembly, bearing brackets and other vital services. With one exception the team found these requirements were addressed either in Bingham's seismic analysis (Reference 2.22) or Westinghouse's seismic analysis (Reference 2.27). There is no evidence, however, of qualification for stress in the stator end turn insulation support system. The design of the motor cannot be considered complete until this qualification is performed. The team considers that this omission should have been identified by both Bingham-Willamette and United Engineers in their reviews of the seismic analysis of the motor. The failure to identify this omission should be addressed in resolving the finding. (Finding 2-17)

FSAR Section 8 3.1.1.i (page 8.3-22) states that motor suppliers are required to verify that actual test data confirms that the torque margin is equal to or greater than that of calculated data. Foreign print 51849-02-238-3 (Reference 2.28) provides calculated data on motor torque which are indicated as "not guaranteed". Westinghouse provided test data (Reference 2.29) on the motor, but the test was performed at no load conditions. Neither Bingham-Willamette nor United Engineers had test data in hand for loaded conditions to verify that the torque margin is equal to or greater than the calculated data (Finding 2-18).

In resolving Finding 2-18, consideration should be given to the relation to Finding 2-16 in that the NPSH required was established by a test not using the as-built motor and that neither Bingham-Willamette nor United Engineers has confirmation that the as-built motor will supply the required torque. A determination should be made as to why the omission of test data was not identified in quality assurance reviews by United Engineers and Bingham-Willamette. (Observation 2-2)

The team reviewed one component procurement, the containment building spray pump. Our findings therefore pertain to this specific pump rather than pumps in general. Finding 2-16 concerns the fact that the pump performance tests were conducted using a test motor rather than the as-built motor for Seabrook, as required by specification. Although the specification required any deviation from this as-built requirement to be approved by United Engineers, there is no documented evidence of review or approval by United Engineers of the deviation. Finding 2-18 concerns the fact that neither the pump supplier (Bingham-Willamette) nor United Engineers has motor test data in hand for loaded conditions to verify that the motor torque margin is equal to or greater than calculated data. Findings 2-16 and 2-18 are related because they indicate that the required NPSH was established by a test not using the Seabrook motor, and that the motor supplier has not provided confirmation that the Seabrook motor will supply the required torque. Finding 2-17 concerns the fact that there is no documented evidence of seismic qualification for stress in the stator end turn insulation support system. Findings 2-17 and 2-18 both indicate the failure of technical and quality assurance reviews by United Engineers and Bingham-Willamette to identify omission of technical data required to be provided by their suppliers. Finding 2-16 through 2-18 are significant because they need to be resolved to confirm that the pump and motor designs are adequate. In addition, Findings 2-16 and 2-18 could affect a determination as to whether there is adequate available NPSH for the pump (see Section 2.2).

2.4 High and Moderate Energy Pipe Break/Crack Analysis

The team reviewed analyses for postulated breaks in high energy fluid piping and postulated cracks in moderate energy fluid piping. This review sampled the failure modes and effects analyses under United Engineers responsibility, which involves 100 definitive zones in the Seabrook plant covering systems in addition to the containment building spray system.

Section 3.6(B) of the FSAR commits to requirements in NRC Branch Technical Positions ASB 3-1 and MEB 3-1, which are enclosures to Standard Review Plan Sections 3.6.1 and 3.6.2 respectively. Standard Review Plan Sections 3.6.1 and 3.6.2 (References 2.30 and 2.31) state that the criteria for defining high energy piping are that maximum operating temperature exceeds 200°F or maximum operating pressure exceeds 275 psig. If both of these conditions are not met, or if the system exceeds either of the above parameters only about 2% of the time (or less), then the system is classified as moderate energy. The design criteria stated in FSAR Section 3.6(B) for protection against piping failures include physical separation of the piping system from essential systems and components either by distance or by enclosure of one of the two. Where neither of these are practical, the FSAR states that pipe whip restraints are used. Measures for protection against pipe whipping or jet impingement resulting from postulated high energy pipe breaks are not provided, according to the FSAR, where the broken pipe cannot cause unacceptable damage to any essential system or component.

Section 3.6(B).1.3 of the FSAR states that a summary of the results of failure or leakage from high or moderate energy lines on nearby safety systems (failure modes and effects analysis), presented in Appendix 3A to the FSAR, verifies that the consequences of failures of high and moderate energy lines will not affect the ability of the plant to be shutdown safely. The team reviewed the technical support for these conclusions. The results of our review are presented below.

Section 3.6(B).2.1.d of the FSAR states that Appendix 3C provides criteria used to evaluate jet impingement loads from high energy piping failures. After jet forces imposed on structures or equipment have been determined, the capacity of the structures or equipment to support these loads without damage is investigated. Appendix 3C states that determination of jet impingement loads on safety related structures requires the following prerequisite information: (a) composite drawings of high energy piping and safety related targets, (b) locations and types of postulated high energy pipe breaks, and (c) state of high energy piping fluid, fluid pressure and pipe size. Detailed criteria are given for calculating blowdown forces, full jet impingement load, jet impingement pressure, jet impingement area and jet impingement envelope.

UE&C Procedure TP-3 (Reference 2.32) discusses considerations in evaluating effects of failed pipes, and states that potential damage from developed jets must be evaluated in every case unless specific justification exists that would allow elimination of jet reaction analysis. The FSAR Appendix 3C criteria provide an adequate method for this, such as by composite drawings showing piping, targets, and jet impingement areas and envelopes. However, the team found no documented evidence that potential damage from developed jets was evaluated, nor any documented justification for not performing the work. (Finding 2-19)

Periodic status reports of failure modes and effects analysis work (Reference 2.62) indicate that performing the jet impingement analyses is at this time recognized by United Engineers as high priority. The schedule for failure modes and effects analysis activities (Reference 2.63) indicates that 65 of 100 piping zones were to have been completely analyzed, approved by management, and reported by 11/23/83 to support an original commercial operation date of 3/84. None of the 100 zones were analyzed, approved, and reported as of 12/19/83. Slippage of the schedule for commercial operation has relieved this problem somewhat; nonethless the team considers it a poor practice to conduct jet impingement analyses as well as other piping failure analyses at this late date. The design cannot be considered complete until the work has been done to locate those instances where jets might damage essential equipment and to protect the equipment as needed in accordance with the licensing commitments. (Unresolved Item 2-4)

The team determined that the Failure Modes and Effects Analysis group had documented analyses of two piping zones, 32A and B, in the Primary Auxiliary Building (References 2.33 and 2.34). Although the technical work has been completed for these zones, a report will not be formally issued until completion of management reviews. Although the draft reports reflect no evidence of jet impingement envelope analysis, as required by FSAR Appendix 3C and United Engineers procedure TP-3, statements are made in the reports on Zones 32A and B with respect to the effect of jet impingement on nearby piping. In five cases, statements are made that the jet from a pipe break will impinge upon a pipe larger than the failed pipe, and therefore no adverse effect is created. Contrary to the requirements of United Engineers procedure GEDP 0005 (Reference 1.93), the team found no evidence of a technical evaluation to establish a basis for this assertion. Such a technical basis would have to consider blowdown forces, distance to targets, wall thickness of the impacted pipe(s), and jet envelopes caused by pipe motion. (Finding 2-20)

Standard Review Plan 3.6.2 (Reference 2.31) states that an unrestrained whipping pipe should be considered capable of breaking smaller pipes which it impacts and developing through-wall cracks in equal or larger pipes with thinner walls. It is possible that this concept for whipping pipes may have been misinterpreted by United Engineers to encompass jet impingement as well, i.e., if a whipping pipe cannot break a larger pipe, then a jet from the same pipe can not damage a larger pipe. The team considers it incorrect to make this extrapolation without an adequate technical basis. We brought this to the attention of the responsible manager, who agreed with the finding and took action to correct the reports. This appears to be a pervasive problem because we identified five examples which were apparently indicative of a misinterpretation within the Failure Modes and Effects Analysis activity.

The FSAR states in Section 3.6(B).1.1 that measures for protection against pipe whipping are not provided when the broken pipe cannot cause unacceptable damage. Appendix 3A summarizes the results of analyses for the effects of pipe whip. United Engineers procedure TP-3 (Reference 2.32) states that unrestrained whipping pipes should be considered capable of causing loss of function of electrical or instrumentation systems or components within the limits of the whipping pipe envelope.

We reviewed technical support data for the conclusions in FSAR Appendix 3A on piping zones 32A and 32B. The pipe break computation sheets (References 2.35 and 2.36) state that equipment (including electrical and instrumentation systems) is protected from specific line breaks by either distance or a barrier. There is no indication of the distance or the basis for how the distance was determined to be adequate. We found no documented evidence of any evaluations of pipe whip envelopes. This is contrary to United Engineers procedure TP-3 which states that "Documentation of these required analyses must be clear, complete, signed, and dated, so that an independent review can be performed. The team considers that the design cannot be considered complete with respect to protection against pipe whip until there are adequately documented evaluations of potential damage to essential equipment within pipe whip envelopes. (Finding 2-21)

Section 3.6(B).2.1.b of the FSAR states that through wall leakage cracks are postulated to occur in moderate energy piping, except where the maximum stress range in class 2 or 3 piping is less than 0.4 $(1.2\ S_h + S_A)$, and that the cracks were postulated to occur in those locations that result in the maximum effects from spraying or flooding. United Engineers procedure TP-3 (Reference 2.32) requires that through-wall leakage cracks be postulated in moderate energy piping, that components/systems affected by the cracks be identified and that each component/system be evaluated for flooding or jet spray. We found no documented evidence of analyses of the effects of cracks in moderate energy piping, as indicated in the FSAR and required by procedure TP-3. (Finding 2-22)

Finding 2-19 concerns the fact that there was no documented evidence that potential damage from jet impingement envelopes was evaluated, as required by United Engineers procedure. Finding 2-20 concerns the fact that analyses of high energy line breaks assumed in five cases that the jet impingement would cause no adverse effect because the impinged pipe is larger than the broken pipe. There was no documented technical basis for this assertion. Finding 2-21 concerned the fact that documentation for pipe break analyses stated that equipment was protected from whipping pipes by distance, but we found no documented evidence of the distance or how the distance was determined to be adequate or of any evaluations of pipe whip envelopes. Finding 2-22 concerns the fact that we found no documented evidence of analyses of the effects of cracks in moderate energy piping.

Finding 2-20 indicates a systematic problem because it occurred in five cases for the two zones we reviewed. We identified the problem to the responsible manager for the Failure Modes and Effects Analysis activity. He agreed that the assumption had been incorrect and took action to correct the problem.

Findings 2-19, 2-21, and 2-22 regarding pipe whipping, jet impingement and moderate energy cracks are systematic since they apply to work on all 100 Seabrook zones currently being reviewed by United Engineers. In our discussions with United Engineers responsible management, there was no disagreement as to the issues involved in the findings, and United Engineers stated that they intend to address these issues in completing work on the 100 zones. It is clear that there are adequate procedures for performing the work and that the responsible group recognizes its importance and there is a schedule for completing the work before commerical operation. In these cases there are clear licensing commitments to provide appropriate protection, and the design cannot be considered complete until the effects of the postulated breaks and cracks have been systematically examined and appropriate protection provided where needed.

2.5 Evaluation of NRC/IE Information Notices

United Engineers has a formal program for the reviewing and processing of NRC generic communications, i.e., Information Notices, Bulletins, etc. United Engineers procedure GEDP-0048 (Reference 1.116) establishes requirements to help assure timely response to all NRC documents containing information which may affect existing United Engineers designs. United Engineers memorandum dated December 5, 1983 (Reference 2.51), noted several IE Information Notices that had been reviewed and dispositioned by United Engineers. Based on discussions with United Engineers personnel, the team concluded that these Information Notices had been processed in accordance with procedure GEDP-0048.

The team examined one IE Information Notice that had been reviewed by United Engineers in accordance with GEDP-0048 and which has application to the containment building spray system. NRC/IE Information Notice No. 81-10 (Reference 2.52) "Inadvertent Containment Spray Due to Personnel Error" describes an event at Sequoyah whereby an auxiliary unit operator misunderstood a verbal instruction and opened a single valve in the residual heat removal system, which created a direct flow path through the residual heat removal system from the primary coolant system and resulted in inadvertent containment spray. The event was caused by lack of operator training and a plant design feature whereby a single valve forms the primary coolant system pressure boundary when using the residual heat removal system for shutdown cooling. United Engineers memorandum, SBU-45242 dated May 27, 1981 (Reference

2.53) to Yankee Atomic, stated they had reviewed the Seabrook Station system for susceptability to the Sequoyah event, and concluded that no design changes at Seabrook were necessary since the plant has no point at which a single major valve forms the reactor coolant boundary. The memorandum recommended that emphasis be placed on proper operator training and operations procedures. The Seabrook Station manager distributed Information Notice 81-10 to operations supervisors, who informed staff members. IMS B4.1.2 dated April 6, 1981 (Reference 2.54), is a routing sheet, which directed all Seabrook Station managers and department heads to review 81-10 as soon as possible. Based on discussions with responsible management and reviews of drafts of Seabrook Station operating procedures, (Reference 2.55 and 2.56), the team determined that these draft procedures included precautions based on the Sequoyah event. The team also examined material developed for licensed operator training by the Seabrook Training Center Staff, Westinghouse Nuclear Training Services, and United Engineers. Two training documents, Containment Building Spray System (HO-CBS) and "Residual Heat Removal System" (HO-RHRS) dated August 3, 1983 (References 2.57 and 2.58) together with related instructional aids, incorporate information on residual heat removal and containment building spray systems interaction and limitations that should assist operators in avoiding the problems cited by Information Notice 81-10.

In summary, we found a well executed program among Public Service of New Hampshire, Yankee Atomic, and United Engineers for ensuring that lessons learned from NRC/IE Information Notices are factored into Seabrook design and operations. For the one example we reviewed, responsible parties made the decision that the design was adequate to prevent inadvertent containment spray, as in a Sequoyah event, but that emphasis should be placed upon strengthening operating procedures and training as a means to help preclude such an event. We had no further questions in this area.

2.6 Conclusions

As discussed in Section 2.2, the team identified concerns about whether there is adequate available net positive suction head (NPSH) for the containment building spray pump. As a related matter we are concerned that there may be a pervasive problem with NPSH calculations on the Seabrook Project as indicated by the numerous deficiencies we found in calculations of NPSH for pumps in three different systems involving both United Engineers and Westinghouse.

Section 2.4 indicates that work is being accomplished at a very late stage in assessing whether there is adequate separation protection of essential components from postulated pipe breaks and cracks in high and moderate energy piping. The design cannot be considered complete until this work is finished. In other respects, the design process appeared to be controlled. Section 2.1 indicates that review of design documents is generally effective except for failure to use Design Change Notices in all situations where their use is required by procedure and to document how comments made in the review process were resolved. Section 2.3 indicates that, with some exceptions, design and analysis requirements delineated in the pump procurement specification were complied with. Section 2.5 indicates that we found a program for ensuring that lessons learned from NRC/IE Information Notices are factored into Seabrook design and operation.

3. MECHANICAL COMPONENTS

The objective of this portion of the inspection was to evaluate the mechanical components aspects of the Seabrook design with emphasis on the control of design information and assumptions relative to the containment building spray system. This review included Yankee Atomic Electric Company, service organization to the licensee, Public Service of New Hampshire; the architect engineer, United Engineers and Constructors; and three subcontractors, Bingham-Willamette, PX Engineering, and ITT Grinnell.

3.1 Design Information

United Engineers System Description No. SD-20 (Reference 1.11) details the functional requirements of the Seabrook containment building spray system. References listed in that document include applicable subsections of the FSAR, USNRC Standard Review Plan and Regulatory Guides, and sections of the ASME, IEEE, and ANSI codes and standards. Additionally listed are a series of specifications, documents and drawings prepared by United Engineers which detail the functional and physical configuration of the containment building spray system.

The major equipment, and the required flow rates, temperatures and pressures for the containment building spray system are tabulated on United Engineers Material Balance Drawings 9763-F-804880, and -804881 (References 1.14 and 1.15). United Engineers Piping and Instrumentation Diagram 9763-F-805023 (Reference 1.16) provides a schematic representation of the equipment, piping and valves for the containment building spray system, and also defines the system safety classifications. United Engineers Piping Isometric Drawings 9763-F-801201 through -801227 (Reference 1.21) detail the physical configuration of the major piping contained in the containment building spray system. Major piping components such as valving and pipe supports are also detailed symbolically on these drawings.

Procurement of major equipment such as tanks, pumps and heat exchangers, as well as valves and vendor engineered supports, is controlled by specifications prepared by United Engineers which are reviewed and approved by Yankee Atomic. For example, United Engineers Specification No. 9763-006-238-3 (Reference 3.2) specifies the functional requirements for the containment spray pumps; United Engineers Specification No. 9763-006-248-45 (Reference 3.6) applies to butterfly valves, and United Engineers Specification No. 9763-006-248-8 (Reference 3.20) applies to vendor engineered supports. United Engineers Technical Procedure TP-22 (Reference 3.26) details methods for the design and analysis of moderate energy containment piping penetrations; United Engineers General Engineering and Design Procedure No. 0044 (Reference 1.52) controls the documentation and verification of digital computer programs, and United Engineers Detail Engineering and Design Procedure 2607 (Reference 1.2) specifies procedures to be used in computerized piping stress analysis. United Engineers Piping Guidelines PGL-1 (Reference 3.1) detail the interaction between the various United Engineers design and analysis groups (as of 08/01/83) required to generate construction-issue drawings for pipe and pipe supports.

As noted on the work flow diagram detailed on p. 1-2-3 of Reference 3.1, the Nuclear and Mechanical Project groups are responsible for the preparation of the piping isometric drawings. The Piping and Pipe Support Project groups are subsequently responsible for the analysis of the piping subsystems shown on these drawings, as well as for the design and analysis of the pipe supports. The Mechanical, Structural and Fluid Analysis Groups provide required technical assistance.

The fabrication and erection effort conducted in the field is controlled by the United Engineers Site Power Engineering As-Built Group, with substantial support from two home office groups in the piping and pipe supports area expressly formed to support the as-built fabrication and erection effort and to control any changes to the issued for construction design. The field effort is controlled both by a series of United Engineers field procedures, and by cognate procedures generated by field subcontractors such as Pullman-Higgins. As an example, United Engineers Field Administrative Construction Procedure No. 7 (Reference 3.19) details the preparation and control of piping erection isometrics, while Pullman Power Products Document No. VI-4 (Reference 3.37) details procedures for the control of United Engineers field installation pipe support drawings and engineering change authorizations.

3.2 Mechanical Equipment

The objectives of this portion of the inspection were to evaluate the structural integrity and functional adequacy of a sample of the mechanical components in the containment building spray system, and to examine the control, review and approval procedures employed by the United Engineers Mechanical Analysis, Piping and Nuclear groups to design and procure vendor supplied mechanical components.

The following components were selected for review: (1) refueling water storage tank CBS-TK-8, (2) spray additive tank CBS-TK-13, (3) containment building spray horizontal centrifugal pumps CBS-P-9A and CBS-P-9B, (4) sump isolation valves 16"-CBS-V8 and 16"-CBS-V14, (5) containment isolation valves 8"-CBS-V11 and 8"-CBS-V17, and (6) the isolation valves (6"-CBS-V38 and 6"-CBS-V43) located in the two parallel lines connecting the refueling water storage tank and spray additive tank.

These components were reviewed for compliance with: (1) FSAR commitments, (2) United Engineers System Design Description SD-20 (Reference 1.11) which details the containment spray system requirements, (3) applicable United Engineers component specification requirements, (4) ASME Section III, Division 1 1974 Code with varying Addenda requirements (Reference 3.117), and (5) applicable United Engineers procedural and other requirements defining the work flow between various United Engineers organizations.

Table 3.2-2 of the FSAR indicates that the containment building spray system is a Seismic Category I system and that the principal design and construction code is the ASME Section III, Division 1, 1974 Code, with various Addenda, requirements. All mechanical equipment exposed to the containment building spray system fluid, with the exception of spray additive tank CBS-TK-13 and containment sump isolation valve encapsulation vessels CBS-TK-101A and CBS-TK-101B, are ASME Code Class 2. The spray additive tank and the shell side of heat exchangers CBS-E-16A and CBS-E-16B and the containment building spray pump seal cooler heat exchangers are ASME Code Class 3. Stress limits for Seismic Category I ASME Code Class 2 and 3 vessels and tanks are given in Table 3.9(b)-5 of the FSAR.

Tables 3.9(B)-22 and 3.9(B)-23 of the FSAR indicate that pumps CBS-P-9A and CBS-P-9B and valves CBS-V8 and V14, CBS-V11 and V17, and CBS-V38 and V43 are active components whose operation is relied upon to assure safe plant shutdown or to mitigate the consequences of an accident. These components are to be designed to perform their intended functions during the life of the plant under all postulated plant conditions. With respect to the operability of these components Public Service of New Hampshire has committed to the recommendations of Regulatory Guide 1.48 (reference 3.115) as reflected in Tables 3.9(B)-10 and 3.9(B)-11 of the FSAR.

The following documents were reviewed for the refueling water storage tank: (1) Westinghouse System Description SD-NAH/NCH-284 for the Safety Injection System (Reference 1.13), (2) UE&C Specification 9763-006-246-1 for the refueling water storage tank (Reference 3.17), (3) UE&C Specification 9763-SD-246-1 for the refueling water storage tank (Reference 3.18), (4) Pittsburgh-Des Moines Steel Co. Contract No. 14084 Design Report (Reference 3.46), (5) Pittsburgh-Des Moines Steel Co. Contract No. 14084, Drawing No. 2 (Reference 3.47), (6) Pittsburgh-Des Moines Steel Co. Contract No. 14084, Drawing No. E4 (Reference 3.48), (7) United Engineers Calculation Set No. 4.3.5.18F (Reference 3.9), (8) United Engineers Calculation Set No. 4.3.5.27F (Reference 3.11), and (9) United Engineers Calculation Set No. 4.3.5.35F (Reference 3.13).

The refueling water storage tank is a 46'-2½" high (exclusive of head) x 44'-0" internal diameter stainless steel flat bottomed cylindrical tank with wall thickness varying between 3/16" and 9/16". The Unit 1 tank is installed at the site in the tank farm enclosure structure. The name plate indicates that the tank was fabricated by Pittsburgh-Des Moines Steel Co. in accordance with the ASME Section III Class 2 Code and is an atmospheric pressure vessel with a design temperature of 100°F.

The review indicated that inconsistencies in the refueling water storage tank design temperature exist between various documents. Table 6.2-75 of the FSAR specifies a design temperature of 88°F; the United Engineers System Design Description SD-20 (Reference 1.11, p. SD-20D-5) specifies a design temperature of 100°F; Westinghouse System Description NAH/NCH-284 (for the safety injection system, Reference 1.13, p. 52) specifies a design temperature of 200°F, while United Engineers Specification 9763-006-246-1 (Reference 3.17, pp. 7-8) specifies a design temperature of 100°F. The temperature listed in the FSAR is given as the "maximum design temperature."

United Engineers indicated that the correct design temperature for the refueling water storage tank is 100°F and that the maximum design temperature of 88°F stated in the FSAR is the maximum operating temperature of the refueling water storage tank to be used in the design of attached piping and appurtenances. United Engineers stated orally to the team that they are initiating action to specify a consistent design temperature in the four documents mentioned above; the FSAR is to be amended and the Westinghouse system description is to be updated to stipulate a refueling water storage tank design temperature of 100°F. The required change to the Westinghouse system description will be implemented by review comments to a recent Westinghouse submittal containing the system description. The review of United Engineers Calculation Sets 4.3.5.18F, 4.3.5.27F and 4.3.5.35F (References 3.9, 3.11, 3.13) indicated that the radial thermal movement of the refueling water storage tank nozzles was calculated on the basis of 86°F, and that a 2°F rise in water temperature from 86°F to 88°F will occur due to spray additive mixing and other effects. In addition, the minimum water temperature in the refueling water storage tank and spray additive tank is to be set at 50°F to prevent freezing in the connecting piping. The 2°F temperature difference will not produce a significant difference in the radial thermal movement of the refueling water storage tank nozzles. Since 50°F, 86°F and 88°F are all less than 100°F, a design temperature of 100°F appears to be acceptable. Although the design temperatures stated in the various documents are inconsistent, these inconsistencies should have no significant effect on the design of the refueling water storage tank and attached piping (Finding 3-1).

Our review of the Pittsburgh-Des Moines Steel Co. design report (Reference 3.46) showed that the seismic qualification analysis of the refueling water storage tank was based on a static analysis which utilized 150% of the peak vertical acceleration. This qualification method is not consistent with the requirements of United Engineers Specification 9673-SD-246-1 (Reference 3.18). The United Engineers specification states that only the dynamic analysis method is acceptable for the seismic qualification of the refueling water storage tank. Qualification by static analysis, testing, or a combination of analysis and testing are specified as not acceptable for the refueling water storage tank. The Pittsburgh-Des Moines Steel Co. design report notes that the Seabrook structural criteria detailed in Subsection 3.7(B).3.1.b of the FSAR permit a static analysis based on 150% of the peak vertical acceleration instead of a dynamic analysis. United Engineers orally indicated to the team that the United Engineers Seismic Specification 9763-SD-246-1 (Reference 3.18) is to be revised to agree with the Pittsburgh-Des Moines Steel Co. design report. The proposed revision is considered technically acceptable. Seismic requalification by the dynamic analysis method should not be required (Finding 3-2). See Finding 4-16.

Our review of the Pittsburgh-Des Moines Steel Co. design report also showed that extensive analyses were performed to demonstrate the structural adequacy of the mixing chamber in the refueling water storage tank and the basic shell of the refueling water storage tank to withstand loads applied at nozzles due to attached piping and at integral pipe support pads for supported piping. These analyses were very extensive and utilized state-of-the-art analytical methods performed in accordance with the criteria detailed in Table 3.9(B)5 of the FSAR.

The following documents were reviewed for the spray additive tank: (1) United Engineers Specification 9763-006-246-6 for field erected tanks (Reference 3.14), (2) United Engineers Specification 9763-SD-246-6 for field erected tanks

(Reference 3.15), (3) Pittsburgh-Des Moines Steel Co. Contract No. 14085 Design Report (Reference 3.49), (4) Pittsburgh-Des Moines Steel Co. Contract No. 14085 Drawing No. 1 (Reference 3.50), (5) Pittsburgh-Des Moines Steel Co. Contract No. 14085 Drawing No. 4 (Reference 3.51), and (6) Pittsburgh-Des Moines Steel Co. Contract No. 14085 Drawing No. 7 (Reference 3.52). The spray additive tank is a 44'-3" high (exclusive of head) x 6'-8" internal diameter flat-bottomed stainless steel vessel with wall thickness varying between 3/16" and 1/2". The Unit 1 spray additive tank has been erected adjacent to the refueling water storage tank in the tank farm enclosure building. The tank was designed and constructed by Pittsburgh-Des Moines Steel Co. in accordance with the ASME Section III Code Class 3 and is an atmospheric vessel with a design temperature of 100°F.

Our review of the Pittsburgh-Des Moines Steel Co. design report for the spray additive tank (Reference 3.49) indicates that seismic qualification of the spray additive tank was also based on a static analysis which utilized 150% of the peak vertical acceleration. This method of qualification is not consistent with the requirements of United Engineers Specification 9763-SD-246-6 (Reference 3.15) which states that only the dynamic analysis method of qualification is acceptable. The Pittsburgh-Des Moines Steel Co. design report references the Seabrook structural criteria as a basis for using the static analysis method with 150% of the peak vertical acceleration instead of the dynamic method of analysis. United Engineers told the team that they will also be revising Specification 9763-SD-246-6 (Reference 3.15) to agree with the Pittsburgh-Des Moines design report (Reference 3.49). Seismic requalification of the spray additive tank should also not be required. See Finding 3-2.

The Pittsburgh-Des Moines Steel Co. design report also showed that analyses were performed for piping loads applied at the spray additive tank nozzles and at pipe supports for piping supported by the spray additive tank. The stress limits utilized in these analyses were in compliance with the limits committed to in Table 3.9(B)5 of the FSAR.

The documents reviewed for the containment building spray pumps included: (1) United Engineers Specification 9763-006-238-3 for the containment spray pumps (Reference 3.2), (2) United Engineers Specification 9763-SD-238-3 for the containment spray pumps (Reference 3.16), (3) Bingham-Willamette Design Report 14210477-05 (Reference 3.81), (4) McDonald Engineering Analysis Co., Inc. Report ME-995 (Reference 3.82), (5) Bingham-Willamette Drawing B-33844 (Reference 3.33), (6) Bingham-Willamette Drawing H-3944 (Reference 3.36), (7) United Engineers Calculation Set No. 4.3.5.36F (Reference 3.25), (8) United Engineers purchase order file for containment spray pumps (Reference 3.105), and (9) United Engineers Nuclear Group review files for containment spray pumps.

The containment spray pumps are Bingham-Willamette 6x10x14B-CD, double suction, horizontal centrifugal pumps installed at elevation (-) 61'-0" in the containment spray equipment vault of the Unit 1 primary auxiliary building. These pumps are ASME Section III Code Class 2 pumps with a design temperature and pressure of 300°F and 300 psig, driven by Westinghouse 600 HP motors.

The cooling water pressure boundary for these pumps is Code Class 3 with a design temperature and pressure of 200°F and 150 psig.

The team's inspection of the containment spray pumps included a visit to the Bingham-Willamette plant in Portland, Oregon. This visit provided the team with an opportunity to sample the design and control procedures employed by vendors of mechanical equipment for the Seabrook Station (see Subsection 3.5). Our review of the Bingham-Willamette seismic design report (Reference 3.81) indicates that the report was certified to be in accordance with the requirements of Rev. 3 of United Engineers Seismic Specification 9763-SD-238-3 (Reference 3.16). The report utilized the static analysis method of seismic qualification. Revision 3 of the specification, dated 09/27/74, states that only the dynamic analysis method of qualification is acceptable. Revision 4 of the specification, dated 05/31/79, however, states that both the static and dynamic analysis methods of qualification are acceptable. Since the pump is a compact component with a fundamental frequency greater than 33 Hz, the static analysis method can be technically justified and requalification by dynamic analysis should not be necessary. See Finding 3-2.

The team's review of the Bingham-Willamette seismic design report (Reference 3.81) also determined that the pump casing calculations shown on pp. 24-25 of Appendix B (which compute a stress of 2,741 psi against an allowable stress of 27,200 psi reported in Table 3.9(B)-13 of the FSAR) although not noted anywhere, have been superseded by the pump pressure boundary calculations in the McDonald report (Reference 3.82). These stresses are inconsistent with the calculation in the McDonald report which computes a maximum stress of 15,958 psi against an allowable stress of 19,800 psi. The FSAR and the Bingham-Willamette report should be consistent with the McDonald report. (Finding 3-3).

The McDonald report does not address the seal cooler heat exchanger shell side ASME Section III Class 3 pressure boundary requirements. Calculations demonstrating compliance with the ASME Code minimum wall thickness requirements should be prepared. These heat exchangers were initially furnished with cast iron pressure boundaries having lower design pressures than required and are currently being replaced with acceptable ASME Code material with wall thicknesses suitable for the design pressure. The team has been informed that the McDonald report will be modified to include the needed calculations (Finding 3-4).

Although paragraph 3.9 of United Engineers Specification 9763-006-238-3 required that all sellers drawings, calculations and test reports were to be certified by a registered professional engineer to be complete and correct, many of the documents submitted by Bingham-Willamette were not certified. In particular, none of the Bingham-Willamette drawings and pump test reports were certified, such as Bingham-Willamette Drawings B-33844 and H-3944 (References 3.33 and 3.36), and Bingham-Willamette pump test reports logged in as United Engineers foreign print numbers 53202-01 238-3 and 53205-01 238-3 (References 3.120 and 3.121) (Finding 3-5).

A review of the United Engineers purchase order file for the containment building spray pumps disclosed a United Engineers recommendation that the pumps be tested to assure operability under the thermal transient conditions specified in paragraph 3.2.2.2 of United Engineers Specification 9763-006-238-3 (Reference 3.2). This recommendation was not approved by the applicant (see United Engineers letter SBU-13320, dated July 25, 1977 (Reference 3.102) and Public Service of New Hampshire letter SB-5178, dated August 10, 1977 (Reference 3.103). The thermal transient is defined as an instantaneous step change in fluid temperature from 40°F to 280°F which occurs after 0 to 20 minutes of pump operation and is associated with the change from the injection to the recirculation mode of operation for the containment building spray system. The United Engineers recommendation and the Public Service disapproval of the thermal transient test were both based on data transmitted by Bingham-Willamette to United Engineers in their letter of February 14, 1977 (Reference 3.104) stating the Bingham-Willamette position that the Seabrook Station containment building spray pumps had been properly designed and would operate during the specified thermal transient condition. The Bingham-Willamette position was based on the results of a transient test performed on a larger Bingham-Willamette pump of similar design. The results of that test were submitted in the Bingham-Willamette letter. Further discussion of the Bingham-Willamette inspection is detailed in Subsection 3.5.

The United Engineers purchase order file (Reference 3.105) indicated that the CBS-P-9B pump had sustained flood damage. (see United Engineers letter SBU-74799, July 1, 1983, Reference 3.106). The pump and motor were immersed to approximately the elevation of the shaft centerline for an unknown period of time. Flooding was due to a break in test equipment during hydrostatic testing of some mechanical equipment; see Pullman Power Products Nonconformance Report NCR 4647, June 13, 1983 (Reference 3.107) and United Engineers Nonconformance Report NCR 2109, June 13, 1983 (Reference 3.108). Subsequent repairs to the pump and motor were evaluated by Bingham-Willamette and Westinghouse service representatives. One oil ring on the pump was damaged during disassembly and was replaced. The pump should be started as recommended in Section 5.9 of this report and monitored during preoperational testing to provide further assurance that the repairs are acceptable (Unresolved Item 3-1).

The following documents were reviewed for the 16 inch sump isolation valves: (1) United Engineers Specification 9763-006-248-37 (Reference 3.8), (2) United Engineers Specification 9763-SD-248-15 (Reference 3.4), (3) United Engineers Active Valve Test Guidelines No. 9763-VTG-1 (Reference 3.7), (4) United Engineers Specification 9763-006-248-1 (Reference 3.117), (5) United Engineers Specification 9763-006-248-47 (Reference 3.73), (6) Velan Engineering Co. Calculation SR-6433 (Reference 3.29), (7) Velan Engineering Co. Test Procedure ST-7002 (Reference 3.30), (8) Velan Engineering Co. Analysis Theory Report (Reference 3.31), (9) Velan Engineering Co. Drawing P3-6040-N15 (Reference 3.32), (10) Velan Engineering Co. Manufacturing and Inspection Instructions (Reference 3.38), and (11) United Engineers Piping Group review files. The sump isolation valves are Velan Engineering Company 300 lb class stainless steel valves. These valves are ASME Section III Code Class 2 valves with a design temperature and pressure of 300°F and 300 psi, respectively, and are located outside of the containment structure in encapsulation vessels located at elevation (-) 31'-6" between the primary auxiliary building and the containment structure.

The review of the various applicable United Engineers Specifications for these Seismic Category I active isolation valves indicates that extremely stringent criteria were imposed on these ASME Section III Code Class 2 valves to ensure their operability during plant faulted conditions. In addition to the ASME Code Class 2 design condition requirements, the following supplemental requirements were imposed: (1)The analytical methods of ASME Section III Code Class I requirements of NB3500 and NB3647.1 for primary membrane, primary bending and secondary stresses, (2) Nozzle loads equal to the full plastic capability of the attached piping, (3) Consideration of simultaneous seismic accelerations of 3.0g along each of the valve principal axes, (4) Valve operability test with valve subjected to nozzle loads and simulated operator seismic load, and (5) Seal-leakage limitation requirements. The review of the various Velan submittals indicates that these requirements and the commitments to Table 3.9(B)-11 of the FSAR were generally satisfied, except as discussed below.

Velan Report SR-6433 (Reference 3.29) indicates that preloading effects were not included in the stress analysis of the yoke mounting screws for the containment sump isolation valves. Paragraph 3.3.11 of United Engineers Specification 9763-006-248-37 (Reference 3.8) requires that torquing requirements for bolted joints must not overstress the bolts. This requirement was not addressed in the Velan report. Assurance that the yoke mounting screws are not overstressed when preloading effects are included is needed to demonstrate their structural integrity under applied loads. Assurance that the bolted joint will not separate under applied loads is needed to demonstrate the functional adequacy of the joint. This is considered to be technically significant. Similar deficiencies apply to all bolted joints on the valves addressed in Velan Report SR-6433. (Finding 3-6).

Velan Test Procedure ST-7002 (Reference 3.30) indicates that the design conditions for the 16 inch containment isolation valves are 445 psi and 350°F. This is inconsistent with the Velan Drawing P3-6040-N15 (Reference 3.32), referenced in the test procedure, which shows design conditions of 300 psi and 300°F. This is not technically significant. However, the Velan test procedure should be revised to reflect the correct design conditions of 300 psi and 300°F as shown on the Velan drawing. (Finding 3-7)

The Velan Seismic Analysis Theory Report (Reference 3.31) shows that the torsional rigidity of the valve, K_t, has units of lbs/in (see page 9 of the report). These units derive from the incorrect definition of K_t given on pages 23 and 24 of the report. The correct definition of torsional rigidity is the item denoted by the symbol lambda on page 23 of the report (Finding 3-8).

The combination of twisting and bending stiffness to compute a minimum stiffness K_{min} defined on page 24 of the report is also in error. The torsional and bending stiffness and modes of vibration are independent quantities. This error should also be corrected on page 54 of Velan Report SR-6433. While these errors are not technically significant, the Velan report should be revised to correct them (Finding 3-9).

A review of United Engineers Specification 9763-006-248-47 (Reference 3.73) for the containment sump isolation valve encapsulations shows that the encapsulation could be filled with water or steam during plant faulted conditions. Additionally, since lines 1211-2-301-16" and 1212-2-301-16" in which the valves are located are filled with water during plant normal conditions, the encapsulation vessels could contain some water during plant non-accident conditions. However, neither paragraph 3.1.1.3 of United Engineers Specification 9763-006-248-37 (Reference 3.8) for the valves nor paragraph 3.2 of United Engineers Specification 9763-006-248-15 (Reference 3.4) for the valve actuator specifies immersion as a possible environmental condition. Assurance that the valve and operator assembly will operate during plant faulted conditions is necessary. See also Subsection 5.5. This is considered technically significant, due to the critical function of these valves (Finding 3-10).

The following documents were reviewed for the 8 inch containment isolation valves V11 and V17: (1) United Engineers Specification 9763-006-248-41 (Reference 3.5), (2) Walworth Aloyco Report ASF-7 (Reference 3.83), (3) Acton Environmental Testing Corp. Report 17062 (Reference 3.84), and (4) United Engineers Piping Group review files. These isolation valves are Walworth Aloyco 300 lb. class stainless steel valves with a design pressure and temperature of 300 psi and 300°F, respectively, and are located outside of the containment structure between the primary auxiliary building and the containment structure. These valves are active Seismic Category I isolation valves and were bought under purchase order number 248-41 (Reference 3.118) and United Engineers Specification 9763-006-248-41 (Reference 3.5). This specification is identical to United Engineers Specification 9763-006-248-37 (Reference 3.8). The requirements for these valves are therefore identical to the requirements for the sump isolation valves.

Our review of the Walworth Aloyco seismic report (Reference 3.83) indicated that the structural integrity and functional adequacy of the bolted joints, including preload effects, have not been demonstrated. See Finding 3-6.

The Acton Environmental Testing Corporation Test Report (Reference 3.84) indicates valve resonance at 18.0 Hz and 32.5 Hz in the "left-to-right" direction and at 25 Hz and 34 Hz in the "front-to-back" direction. A high transmissibility at 18.0 Hz caused by strong cross-coupling along the horizontal axes was also noted. The test report indicates that valve operability under applied nozzle loads and applied seismic vibratory loads was verified, despite the frequency requirement anomaly. These test results were contrary to the requirements of paragraph 3.1.2 of United Engineers active valve test guidelines 9763-VTG-1 (Reference 3.7). However, these results were reviewed and found conditionally acceptable by the Mechanical Analysis group (see United Engineering letter MM#9156A, May 24, 1982, Reference 3.109), subject to review under a verification program which was being formulated by the Piping Group. Assurance that the valves are modeled in accordance with the requirements of Paragraph 5.3.5(g)-(i) of United Engineers procedure DEDP-2607 is therefore not currently available and should be confirmed (Unresolved Item 3-2).

The following documents were reviewed for the 6 inch isolation valves V38 and V43: (1) Walworth Aloyco Stress Report ADSR-21 (Reference 3.85), (2) Acton Environmental Testing Corp. Test Report 17062-82N-1 (Reference 3.86), and (3) United Engineers

Piping Group review files. These isolation valves are Walworth Aloyco 150 lb. class, stainless steel, ASME Section III Code Class 2 valves with a design pressure and temperature of 25 psi and 100°F, respectively. The valves were purchased under United Engineers purchase order number 248-41 (Reference 3.118) and their design requirements are identical to those for the 8 inch containment isolation valves. Our review of the Walworth Aloyco stress report indicated, as noted for the other valves reviewed, that bolt preload effects had not been evaluated for these 6 inch valves. See Finding 3-6.

The Acton Environmental Testing Corp. test report indicated resonances at 27.5 Hz in the "right-to-left" direction and 30.5 Hz in the "front-to-back" direction. As before, verification of compliance with the modeling requirements of United Engineers procedure DEDP-2607 (Reference 1.2) should be obtained during the United Engineers verification program. See Unresolved Item 3-2.

During a review of United Engineers Calculation File 4.3.5, the results of Calculation Set 4.3.5.17F (Reference 3.10) were compared with the design requirements of the containment building spray system. The calculation shows that closure of the motor operated containment isolation valves in 10 seconds, during containment spray pump operation could induce water hammer peak pressures of 427 psig in lines upstream of the valves, including the containment spray heat exchanger outlet lines 1214-2-301-8" and 1216-2-301-8" and the containment spray pump discharge lines 1213-2-301-8" and 1215-2-301-8". Review of United Engineers Drawing 9763-F-804881 (Reference 3.110) showed that the maximum operating pressure in these lines during the injection and recirculation modes of operation is 376 psig. Both of these pressures exceed the 300 psi ASME Code design pressures of the tube side of the containment spray heat exchangers and pumps. The Code design pressure should be the maximum operating pressure. The United Engineers Nuclear Group indicated orally to the team that the containment building spray system description was to be modified to specify that closure of the isolation valves should not be permitted during pump operation. This is considered technically significant, and assurance that valve closure will not occur during pump operation is needed. United Engineers indicated orally to the team that the pressures (and the temperatures) shown on United Engineers Drawing 9763-F-804881 (Reference 3.110) were inconsistent and would be revised. The revisions will be consistent with the 300 psi design pressure for the piping and equipment from the containment spray pumps to the isolation valves. Review of piping analyses performed by the Mechanical Analysis group shows that peak pressures were properly considered in the piping stress analysis (Finding 3-11).

In summary, a number of the Findings detailed in Subsection 3.2 reflect discrepancies and omissions in calculations and specifications which are not considered technically significant, since correction should not require redesign.

Findings considered technically significant involved failure to demonstrate the functional adequacy of bolted joints (Finding 3-6), failure to evaluate the possible immersion of the sump isolation valve and valve operator (Finding 3-10), and failure to confirm that closure of the containment isolation valves will not occur during operation of the containment building spray pumps (Finding 3-11).

Finally, containment building spray pump CBS-P-9B should be monitored during preoperational testing to verify functionality after repair due to immersion (Unresolved Item 3-1), and it should be confirmed that valves are modeled in accordance with United Engineers procedures (Unresolved Item 3-2).

3.3 Piping Stress

The objective of this portion of the inspection was to evaluate the adequacy of the pipe stress analyses performed for the containment building spray system by the Mechanical Analysis Group. The team also evaluated the relationship between the Mechanical Analysis Group and other key disciplines involved in the containment spray analysis and design effort. The coordinated effort which results in the stress analysis of a piping system originates with the Piping Project Group, which solicits information from the Nuclear Project Discipline for nuclear island piping, and from the Mechanical Project Discipline for turbine plant piping. Input data includes the relevant piping isometric drawings, thermal anchor displacements for equipment, thermal and pressure loads, response spectra for various building locations, and preliminary support locations. The Piping Project Group supplies all pipe data (size, weight and insulation), valve weights and configurations, valve and equipment allowables, fitting specifications, and loading conditions.

The piping isometric drawings and associated information are transmitted to the Mechanical Analysis Group, which performs a preliminary stress analysis to verify the structural adequacy of the piping system. The preliminary pipe reactions generated by that analysis, which are based on the generic stiffnesses detailed in United Engineers Procedure For Computerized Piping Analyses, DEDP-2607, Section 5.3.3 (Reference 1.2), are used to design the pipe supports. The Mechanical Analysis Group confirms that the magnitudes of the valve nozzle loads, flange loads, and valve operator seismic accelerations generated in the piping stress analysis fall within allowable limits. The results of the piping stress analyses are transmitted to the Piping Project Group, which completes the piping stress analyses by verifying the equipment nozzle loads and boundary restraint loads, and by forwarding the preliminary pipe reactions to the Pipe Support Group. All work transmitted to and from the Piping Project Group follows the procedures outlined in United Engineers Piping Guidelines Standard PGL-1 (Reference 3.1). The Mechanical Analysis Group evaluates any design change which comes up within the continuing design cycle and decides if the magnitude of the change warrants reanalysis. Reanalysis is only performed for design changes deemed significant or for the 'as-built' verification analysis.

Four stress analysis packages were selected for review: (1) piping routed from the tube side outlet nozzle of the containment spray heat exchanger to an anchor at El. 1.0' within the containment building; Train 'A' (Reference 3.22); (2) parallel piping system Train 'B' (Reference 3.57); (3) branch lines off the above referenced piping systems, which feed water to the refueling water storage tank (Reference 3.59) and (4) continuation for Trains 'A' and 'B' of supply lines for the four containment spray rings within the containment building (References 3.65, 3.67-3.70).

The stress packages were reviewed for input information, boundary assumptions, modeling techniques, and consistency of information between disciplines. The magnitudes of resulting stresses and loads were reviewed for compliance with licensing commitments. Input information checked included piping geometry, pipe dimensions, weights per unit length, valve weights, materials, design and operating temperatures and pressures, loading cases considered and response spectra. Boundary conditions were checked to insure that applicable thermal displacements had been included and the decoupling assumptions made were evaluated against the procedures specified in Section 5.1.2 of United Engineers Procedure for Computerized Piping Analyses (Reference 3.21). A review of the valve and pipe fitting models, and support stiffnesses, was included in the check of modeling techniques. All analyses reviewed were checked for consistency between the stress analysis package and input derived from other disciplines. A consistency check was also made between the reaction loads generated in the stress package and the equipment allowable nozzle loads specified by the Piping Project Group. The structural adequacy of each piping system analyzed within the four reviewed stress packages was checked for consistency with FSAR commitments.

In the four stress packages reviewed, the ADLPIPE computer program was used. United Engineers currently maintains two versions of ADLPIPE. ADLPIPE 2 (Reference 3.100) is an original version of ADLPIPE (Reference 3.101) which has been modified by United Engineers to incorporate the recommendations of Regulatory Guide 1.92 (Reference 3.97) and the requirements of ASME Section III, 1974 Edition (Reference 3.98). ADLPIPE 2 is used only for the analysis of Class 2, and 3 and B31.1 piping systems. ADLPIPE-D (Reference 3.99) is the commercial version of ADLPIPE which can be used for all classes of piping systems, and accommodates all code editions through 1977. For the analyses reviewed by the team a version similar to ADLPIPE 2 was used as committed to in Section 3.9(B)1.2 of the FSAR.

The first stress package reviewed was Calculation Set 550.02, parts A and B (Reference 3.22). Part A consists of an 8" piping line 1214-2-301-8" (Reference 3.23) which is routed between the Heat Exchanger CBS-E-16A outlet nozzle and containment penetration X-1?. Part B is the continuation of line 1214-2-301-8" at the penetration (inside containment) to anchor 1214-A-01 located at El. 1'-0". In the team's review of Parts A and B, input information was found to be consistent and correct, but not complete. No consideration was given to the effect of waterhammer loading on the containment spray rings and the associated piping downstream of valve 8"-CBS-V11 (Part B) during initial fill transients. As stated in Section 3.9(B).3.1 of the FSAR, thrust resulting from fluid flow should be considered in stress evaluation and support design. A report generated by the United Engineers Fluids Analysis Group to evaluate the effect of waterhammer on the containment spray rings (Reference 3.24) indicates that the magnitudes of the pipe stress levels would increase marginally, but that supports in the path of waterhammer should be reviewed for load increases (Finding 3-12).

The radial thermal displacement for the Heat Exchanger CBS-E-16A outlet nozzle is (+X) 0.044" but was input in Reference 3.22 as (-X) 0.044". When the analysis was performed on 2/4/81, there were no Anchor Displacement Data Sheets which would have provided documentation for the outlet nozzle thermal displacement. This is in violation of Section 9.0 of United Engineers Procedure for Computerized Piping Analyses, DEDP-2607 (Reference 3.21). This appears to be a random error with only minor differences expected in the stress levels, the equipment and support loads (Finding 3-13).

Branch line 1218-301-4" was not incorporated in the analysis of line 1214-2-301-8", Part A. Thus, the interaction between the 8" piping line and its 4" branch was not accounted for as prescribed by Section 5.1.2 of DEDP-2607 (Reference 3.21). The technical significance of this failure to properly decouple these lines can only be gauged by reanalysis of the pipe subsystem (Finding 3-14).

For both Part A and B, the modeling techniques used and consistency check of information between disciplines were acceptable. Stress levels and load combinations were consistent with the FSAR. The sign of the thermal displacement should be changed and Part A should be reanalyzed in order to accommodate the improperly decoupled 1218-1-301-4" line. As for the documentation calculation for the CBS Heat Exchanger outlet nozzle, United Engineers recently performed a displacement analysis (Reference 3.56) which confirms the magnitudes of the nozzle thermal displacements used in the analysis. Consideration should be given to the effect of waterhammer loads for Part B; i.e., a fluid analysis calculation and a pipe stress analysis confirming structural adequacy.

The second piping stress package reviewed was Calculation 550.03 (Reference 3.57) for 8" line 1216-2-301-8" (Reference 3.58). There are two parts to the calculation, A and B, and they are basically parallel in routing to the previously reviewed package 1214-2-301-8" (Reference 3.22). For this analysis the containment penetration is X-15, the heat exchanger is CBS-E-16B and the anchor at El. 1'-0" is 1216-A-01. The team verified all items of input, modeling, boundary assumptions, consistency of information and compliance with licensing commitments, except for the following items.

The interaction effects between an 8" piping line 1216-2-301-8" and a 4" branch line 1217-1-301-4", Part A of the package, were not accounted for as prescribed by DEDP-2607 (Reference 3.21). This could result in a significant increase in loading to pipe supports adjacent to the 4" line 1217-1-301-4". See Finding 3-14.

At the time of the analysis (2/4/81) there were not any Anchor Displacement Data Sheets which would have provided documentation for the heat exchanger outlet nozzle thermal displacements. This is in violation of Section 9.0 of DEDP-2607 (Reference 3.21). See Finding 3-13.

No consideration was given to the effect of waterhammer loading on the containment spray rings and the associated piping downstream of valve 8"-CBS V17 (Part B) during initial fill transients. As stated in Section 3.9(B).3.1 of the FSAR, thrust resulting from fluid flow should be considered in stress evaluation and support design. This is a systematic error of omission for all containment spray piping reviewed within containment. See Finding 3-12.

It is recommended that Part A be reanalyzed in order to meet the requirements of Section 5.1.2 of DEDP-2607 (Reference 3.21) for the decoupled 1217-1-301-4" line. As stated in the review of the first stress package, United Engineers has recently performed a heat exchanger nozzle thermal displacement analysis (Reference 3.56) which confirms the magnitudes of the nozzle thermal displacements used in the analysis. Also, a stress evaluation and a review of potentially increased support loads should be conducted for the waterhammer loading.

The third piping stress package reviewed was for Calculation 551.00 (Reference 3.59), which included lines 1218-1-301-4" (Reference 3.60) and 1217-1-301-4" (Reference 3.61). The two parts of this package consisted of 4" piping which was in violation of Section 5.1.2 of DEDP-2607 (Reference 3.21) as noted in the first (Reference 3.22) and second (Reference 3.57) packages reviewed. See Finding 3-14.

Input information, support stiffness, consistency of input and output information related to Calculation 551.00, and compliance with licensing commitments, were reviewed and found to be acceptable. When valves 4" CBS-V31 (line 1217-1-301-4") and 4" CBS-V32 were modeled, no consideration was given to the mass and center of gravity of the eccentrically oriented valve operator. For both cases the operator is two-direction supported (support 1217-SG-8 for valve 4" CBS-V31 and support 1218-RG-3 for valve 4" CBS-V32), with the support attached directly to the pipe. Since load and moment effects from the operator and support must be considered, the valve model is in violation of Section 5.32 of DEDP-2607 (Reference 3.21). This is not considered technically significant (Finding 3-15).

At the time of the recommended reanalysis of Calculations 550.02 and 550.03, valves 4" CBS-V31 and 4" CBS-V32 should be modeled properly to give consideration to the mass of valve operator and respective support. Pipe supports should be reviewed for increased loading. The third part of the above mentioned Calculation 551.00 consists of piping line 1217-1-301-4" running from pipe anchor 1217-A-1 to a 3-way pipe support 1217-SG-12 (Reference 3.61). When valve 4" CBS-V33 was modeled, no consideration was given to the mass and center of gravity of the eccentrically oriented valve operator. Since load and moment effects from the operator and support (1217-SG-9) must be considered, the valve model violates Section 5.32 of DEDP-2607 (Reference 3.21). See Finding 3-15.

It is recommended that this part of Calculation 551.00 be reanalyzed for the dead weight and seismic loading conditions, with stress and load changes evaluated. The United Engineers technical staff orally indicated to the team the existence of approximately twenty-five eccentrically oriented valve operators, which had not been modeled for analysis. Three other examples of this valve are 20" CC-V26, 20" CC-V427, and 20" CC-V448 (References 3.62-3.64). For all three valves (4"-CBS-V32, 32, 33) a note was included on the respective isometric drawings (Reference 3.60, 3.61) stating: "Valve Operator not modeled since it is restrained by its own pipe." As explained, this is an incorrect assumption and should be deleted from the isometrics, as it violates Section 5.3.2 of DEDP-2607 (Reference 3.21). This error is therefore systematic and must be corrected and stress levels and support load increases should be reviewed for design adequacy. See Finding 3-15.

The fourth stress package reviewed was Calculation 550.00. This package is broken up into five subsections which represent the two vertical supply lines and four containment spray rings within the containment dome. Part A (Reference 3.65) represents piping line 1216-2-301-8" (Reference 3.66) running up the containment wall between pipe anchors 1216-A-01 (El. 1'-0") and 1216-A-12 (El. 166'-13/16"). On the first page of the stress package, the Summary Table states that: "This summary is valid for similar line 1214-2-301-8". No explanation or justification for assuming similar geometry and loads for these two lines is provided. There are support data sheets for the analyzed 1216-2-301-8" piping line but none for the comparable line 1214-2-301-8". This appears to be a random error that violates the requirements of Section 9.0 of DEDP-2607 (Reference 3.21) (Finding 3-16).

Reference 3.58 gives the elevation of anchor 1216-A-01 as 0'-0", while on Reference 3.66 it is given as 1'-0." This is considered a minor random error that should be corrected (Finding 3-17).

No consideration was given to waterhammer loading as detailed in Reference 3.24. This is in violation of Section 3.9(B).3.1 of the FSAR. It is recommended that Part A be more complete in documenting assumptions, that support data sheets be included for piping line 1214-2-301-8", and that a stress analysis be performed for waterhammer loading with stress levels and support loads reviewed for adequacy. See Finding 3-12.

Part B of Calculation 550.00 (Reference 3.67) represents the outermost containment spray ring, line 1225-1-301-6" (Reference 3.66) at elevation 145'-0". The analysis runs from pipe anchor 1214-A-11 to anchors 1215-A-09 and 1225-A-17 on the ring. Considering the ring in the plan view, the ring was modeled for three of the four quadrants, with the North-East quadrant (between anchors 1225-A-09 and 1225-A-17) using support reactions and pipe stresses derived from the almost identical South-East quadrant (between anchors 1225-A-17 and 1225-A-25). Except for a comment stating that results from one quadrant were valid for a similar quadrant, there was no explanation or justification for this assumption. See Finding 3-16.

The waterhammer analysis recently performed by the Fluid Analysis Group (Reference 3.24) indicates loads that have not previously been considered. As stated in Section 3.9(B).3.1 of the FSAR, thrust resulting from fluid flow should be considered in stress evaluation and support design. The team recommends that Part B of Calculation 550.00 be reanalyzed to incorporate waterhammer loading, and that support stiffnesses be updated as specified in Section 5.3.3 of Reference 1.2. See Finding 3-12.

Subsection 'C' (Reference 3.68) of Calculation 550.00 represents piping line 1214-5-301-6", which originates at pipe anchor 1214-A-16 and forms the containment spray ring having the second highest elevation at El. 180'-1 3/16" (Reference 3.66). Part 'D' (Reference 3.69) represents piping line 1216-5-301-4" which runs from pipe anchor 1216-A-17 to the containment spray ring having the highest elevation at El. 187-3 11/16". The team reviewed, for both subsections, input information, boundary conditions, modeling techniques, consistency of input and output between disciplines, and stress and load compliance with licensing commitments. All were found acceptable except for the previously mentioned systematic lack of consideration of waterhammer effects. It is therefore recommended that a stress analysis be performed and a review of increased support loads be investigated for the waterhammer loading for these lines as well. See Finding 3-12.

Part 'E' of Calculation 550.00 (Reference 3.70) represents piping line 1214-2-301-8" (Reference 3.71) running between pipe anchors 1214-A-11 (El. 144'-5 3/16") and 1214-A-16 (El. 180'-1 3/16"). We found no problems with the basic input information, modeling, boundary conditions and compliance commitments. We did find one problem with one support data sheet assumption. Piping line 1214-2-301-8" of this calculation is similar to line 1216-5-301-4" (not analyzed) which runs between pipe anchors 1216-A-12 (El. 166'-0") and 1216-A-17 (El. 187-3 11/16"). The support loads for the analyzed line were then assumed representative for the 1216-5-301-4" line which was not analyzed. Both lines have similar expansion loops between the pipe anchors. In the plan view for both of these piping lines, pipe line 1216-5-301-4" has pipe support 1216-SG-13 lying plant west of the expansion loop while 1216-SG-15 lies east of it. Similarly, line 1214-2-301-8" has both pipe supports 1214-SG-12 and 1214-2-301-13" located plant west of its expansion loop. Support data sheets improperly assumed that the 1214-SG-12 support loads were applicable for support 1216-SG-13, and that 1214-SG-13 support loads were applicable for support 1216-SG-15. Since the supports are not similarly located this is an inaccurate comparison of loads. This is a random error. The magnitude of loading is such that no effect on support design should occur. See Finding 3-16.

As in all other containment spray piping within containment no consideration was given to waterhammer loading (See Finding 3-12). It is recommended that support loads tabulated on support data sheets for supports 1216-SG-13 and 1216-SG-15 be corrected, with load comparisons being made with similarly located supports on line 1214-2-301-8".

The containment building spray system, made up of the four spray rings, plays an essential role in the removal of heat from the containment atmosphere. Thus, the pipe stress analysis and the resulting support design and analysis should be complete in input, modeling, consistency, and compliance with licensing commitments.

The team also reviewed hand calculation reports which analyzed (1) non-nuclear safety class I piping, (2) heat exchanger vessel nozzle thermal displacements and (3) local stress analysis of a support welded to a pipe. Calc Set No. 1217-4-4"-365 (Reference 3.41) represents the 1217-4-4" (Reference 3.80) piping line which runs from pipe support 1217-SG-12 to support 1217-SG-206. The hand analysis concerns itself with a frequency calculation, and maximum stresses and loads for pressure, dead-weight, thermal and seismic loading conditions. At the time of analysis no formal procedure for the stress analysis and load calculations for non-nuclear safety class I piping was available. Since then, a procedure has been generated: "Preparation, Documentation, and Control of Pipe Stress & Load Calculations," (Reference 3.40) which establishes methods for the documentation and control of non-nuclear safety class I pipe stress and load calculations. The hand analysis was basically compatible with the more formal procedures, and acceptable in its results.

As reported in Finding 3-13, no formal calculation was available for the heat exchanger CBS-E-16A nozzle displacements due to thermal growth. The Nuclear Design Group recently issued such an analysis, calculation 43539-F (Reference 3.56), which calculated thermal nozzle displacements for all nozzles for the normal operating, upset and emergency conditions. The team found the analysis to be acceptable.

The team reviewed calculation 1217-RG-08 (Reference 3.39) for the local stresses at stanchion #1217-SG-08 of piping line 1217-1-301-4" (Reference 3.61). The purpose of the analysis was to substantiate that local stresses which result from a 3" trunnion, welded to and transferring loads to a 4" pipe, meet the ASME Code requirements. Section 4.4 of Welding Research Bulletin No. 107 (Reference 3.72) emphasizes that the nondimensional curves used for stress calculations do not go beyond 0.5 for beta and should not be used beyond this limit. Thus the assumption used in calculation 1217-RG-08 (Reference 3.39) which states that going beyond the 0.5 limit of beta will produce conservative stresses is not justified. However, for this particular analysis, no stress problems should result from a reevaluation, due to the high level of conservatism and the moderate level of stresses (Finding 3-18).

In summary, a number of the Findings detailed in Subsection 3.3 involved failure to model piping subsystems in accordance with in-house procedures (Findings 3-14, 3-15), failure to document assumptions in similarity of geometry and loads for different piping subsystems (Finding 3-16), and failure to consider the effect of waterhammer analysis (Finding 3-12).

The technical significance of these Findings cannot be established a priori. Reanalysis is required to confirm the integrity of the piping and supports.

3.4 Piping Supports

This Subsection summarizes the review conducted to verify the design adequacy of the pipe supports for the containment building spray system.

The preliminary pipe support locations, restraint directions, and types are initially detailed on piping isometric drawings prepared by the Nuclear Project group for nuclear island piping, and by the Mechanical Project Group for turbine plant piping. The Mechanical Analysis Group performs a detailed stress analysis of the various subsystems shown on the piping isometric drawings in accordance with United Engineers DEDP 2607 (Reference 1.2). The magnitudes of the pipe reactions derived from this initial stress analysis are sent to the Pipe Support Design Group, which designs and details the pipe supports and performs analysis required to verify the support stiffness and frequency. The pipe support drawings are then issued for construction. At the site, the United Engineers Site Group prepares a pipe support fabrication drawing which is issued to Pullman Power Products for fabrication and erection. Any out-of-tolerance deviation between the fabrication drawing and the as-built configuration will be detailed on that drawing when Pullman Power Products performs the 100 percent as-built walkdown.

United Engineers Pipe Support Design Guidelines (Reference 1.4) provide technical support and help insure conformance to United Engineers design criteria. As detailed in Reference 1.4, all pipe supports are required to exhibit a certain minimum stiffness, varying from 1X10E4 to 1X10E6 lbs/in., which is a function of the size of the restrained pipe. Reference 1.4 also requires that supports exhibit a fundamental frequency of not less than 33 Hz (see also Subsection 3.9(B).3.4.a.1 of the FSAR), and defines the support configuration. The structural response of the supporting structure is considered to be separately addressed by the generation of amplified response spectra.

The control exerted over the United Engineers design and analysis of pipe supports was considered to be excellent, as a general rule. The sample calculations reviewed indicated an awareness of, and conformance with, the design guidelines detailed in Reference 1.4.

All material requested was rapidly obtained, and with minor exceptions, was found to be controlled in accordance with the procedures detailed in United Engineers Procedure for Preparation, Documentation and Control of Pipe Support Group Calculations (Reference 3.27).

Pipe support M/S 1214-SG-63 is attached to the underside of a W12X79 beam, and supports two 8" lines in both the vertical and transverse directions, line nos. 1214-2-301-8" and 1216-2-801-8". The location and configuration of the pipe support are detailed on pages 5 and 6 of Calculation Set No./Support No. M/S-1214-SG-63, Rev. 3, dated 08/15/83 (Reference 3.88). United Engineers Piping Isometric Drawing 9763-D-801214, Rev. 6, dated 07/07/82 (Reference 1.21), details a top of steel elevation of (-) 7'-10" for the W12X79 beam. United Engineers Piping Isometric Drawing 9763-D-801216, Rev. 7, dated 07/07/82 (Reference 1.21), details a top of steel elevation of (-) 8'-4" for the same W12X79 beam. The discrepancy in the top of steel elevation of the W12X79 beam shown on these piping isometric drawings should be resolved. United Engineers containment steel framing plan drawing 9763-F-102316 Rev. 6, dated 03/17/82 (Reference 3.89) confirms that the top of steel elevation for the W12X79 beam is (-) 8'-4" (Finding 3-19).

United Engineers analyzed piping is normally subjected to a seismic event (operating basis or safe shutdown) by applying amplified response spectra at each of the pipe reaction and anchor points of the piping mathematical model, and generating the envelope of these spectra as the bounding seismic event. The validity of this approach rests on the important assumption that there will be no significant dynamic interaction between the supporting structure and the attached pipe. Subsection 3.7(B)2.3 of the FSAR, Procedures Used for Analytical Modeling, notes that: "Equipment having relatively small mass or high frequency are decoupled from the supporting structure, but their mass is included with the supporting system. The major equipment systems, whose stiffness, mass and frequency have significant dynamic interaction with the supporting structure, are included in the detailed model of the structure. In such cases, a detailed equipment model is coupled with the supporting structure model. As an example, the containment concrete internals are coupled with the NSSS model." The seismic analysis performed on the pipe configuration which is detailed on the piping isometrics, cited in Finding 3-19, decouples the pipe from the support steel shown on the steel framing plan. The basis for this approach is detailed in Subsection 3.7(B).3.3 of the FSAR. The United Engineers basis for the preliminary design of support steel is to select a beam size, in conjunction with a best estimate of the applied loads, which yields a fundamental frequency of not less than 20 Hz for the beam. Support steel is subject to a final check under the beam verification program. In general, the dynamic interaction yields higher responses than the uncoupled model. Therefore, the team recommends that an analytical model which couples the support steel and the attached pipe be analyzed to confirm that the default (uncoupled) seismic analysis yields sufficiently conservative support loads and pipe stresses. (Unresolved item 3-3).

The team also noted that the effect of the torsional moments induced in the W12X79 support beam by the vertical and lateral seismic loads is not addressed in Calculation Set No./Support No. M/S-1214-SG-63, Rev. 3, dated 08/15/83 (Reference 3.88). The W8X31 and W10X33 beams frame into the W12X79 support beam at the location of the pipe support with shear connections, so that full torsional restraint cannot be assumed. The ability of the connections to adequately resist the applied torsional loads must be assured (Finding 3-20).

Pullman Power Products Document No. III-4, Rev. 19, dated 10/14/83, Subsection 3.5.2 (Reference 3.90), notes that all piping isometric drawings for field installation that had been previously generated by Pullman Power Products would be turned over to United Engineers after 01/17/83, to be controlled (voided, revised, issued) by United Engineers after that date. Two such examples of these drawings are Pullman Power Products Isometric Drawing No. CBS-1213-01, Rev. 9, dated 11/01/83 (Reference 3.91) which carries the note "U.E.&C. Drawing as of Rev. 7", and Pullman Power Products Isometric Drawing No. CBS-1213-02, Rev. 2, dated 01/14/83 (Reference 3.92), which carries the note "U.E.&C. Drawing as of Rev. 12". Neither of these drawings carries a P.E. stamp. This is in violation of the United Engineers Nuclear Quality Assurance Manual, subsection 3.2 (Reference 1.55), which mandates certification of pipe erection drawings by a Registered Professional Engineer. This is not technically significant, but represents a discrepancy in the handling of the field installation drawings that should be resolved (Finding 3-21).

3.5 Bingham-Willamette

During the inspection a visit was made to the Bingham-Willamette Company, the manufacturer of the containment building spray pumps. This visit provided the team with an opportunity to sample the design and control procedures employed by vendors of mechanical equipment for the Seabrook Station.

Discussions with Bingham-Willamette pertained to Findings 3-3, 3-4, and 3-5, and assurance of pump operability during specified thermal transient conditions. The Findings derived from that portion of the inspection are reported in Subsection 3.2. Results related to pump operability derived during the inspection at United Engineering are also contained in Subsection 3.2. The remainder of this Subsection summarizes the results of the inspection conducted at Bingham-Willamette related to pump operability.

Bingham-Willamette stated that the containment building spray pumps had been properly designed and would operate during the thermal transient conditions specified in United Engineers Specification 9763-006-238-3 (Reference 3.2). The Bingham-Willamette statement was based on the results of thermal transient testing of a larger Bingham-Willamette pump of similar design. Review of the test data for the larger Bingham-Willamette 12x14x23 CD pump showed that the pump was subjected to two cycles of a thermal transient consisting of a change in temperature from 60°F to 290°F in approximately 5 to 6 seconds at a flow rate of 2900 gpm. The transient rate decreased from approximately 200°F/Sec at the start of the transient to approximately 10°F/sec at the end of the transient. This transient is similar to the actual transient to which the containment building spray pumps could be subjected during plant faulted operation, as specified in United Engineers Specification 9763-006-238-3 (Reference 3.2). The test results could therefore be used as a reasonable basis for extrapolation to the smaller B-W 6x10x14B-CD Seabrook Station containment building spray pumps.

Bingham-Willamette indicated orally to the team that "rubbing" occurred at the impeller and casing wear rings during the thermal transient testing of the larger pump as initially designed. The pump was subsequently modified to increase the clearances between the wear rings and was then successfully tested. The modified clearances were purportedly in accordance with the requirements of API Standard 610 (Reference 3.87). This standard specifies a minimum diametral clearance of 0.020 in. for rotating members with diameters between 8.000 to 8.999 inches for cast iron, bronze hardened 11 to 13 percent chromium, and materials of similar galling tendencies. The standard recommends an additional 0.005" diametral clearance for materials having greater galling tendencies and special considerations for pumps designed for temperatures of 500°F and higher. It was noted that the as-machined (unmounted) clearances at the wear rings were in accordance with API Standard 610 (Reference 3.87), but that the as-mounted clearances were unknown. Dimensions which determine the clearances for the two pumps under consideration are detailed on Bingham-Willamette drawings B-35614 and A-50329 (References 3.111, 3.112) for the Bingham-Willamette 6X10X14B-CD pump, and on Bingham-Willamette drawings A-47638 and A-47639 (References 3.113, 3.114) for the larger (modified) Bingham-Willamette 12X14X23-CD pump.

Based on the as-machined dimensions, it would appear that the clearances in the Seabrook containment building spray pumps are adequate to assure their operability during the specified thermal transient. However, since operability should be based on the as-mounted clearances rather than the as-machined clearances, and since the as-mounted clearances for the Seabrook Station containment building spray pumps are not known, no conclusion regarding their operability under the specified thermal transient can be drawn. United Engineers should obtain the as-mounted dimensions of the containment building spray pumps, or perform a thermal transient test, in order to resolve this item (Finding 3-22).

3.6 PX Engineering

The team visited PX Engineering in order to review the design, analysis and fabrication of the containment sump isolation valve encapsulation vessel, which was procured in accordance with United Engineers Specification 9763-006-248-47 (Reference 3.73). This specification called for four encapsulations to be furnished in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section III, Subsection NC (Reference 3.98), and NRC Regulatory Guide 1.48 (Reference 3.115). Each encapsulation surrounds a containment sump isolation valve and operating mechanism in order to prevent the release of radioactive fluid or gas to the environment in the event of a plant faulted condition. Electrical aspects of the vessel are discussed in Section 5 of this report. Mechanical aspects are discussed below.

The encapsulation stress report generated by PX Engineering (Reference 3.74) was reviewed by the team, as well as associated correspondence between PX Engineering and United Engineers (Reference 3.116). The stress report detailed a seismic analysis per United Engineers Specification 9763-SD-248-47 (Reference 3.75), and verified the wall and head thickness of the encapsulation, as well as the support design, in accordance with Specification 9763-006-248-47 (Reference 3.73). The Hydro Test Procedure (Reference 3.76) and Halogen Leak Test Procedure (Reference 3.77) employed by PX Engineering were also reviewed to verify consistency with Specification 9763-006-248-47 (Reference 3.73). The team also reviewed the PX Engineering Quality Assurance Manual (Reference 3.78).

The team noted a discrepancy between the encapsulation weights (empty, and filled with water) calculated in the stress report (Reference 3.74), and the vessel weights tabulated on a PX general arrangement drawing (Reference 3.79). The calculated vessel weights given on page 3-1 of the referenced stress report are 5307 lbs. empty and 14113 lbs. full of water. The vessel weights listed on the PX Engineering general arrangement drawing (Reference 3.79) are 2900 lbs. empty and 11700 lbs. full of water. This is considered to be a random error which is not technically significant (Finding 3-23).

3.7 ITT Grinnell

The team visited ITT Grinnell in order to review the pipe support reverification work that ITT Grinnell performed for United Engineers. The United Engineers Engineering Assurance Program Status Report dated 08/31/83 (Reference 1.59) summarizes the status of items requiring corrective action. Item 9 of that status report (extracted from United Engineers Report No. NHE-14, evaluated on 7/12-8/29/82 (Reference 1.60) notes that: "A large number of pipe supports have been designed prior to 2/80, whose stiffness may not meet the requirements of the piping specification. Four of five randomly selected CBS supports fell into this category. This, in addition to the delays in incorporating ARS data into stress analysis, bring into question the supports already manufactured and installed in the field. PSNH has contracted to have the 1700+ supports installed."

The Status column of the reference report notes: "Resolved - ITT Grinnell analysis is complete. UE&C review/redesign effort is 80% complete." The contract for the verification work performed by ITT Grinnell on behalf of

United Engineers was issued as Change Order No. 42 to United Engineers Purchase Order 9763-006-248-8, dated 06/01/82 (Reference 3.12). The last paragraph in that Change Order requires that: "Seller shall prepare a Technical Specification incorporating the Technical Criteria for the verification analysis and a description of the techniques to be used by Seller to perform the analysis and documentation of the analysis. This Technical Specification shall be reviewed and accepted by Purchaser prior to work." ITT Grinnell subsequently prepared Document SB-001, Technical Specification for Reverification of Supports (Reference 3.28) and Rev. 2 of that document controlled the pipe support verification work performed by ITT Grinnell for United Engineers. ITT Grinnell began work on 04/26/82 and completed the verification effort on 03/15/83.

The team reviewed a sample of the calculation packages prepared by ITT Grinnell and generally found these packages to be properly controlled, and in conformance with ITT Grinnell Document SB-001 (Reference 3.28).

A sample of twelve reverification packages prepared by ITT Grinnell was reviewed to determine if the STRUDL computer program coding for the pipe support geometry and loads had been signed by the preparer and checker. The package for support 1201-RG-07, Rev. 7, run 1 of 2 (Reference 3.93), had been signed by the preparer but not the checker. The package for support 1201-SH-1, Rev. 3, run 1 of 1 (Reference 3.94) was not signed by the preparer or checker. These two examples violate Procedure QCES-2.3.3 of the ITT Grinnell Corporation Engineering Services Quality Assurance Manual, Rev. 1, dated 02/14/83 (Reference 3.42). The technical accuracy of all packages prepared by ITT Grinnell should be confirmed by United Engineers (Finding 3-24).

The ITT Grinnell Engineering Standards, Design Policy Procedures, and Rework Procedures that formed the technical basis for the ITT Grinnell reverification program, and which were listed in Section 3 of ITT Grinnell Technical Specification SB-001 (Reference 3.28) were not reviewed or examined by Yankee Atomic, as noted orally by ITT Grinnell technical staff. This is contrary to the requirement of Change Order No. 42 to United Engineers Purchase Order 248-8 (filed on behalf of Yankee Atomic, the purchaser), dated June 1, 1982 (Reference 3.43) which requires that: "This technical specification shall be reviewed and accepted by Purchaser prior to work." This is also contrary to subsection 2.1.1.5 of the Yankee Atomic Quality Assurance Manual, Rev. 2, dated 03/31/78 (Reference 3.119), which requires that: "Provisions of technical documents by the vendor shall be examined." The team therefore concludes that the review conducted by Yankee Atomic was deficient, since it did not adequately address the design and analysis procedures that were to be used by ITT Grinnell to perform the reverification work for United Engineers. (Finding 3-25).

The pipe support reverification packages prepared by ITT Grinnell for United Engineers did not consider frictional effects for thermal movements less than 1/16". Two such examples are contained in the United Engineers calculation sets for support nos. 326-SG-01, Rev. 1, dated 05/12/83 (Reference 3.95), and 179-SG-04, Rev. 3, dated 09/22/83 (Reference 3.96), which include both the ITT Grinnell calculations, and the United Engineers closeout calculations which subsequently address frictional effects not considered by ITT Grinnell. This is contrary to subsection 5.1 of ITT Grinnell Technical Specification SB-001

(Reference 3.28), which requires that friction be evaluated for all cases where thermal movement does not equal zero. This is not technically significant, as the magnitudes of the corresponding loads are low. However, United Engineers had committed to consideration of frictional force due to thermal movement in Subsection 3.9(B).3.4.a of the FSAR (Finding 3-26).

ITT Grinnell support calculation for pipe Support No. 1203-RG-8, Rev. 8, dated 09/03/82 (Reference 3.45), was reviewed for technical content. The calculations for the principal moments of inertia and section moduli for the 6x4x½" angle detailed on page 10 of this calculation were found to be incorrect. The calculated value of the principal moment of inertia is 17.33 in^4 while the correct value is 20.07 in^4. This data is subsequently input to the STRUDL run dated 09/07/82, which forms a part of this calculation package. This is considered to be a random error and is not believed to be technically significant, since there is not a substantial difference between the calculated and the correct moments of inertia (Finding 3-27).

ITT Grinnell support calculation for pipe support no. 1203-RG- 3, Rev. 5, dated 09/03/82 (Reference 3.44), was reviewed for technical content by the team. The calculation for the support stiffness in the negative Z direction given on page 6 is inadequate and possibly incorrect, due to the use of displacement data generated by a STRUDL run which specifies an insufficient number of significant figures. The specific stiffness in the negative Z direction is the ratio of the 1000 lbs. applied as a load in the negative Z direction in the STRUDL model to the resultant displacement of 0.001 inches output by the STRUDL model. This ratio yields a stiffness in the negative Z direction of 1x10E6 lbs/in, which is the magnitude of the minimum stiffness allowed for this support. However, due to roundoff, the magnitude of the displacement could be as high as 0.00149 inches, which would yield a corresponding stiffness of 0.67x10E6 lbs/in, causing the support to fail the minimum stiffness criterion of 1x10E6 lbs/in. This appears to be a systematic error. It is probably not technically significant, since the variation between the calculated and actual stiffnesses is not substantial, and pipe stress analyses are not sensitive to minor variations in the magnitudes of the support spring constants. However, United Engineers had committed to minimum support design stiffnesses in Subsection 3.9.(B).3.4.a.1 of the FSAR (Finding 3-28).

3.8 Conclusions

On the basis of the review conducted in the mechanical components area, a total of twenty-eight findings and three unresolved items were formulated. The team concluded that the design process in this area is generally controlled. However, nine of these items are deemed to have potential technical significance, since their resolution could possibly necessitate re-design. These items are summarized below.

The team recommends that the containment building spray pump be monitored during preoperational testing to assure proper functioning subsequent to its repair after immersion, as discussed in Unresolved Item 3-1. The functional integrity of the bolted joints detailed in Finding 3-6 should be demonstrated. The functionality of the containment sump isolation valves and their actuators under possible immersion should be addressed as delineated in Finding 3-10. Closure of the containment isolation valves in 10 seconds (Finding 3-11) during the operation of the containment building spray pumps should be reviewed. Waterhammer loads, correct modelling procedures and documentation of all assumptions should be addressed in all needed piping reanalysis (Findings 3-12, 3-14 and 3-16). Dynamic interaction between support steel and attached pipe (Unresolved Item 3-3) should be addressed. Finally, the functional adequacy of the containment building spray pump under specified thermal transient loadings (Finding 3-22) should be confirmed.

4. CIVIL AND STRUCTURAL

The objectives of this portion of the integrated design inspection were to evaluate the civil and structural engineering practices and technical execution of the design with specific emphasis upon control and exchange of information within the project. The team inspected areas defining whether (1) regulatory requirements and design bases as specified in the license application have been correctly translated and satisfied as part of specifications, drawings, and procedures, (2) correct design information has been provided both internally and externally to the responsible design organizations including selected off-site subcontractors, (3) design engineers had sufficient technical guidance to perform assigned engineering functions and (4) design controls, as applied to the original design, have also been applied to design changes, including field changes. These objectives were accomplished by selecting a sample of structural elements which make up the building structures or are supporting mechanical, electrical, and instrumentation and control systems and equipment being reviewed by team members in those specific disciplines. This sampling was also used to assess the interdisciplinary interface design control exercised on the Seabrook Project.

4.1 Design Information

The objectives of this phase of the inspection were to evaluate, based on specific examples, how the basic civil-structural design criteria taken as input from such sources as the NRC regulations, the General Design Criteria, Regulatory Guides, the Standard Review Plan, Branch Technical Positions and industry codes and standards and committed to in the FSAR have been incorporated into design documents and design and quality control procedures. Where possible commitments were selected from the FSAR as they relate to the civil-structural discipline design effort relative to the containment building spray system. Where it was not possible to relate directly to the containment building spray system, basic structural commitments and elements were selected for review. Also included in the objectives of the inspection was an evaluation of the involvement of Yankee Atomic as the agent for Public Service Company of New Hampshire in the major design effort delegated to United Engineers. United Engineers, the Seabrook architect-engineer, was the major design organization reviewed during this inspection. Interfaces and information flow between the various organizations involved in the design were also defined and evaluated in order to assess design control mechanisms.

In the civil-structural discipline, the basic document used in design of the containment structure was the American Society of Mechanical Engineers, Boiler and Pressure Vessel Code, Section III, Division 2, "Code for Concrete Reactor Vessels and Containments", 1975 Edition (Winter 1975 Addenda for containment liner; Winter 1976 Addenda for reinforced concrete) (Reference 4.1). For other reinforced concrete structures, the American Concrete Institute, ACI 318-71, "Building Code Requirements for Reinforced Concrete" (with Commentary) was used (Reference 4.2). For steel structures the American Institute for Steel Construction (AISC), "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings," 1969 Edition (including supplements 1, 2 and

3) was used (Reference 4.3). For quality requirements the applicant committed to use American National Standards Institute N45.2-1974, "Quality Assurance Program Requirements for Nuclear Power Plants" (Reference 1.119). These commitments are contained in Sections 3.8.1.2, 3.8.3.2 and 3.8.4.2 of the FSAR.

The team reviewed the involvement of Yankee Atomic in the civil-structural aspects of the plant design by reviewing a sample of the basic design control and quality assurance documents and by a review of a sample of work completed by Yankee Atomic in carrying out their responsibility to control the design of the facility, provide construction coordination and execute their quality assurance functions.

The principal documents providing for the implementation of all quality assurance aspects of the Seabrook plant for Yankee Atomic are the project policies (Reference 1.46 & 1.47 series and 1.48 & 1.49) and the Seabrook Quality Assurance Manual (Reference 1.45 series). The project policies provide guidelines for implementation of the specific phases of the quality assurance system and describe the processing of documents such as engineering review reports, filing of documents, and handling of engineering documents. The Quality Assurance Manual establishes the procedures for the internal and external quality controls of Yankee Atomic such as the scope and frequency of audits, interface controls, and provides guidelines for the review of specific categories of documents.

The team reviewed the series of procedures contained in the Yankee Atomic Quality Assurance Manual, Section 3 on Design Control. This series of procedures, Procedures 3.1 (Reference 1.45.2), 3.2 (Reference 1.45.3) and 3.3 (Reference 1.45.4), defined the documents which Yankee Atomic would review and defined the method of resolving comments on those documents and defined the methods of controlling interfaces between contractors for the Seabrook Project. The team concluded that these procedures were adequate to define the design control mechanisms in the production of design documents in the civil-structural discipline.

The team focused on seven of twenty-nine specifications and one purchase order in the civil-structural area which had been prepared by United Engineers and reviewed by Yankee Atomic. The documents reviewed were (1) 006-12-5, "Fabrication of Safety-Related Structural Steel Work" (Reference 4.4); (2) 006-13-2, "Containment Concrete Work" (Reference 4.5); (3) 006-13-3, "Category I Concrete Work Other Than Containment" (Reference 4.6); (4) 006-14-2, " Installation of Reinforcing Bars in Containment Structure" (Reference 4.7); (5) 006-14-3, "Installation of Reinforcing Bars in Category I Structures (Other Than Containment) (Reference 4.8);" (6) 006-18-1, "Furnishing of Miscellaneous Embedded Steel and Weldments" (Reference 4.9); (7) 006-18-14, "Anchor Plates and Embedded Plates in Containment" (Reference 4.10); and (8) 006-80-1, "Containment Design" (Reference 4.11). Three of the eight documents had been designated via the Yankee Atomic project policies ("UE&C Specification Review List", Project Policy No. 5, Reference 1.47), as requiring an engineering review form, meaning that each document was to have documented evidence of the Yankee Atomic review. The remainder of the sample did not require a documented review within the Yankee Atomic project files for Seabrook. For all of the eight documents the team found evidence in the records that Yankee Atomic had provided technical comments and input into the development of the detailed specifications and orders for materials, fabrication and field construction of items in the civil-structural discipline. In addition, when changes were made in the specification or the associated purchase order, Yankee Atomic was responsible for accepting the changes. One example of control exercised by Yankee Atomic over the design process was on the subject of the use of Code Cases for the application of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section III, Division 2 (Reference 4.1), to the containment. Since approval for the use of Code Cases must be given by the NRC, Yankee Atomic had exercised control over United Engineers to assure that the Code Cases utilized were acceptable to the NRC. The team reviewed a series of letters between United Engineers and Yankee Atomic related to this particular item during its inspection of Yankee Atomic (References 4.12 through 4.17).

The team noted that the Yankee Atomic "Drawing Review List", Project Policy No. 7 (Reference 1.47.2) required no review of structural design drawings. The team did, however, review the actions taken by Yankee Atomic on a sample of engineering change authorizations on which Yankee Atomic had exercised control over United Engineers. The actions taken by Yankee Atomic of the sample reviewed were judged to be acceptable.

The team also reviewed an audit report by Public Service and Yankee Atomic of an audit conducted on July 26, 1973 at United Engineers' offices in Philadelphia, Pennsylvania. The purpose of the audit was to verify disposition of the open items of the previous two internal audits of design control. The report (Reference 4.18) discussed three items identified in the previous audit, conducted on May 15, 1973 which had not been satisfactorily resolved. No new open items were found during the audit. In a subsequent letter, dated August 30, 1973 (Reference 4.19), United Engineers discussed the proposed resolution of the items covered in the subject audit report demonstrating completed corrective action. The team noted that the identification of the staff conducting the audit and as stated in the audit report was not made by full name or by title, but by their initials. The team found that such identification of personnel makes it at least extremely difficult and sometimes impossible to trace down the people involved. The team did, however, judge that the audit had been adequately performed.

Design information developed by United Engineers from the commitments in the FSAR were reviewed by the team. The basic document addressing the civil-structural discipline area is listed as a system description on the Seabrook project system description master index. The document is known as the Structural Design Criteria, SD-66 (Reference 1.3). Several discrepancies between the FSAR commitments and the Structural Design Criteria were found as well as internal inconsistencies within the Structural Design Criteria document. The team also found that these problems had been translated into the calculations. From the team's effort on this aspect of the inspection the confusion appeared to be limited to the safety classification and design loads for the tank farm structure. Provided below is a summary of the problems found by the team in tracking the development of design criteria to design procedures and finally to a completed design for seismic loads, live loads and tornado loads.

Table 3.2-1 of the FSAR lists as Category I structures, the foundations and dikes of the refueling water storage tank. Absent from the list of seismic Category I structures is the structural steel frame and roof system of the tank farm, indicating it is apparently acceptable for them to be non-seismic Category I. The FSAR in Section 3.2.1 states that several non-seismic Category I structures are designed against collapse onto seismic Category I structures due to safe shutdown earthquake loadings and that details are in Section 3.7(B).2 of the FSAR. A specific review of Section 3.7(B).2.8 indicated that "all non-seismic Category I structures which, due to their proximity to seismic Category I structures could possibly compromise the safety function of the seismic Category I structures by their collapse, are either designed to collapse away from the adjacent seismic Category I structures or are designed for the safe shutdown earthquake loading." Table 3.7(B)-22 indicates that the tank farm area steel framing over the refueling water storage tank is designed not to collapse into the Unit 1 primary auxiliary building.

The Structural Design Criteria, SD-66 (Reference 1.3) indicates in Section 3.1.24 that on November 30, 1982 when Revision 1 was made to the document, the tank farm area, including the concrete and main steel framing (the entire structure), was categorized as seismic Category I. This meant upgrading the structural steel portion of the structure from non-seismic Category I to seismic Category I. In Table 3.3.-2, which tabulates the loads applicable to non-Category I structures, there is an entry for the tank farm area, Unit I structural steel framing which indicates the design is to be under the provisions of the Uniform Building Code which is not consistent with seismic Category I design requirements.

The tank farm structural steel is seismic Category I based on Section 3.1.24 of the Structural Design Criteria, SD-66 (Reference 1.3). The calculations and drawings are all classified as seismic Category I which was apparently the design intent at the time of the inspection. The design load combinations listed in the calculation for the tank farm structural steel, Calculation No. WB-61, Sheet 10 of 79, dated September 28, 1978 (Reference 4.20) omits load combinations containing the safe shutdown earthquake. This violates the Structural Design Criteria, SD-66, Table 5.4-2 (Reference 1.3) in that two load combinations that must be considered contain the safe shutdown earthquake loads. (Finding 4-1)

The team reviewed the treatment of live loads for the Seabrook Project. The FSAR in Section 3.8.3.3 in addressing design loads on structures inside containment indicates live loads are only present during shutdown conditions. FSAR Section 3.8.4.3 in addressing design loads on Category I structures other than containment utilizes the normal definition of live loads. The Structural Design Criteria, SD-66 (Reference 1.3), indicates that the minimum floor live load is 100 pounds per square foot, except in the administration building. In actuality, only two floor areas utilize live loads in combination with seismic loads as a result of an exception taken in Table 4.2-1.

The use of zero live load for most floors when considering load combinations which include earthquake loads, on the basis that there will be no permanent live loads during plant operation is considered to be erroneous considering situations which can occur during plant operations. This means that in reality no moveable equipment, personnel, or material can be placed on the plant's Category I floors except the control building at Elevation 75 feet during operation. The team recognizes that there are no doubt available live load capacities on the various floors as a result of the development of the design with respect to actually knowing all loads such as fixed equipment, piping, and cable trays. The value of these available capacities are, however, apparently unknown in each area of the plant. This would not mean the structures are unsafe under the final as-built loads, but it would dictate that the plant operations staff could not allow moveable equipment, stored material or other similar moveable loads to be placed on any Category I floor except in the control building at Elevation 75 feet during operation until the margins are known. This situation is noted as a generic finding applying to all Category I structures at Seabrook. (Finding 4-2)

Based on the current information the team recommends that the technical specifications for plant operations place live load control limitations on the plant operators. It is recommended that in order to resolve this finding, the licensee consider alternatives such as determining the actual live loads which the floor areas can tolerate under seismic conditions and still meet the stress allowables or structural capacities. United Engineers has, at the time of writing this report, orally informed the team that they have undertaken a review of this matter. The new facts and information since the inspection was completed should be addressed in the response to Finding 4-2.

With regard to tornado loads the FSAR in Table 3.3-4 indicates that the tank farm area structural steel framing over the refueling water storage tank is a non-Category I structure designed to collapse in such a manner as to fall away from the primary auxiliary building due to tornado wind loading. Additionally, Section 3.3.2.3 of the FSAR prescribes a special design procedure for non-Category I structures under tornado loadings in which roof slabs are considered to be expendable under tornado loadings but the steel frame and one-third of the siding are to remain intact and not collapse.

The Structural Design Criteria, SD-66 (Reference 1.3), in Section 3.1 lists Category I structures with two footnotes, (1) and (2), which are utilized to denote those structures in Section 3.1 which are not designed for tornado missiles or for tornado loads. Item 3.1.24 for the tank farm area (concrete and main steel framing) has no notation of Note (1) or (2) applying which would mean that the complex is designed to resist all tornado effects. However, Table 3.3-2 indicates that the tank farm area (steel framing) is designed to resist tornado pressure, but not tornado missiles. Additionally, Section 4.4.2.6 which addresses the design procedure for non-Category I structures indicates the roof is expendable during a tornado and can be allowed to become detached or fail. This would mean the concrete roof slab could generate missiles.

Based on the above information and that found while reviewing the calculations for the tank farm structural steel the team noted that the criteria had not been followed. The calculation for the tank farm structural steel, Calculation No. WB-61 (Reference 4. 20), indicates no design for tornado loading for the structural steel framing of the tank farm area. This was found to be inconsistent with Section 3.1.24 (including footnotes (1) and (2)) of the Structural Design Criteria, SD-66 (Reference 1.3) which indicates the steel framing is designed for tornado loads. (Finding 4-3)

As a result of the inspection United Engineers stated to the team orally that the operating basis earthquake load combination always controls for the design of the structural steel beams. They also indicated that this statement, with a justification, will be incorporated into the structural design calculations; however for bracing it is not clear that the operating basis earthquake will control the design. United Engineers has stated that the design of the tank farm area structure is under re-evaluation as a result of the inspection. The latest facts in this matter should be confirmed in the response to Findings 4-1 and 4-3.

In reviewing procedures used to implement the design criteria the team discovered two manuals in violation of the United Engineers' own internal procedures. Controlled Copy #38 of the United Engineers Administrative Procedures (Reference 1.56) for the Seabrook Project was missing a memorandum dated January 31, 1974 included as the fifth revision of "Control of FSAR Commitments," United Engineers Administrative Procedure No. 20 (AP-20) (Reference 1.121) on October 1, 1975. This memorandum was to exist as part of AP-20 to indicate that "Preparation of Specifications," United Engineers General Engineering and Design Procedure No. 0015 (GEDP-0015), Rev. 2, dated April 28, 1975 (Reference 1.100) replaced AP-20. Controlled copy #38 was missing page 27-2 of "General Administrative Procedures," United Engineers Administrative Procedure No. 27 (AP-27 (Reference 1.117) and also page 30-3 of "Control of PSAR Deviations," United Engineers Administrative Procedure No. 30 (AP-30) (Reference 1.122). Controlled copies #38 and #46 were missing, "Safety Related Calculation Closeout Program," United Engineers Administrative Procedure No. 53 (AP-53) (Reference 1.123). The ommissions are violations of "Controlled Documents," United Engineers Administrative Procedure No. 23 (AP-23) (Reference 1.85), which provides for assuring that the United Engineers Administrative Procedures Manuals are complete and current. This finding represented two of two samples examined as not being current. No direct effects on the design were found as a result of these items. (Finding 4-4)

Based on information at the time of the inspection, it appeared the documents had been sent to individuals in an incomplete condition when the controlled copy had been assigned. Consideration should be given to conducting a systematic review and updating of all controlled copies of the Administrative Procedures Manuals.

During the review of documents providing for or addressing the basic design criteria information, design input and design execution the team located documents in the structural subject files appearing to be what the team would consider as design documents or technical memoranda which did not appear to be controlled under the requirements of the "Correspondence Control System," United Engineers Administrative Procedure No. 2 (AP-2) (Reference 1.82). This procedure states that "all technical correspondence whether it is a letter, telecopier or internal memorandum will be controlled by the Project Document Control Center." It further states that "by definition, Technical Memos are those dealing with the technical aspects of engineering and/or design effort of the project." The team concluded that the internal memoranda listed in References 4.21 through 4.28 were not controlled as required. The subjects addressed ranged from a letter discussing what should be stated in the FSAR with regard to the effect of tornado loads and seismic loads to the need to change fasteners for blow-out panels in the main steam feedwater pipe chase. (Finding 4-5)

Based on this finding the team is of the opinion that the structural subject files should be carefully reviewed for material which should be controlled under United Engineers Administrative Procedure No. 2 (Reference 1.82) and those documents meeting the requirements be placed in the Document Control Center as well as being evaluated for project impact.

Four instances of misfiled information within the structural subject files were found by the team. Material found in Index 1.2.5 instead of 11.7.1.5, in Index 1.0.1.28 instead of 1.1.4, in Index 1.0.1.33 instead of 1.0.3.3 and in Index 1.0.1.23 instead of 1.0.1.27. This is not a finding or an unresolved item but an item which the licenssee may wish to consider. (Observation 4-1)

The team concluded that the design criteria committed to had been adequately incorporated into design documents except as noted in this report. Design procedures to control the design execution of the Seabrook Project except as noted in the findings related to the treatment of live loads, and the classification of the tank farm structural steel and the effects of tornado loadings on that structure also appear to be adequately controlled. The interfaces and flow of information between Yankee Atomic and United Engineers was judged to have been more than adequate and the team determined that the Yankee Atomic control over the design effort by United Engineers was adequate. It appeared that Yankee Atomic had provided satisfactory control over the development of the various specifications for materials and for fabrication and construction in the civil-structural discipline.

4.2 Seismic Analysis

The objective of this portion of the inspection was to examine the adequacy and coordination of the seismic analysis, design, and the resulting floor response spectra for the containment structure including the interior structures and the tank farm area which houses the refueling water storage tank and the spray additive tank.

The seismic analysis review began with the team reviewing the basic seismic data and assumptions regarding the specified earthquakes. Since there are no existing earthquake records pertinent to the Seabrook site as indicated in FSAR Section 3.7(B).1.1, the seismic input was defined at the bedrock in form of the design response spectra for the operating basis earthquake and the safe shutdown earthquake in conformance with Regulatory Guide 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants, (Reference 1.124). The duration of the earthquake was estimated at 10 to 15 seconds as indicated in Section 3.7(B).1.1 of the FSAR. The type of engineered backfill used under all seismic Category I structures is stated in FSAR Section 3.7(B).1.4 to be fill concrete, with an exception of safety-related electrical duct banks, electrical manholes and the service water pipes which were founded on off-site borrow or tunnel cuttings. The team found that both the time-history and the response spectrum analyses were performed for the operating basis earthquake and the safe shutdown earthquake conditions as indicated in FSAR Section 3.7(B).2.2. The critical damping ratios used for the seismic analyses are those provided in Table 3.7(B)-1 of the FSAR for the operating basis earthquake and for the safe shutdown earthquake. These were noted as being in conformance with NRC Regulatory Guide 1.61, "Damping Values for Seismic Design of Nuclear Power Plants," (Reference 1.125).

The dynamic analyses were performed by the Structural Analysis Group in order to determine the seismic forces needed for the design of structural elements such as the structural steel beams and bracing and the reinforced concrete walls and slabs. This analysis also led to the development of amplified response spectra which were used for seismic qualification of equipment, analysis of piping systems, and for design of structural steel beams and reinforced concrete.

"Control of Seismic Design", United Engineers Administrative Procedure No. 36 (AP-36), (Reference 1.87) addresses the control of seismic analysis and seismic design of structures, systems and components and defines the responsibilities of the project personnel and staff groups for the Seabrook Project. It also describes the requirements for the development and control of amplified response spectra in accordance with "Development and Use of Amplified Response Spectra for Seismic Design and Analysis of Structures and Systems," United Engineers General Engineering and Design Procedure No. 12 (GEDP-0012) (Reference 1.97), except for deviations. The deviations were as identified in "General Engineering and Design Procedures", United Engineers Administrative Procedure No. 28 (AP-28), (Reference 1.126).

From the documents which we reviewed it appears that the pivotal figure in the interfacing between various disciplines is the coordinator of seismic design. The team judged that introduction of this position in the organization of the staff of United Engineers helped assure coordination of the activities related to the seismic design of structures, systems and components since numerous separate groups are involved in the complete design process.

The amplified response spectra were computed by means of a time-history seismic analysis. The overall dynamic response of a structure was determined by analyzing a model formed by lumping the mass of the structure and the non-movable equipment. These masses were, in most cases, lumped at the floor elevations. The masses were connected by weightless elastic beams which represent the structural members between mass points. Torsion was accounted for by considering the eccentricity between the center of mass and the center of rigidity. Floor slabs were assumed to be rigid in their own plane. Based on the samples reviewed, the team found these procedures to be consistent with FSAR Section 3.7(B).2.3.

Each of the structures reviewed was analyzed for two horizontal components and one vertical component for the operating basis earthquake and the safe shutdown earthquake. From the samples we reviewed, the team found that the responses from the three components were combined by the square-root-of-the-sum-of-squares method in accordance with Section 3.7(B).3.7 of the FSAR.

Local amplifications of overall response were computed by one of two methods. In the first method, the slabs, beams and columns were evaluated for a range of frequencies selected for all local frequencies below 33 hertz. An overall stick model was then generated in such a way that at each elevation examined, the summation of the weight of the single-degree-of-freedom modes and the stick model mode equaled the total weight. The single degree of freedom systems, representing the computed range of local frequencies were connected to the overall stick model as if they were all rigid. The stick model was then analyzed using the ground motion of the artificial time-history as the input forcing function.

The other method consisted of performing a dynamic analysis, using finite elements, in sufficient detail to predict local modes of vibration. In this case the input forcing function, at the elevation of the structural element, was used as the response time history from the overall stick model. Based on the samples reviewed both of the methods being used were found to be consistent with FSAR Section 3.7(B).2.5.

The frequency and time-history analyses were performed using the STARDYNE computer program (Reference 4.29). As a result, the maximum responses of a series of single-degree-of-freedom oscillators were obtained, over a range of frequencies and the plot of these values was the amplified response spectrum, which was generated using the SAG058 computer program (Reference 4.30). The SAG054 (Reference 4.31) program was then used to generate amplified response spectra tables by enveloping raw curves generated by SAG058 and spreading the peaks by 10 percent or more in accordance with the recommendations of Regulatory Guide 1.122, "Development of Floor Response Spectra for Seismic Design of Floor Supported Equipment or Components," (Reference 1.127). We found that the methods of generating the amplified response spectra to be a controlled process.

The team then selected examples of structures, systems or components which had undergone a seismic design and evaluated the seismic analysis against the appropriate procedures and accepted engineering practice.

(1) Tank Farm Structure

The tank farm structure is essentially a box like structure composed of a reinforced concrete wall on the east side and a braced structural steel frame on the other sides. Exposed portions of the braced frame are covered by metal siding. The roof is a concrete slab. The mathematical stick model consists of lumped masses connected by massless springs. The calculations used for the development of the mathematical model are contained in United Engineers Calculation No. SBSAG-5WB (Reference 4.32).

There are approximately 15 feet of fill concrete under the refueling water storage tank and the spray additive tank. A three inch gap was provided between the fill concrete, including the mat, and the west wall of the waste processing building as shown on United Engineers drawing, "Tank Farm and Pipe Tunnel", Drawing F-111818 (Reference 4.33). A concrete curb was placed on the top surface of joint as shown in Detail 111819DD, United Engineers drawing "Tank Farm and Pipe Tunnel," Drawing F-111819 (Reference 4.34). This joint is shown along the east edge of the fill concrete only, meaning that the seismic model for north-south response should not reflect an unstiffened model over the lower 15 feet. Field inspection indicated no differences with the requirements of the United Engineers Drawings F-111818 and F-11819. The mathematical model described in Calculation No. SBSAG-5WB (Reference 4.32) does not account for the stiffening effect of the fill concrete since the base of the seismic model utilized was erroneously designated to be at the bottom of the fill concrete.

The stiffness of the reinforced concrete portion of the building was considered by United Engineers as a combination of shear stiffness and overall bending stiffness. Therefore, instead of summing up the rectangular cross sectional area of walls oriented in the direction of interest, United Engineers considered each wall separately in determining the shear deformation. This shear deformation of each wall was composed of pure shear displacements as well as being characterized as a guided cantilever with a moment of inertia based upon the rectangular shape. The sum of the shear stiffness of each wall was calculated, so that an area and a bending moment of inertia of the stick was determined consistent with the shear stiffness. The problem with this method is that if indeed both shear stiffness and overall bending stiffness were important, the method would underestimate the overall bending stiffness, particularly since flange effects were not considered.

Based on the fact that the seismic model did not incorporate the stiffening effect of 15 feet of fill concrete in the north-south response direction, that only the shear stiffnesses were included in the overall computation of building stiffness, and that the flange effects for bending stiffness were neglected, the team concluded that the aggregate building stiffness was inaccurately calculated. This has the potential of shifting the fundamental frequency of the structure and consequently changing the location of peak frequencies as well as the value of acceleration in the amplified response spectra. The modeling was not consistent with the FSAR, Section 3.7(B).2.3 which states that "the elevation of the point-of-fixity of the mathematical model is .... a lowest elevation of upper surface of concrete backfill which bears directly against the structure." (Finding 4-6)

It is noted that during the week of December 5, 1983 while the inspection was underway and this concern over the modeling technique was raised, United Engineers made some additional computer computations which seemed to indicate that the particular seismic model used was not sensitive to changes in stiffness.

For the structural steel frame in the tank farm structure, the center of mass and center of stiffness did not coincide for each element and therefore were connected by rigid elements which accounted for the torsional inertia. The beam elements appeared to be assigned the appropriate torsional stiffness. In the case of the structural steel frame, the bending and shear stiffnesses were based entirely on a shear type response in that the nodes were, in general, restrained from rotation about the horizontal axes. The calculations of the area and the bending moment of inertia were calculated consistent with the rotational constraints imposed on the model. While the combination of area and bending moment of inertia were consistent with overall shear stiffness, individually the properties were not consistent with the actual structure. The rotational constraints imposed also, in effect, eliminated overall bending from any consideration. This approximation could result in a significant overestimation of the stiffness of the structural steel framing.

In calculating the stiffness of the structural steel bracing, United Engineers assumed that all X-bracing was composed of angles 4"x4"x3/4". In fact, the bracing actually consists of substantially larger members as indicated in United Engineers drawings "Tank Farm and Pipe Tunnel," Drawings F-111824 and F-111825 (References 4.35 and 4.36). The neglect of overall bending in the development of the stiffness of the stick model did not significantly simplify calculations, but did raise questions concerning the correct stiffnesses of the mathematical model. (Finding 4-7)

United Engineers personnel have orally stated the tank farm mathematical model was unique and no other mathematical models were prepared in such a way. Additionally, it was stated that the usual practice of the Structural Analysis Group is to prepare a static structural model and with the aid of a computer program, appropriate stiffness properties are calculated without the need for the approximations such as those used in the tank farm model. The team had insufficient time to confirm that the tank farm structure was an isolated case of modeling difficulties. Because of discrepancies between the assumptions used in the development of the mathematical model for the structural steel frame and the reinforced concrete tank farm structure, new calculations and computer analyses should be performed. It is the team's recommendation that the tank farm mathematical model should be recalculated incorporating effects of overall bending and the actual structural configuration.

At the time of writing this report it was the team's understanding from oral communications with United Engineers that they are in the process of re-evaluating the analysis and, if necessary a re-analysis will be performed. The new facts and information on these matters should be provided in the response to Findings 4-6 and 4-7.

(2) Containment Structure

The containment shell was represented as a lumped mass (stick) model fixed at elevation -30 ft. The shell and the internals including polar crane were uncoupled for the purpose of the final analysis completed in United Engineers Calculation No. SBSAG-4CS4 (Reference 4.37). The analysis assumed that the liner is not a resisting structural element, but its mass has been included in the lumped masses of the model. Since the shell is essentially axisymmetric, and its center of mass and center of rotation coincide, the torsion due to the geometry of the structure has not been considered.

In the case of the containment internal structures, they were modeled as a series of concentrated weights, located at their respective centers of mass. These weight centers have been located at specific elevations, which in most cases is at the top of the respective slabs. The weights representing the slabs have been connected by weightless, elastic beams representing structural components between the elevations of the concentrated weights. The team considered the modeling to be consistent with FSAR Section 3.7(B).2.3.

The structural response was determined using the response spectrum modal analysis method. The total response of the structure was calculated by superposition of the responses of each mode by the square-root-of-the-sum-of-the-squares method. This approach was found to be consistent with FSAR Section 3.7(B).2.

Based on the team's review of the examples of seismic design we found that the Regulatory Requirements and criteria set forth by the licensee in the FSAR have been followed except for the case of the tank farm structure which the team judged to be an isolated case on which we had questions. The two findings related to the seismic analysis of the tank farm most likely arose from the changes in design philosophy for the structure from first an exposed, open area to a closed non-Category I superstructure to a closed Category I superstructure. Procedures exist to control the seismic analysis, the design interfaces and the design input. For the civil and structural area in general, the design execution was judged to be good based on the examples reviewed. Documentation of calculations and supporting records was well done, in the team's opinion.

4.3 Design of Structural Elements

The objectives of this portion of the inspection were to examine the adequacy and coordination of analysis, design, engineering drawings, shop drawings and construction of structural elements located in Category I structures which are associated with the containment spray system.

Our inspection of structural elements encompassed structural steel members in the containment recirculation sump, structural steel in the annulus area of the containment, supports on the containment dome liner, structural steel and concrete of the tank farm, and a platform in the primary auxiliary building.

(a) Containment

The containment recirculation sump screens and collects the water available for supplying containment building spray and residual heat removal pumps during the recirculation mode of operation following an accident. The screens for the sump are attached to the structural steel framing. We reviewed the design calculations for the screen structure which are contained in United Engineers' calculation "Design of Screen for Recirculation Sump in Containment Building", Calculation No. CI-2 (Reference 4.38). The structure was designed for the load combination of the dead load, live load and the operating basis earthquake as required by the FSAR and the Structural Design Criteria, SD-66 (Reference 1.3). The calculation contained a statement that the equation used was the controlling load combination equation, but there was no comparative analysis or any evidence that the safe shutdown earthquake had been considered. Additionally, the effects of thermal expansion of the beams had not been taken into account as required by the criteria. The United Engineers drawing pertinent to this structure, "Containment Steel, Recirculation Sump Screen Details", Drawing F-101486, dated October 29, 1978 (Reference 4.39) was released for construction of embedded anchor plates on September 29, 1978 and for structural steel construction on January 21, 1980. We concluded that consideration of the safe shutdown earthquake loads should be evidenced in the design and that omission of this load is violation of the "Structural Design Criteria" SD-66, Table 5.4-2, Rev. 0, dated October 19, 1976 (Reference 1.3) which requires consideration of a loading combination which includes the safe shutdown earthquake. (Finding 4-8)

During our inspection, Revision 2 to the calculations (CI-2) was added (dated November 25, 1983) which included an explanatory note that the amplified response spectra tables have been consulted and it appears that the original design was conservative. These new facts should be confirmed in response to Finding 4-8.

Examination of Detail 101486M on "Containment Steel, Recirculation Sump Screen Details," United Engineers Drawing F-101486 (Reference 4.39) revealed that the bent plate connector had not been placed centrally with respect to the structural channel member to which it is bolted and was instead moved toward the upper flange of the channel. This was inconsistent with the analysis, in Calculation No. CI-2, which assumed that the connector would be placed so that the center of the bolts on the connecting plate would coincide with the center of gravity of the channel. We verified that the eccentricity between the centroid of the bolts and of the channel was transferred on to the shop drawings, Cives Corporation Drawings No. E1001 and E1002, dated April 25, 1980 (References 4.40 and 4.41). During our inspection at the site on December 5 and 6, 1983, we found that the installation was consistent with these drawings. Since the members are subject to the movement along their longitudinal axes due to thermal conditions, the displacement of the connector from the centroidal axis of the beam introduces eccentricity which will result in increased stresses at the connecting plates. This condition had not been analyzed in accordance with the American Institute of Steel Construction Specifications (Reference 4.3) which requires analysis of non-standard connections. (Finding 4-9)

Additional calculations were performed during the inspection to account for the above condition and it was determined from the sample reviewed that the resulting stresses appear to be within the code allowables and, therefore, the structure as built seems adequate. The new information and facts developed should be confirmed in the response to Finding 4-9.

While inspecting the steel in the annulus, between the containment shell and the secondary shield in the containment structure, we observed that a number of steel beams framing into the steel plates embedded into the concrete had been modified. The modifications consisted of extending the lower part of the web of the beams and providing plates to accommodate the lower bolt in the plate which had been welded to the embedded plate. Upon examination of the pertinent shop drawings, Cives Corporation Drawing 6816-X163B (Reference 4.42) and United Engineers Drawing, F-102320 (Reference 4.43), we found that this modification had been necessary due to the fact that the embedded plates had been installed at the wrong elevation. The plates were installed too low to be compatible with the elevation of the structural steel in the area of the annulus. In our discussion with the cognizant design engineers it was determined that the modification of the connections was not reflected in the analysis completed. The calculations were contained in Calculation No. CI-70 (Reference 4.44). We determined this to not be in conformance with the American Institute of Steel Construction Specification, Section 1.15.3 (Reference 4.3) and the Structural Design Criteria, SD-66, Sections 2.1.2 and 6.2.5.1 (Reference 1.3). The requirements are that a connection detail which introduces eccentricities must undergo a specific detailed analysis which was not done in this instance. (Finding 4-10)

We have been informed orally by United Engineers subsequent to the inspection that a new detailed analysis of the connection has shown it to be adequate and that the calculation is being revised to indicate conformance to the specification requirements. During the inspection we also requested that additional analyses be performed to determine the adequacy of the various eccentric connections. During the inspection we were orally informed by United Engineers that a program which will re-evaluate connections, which depart from the standard connections contained in the American Institute of Steel Construction Specification (Reference 4.3) and not analyzed, will be reviewed over the entire project. This will be done by selecting a representative sample and analyzing the connections in that sample in accordance with the American Institute of Steel Construction Specification requirements. We were told by the design engineers of United Engineers who were involved in design of the containment structural steel in the annulus that misalignment of the embedded plates with structural beams is widespread in Unit 1. They said that in the case of Unit 2 there was an effort to rectify this situation and to install the plates at the proper elevations thus alleviating problems for the as-built conditions. They indicated that this was not completely successful and as a result there are cases where beams had to be modified in Unit 2. The modifications were made at the fabricator's facility and shipped to the field ready for installation. In view of the evidence that the design engineers are aware of the need for further analysis of these connections and that additional action is under way we did not pursue this matter further. The facts in this matter should be confirmed in response to Finding 4-10.

Another item which is related to this area of containment pertains to the connection of the beams to the columns in the annulus steel. Examination of the Cives Corporation Drawing 6816-X102A dated November 11, 1982 (Reference 4.45) revealed that in order to accommodate welds between connecting angles and the beams framing into columns, but not perpendicular to the columns, the axis of each beam was shifted by one inch from the centroidal axis of the support column. This resulted in an eccentricity with respect to the column, which in turn induced torsion in the column. We have found that this was not accounted for in the analysis and that it violates the Structural Design Criteria, SD-66 (Reference 1.3) and Section 1.15.3 of the American Institute of Steel Construction Specification (Reference 4.3). In our opinion, the effect of torsion induced in the columns is to increase stresses in the members and these stresses should be evaluated to determine the effect on over-all member stresses. We recommended that action be taken to assess impact of this eccentricity and an analysis be performed to evaluate the resulting stresses. (Finding 4-11)

Subsequent to the inspection we were orally informed that a study was made by United Engineers of this type eccentric connection and it was determined the 1-inch eccentricity did not increase the stresses above the allowables. The new facts in this matter should be confirmed in response to Finding 4-11.

Calculations for attachments to the steel liner in the containment dome were also reviewed by the team. These calculations, "Attachments to Liner Supporting Ducts, Pipes and Electrical Equipment", Calculation No. CS-22 (Reference 4.46) were to provide support attachment points for installed items from other disciplines like the containment spray rings of the containment building spray system. Coordination between disciplines was reviewed as well as the flow of information in the complete design sequence.

On Sheet 85 of 139 in Calculation CS-22 (Reference 4.46) a structural steel member made from an angle shape was sketched incorrectly so that the horizontal leg was reversed from the direction utilized in the calculations. On Sheet 98 of 139 in Calculation CS-22 (Reference 4.46) a structural steel member made of an angle section shown in Section AA in the calculational sketch should have been drawn with the horizontal leg reversed from the direction used in the calculations. Revised Sheets 17 and 23 of 139 in Calculation CS-22 (Reference 4.46) were not included in the listing of the "Calculation Revision Control Sheet" as required by "Preparation, Documentation and Control of Calculations" United Engineers General Engineering and Design Procedure 0005 (GEDP-0005), (Reference 1.93). In the above instances where the sketches were improper, the errors were corrected apparently by a knowledgeable detailer when preparing the shop drawings so that the connections were properly made. Since the team found no other clustered examples of this type of error in other sets of calculations they were judged to be isolated. This is not a finding or an unresolved item, but an item the licensee may wish to consider. (Observation 4-2)

In examining the input data to the SHELL I (Reference 4.47) computer program the team found that the input data referenced were not the correct data since they had been superseded by a more recent set of calculations. Seismic forces and moments as used on Sheets 30 through 35 as input in the calculation "Design of the Containment Shell and Dome", Calculation No. CS-15 (Reference 4.48) were obtained from modified seismic analysis SBSAG-4CS3 (Reference 4.49). This had been transmitted by a memorandum dated October 12, 1979, (Reference 4.50). SBSAG-4CS3 had been superseded by the final seismic analysis SBSAG-4CS4

(Reference 4.37). Although comparison of the SBSAG-4CS3 and SBSAG-4CS4 analyses shows that their results are very similar and that the seismic forces and moments used as input for the SHELL I computer program utilized in Calculation CS-15 seem conservative, we determined that use of the outdated data is a violation of "Calculations", United Engineers Administrative Procedure No. 22 (AP-22) Appendix A, (Reference 1.128) and 10 CFR 50, Appendix B, Section III, "Design Control", dated August 1, 1980 in that the incorrect input data were utilized. (Finding 4-12)

Subsequent to our inspection United Engineers orally informed us that a recheck of the calculation using the current input data yielded results that were still satisfactory when compared to the existing design; this should be addressed in response to Finding 4-12.

We reviewed the various stages of the static analysis of the containment structure which utilize the results of the seismic analysis described above. The containment structure (the shell and the dome) was designed using several computer programs. Some of them such as LESCAL, WILSON I and WILSON II have been documented in the FSAR Appendix 3F. There were others, however, such as SHELL I (Reference 4.47) and SHELL II, (Reference 4.52) which have not been included in the FSAR in Appendix 3F. This is in violation of the licensee's commitment made in Section 1.8 of the FSAR to meet Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," Section 3.8.1.4, (Reference 1.129). (Finding 4-13)

The axisymmetric analyses of the containment structure for dead load, pressure, and temperature under both operating and accident conditions were performed using the WILSON I computer program. The shell model for the operating basis earthquake and safe shutdown earthquake was analyzed using WILSON II program. The team concluded that a proper analysis had been performed.

(b) Tank Farm

A structural steel beam, Mark B9, located on the Elevation 81 foot roof along Column Line 0.5 was designed for dead loads, live loads, and operating basis earthquake loads in Calculation No. WB-61, sheet 17 of 79, checked September 28, 1978 (Reference 4.20). Later, a redesign was made to add the sag rod loads to the dead loads, live loads, and operating basis earthquake loads (Sheets 9I and 9J of 79, checked November 3, 1979). The original calculation (WB-61, Sheet 17 of 79, checked on September 28, 1976) was not voided as required by "Procedure for Preparation, Documentation and Control of Structural Calculations," United Engineers General Engineering Design Procedure No. 0005 (GEDP-0005), Paragraph IID, (Reference 1.93). Subsequently, another calculation was made (WB-61, Appendix A, Sheet 10 of 16, Rev. 3, checked on June 17, 1981) which added a pipe support load, but neglected the sag rod loads. Again the previous calculation was not voided. The safe shutdown earthquake pipe support load was incorrectly combined with beam operating basis earthquake loading and designed for safe shutdown earthquake allowable stresses. The neglected loads and the combining of operating basis earthquake and safe shutdown earthquake criteria for stress checks against those associated with the safe shutdown earthquake violates Structural Design Criteria, SD-66 (Reference 1.3). (Finding 4-14)

This was judged by the team to be an isolated case. The fact that there was some confusion over whether or not the structural steel in the tank farm was Seismic Category I probably led to the type of problems described above. It is the team's understanding that the beam has been evaluated by United Engineers since the inspection as seismic Category I in a systematic application of all load combinations. United Engineers has orally stated that the design calculations have been revised and no physical changes in the beam are required since the pipe support was relocated for other reasons. This should be confirmed in response to Finding 4-14.

The calculations for the reinforced concrete walls along Column Lines 4.5 and 5.0 are contained on sheets 8 and 9 of 13, United Engineers Calculation No. WB-68 (Reference 4.53). The calculations were based upon the method described on page 351 of the "American Concrete Institute Design Handbook," SP-17(73) (Reference 4.54) in accordance with the strength design method of American Concrete Institute Code, ACI 318-71 (Reference 4.2). The method is appropriate for reinforced concrete sections subject to combined bending and axial load when the section is controlled by tension. The calculation procedure is described in Flexure Example 3 of the Design Handbook which neglects any compressive reinforcement. The calculations did not include an adjustment of the value of the capacity reduction factor, Ø, for combined bending and axial load. The results of the calculations indicated a requirement for reinforcing less than that which would be required utilizing the correct Ø factor. The tendency of the designers to provide more reinforcing than actually required by design because of practical and geometrical reasons may mean that sufficient reinforcing is in fact present for the revised calculations. This appears to be a systematic error for the tank farm walls. The team recommends a review of the design of all reinforced concrete members subject to combined bending and compression. (Finding 4-15)

Subsequent to the inspection the team was orally informed by United Engineers that they have redone the calculation and found that adequate numbers of reinforcing bars were provided in the original design. This should be confirmed in response to Finding 4-15 and the use of an incorrect Ø factor in other calculations and by other engineers should be addressed.

The overall assessment of the design controls in the area of design of structural elements indicates that the design utilized the design criteria and provided adequate margins of safety with regard to the code allowable stresses or necessary factored load capacities. While the team found several errors and omissions in the design calculations, it is not expected that any of these instances will require strengthening of the members. This is due to the conservatism of design and the capability for redistribution of stress. We do not expect that the neglect of additional stresses produced by the modification of the beams (Finding 4-10) or eccentricities of columns (Finding 4-11) will result in a significant reduction of the margins with respect to the code allowables. The team concluded that the structural elements examined have adequate capability to resist the expected design loads.

4.4 Design for Supported Mechanical Systems and Components

The objectives of this portion of the inspection were to examine the coordination between the design of the mechanical components, the support structure, and the design of structural elements and to verify that selected samples represent an adequate design.

Two tanks and a pipe support were selected for review. Both tanks are part of the containment building spray system and are located in the tank farm structure. The pipe support was also in the tank farm structure. Both tanks are supported at their base by anchorages around the circumference. The anchorage, into the fill concrete structural base, is by means of high strength anchor bolts. The seismic load for the spray additive tank was obtained by assuming horizontal and vertical accelerations equal to 1.5 times the peak of the ground response spectra. This equivalent static analysis was completed in conformance with the method as provided for in Section 3.7(B).3.1 of the FSAR, but the analysis method had not been defined in the United Engineers procurement specification, Specification 006-246-6 (References 3.14 and 3.15) for the tank. This indicated that United Engineers had not provided sufficient instructions in the specification on how to execute the analysis although a proper analysis was in fact performed.

The refueling water storage tank was purchased from Pittsburgh-Des Moines under United Engineers Specification 006-246-1 (Reference 3.17 and 3.18). Pittsburgh-Des Moines prepared design calculations for the refueling water storage tank (Reference 3.46). In calculating the stiffness of the cylinder in which only the overall bending stiffness was considered, the shear stiffness was neglected. This is inappropriate for a thin walled tank of large diameter. Only the fundamental frequency was calculated and higher modes were neglected in violation of Section 2.3.3.1.7 of United Engineers Specification 006-246-1. A reanalysis could indicate greater design seismic loads; however, it appeared to the team that the thickness of the cylinder could accommodate somewhat greater meridional compressive stresses and that there may be additional capacity in the anchor bolts. Therefore, the team does not expect that there would be a requirement for material changes as a result of a reanalysis; however, such a reanalysis is necessary to meet the requirements of the specifications and good engineering practice. (Finding 4-16)

The review of the tank calculations prepared by Pittsburgh-Des Moines was the responsibility of the Mechanical Analysis Group at United Engineers. The design responsibility of the anchor bolts was divided between organizations. Pittsburgh-Des Moines specified the bolt diameter and steel designation and the Structural Group at United Engineers was responsible for the design of the embedment length and local reinforcing, if required, in the concrete base. The number, size, and type of bolts required by Pittsburgh-Des Moines in the as-built condition at the site was observed to be correct.

The pipe support which was located on the structural steel, Beam B-9, in the tank farm, discussed in Section 4.3 of this report, was relocated so that the support was anchored into the concrete wall located parallel to and adjacent to Column Line E.7 in the tank farm instead of being supported by the structural steel beam. The sketches for the relocated pipe support structure were designed and presented on United Engineers Drawing M-8018335, Support No. M/S-1833-RG-04, Sheets 13 through 17 (Reference 4.55). During the field inspection, the support was observed. A comparison of the field installation with the design drawings indicated that several members were larger than required by the design. The team had no questions relative to these discrepancies in view of the oversized members and the fact that the increased support stiffness would be small when compared to the effect on the piping analysis caused by changing the anchor point from a steel beam to a more rigid concrete element.

Based on the samples selected for review, the team concluded that the proper requirements had been provided in the specification for the tanks and that the elements of design control were exercised, but United Engineers had failed to note that one element of the requirements was not met by the vendor, Pittsburgh-Des Moines, for the refueling water storage tank. This was apparently a limited failure in assuring total design verification of the subcontractor's work or to identify the discrepancy during an audit. No discrepancies or findings were noted for the spray additive tank. The pipe support structure examined which had undergone location changes indicated that the necessary design interfaces between disciplines had been utilized and that control of design changes had been exercised. With the exception of the needed recalculation for the refueling water storage tank (Finding 4-16) the team found the samples of the designs in this area to be adequate.

4.5 Design for Supported Electric Equipment

The objective of this portion of the inspection was to review selected samples of specific designs related to the structural support of electric equipment in order to assess the interface between the electrical and civil-structural disciplines for design. Specifically, a determination was to be made as to whether the licensee's design commitments contained in the FSAR and other relevant documents have been met, correct design information has been coordinated and complete interfaces made through a logical design process, and the completed design is adequate. Cable tray supports were selected for review in this area.

The design of cable tray supports for the Seabrook Project is governed by the document known as the "Technical Guide for the Design and Analysis of Seismic Category I Cable Tray Support Systems" (Reference 1.9). The team's effort in the area of the cable tray support design included a review of the technical content and details contained in this Guide as well as the execution of the design. The Guide is considered to be a controlled design manual. The development of this technical guide was the responsibility of the Mechanical Analysis Group which is a staff group reporting to the Chief Engineer of Power in the United Engineers Philadelphia office.

The analysis and design procedures provided in the Guide are a composite of the results of actual test data for various components or elements of the tray support system with analytical procedures and the use, in many instances, of a bounding type assumption in order to realize a workable design procedure so that each and every design solution is not unique. The team reviewed specific

FSAR commitments regarding the design of the cable tray support system. The relevant commitments were noted to be in Sections 1.8, 3.2, 3.7.3, Table 3.7(B)-23, 8.1 and 8.3 of the FSAR.

Only general and very limited commitments were found in the FSAR with regard to the manner in which the analysis and design of the cable tray support system would be executed. Note 5 to Table 3.2-1 in the FSAR stated that "qualification of the conduit and cable tray raceways for the Class 1E safety related circuits have been confirmed by analysis, and calculations verify the adequacy of the systems based on the properties of the raceways (including tray where applicable) and support components." In Section 3.7.3 of the FSAR one of the methods of seismic analysis for subsystems utilized the cable tray support system as an example of application of the dynamic analysis method using the modal response spectrum technique. Diagrams were provided in FSAR Figures 3.7(B)-31 and -32 to illustrate a typical ceiling to floor cable tray support as well as a mathematical model representation which was used in the dynamic analysis. This constituted the majority of the analyses and design details provided in the FSAR. No inconsistencies between the FSAR and the Technical Guide were found during our sample review. The bases for the design of the Category I cable tray support systems appeared to be founded on a combination of test data in two areas and accepted analytical and design processes.

Sample calculations were selected by the team to assess the execution of the design process and the adequacy of the resulting design. This included review of a series of calculations related to the lateral support of cable trays in the control building. Preliminary calculations for Section SW-3 (Reference 4.56) were selected for review. All assumptions were noted and those which required future verification were so marked. This was found to be consistent with the technical procedures guide which defined the completion, control and documentation for calculations. The team judged the sample calculations to have been completed properly with the provisions of the Technical Guide (Reference 1.9).

Two of the three vendor catalog references utilized for strut material and hardware data utilized in the calculations for Section SW-3 were used in the verification process by the team. No discrepancies were found in the samples examined and the interpretation and application of the data were judged to be correct. It was noted in the calculations that where several individual bents of laterally unconnected support frames are subsequently tied together laterally through braces, United Engineers utilizes the square-root of the sum of the squares method to combine lateral loads. The team had no disagreement with this concept. In general there appears to be significant margins in the tray support system due to the simplifying assumptions made to minimize the number of unique designs required.

The procedures and execution of the design of the cable tray support system for lateral loads were reviewed against the requirements of Section 4, Design Process, Section 5, Interface Control and Section 7, Document Control of American National Standards Institute ANSI N45.2.11-1974 (Reference 1.137) to which the project is commited. The design activities were found to be prescribed in specifications, procedures and the Technical Guide (Reference

1.9) for this task. These documents appear to provide adequate control of the design execution to be completed by the individual designers. The process appears to be adequately controlled in practice and the completed design was judged to be adequate.

4.6 Design for Supported Instrumentation and Control Equipment

The objective of this portion of the inspection was to determine for a sample of instrumentation and control systems whether the analysis and design process for supports was executed in accordance with the appropriate procedures and in conformance with the guidelines contained in the licensee commitments and the Quality Assurance Manual, the correct design information related to the support of the Instrumentation and Control systems was coordinated and complete interfaces made in a controlled design process, and the completed design for supports is adequate.

The equipment selected for this inspection was an instrumentation rack designated MM-IR-14, located in the equipment vault at approximately Elevation 3 feet, west of Column Line D and north of Column Line 1. The team verified that the development of the amplified response spectra used for the design of the instrumentation rack was in accordance with "Control of Seismic Design," United Engineers Administrative Procedure No. 36 (AP-36) (Reference 1.87).

The sketch of the mathematical model in United Engineers Calculation No. SBSAG-22PB (Reference 4.57) of a stairway floor frame at approximately Elevation 3 feet was incorrectly made in locating the model with respect to Column Line D. The horizontal location of the model of the platform was incorrect when compared to United Engineers Drawing F-101558 (Reference 4.58). Since the model itself was dimensioned correctly, the relative displacement of the model by 34 inches west in relation to the reference points did not affect the results of the analysis performed by the Structural Analysis Group. This was not a finding or an unresolved item, but represents an apparently isolated instance found by the team where there was an apparent lack of attention to the details. The licensee may wish to consider this information. (Observation 4-3)

In our inspection we observed that the United Engineers structural design drawings Nos. F-101558 and F-101562 (References 4.58 and 4.59 respectively) were released for construction on September 28, 1976 and July 6, 1978. The supporting structural design calculation, "Primary Auxiliary Building, Equipment Vault Steel Framing (030)", Calculation No. PB-76 (Reference 4.60), was completed on December 1, 1983. We requested that the original structural design calculations, from which the above design drawings were prepared and the members fabricated and installed, be presented for inspection. The original design calculations could not be found and we concluded that the absence of such computations constitutes a violation of "Calculations," United Engineers Administrative Procedure No. 22 (AP-22) (Reference 1.128), Section 2.3.1, which requires that calculations related to drawings released for construction or installation shall be either preliminary or final. This was judged to be an isolated finding where drawings apparently were released prior to the preparation of calculations. (Finding 4-17)

A review of Calculation No. PB-76 (Reference 4.60) revealed that when the designer considered different load combination equations involving seismic loads, the live load had been omitted. We considered this to be in violation of the FSAR in Section 3.8.4.3. Within this section of the FSAR it is stated that the load combinations considered in the design are provided in Table 3.8-16. That table specifies that live loads are combined with seismic loads in all instances. We discussed this matter with the staff of the Structural Group. They presented a view that this is consistent with sound engineering practice since during operation of the plant there will be no load (such as people or material which could be classified as live load.) The team noted that the omission of live loads in load combinations with seismic loads on floor areas not covered by equipment is considered to be a violation of the Structural Design Criteria, SD-66 (Reference 1.3). (Finding 4-18)

A review of United Engineers Drawing F-101562 (Reference 4.59) of the structural steel framing in the equipment vault indicated that no dimensions existed to orient the plan views in the north-south direction without the use of the reinforced concrete drawings for the same area which were not listed as reference drawings. This was not a finding or an unresolved item but is mentioned as an item the licensee may wish to consider. (Observation 4-4)

During field inspection at the plant, we observed that one leg of the instrumentation rack MM-IR-14 in the auxiliary building equipment vault at approximately Elevation 3 feet is resting on a 1/2 inch thick floor plate instead of the channel structural member, C10x15.3, as assumed in Calculation No. PB-76, (Reference 4.60). This installed configuration formed a cantilevered plate with respect to the channel. We concluded that this is contrary to sound engineering design and recommended that a vertical stiffener plate be provided, welded to the channel and the plate, under the leg of the rack to carry the load to the channel. The reason for this recommendation is that the leg of the rack is situated at the corner of an opening in the floor plate of the platform. The opening was cut to accommodate vertically oriented electrical cables. The cut out will cause some stress concentration in addition to the bending stresses introduced by the plate cantilever. A review of the level of stresses in Calculation PB-76 in the plate platform supporting the rack indicated existing stresses were low with respect to the code allowables. Since it was judged that the additional stresses just described would not increase the total stresses so as to violate any requirements regarding existing codes or procedures we did not consider this to be a finding or an unresolved item. We believe, however, that providing a stiffener plate as described would be advisable and would improve the design where the main load carrying member was not in the direct load path. (Observation 4-5)

In summary, the team concluded that the design of supported instrumentation and control equipment is controlled by adequate procedures and that, for the sample reviewed, the procedures were generally followed and the resulting design was was adequate.

4.7 Subcontractors Off-Site

The objectives of this portion of the report were to ascertain how the licensee's design commitments being implemented by United Engineers were being transmitted to and used by several off-site subcontractors, what level of control was maintained by United Engineers over subcontractors, and what manner the subcontractor performed and controlled activities impacting the design of the facility.

The review of the work of Professor Edwin G. Burdette was completed utilizing records at United Engineers in Philadelphia. In order to complete this phase of the inspection effort a selection was made from a list of subcontractors doing work in the design, engineering and services area of the project. The first subcontractor selected was Professor Edwin G. Burdette who was chosen as an example of direct design related services. He conducted tests to verify certain design parameters. The second and third subcontractors were selected on the basis of the volume of work as well as the fact that both represented the next step in the design and construction process beyond the basic design engineering effort completed by United Engineers. These were William J. Lester, Inc. who performed structural steel detailing and Bethlehem Steel Corporation who performed detailing and fabrication of reinforcing steel for the Seabrook Plant.

In 1980, United Engineers contracted with Professor Edwin G. Burdette of the University of Tennessee, to perform tests to confirm the load-displacement relationship of the liner plate anchorage system to be embedded in the Seabrook concrete containment. The objective of these tests was to confirm, by test, the adequacy of the liner anchorage system in meeting the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section III, Division 2 (Reference 4.1). We reviewed the available documents pertinent to the tests provided by United Engineers. The test program was administered as a part of the Purchase Order No. H.O. 56971, with Change Order No. 1, dated September 29, 1980 (Reference 4.61). The "Procedure for Containment Liner Anchor Load Test" (Reference 4.62), required that the specimens be prepared at the Seabrook Plant site using the procedures and material approved for construction of the containment structures. We concluded that the specimens used in the tests adequately represented the containment structure and the liner with its embedment system.

The test procedure required that all measuring and test equipment be calibrated before testing and evidence of calibration be available for review. We were provided with a Testing Machine Verification Certificate, (Reference 4.63) which stated that the 120,000 lb. capacity machine, Serial No. 60096-1, belonging to University of Tennessee, had been calibrated and the loading ranges had been found accurate with tolerances ranging from 0.42 to 0.83 percent. The calibration was performed by the Tinius Olsen Testing Machine Company, Inc., of Willow Grove, Pennsylvania on June 10, 1980. The load cells output readings found in the report were based on the load readings from the same testing machine referencing the same calibration date. The team concluded that the testing program had been adequately executed and controlled.

In February of 1982, Professor Edwin G. Burdette was also under contract to United Engineers to conduct tests of surface-mounted plates witn expansion anchors in order to determine the validity of the value of the prying factor equal to 1.2 which had been calculated by United Engineers for use in the design. The test program was conducted under Purchase Order No. 210-9 (Reference 4.64). The purchase order contained no reference to 10 CFR 50, Appendix B or other quality requirements for the testing program. The team determined that the test specimens were fabricated under the quality assurance program for the Seabrook Plant, however, no quality requirements existed on the control of the testing equipment. The team received calibration data for the same University of Tennessee 120,000 lb capacity Tinuis Olsen machine used on the liner anchor tests. This calibration was completed on January 7, 1982 which is prior to the date the prying factor tests were begun.

The test report did not contain an identification of the test machine utilized so that there was no direct link of the calibration data to the data obtained in the prying factor tests. The team determined that United Engineers' Quality Assurance Procedures "Design Control," QA-3 (Reference 4.65) "Control of Measurement and Test Equipment," QA-12 (Reference 4.66) and "Project Level Design Review and Design Verifications," General Engineering and Design Procedure-0022 (GEDP-0022), (Reference 1.103) had not been completely followed. (Finding 4-19)

A brief review of work completed by Willard J. Lester, Inc. was completed during this inspection utilizing records at United Engineers in Philadelphia. This firm prepared detailed shop drawings for structural steel from the design engineering drawings produced by United Engineers utilizing standard details and specific details and instructions (References 4.67 and 4.68) as issued by United Engineers. These then formed the basis of the "Structural Steel Detailing Policies and Procedures" of the Willard J. Lester, Inc. (Reference 4.69). This company worked first as a subcontractor to Lyons Iron Works, Inc. who held the contract to detail, fabricate and furnish structural steel under Purchase Order 006-12-1 (Reference 4.67). After Lyons Iron Works, Inc. closed its operations due to bankruptcy, a purchase order (Purchase Order 006-12-4) (Reference 4.68) was issued to Willard J. Lester, Inc. to continue to produce shop drawings for structural steel. This subcontract lasted only for several months until Cives Corporation took over all detailing, of the structural steel in February of 1979.

Several of the drawings produced by the detailers at Lester, Inc. were reviewed for conformance to the detailing practices and standards of the American Institute of Steel Construction Specifications (Reference 4.3) and no discrepancies were noted. The team concluded that for the samples the specification requirements for structural steel detailing had been met.

Another of the subcontractors reviewed during this inspection was Bethlehem Steel Corporation. The review was conducted at Bethlehem, Pennsylvania. The basis of the subcontract in this case for services and material was the United Engineers document, "Specification for Furnishing, Detailing, Fabricating and Delivering Reinforcing Bars," Specification 006-14-1 (Reference 4.70). No distinction was made in the specification between reinforcing for the containment and other structures, so that all work and material supplied by Bethlehem Steel was to conform to the ASME Code Section III, Division 2 (Reference 4.1). The team placed specific emphasis on the manner in which ASME Code, Section CC-2700, Materials Manufacturer's Quality Assurance Programs (Reference 4.1), was implemented under the requirements of the specification. The reason for this was due to the fact that the Seabrook Project represents the first incorporation of the ASME Code, Section III, Division 2 into a plant nearing completion. Bethlehem Steel, prior to the start of the Seabrook project, had used 10 CFR 50, Appendix B as the basis of a quality assurance manual which was undergoing rework early in 1974 when the United Engineers specification was issued.

While reviewing Bethlehem Drawing No. 017RM31 (Reference 4.71) and comparing it with the corresponding United Engineers design drawing, Drawing F-101402 (Reference 4.72), we observed that the spacing of the horizontal stirrups which on the design drawing was 16" whereas on the detailed shop drawing the spacing was 8". The total amount of the reinforcing steel remained unchanged in spite of the change in spacing. The design drawing had not been updated to reflect the change in spacing. The reinforcing steel remained designated in the design drawing as 2x4-#6 at 16". We found that this is a violation of "Document Control - Foreign Print System," United Engineers' Administrative Procedure No. 29 (AP-29), Section 8.6.2, Rev. 7, dated April 12, 1983 (Reference 1.130). In all of the drawings reviewed this was the only case where a discrepancy between the design and shop drawing was found. The team learned that United Engineers had accepted the Bethlehem detail but did not revise the design drawing. This finding had no generic implications and was judged to be an isolated instance of lack of consistency and failure to maintain up to date documents. (Finding 4-20)

Subsequent to the inspection the team was orally informed by United Engineers that the drawing has been revised so that the shop drawing and the engineering design drawing are consistent. These facts should be addressed in the response to Finding 4-20.

Based on the review of completed work and the work observed, the team concluded that the licensee's design commitments had been clearly transmitted to Bethlehem Steel via the specification and the engineering drawings and details. Letter and meeting communications also served as an important part of the total process of providing design interfacing and design input. The team's sample review indicated that Bethlehem Steel had also executed their procedures adequately. A system for the review of shop and placing drawings existed and was being effectively implemented in accordance with the Bethlehem Steel Quality Assurance Procedures Manual. There is a system to document and control the records and design changes to assure that the latest updated input data are being used for the development of shop and placement drawings. Based on the team's observations it is evident that the Bethlehem Steel's audit system has been effective in identifying most random errors and assuring corrective action has been taken.

As a result of the team's review and observations of the work of Professor Edwin G. Burdette, Bethlehem Steel, and Lester, Inc. on the Seabrook Project it is the conclusion of the team that the necessary elements of design control have been in existence during the performance of services under subcontracts to United Engineers for the plant structures. Additionally, we have concluded that these controls were adequately implemented. Two findings were noted. One in traceability of a testing machine calibration (Finding 4-19) and the other on an inconsistency between an engineering design drawing and a shop drawing (Finding 4-20). Both findings were judged to be isolated cases.

4.8 As-Built Conditions and Surveys

The objective of this portion of the inspection was to ascertain how the changes generated by as-built conditions such as in structures, systems and components are processed by United Engineers and the contractors, how the acceptability of final loads resulting from location of pipe supports, electrical cable trays and ventilating systems, including those not specifically considered in the original design, are verified, and how the drawings and identified supporting documents are updated, maintained and certified, so that the completed work reflects the as-built conditions of the plant and document that the structures meet the design requirements.

The team first reviewed the United Engineers procedures which were available to control this area of plant design and construction. Among the documents which control as-built conditions of structures, systems and components we reviewed those which seem to be the most essential in the process. Those are: "Changes to Project Documents", Administrative Procedure No. 15 (AP-15), issued on May 31, 1974 with numerous later revisions (Reference 1.66), "Cutting Reinforcing Steel in Permanent Concrete Structures", Administrative Procedure No. 38 (AP-38), issued on September 5, 1980 (Reference 1.131), "As-Built Documents", Administrative Procedure No. 39 (AP-39), issued on November 17, 1980 (Reference 1.132), "Minimum As-Built Record Drawing Listing," Technical Procedure No. 11 (TP-11), issued on April 29, 1983 (Reference 1.133), "Project Reference Manual - Supplemental Information for Design Change Program," Technical Procedure No. 23 (TP-23), (Reference 1.134), and "Project Instruction for Handling UE&C/Contractor Nonconformance and/or Deficiency Reports", Field Administrative Construction Procedure No. 1 (FACP-1), issued on November 27, 1979 (Reference 1.135).

"As-Built Documents," United Engineers Administrative Procedure No. 39 (AP-39), in Attachment No. 3, contains the types of conditions or changes which do not require as-built information and incorporation into United Engineer drawings. In this category, we found the reinforcing steel changes. We inquired why an important item like reinforcing steel is not required to be recorded to reflect as-built conditions. We were informed that as-built information is required only in those cases where the amount of steel is different than that stated on the design drawings. Relocation of reinforcing steel within specified limits is permitted under this concept.

We expressed our opinion that the procedure does not restrict the discrepancy between the design and as-built conditions in any way and such a deviation could consist of providing reinforcing bars of smaller cross-sectional area, omission of reinforcement in some area altogether or some other change that might impact the design. We did not receive a satisfactory explanation regarding this matter and we consider this a shortcoming of the procedure. We do agree that there are many field situations where a change in placing of reinforcing steel may be tolerated and even sometimes necessary. We believe, however, that the procedure, Administrative Procedure No. 39 (Reference 1.132) should be revised in order to avoid gross deviations from the design requirements. Such deviations could result in an inferior or inadequate structure. This was not a finding or an unresolved item, but is mentioned as an item the licensee may wish to consider. (Observation 4-6)

The details of processing as-built documentation identified in "As-Built Documents", United Engineers Administrative Procedure No. 39, (AP-39) (Reference 1.132) are described in "Minimum As-Built Record Drawing Listing," United Engineers Technical Procedure No. 11 (TP-11), (Reference 1.133). The team concluded the procedures were adequate to control the as-built records and assure sufficient information will be available in the future.

(1) Structural Steel As-Builts

The procedures for this program are described in United Engineers "Guidelines for Beam Verification", dated September 19, 1983 (Reference 4.73). The beam verification program was established in order to ensure that all the structural steel beams are rechecked for all the imposed loads. The treatment of live load is in conformance with the Structural Design Criteria, SD-66 (Reference 1.3), Table 4.2-1. Note 1, to Table 4.2-1 states that uniformly distributed live load shall not be considered with seismic load conditions except those loads which are marked permanent are included in the calculations. As noted in Section 4.1 of this report, the matter of live loads combined with seismic loads is under study by United Engineers.

The design of the structural steel beams for the tank farm area as provided in Calculation No. WB-61 (Reference 4.34) was based upon using the uniform snow load which is considered a permanent live load. The team determined that the design procedure used was applied in accordance with the "Guidelines for Beam Verification". The team, after reviewing the guidelines concluded they were adequate and were being properly implemented based on the current United Engineers criteria. The tank farm structural steel has not been addressed by the beam verification program as yet; however, it is scheduled for completion. The team recommends that this be done subsequent to any reanalysis for the seismic loads as described in Sections 4.1 and 4.2 and addressed in Findings 4-1 and 4-7. This is not a finding or an unresolved item, but an item which the licensee may wish to consider. (Observation 4-7)

Site Engineering prepares calculations related to as-builts. This effort is now under the control of "Procedure for Site Calculations," Field Administration Construction Procedure No. 10 (FACP-10) (Reference 1.136). The majority of calculations concerned misalignments of structural steel connections. The usual case involved a misalignment of bolt holes, which required a replacement connection made by welding. The welding was designed to provide the equivalent strength of the bolts, even though the actual forces might be less while this resulted in an overly conservative connection, it did eliminate several cycles of communication concerning design load requirements. The team examined two instances where the field had taken action under this procedure. The team concluded that proper action had been taken.

(2) Reinforced Concrete As-Builts

No specific overall program currently exists to assess the final loads resulting on concrete structures which would encompass pipe supports, equipment, cable trays, and other systems. This is not a finding or an unresolved item, but an item the licensee may wish to address. (Observation 4-8)

Under "As-Built Documents," United Engineers Administrative Procedure No. 39 (AP-39) (Reference 1.132) certified as-built reinforcing steel drawings are not required. The footnote in the Attachment 2 of AP-39 states that contractor drawings will be controlled at the site as foreign prints, marked for information and turned over to United Engineers in the Philadelphia office and Yankee Atomic. The method of monitoring and recording of reinforcing steel cut or damaged is described in the "Cutting Reinforcing Steel in Permanent Concrete Structures", United Engineers Administrative Procedure No. 38 (AP-38), (Reference 1.131). Our inquiries as to why the drawings affected by the damaged reinforcing bars are not recorded by the Document Control Center in the field or the home office did not produce satisfactory results. It was later found that Site Engineering is maintaining documentation. AP-38 establishes responsibilities of organizations for approval of cutting reinforcing steel during drilling into permanent plant concrete structures so that the process is controlled and the effect on the design is controlled. The team found these procedures to be adequate. The team did establish that the site approval change has been discontinued, yet Revision 1 of AP-38, dated July 31, 1981, has not been updated to reflect this fact and erroneously requires use of the site approval change instead of the current engineering change authorization or request for information. (Finding 4-21)

We have been informed by the United Engineer's staff that since the time when the form was discontinued, changes resulting from cutting of reinforcing steel have been treated as engineering change authorizations. The team believes the current method for addressing cut reinforcing steel is adequate to control the needed changes; however the procedures are not consistent. This should be addressed in the response to Finding 4-21.

The team reviewed the technical disposition of two nonconformance reports by the site personnel. The team concluded the technical resolution in both cases was adequate.

To continue the review the process for controlling as-built conditions in reinforced concrete the team selected five engineering change authorizations dealing with coring concrete and cutting of reinforcing steel. The first four being selected for review were in the diesel generator building and the last was in the tank farm area. These engineering change authorizations were: (1) 02/0772D (Reference 4.74), (2) 06/1670B (Reference 4.75), (3) 59/4010A (Reference 4.76), (4) 73/4572C (Reference 4.77) and (5) 01/4217 D&E (Reference 4.78). The team reviewed these five engineering change authorizations from the standpoint of the technical resolution and the execution of the associated field work in accordance with the authorization. In each case the contractor authorized to make the cuts or cores had provided as-built data as prescribed in the approved engineering change authorization and the data had been adequately incorporated into the as-built documents.

Based on the team's review of the control of cut reinforcing, it was determined that this activity is well controlled by procedures and the appropriate interfaces have been established. Checks are made against known margins to verify that the original design has not been compromised and the necessary documentation has been provided. The Technical Assistance Group under the Lead Civil Engineer of Site Engineering was determined to be executing this operation in a well controlled manner.

Based on the team's review of a sample of the important procedures related to design changes, field changes and those dealing with as-builts, we concluded that fully adequate procedures are in-place to define the control mechanisms. Certain aspects of the procedures and some specific procedures have not been in use over the entire life of the project but United Engineers has recognized this and is taking action. For example, in a memorandum dated September 6, 1983, MM-1457A (Reference 4.79) it is stated that "It is recognized that there are a good number of historic engineering change authorizations which, based on the judgment of the engineer at the time, were issued for which there may be no calculations." The project has defined a program to address these historic engineering change authorizations and develop calculations for them as necessary. We think that this is a noteworthy effort which when completed will contribute to improve confidence in the level of quality control of the plant.

The team found the execution of the procedures to be adequate as noted in the examples discussed. In addition the team found the documentation in the examples reviewed to be adequate. Based on the team's sampling of examples of documentation of the as-built conditions and comparison to the conditions existing in the field the conclusion is that the as-builts represent the field situation accurately.

The one important item disclosed in this portion of the inspection effort was that there is no program in-place or planned to address the final loads resulting on the reinforced concrete structures. The team concluded that based on the limited knowledge of actual loads at the time of the basic structural design and the fact that floor live load capablity is undefined, a program is advisable. The general attitude that the concrete structures can carry all the loads is not substantiated by facts. The licensee should address this issue in conjunction with the question of allowable floor live loads.

4.9 Conclusions

The scope and the depth of the inspection was sufficient to reach certain conclusions regarding the design control exercised over the design and engineering aspects of the civil-structural discipline and the related safety features of the Seabrook Plant. Based on the observed facts, the correspondence we reviewed, discussions, and other information acquired during this inspection, we concluded that design of the safety related features pertinent to the civil-structural discipline is a controlled process.

As a result of the inspection we identified twenty-one findings and eight observations. All of our findings but four have been discussed with the staff of United Engineers and we have been verbally informed that appropriate action has been or will be taken to ascertain that there will be no circumstances which might result in unacceptable margins of safety. Several of the findings appear to have greater significance than others with regard to possibly impacting the actual structures. Finding 4-2 which appears to reflect on the generic approach to the application of live loads in combination with seismic loads should be further evaluated by the licensee to assure that the structural members have load resisting capability in accordance with the regulatory requirements. Findings 4-1, 4-3, 4-6 and 4-7 clearly define the necessity for focused attention on the tank farm structure which houses the refueling water storage tank and the spray additive tank. First, the seismic classification of the structure must be consistently defined and carried through the design and then the tornado conditions the structure must resist as well as what the acceptable behavior is to be, must be defined. Once consistency has been established for the design bases it will be necessary to consider reanalysis of both the concrete and structural steel portions of the structure to clearly reflect the as-built members and boundary conditions. Also, since the tank farm structure has little structural symmetry, the reanalysis should address torsional effects due to seismic loads. Findings 4-9, 4-10, and 4-11 all dealt with eccentric connections in structural steel members which should have been analyzed as non-standard joints, but were found during the inspection to not have been subjected to a specific analysis. Apparently, subsequent analysis by United Engineers has now properly verified these connections in accordance with the FSAR commitments, but the incidence of these unanalyzed eccentric joints was so prevalent that the team recommends a program to address the issue.

There was one observation, which the team also believes merits special attention. Observation 4-8 highlights the need for the licensee to consider some type of verification program for concrete structures similar to the beam verification program currently in-place for structural steel. The team concluded that such a program is highly advisable considering the original unknowns that existed with respect to attachments and extra loads added on the concrete since the time of original design.

As a result of the integrated design inspection at United Engineers the team reached some conclusions that were not listed as findings, observations or unresolved items, but are categorized as comments in the area of quality project management. These include (1) the organization of the normal civil-structural work appears to be very compartmentalized into numerous entities creating extra interfaces, (2) specialized staff groups apparently are not subjected to technical audits as are the project groups since the specialized groups are considered the "experts", (3) the number of procedures which seem to change often in some part may be the result of the separate groups each operating in a different manner and procedures becoming too specific, and (4) the personnel of United Engineers are well trained and have considerable design experience.

Based on the facts gained during the integrated design inspection, the team concluded that the design process in the civil-structural area appeared to be controlled. There were, however, instances of isolated weak points associated with some of the elements of design control as noted in the findings and observations.

5. ELECTRIC POWER

The objectives of this portion of the inspection were to evaluate the adequacy of the control of the design and installation of the electric power portion of the Seabrook containment building spray system. Usually, the electric power aspects of the design do not consist of separate work packages for systems such as the containment building spray system. For instance, the voltage regulation calculations for the station electric distribution system included the electric components of the containment building spray system as well as other systems. Accordingly, the team reviewed samples of various electric systems that included containment building spray system electric equipment and components. The team examined the degree of conformance to the FSAR, regulatory guides, criteria, standards, and design inputs from other disciplines with emphasis on the handling and control of interface information from these disciplines. The team also reviewed the responsibilities of the organizations involved in the electrical design and installation process and various project, administrative, and general engineering design procedures applicable to the design of electric power aspects of the project.

5.1 Design Information

This section describes the responsibilities and functions of the groups involved in design and installation of electric systems and components at the Seabrook Station.

The Yankee Atomic electrical engineering group reviews and approves the electric power section of the FSAR, all safety-related electrical systems drawings, system descriptions, calculations, equipment specifications, its purchase documents and qualification reports, and certain engineering change authorizations. The cognizant engineers in this group monitor various electric equipment installation and tests at the station site and witness tests of purchased electric equipment at vendor facilities. This group also reviews United Engineers or Westinghouse recommended actions on NRC generic communications, such as IE Bulletins and Information Notices pertaining to electric components. Distribution of these documents to the appropriate engineering and quality assurance groups for information, comments and resolution are handled according to Yankee Atomic's project policy 13 (Reference 5.1).

The team reviewed the Yankee Atomic electrical group's correspondence files in the area of specifications and calculations. We found records of reviews and comments controlled, and the group actively involved in the design review process.

The team reviewed Yankee Atomic's quality assurance audit of one electrical contractor (Fischbach) and noted that there were six audits performed in 1983. Yankee Atomic's findings were transmitted to Fischbach and United Engineers (Reference 5.2) and the reply from Fishbach (Reference 5.3) appeared to have been adequately controlled.

United Engineers chief electrical engineer's staff reviews design documents of all safety-related electric systems and equipment, and provides expert opinion and assistance to the Seabrook project electrical design group on various technical matters when requested. The chief engineer's staff also provides assistance in the performance of calculations in support of the FSAR, and developed a computerized conduit and cable schedule program (CASP) that has been used on the Seabrook Project. This program is designed to automatically route cables through the shortest possible path between equipment.

United Engineers' project electrical engineering group is responsible for the design of the electric portion of the plant. This group prepares electrical design calculations, drawings, procurement specifications for electric equipment, construction specifications, system descriptions, and the electrical section of the FSAR. It reviews vendor documents and electrical interface information contained in other disciplines' design documents, and approves certain engineering change authorizations. This group is divided into various sections for design, procurement, and installation of electrical systems and equipment including sections devoted to distribution systems, physical systems, Appendix "R" and associated circuits, reactor and balance of plant systems, and site support engineering.

The Distribution System section is responsible for all electrical calculations, developing the main single-line diagram, schematics, specifications, and purchase of all electrical distribution and control equipment.

The Physical Systems section provides technical design and drafting support in several areas of construction including drawings for installation and connection of the electrical equipment. These areas typically include duct banks, cable tray and conduit design and layout, cable routing (CASP), electrical installation drawings and details, grounding, lighting, communication, cathodic protection and conceptual design for tray and conduit supports. The conceptual design for tray and conduit support are reviewed and analyzed by the Mechanical Analysis group for seismic capability and returned to this section for final design and drafting. This section also provides construction drawings to United Engineers site electrical group and Fischbach, the electrical installation contractor.

The Appendix R and Associated Circuits section is responsible for the analysis of all redundant safety-related and nonsafety-related associated circuits regarding protection of safety-related circuits from fire. This section also analyzes all circuits and components for compliance to the physical separation and identification criteria specified in the FSAR.

The Reactor System section provides electrical interface information for all nuclear steam supply systems equipment, whereas the Balance of Plant section provides balance of plant electrical interface information to other disciplines and various sections of the project electrical engineering group.

The Site Support section provides answers to the United Engineers site electrical group's questions. It also reviews, coordinates and approves field initiated engineering change authorization documents. These documents authorize the contractor to perform the work before the change is incorporated in the design documents, revised and issued. This section also responds to field-initiated "Requests for Information" which are written requests for interpretation or clarification of design documents that do not require any calculation, exceptions, or changes to the engineering documents.

The seismic and environmental qualification of all electric equipment purchased by the project electrical group is reviewed by two separate groups, Mechanical Analysis group and Qualification Task Force. Their comments are provided to the project electrical group for resolution and approval. The Mechanical Analysis group reviews the vendor seismic qualification reports. Since November 1983, the Qualification Task Force has become part of the project electrical group, however, its function has remained the same. Also, since 1980, an outside organization, Impell, has been contracted by Yankee Atomic to perform independent evaluations of environmental qualification of electric equipment.

United Engineers' site electrical group manages the electrical installation by contractors and implements quality control measures in receiving, inspection, and storage of all electric equipment at the site. This group also coordinates and initiates field changes in accordance with United Engineers Administrative Procedure AP-15 (Reference 5.4).

The team reviewed the United Engineers electrical group's correspondence with the Yankee Atomic's electrical group, United Engineers chief electrical engineer, vendors of electric equipment, and site electrical group as well as interdisciplinary information flow. These included meeting notes, letters, memoranda, and review requests on design and procurement of various electric equipment. We found that the United Engineers electrical group's technical correspondence appeared to be detailed, controlled, and well documented.

5.2 Calculations

The objective of this portion of the review was to evaluate and ascertain if the calculations used in the containment building spray system electric component sizing were adequately controlled.

The team reviewed the short circuit calculation (Reference 5.5) and voltage regulation calculation (Reference 5.6) performed by the United Engineers electrical group for the 13.8kV, 4.16kV and 480 volt distribution systems. These calculations established the adequacy of switchgear ratings, transformer impedances and sizes, and voltage available at equipment terminals for all modes of plant operation. Computer programs were used to perform the short circuit and voltage regulation calculations. The conditions assumed in the calculations appeared to be well founded. The data used was from United Engineers' station main one-line diagram and electrical equipment data packages (Reference 5.7). The criteria used were based on Yankee Atomic letters (Reference 5.8, 5.9) and the conclusions derived from these calculations appeared reasonable.

These calculations were controlled by United Engineers' quality assurance procedures (Reference 5.10), administrative procedures AP-21 and -22 (Reference

5.11 and 5.12), and general engineering design procedure GEDP-0005 (Reference 5.13). The performance and control of these two calculations appeared to be acceptable, in general. The main generator step-up transformer impedance was not, however, included in the impedance diagram for the bus voltage calculation, whereas it was included in the impedance diagram used for the short circuit current calculations. The following reasons were given by United Engineers for not including the main transformer impedance in the voltage calculation: (1) the main transformer impedance when converted to a per-unit base is insignificant compared to the per-unit impedance of other transformers in the station electric distribution system, and (2) the computer program is incapable of calculating correct bus voltages if the various transformer impedances differ by several orders of magnitude. The team considered the inability of a computer program to handle a specific electrical design configuration an invalid reason for not evaluating and modelling the actual system, including the main transformer. The insignificance of the main transformer impedance can only be established if the voltage calculation is performed including this impedance and the resulting voltages at 480 volt and 120 volt class 1E buses are not significantly lower for running and starting modes of Class 1E and non-Class 1E motors. No study was performed to establish that the main transformer impedance has no effect on station bus voltage regulation. Such a study should be performed (Unresolved Item 5-1).

The medium voltage protective relay coordination (Reference 5.14) was reviewed as a sample to establish the adequacy of station distribution system protective relaying. The calculation was found to have been adequately controlled.

The request for the additional information section of the FSAR (Reference 5.15) indicated that all motors will receive more than the minimum 90% of their rated voltage during normal plant operating conditions. The relay coordination calculation (Reference 5.14) showed that the second level undervoltage relay set point for disconnecting a degraded voltage electric power source from Class 1E buses corresponded to 83% of the motor voltage rating. The calculation did not establish that the Class 1E equipment will be adequately protected by this lower voltage (83%) set point. Apparently no study was performed to establish the required set point for protection of Class 1E equipment. Specifying an undervoltage set point of 83% violates the FSAR commitment of 90%. In responding to this item the licensee should indicate the set point required to provide adequate protection of Class 1E equipment (Finding 5-1).

The team reviewed the power cable sizing and application calculation (Reference 5.79). This calculation established cable sizes for specific feeder loads (e.g., containment building spray pump motors), and guidelines for power cable sizes for use with smaller loads (e.g., motorized valve actuators). The criteria for feeder cable sizing included the capability to withstand fault current heating for a period of about 7 cycles without causing an insulation temperature rise above industry accepted valves. The calculation also considered feeder and power cable load currents with derating factors applied to account for ambient temperatures, and conduit, tray and duct characteristics. Maximum circuit lengths for low voltage cables were established to ensure acceptable voltage drops at the load terminals.

The Onderdonk equation (Reference 5.80) was used by United Engineers to determine minimum 5kV and 15kV feeder cable conductor sizes. This equation relates fault current duration and magnitude to conductor cross sectional area, conductor operating surface temperature, and final surface temperature at the completion of fault clearing by protectice devices. It is considered to be an acceptable model for determining permissible current versus time characteristics for power cable under fault conditions (References 5.80 and 5.81). The team confirmed that the cable continuous (90°C) and short circuit (250°C) temperature ratings used in the calculation were given in the cable specifications (References 5.82 and 5.83), and were consistent with allowable values for ethylene propylene rubber-insulated power cable conductors given in the applicable industry standards (References 5.80 and 5.81). Fault current duration times used in the analysis were reviewed and considered reasonable based on protective relay pickup and breaker interrupting times. United Engineers used the maximum available 13.8kV and 4.16kV asymmetric bus fault currents in the Onderdonk equation. The team concluded that the calculations including the methodology, assumptions, and data used to determine cable conductor sizes based on fault current withstand capability were satisfactorily controlled.

Allowable ampacities for continuously loaded power cables were also developed in a United Engineers calculation (Reference 5.79). Ampacities and derating factors for 5kV and 15kV feeder cables and 600V heavy power cables were based on the Insulated Cable Engineers Association publication number 46-426 (Reference 5.84) recommendations for 3 conductor and single conductor triplexed cable in conduit ducts and trays at various ambient temperatures (e.g., 40°C air ambient). The derating factors were based on a tray fill configuration of a single layer of 6 cables with 1/4 diameter spacing between cables. Low voltage, medium power cables were defined in the same calculation as 600-V cables with conductor sizes 2/0 and smaller. Ampacities and derating factors were also based on Insulated Cable Engineers Association publication number 46-426 (Reference 5.84) for cables installed in conduit and ducts. The FSAR, Section 8.3.1.4, restricted tray fill to 40% of usable tray volume for medium power cables. The calculation showed that 40% tray fill corresponded to an equivalent depth of 1.65 inches, assuming no spacing between cables. Cable ampacities were obtained from Insulated Cable Engineers Association publication number 54.440 (Reference 5.85) for the nearest standard tray fill height of 1.50 inches. Additional derating factors consistent with Insulated Cable Engineers Association publication number 54-440 were then applied for cable diameter size effects and inside containment 50°C ambient temperatures. The team verified that the ampacity data used in the cable sizing and application calculation was adequately controlled.

Power and feeder cables were sized in an United Engineers calculation (Reference 5.79) with ampacities at least 125% greater than full load current. Where cables were routed through different types of raceways and ambient temperature regions, the ampacities were based on the most restrictive derating. The team reviewed the loads (References 5.87 through 5.94 and 5.125) and sizing calculations for the 13.2kV reactor coolant and circulating water pump motor feeders, the 4kV containment spray and emergency feedwater pump motor feeders, the 4.16kV/480V unit substation feeders, and the 460V containment spray system motorized valve actuator (CBS-V5, -V14, -V17 and V-43) cables. We found the sizing information for these loads was adequately controlled.

Additional deratings due to fire stops and barriers were not included in the cable sizing and application calculation (Reference 5.79). The calculation stated that fire stop and barrier deratings will be considered on a case-by-case basis. United Engineers developed test specifications (Appendix B of Reference 5.95) for representative Seabrook cable and barrier configurations which will determine, when testing is completed, suitable derating factors for use with the calculated cable ampacities of Reference 5.79. The team examined the specification and was satisfied that the approach appears to be reasonable. No such deratings, however, were applied before or during the team's inspection. We had no further questions on cable deratings resulting from fire stops and barriers.

The team found one omission in the cable sizing and application calculation. There was no consideration of cable ampacities and deratings for cables located in the Main Steam - Feedwater Piping Enclosure Building. The power cable CASP report (Reference 5.96) shows that low voltage Train A and B cables are run in this building in trays and conduit, respectively. The Service Environment Chart (Reference 5.97) shows that the Piping Enclosure Building ambient temperatures during normal operation can reach 130°F (54.4°C). The cable sizing calculation was performed for normal ambient temperatures of 70°C in the pressurizer region, 50°C inside containment, and 40°C for all other plant locations. Since the Piping Enclosure Building is included in the general plant area, the 40°C basis used in the calculation is incorrect for power cables run in this building. The team reviewed FSAR plant layout drawings, Service Environment Chart (Reference 5.97) information, and the cable sizing calculation, and did not identify any other apparent plant region omissions. The team believes this to be an isolated error (Finding 5-2).

The Seabrook cable sizing and application calculation (Reference 5.79) also established maximum circuit lengths at 460 and 115 Vac, and 125 Vdc which resulted in voltage drops at the load of less than 2% or 3%, depending on cable conductor size. The team reviewed the methodology used to determine maximum permissible circuit lengths. Random checks of the calculations were performed of permissible circuit lengths for 125 Vdc motor, and 460 Vac motor, heater, and transformer loads. The team also reviewed sample cable lengths given in the CASP report (Reference 5.96) for the containment building spray system motorized valve actuators and found that these cable lengths resulted in voltage drops of less than 3% at the motor terminals. The voltage drop and maximum circuit length calculations in the areas examined appeared to be controlled.

The team reviewed the Class 1E battery calculation (Reference 5.98). The batteries are lead-calcium power station type consisting of a total of four 125Vdc batteries, chargers, and dc buses; i.e., 2 per train. Each of the four Class 1E batteries is sized to have sufficient capacity to supply two load groups in each of the 2 trains when one battery is out of service. Essentially, the Seabrook dc system is sized with four 200% batteries.

The team examined United Engineers development of the dc load duty cycles used in the battery sizing calculations. The Seabrook FSAR, Section 8.3.2, required that batteries have sufficient capacity to accommodate maximum safety-related loading during a 2-hour loss of offsite power. We observed that loads were tabulated in the calculation according to duration out to 2 hours. We found that momentary loads, such as in-rush currents, were defined to exist for a 1-minute duration, and that randomly occurring loads were postulated to occur at the most critical time in the duty cycles. These practices were considered to be consistent with the load definition guidance given in IEEE Standard 485 (Reference 5.86). We also compared the tabulated loads in the calculation to the 125Vdc single line diagram (Reference 5.99), and inspected the Class 1E inverter load calculation (Reference 5.100) to confirm that major loads were included in the dc load cycle. The team concluded that the identified dc loads appeared to be correctly incorporated into the duty cycles.

The battery sizing methodology was based on IEEE Standard 485 (Reference 5.86). The calculation used battery capacity rating factor data supplied by the manufacturer, Gould Inc. (References 5.101 and 5.102) to determine battery cell size requirements for the established load duty cycles. Gould provided this data (Reference 5.102) for several battery models and final cell discharge voltages. For the Seabrook dc load duty cycles and a final battery discharge voltage of 1.78 vpc (Reference 5.103), United Engineers determined that the Gould model NCX 2250 battery would provide adequate capacity. This capacity included a 25% aging margin as recommended in IEEE Standard 485. Review of the calculations and data (References 5.98 and 5.102) showed that the calculation was performed using capacity rating factors for a Model NCX 1200 battery instead of the NCX 2250. Both models have long-term capacity rating factors at a final discharge voltage of 1.78 vpc, however, the short-term characteristics are different as given by Gould in Reference 5.102. The use of the wrong data does not affect the present design because the long-term dc load duty cycle sets the battery sizing requirements at Seabrook. The use of the NCX 1200 data results in an overprediction of the margin (36% vice 28%) that actually exits in the first 15 minutes of the duty cycle at the battery end of life. The sizing calculation should be revised using the correct rating factor data. Use of erroneous data was common to all four Class 1E batteries B-1A, B-1B, B-1C, and B-1D (Finding 5-3).

FSAR Request for Additional Information number 430.30 states that the Seabrook Class 1E batteries were sized in accordance with IEEE Standard 485 (Reference 5.86), and that a design margin in excess of 15% was applied in the sizing calculation. Our review of the battery calculation (Reference 5.98) revealed that no explicit design margin was shown for the load profile, or alternatively the battery positive plate computation. This practice was inconsistent with the response stated to Request for Additional Information number 430.30. The effect on design is minimal. The team was able to estimate that a design margin of at least 11% existed at the battery end of life (i.e., after the 25% aging margin is used up) based on the existing duty cycle and model NCX 2250 battery selected for the Seabrook application. This 11% margin is consistent with the 10 to 15% design margin in Section 6.2 of IEEE Standard 485 (Reference 5.86). The calculation, however, should be revised explicitly showing how the 15% design margin stated in FSAR Request for Additional Information number

430.05 is achieved, or the FSAR should be revised stating the applicable margin used (Finding 5-4).

To determine Yankee Atomic's involvement in the calculational aspects of the design process, the team reviewed correspondence between United Engineers and Yankee Atomic (References 5.17 thru 5.23). We found that all comments were satisfactorily resolved and incorporated in the calculation. We found the calculation review process to be adequately controlled.

In summary, our review in this area indicated four findings and one unresolved item. The team concluded that none of the four findings should result in equipment changes. Findings 5-1 and 5-4 are inconsistencies between the FSAR commitment and supporting design calculations. Finding 5-3 was as an error in the use of battery vendor supplied data, and Finding 5-2 was an inconsistency in the ambient temperature used for one area of the plant in sizing power cables.

5.3 Specifications and Vendor Documents

A review of specifications for sample electric equipment was conducted to evaluate containment building spray system electric component procurements. The team reviewed specifications and related purchasing documents for three electrical components providing motive and control power to containment building spray system pumps and valves.

The team reviewed the 5kV switchgear specification (Reference 5.30). The team determined that the specification provided information for the design, fabrication, quality assurance, test, qualification, and shipment of the switchgear assembly. The requirements appeared to be consistent with industry standards such as ANSI Standard C37 (Reference 5.24), IEEE Standard 344 (Reference 5.25), and IEEE Standard 323 (Reference 5.26) and ratings were based on a United Engineers calculation (Reference 5.5). Preparation and reviews of the specifications were found controlled in accordance with general engineering design procedures, "Preparation of Specification" (Reference 5.27), "Management Level Design Review By Chief Discipline Engineer" (Reference 5.28), and administrative procedure "Conduct of Design Review" (Reference 5.29). Brown Boveri is the vendor of the 5kV, Class 1E switchgear for both units of Seabrook Station. The team reviewed the design control process, design change information, review comments, and shop drawings at United Engineers and at Brown Boveri's facilities. We also reviewed inspection and shipping documents for one set of 5kV, Class 1E switchgear shipped to the Seabrook site. Our review indicated a controlled process.

The containment building spray pump drive motor is a 4000volt, 600-hp motor manufactured by Westinghouse. The motor has a National Electrical Manufacturers Association Class B insulation system with a rated temperature rise of 80°C. The motor is supplied with sleeved bearings, and thermocouples for monitoring of bearing temperatures. Under the requirements of the containment building spray pump specification (Reference 5.104), the pump vendor Bingham-Willamette procured the pump drive motors from Westinghouse according to the requirements of United Engineers general specification for ac induction motors (Reference 5.105). The team reviewed the general ac motor specification and found that it provided requirements and guidance for motor design, construction, performance, certification data, approved manufacturers, and quality assurance requirements for Class 1E applications. We found that the motor specification requirements were comparable to those given in the National Electrical Manufacturers Association Standard MG 1 (Reference 5.106). Based on the sample provisions reviewed, the guidance and requirements given in the ac motor specification appeared to be adequate with respect to the containment building spray pump drive motor application.

The team examined the involvement of the United Engineers electrical group in the containment building spray pump motor procurement and design review process. The electrical group performed contract pre-award reviews of motor information supplied by Bingham-Willamette (Reference 5.107). After award of the pump contract to Bingham-Willamette, Westinghouse had comments on the general motor specification (Reference 5.105). These comments were reviewed by the United Engineers electrical group (References 5.108 and 5.109) and subsequently resolved in a meeting attended by United Engineers, Bingham-Willamette, and Westinghouse (Reference 5.110). The involvement of the electrical group thereafter included monitoring conformance with the general motor specification and reviewing motor outline drawings (References 5.111 thru 5.118) and motor data (References 5.119 thru 5.124).

We reviewed the vendor-supplied motor documents and compared the information to the United Engineers general induction motor specification (Reference 5.105) requirements, and based on the sample examined, found them in conformance. Motor data sheets (References 5.125 thru 5.128) showed that motor performance characteristics exceeded National Electrical Manufacturers Association Standard MG 1 minimum requirements. The motor outline drawing (Reference 5.129) summarized physical, mechanical, and electrical information required by the general motor specification. Our review of the temperature versus horsepower curve (Reference 5.127) showed that a 42°C motor temperature rise could occur above a 40°C ambient. Since the peak containment building spray pump vault temperature is less than 148°F or 64.4°C during the post-loss-of-coolant accident mitigation period as shown in the Service Environment Chart (Reference 5.97), the winding temperature rise should be within the allowable limits established in the National Electrical Manufacturers Association Standard MG-1, Section 20.40 (Reference 5.106) for the Class "B"-rated containment building spray pump motor insulation system.

The team observed inconsistencies in motor lube oil and bearing temperature information in various containment spray pump motor documents. The motor outline drawing (Reference 5.129) was based on information supplied by Westinghouse to Bingham-Willamette (Reference 5.130). The drawing stated that bearing temperatures should not exceed 95°C; no information was provided on lube oil temperatures. The Bingham-Willamette containment building spray pump instruction manual (Reference 5.131) stated motor bearing temperatures should not exceed 90°C, and that motor shutdown was required if the motor lube oil temperatures exceeded 71°C. A summary report (Reference 5.132) of a Westinghouse-United Engineers meeting disclosed that the pump should be tripped when motor lube oil temperatures reach 85-90°C; no information was presented on allowable bearing temperatures except that bearings fail above this range. The team was unable to obtain a basis for these inconsistencies in our discussions with United Engineers personnel. The temperature discrepancies should have minimal effect on design or operation of the motor bearing since a high temperature alarm is received on the station computer at 80°C (Reference 5.133). United Engineers, however, should establish the correct maximum allowable bearing and lube oil temperatures for the containment building spray pump motor, and have the appropriate documents revised as required. United Engineers should also verify that these allowable motor bearing and lube oil temperatures are not exceeded during post-accident operation of the containment spray pump since pump vault ambient temperatures can reach 148°F (or about 64.4°C) as given by the Service Environment Chart (Reference 5.97) (Finding 5-5).

The team reviewed the 480 volt motor control center purchase specification (Reference 5.31) and related vendor documents (Reference 5.32) and compared these documents with the objective of determining their adequacy and consistency. The 480 volt distribution system description (Reference 5.42) provides basic requirements for the overall 480-volt system design including motor control centers. The manufacturer's data (Reference 5.32) was compared to the purchase specification requirements and found to be consistent with the specification and design criteria in the system description . Changes and revisions to the procurement document were current, reviewed and approved by authorized personnel. The documentation on the 480 volt motor control center appeared to be adequately controlled. The team had no further questions in this area.

In summary, our review in this area indicated one finding (5-5) involving inconsistencies in the containment spray pump motor bearing and lube oil temperature information given in various vendor documents. In other aspects, the samples reviewed indicated controlled transmittal and use of technical data.

5.4 System Descriptions

The objective in this portion of the inspection was to review the description and interface information in the electrical system description and determine if the design process, as reflected in this document, was controlled. The team reviewed the electrical section of the containment building spray system description, SD-20 (Reference 5.34) and the 4160 volt distribution system description, SD-74 (Reference 5.35). The motor electrical ratings included in the containment building spray system description were compared with the motor data sheet (Reference 5.125). The 4160 volt distribution system description was reviewed in detail comparing its contents with other related documents such as the FSAR (Reference 5.64), emergency diesel generator electrical specification (Reference 5.37) and the diesel generator system description, SD-76 (Reference 5.36). While comparing the contents of the above four documents, the team noticed that the diesel generator breaker protective trips retained during an accident were inconsistent among the four documents. System description SD-74 lists 5 trips, system description SD-76 lists 3 trips, whereas the FSAR and the emergency diesel generator electrical specification list 4 trips. Administrative procedure AP-41 (Reference 5.38) requires a design change notice or engineering change authorization to be prepared for a deviation from the FSAR. No design change notice or engineering change authorization was prepared for the deviations from the FSAR statement regarding diesel generator breaker protective trips. The team concluded that the administrative procedure AP-41 was not followed causing an inconsistency in the design documents. United Engineers personnel orally stated to the team that system descriptions SD-74 and SD-76 would be revised to include the same protective trips for the diesel generator breakers during an accident as were specified in the FSAR (Finding 5-6).

The team reviewed sample design change notices to determine if the required changes had been incorporated in the affected documents. Design change notice, DCN 030303B (Reference 5.39), changes the 5 kv, class 1E bus fast transfer scheme from a synchronized voltage to a residual voltage relaying scheme. This design change notice did not list the associated 5 kv switchgear specification (Reference 5.30) and 4160 volt distribution system description (Reference 5.35) as affected documents which should reflect the changes required by the design change notice. United Engineers General Engineering Design Procedure, GEDP-032 (Reference 5.41) and Administrative Procedure AP-15 (Reference 5.40) require all affected documents to be listed in the design change notice. The team concluded that the administrative procedure AP-15 was not followed. The team noted that a subsequent revision of the system description SD-74 (Reference 5.43) includes this change but the switchgear specification (Reference 5.30) still described the synchronized voltage relaying scheme instead of the residual voltage relaying scheme. United Engineers personnel orally stated to the team that this change would be included in the next revision of the switchgear specification (Reference 5.30) (Finding 5-7).

Both findings discussed above constitute violation of administrative procedures. They were considered minor isolated errors that did not substantially affect the design. The design documents for the hardware change were correctly transmitted to the switchgear vendor and field installation. Our review in this area did not indicate any pervasive problem and the team did not have any further questions on these topics.

5.5 Equipment Qualification Reports

The objective of this review was to determine if the electric equipment delivered and installed at the Seabrook site were adequately qualified for the environmental and seismic requirements of the Seabrook site.

The team reviewed four electric equipment qualification reports to evaluate the method used to review and process the data. The environmental qualification report submitted to United Engineers by an electric equipment vendor is evaluated by two sections of the project electrical engineering group. The Distribution System Section reviews the report for correctness of the components and the Qualification Task Force reviews it for the correctness of environmental parameters, test or analysis results and qualified life of the components. The seismic qualification report submitted to United Engineers by an electric equipment vendor is evaluated by United Engineers' staff Mechanical Analysis Group with emphasis on the specified seismic response spectra and the latest United Engineers seismic response spectra. In addition, an outside organization (Impell) was contracted by Yankee Atomic to perform independent evaluations of environmental qualification. Impell performs technical evaluations to ensure that vendor documents and qualification programs satisfy NUREG-0588 criteria

(Reference 5.135), and the general requirements in IEEE Standard 323 (Reference 5.26).

The team reviewed the United Engineers Qualification Task Force responsibilities and procedures. The Qualification Task Force assembles equipment documentation packages for evaluation by Impell. These packages typically include vendor test reports, United Engineers equipment specifications, vendor supporting documents and drawings, and generic Seabrook information such as the high energy line break analysis (Reference 5.136), Environmental Service Chart, (Reference 5.97), Post-accident Dose Engineering Manual (Reference 5.137) and Class 1E Equipment List (Reference 5.138). Impell performs detailed technical evaluations and issues a Qualification Assessment Report. These reports include a list of comments and questions. The Qualification Task Force is responsible for (1) contacting the equipment vendors to obtain technical information to resolve qualification deficiencies, (2) performing engineering analyses, and (3) developing technical responses. The responses are forwarded to Impell for additional evaluation to determine if the deficiencies have been resolved. When Impell has been convinced that qualification of the equipment has been demonstrated, Impell issues a Final Qualification Assessment Report. A copy of this document is maintained in the equipment qualification files at United Engineers.

The Qualification Task Force does not have formal procedures which define its scope or work methods, although it is required to follow all administrative, quality assurance and general engineering design procedures invoked on the Seabrook project. At the time of the team's inspection, procedures were being developed which defined some of the Qualification Task Force's responsibilities, interfaces, and work products. The team was able to inspect the draft purchase order qualification document file procedures (Reference 5.139), and draft input and review guidelines for the Class 1E Equipment List (Reference 5.140). Our review of the sample material in this area did not disclose any problems and we had no further questions.

The Class 1E Equipment List (Reference 5.138) is used by United Engineers, Yankee Atomic, and Impell to identify equipment requiring qualification, equipment qualification status, and as a compilation of supporting information. The list is actually a computer printout. However, it is issued by United Engineers as a numbered drawing (9763-M-505300) to ensure that its information and distribution are controlled. The team observed that this drawing was distributed to Yankee Atomic, Impell and other United Engineers engineering groups (References 5.141, 5.142) without signoff, review or approval as required by United Engineers Quality Assurance Procedure QA-3, Section IV.E.3 (Reference 5.143). Specifically, the equipment list was not initialed by the originator and then reviewed, checked, and initialed by another person. It was not submitted to affected disciplines for review and signoff, and reviewed or approved by the supervising discipline engineer or project engineering manager or designated cognizant individual. In discussing this matter with Qualification Task Force personnel, we determined that lack of drawing control in accordance with Quality Assurance Procedure QA-3 was recognized.

The effect of this practice on the design process is not known. Erroneous, unchecked information could be distributed and used by various engineering groups within United Engineers, Yankee Atomic, Impell and possibly equipment vendors. For example, the team observed that 3 United Engineers design groups identified, in their internal correspondence (References 5.144 thru 5.146), several errors in the Class 1E equipment list approximately five months after its issuance. The team believes the chance of incorrect data being distributed would be greatly reduced if the reviews and approvals required by Quality Assurance Procedure QA-3 were performed prior to issuance of each revision of the Class 1E Equipment List. Because of the systematic lack of formal approval for this list, United Engineers should check for incorrect information that might be inadvertently entered (Finding 5-8).

During the inspection the team was shown a draft procedure (Reference 5.140) for the Class 1E Equipment List. This document defined responsibilities for identifying Class 1E equipment, information criteria, and review and approval requirements. In the response to Finding 5-8, United Engineers should (1) state whether the procedure has been reviewed, approved, and implemented in accordance with appropriate procedures and (2) also report the results of their check for information errors in the list, and subsequent actions taken to correct any errors that were found.

The team reviewed the Service Environment Chart (Reference 5.97). This chart summarizes environmental service conditions for major plant regions. It is a controlled design document, and is assigned a drawing number. The team verified that the chart was reviewed, revised, and maintained in accordance with the requirements for drawings in United Engineers Quality Assurance Procedures QA-3 and QA-5 (References 5.143 and 5.147). We examined a number of sample analyses which provided environmental service conditions for the containment building spray pump vault and inside containment (References 5.148, 5.158 and 5.224). In all the sample cases examined, the relevant environmental data was correctly summarized on the chart. The team found two references on the Service Environment Chart incorrectly identified. Revisions 10 (9/14/82) through 13 (6/24/83) of the chart refer to two reports: Report 9763-006-S-N-3, "Radiation Integrated Dose Values", and Report 9763-006-S-N-2, "High Energy Line Breaks Inside Containment". The team requested both reports for review. For Report 9763-006-S-N-3 the team received an un-numbered document entitled "Extractions - Post-accident Dose Engineering Manual" (Reference 5.137) which consisted of exerpted data from Section 2.3 of the "Post-accident Dose Engineering Manual" (Reference 5.148). For Report 9763-006-S-N-2 we received an undated report of an analysis entitled "Analysis of High Energy Line Breaks Outside Containment" (Reference 5.136). Neither document had the Seabrook project report number (9763-006-S-N-2 or 9763-006-S-N-3) or title referenced on the Service Environment Chart. These important documents contain data on radiation total integrated dose values, and temperature and pressure profiles for various plant locations. In many cases, the user of the Service Environment Chart is referred to these documents in order to obtain detailed data. The team reviewed these documents (References 5.137 and 5.136), and verified that the sample environmental data that was examined was correctly incorporated into the Service Environment Chart. No impact on design is expected, however, the chart should be revised to show the correct references. (Observation 5-1)

In addition, the line break analysis (Reference 5.136) and dose engineering manual (Reference 5.148) were controlled documents. However, the summary dose document (Reference 5.137) did not appear controlled. Since Reference 5.137 appears to be a basic source of reference data on environmental conditions, it should be controlled in accordance with Quality Assurance procedure QA-3. The team considers that this procedural error should be corrected and the summary dose document should be reviewed to assure the data is correct (Finding 5-9).

The team reviewed the environmental and seismic qualification reports for medium voltage (5 kv) switchgear. Brown Boveri is the vendor for the switchgear and prepared the associated qualification reports. The team reviewed the latest seismic qualification report (Reference 5.44) and the environmental qualification report (Reference 5.45) that had been reviewed by United Engineers Mechanical Analysis Group and Qualification Task Force. The seismic qualification is based on similarity of the purchased switchgear to a representative switchgear. The representative switchgear was tested by Wyle Lab, according to their test plan (Reference 5.46), which does not provide mounting details of the test specimen on shake table. Section 8.5 of the IEEE Std 344 (Reference 5.25), cited in the purchase specification (Reference 5.30) requires that a comparison be made between the purchased equipment and the test specimen when qualification is by similarity of equipment. Our review indicates that Brown Boveri approved, in their letter (Reference 5.47), the anchoring method of the switchgear specified by United Engineers in their drawing (Reference 5.48). The teams field inspection confirmed that the actual tie down (welding) of the switchgear is in accordance with United Engineers anchoring method. The approval was not based on a comparison of United Engineers method to the test specimen's anchoring. Since the Wyle lab test plan (Reference 5.46) does not include mounting details of the test specimen, there is no documented basis for Brown Boveri's assertion that United Engineer's method for anchoring electric equipment (Reference 5.48) is adequate for seismic loading of the 5 kv switchgear. This is a violation of the purchase specification requirement. The seismic qualification report (Reference 5.44) should address the adequacy of United Engineers anchoring method for the switchgear (Finding 5-10).

Our review of the environmental qualification report (Reference 5.45) indicated that the control wire type mentioned in the report is different from that of Brown Boveri's bill of material (Reference 5.49). The wire specified in the bill of material is the type actually used in the switchgear cubicles already delivered for Unit 1. The qualification report (Reference 5.45) indicates that the control wire used in switchgear cubicles for both units are "GE-SIS-VULKENE Supreme" whereas the bill of material (Reference 5.49) and the field inspection confirm that for Unit 1 cubicles, Brown Boveri used "GE-SIS-VULKENE". This latter wire type is not qualified to IEEE Std 383 (Reference 5.50) as stated by GE in their letter to Gould (Reference 5.52). The switchgear purchase order specification (Reference 5.30) does not require IEEE 383 qualification, rather it requires control wires to be qualified to Insulated Cable Engineers Association's Standard, S-19-81 (Reference 5.51). Also, IEEE Std 383 (Reference 5.50) allows individual insulated control and instrumentation cables which are type tested to be qualified to Insulated Cable Engineers Association Standard for flame resistance test. This finding is, therefore, catagorized as an error in the vendor document that does not necessitate a design change (Finding 5-11).

The team inspected the containment building spray pump motor qualification file (Reference 5.149). At the time of our inspection the Qualification Task Force was in the process of resolving motor qualification deficiencies. The team examined documents supplied by the Qualification Task Force to Impell for evaluation of motor qualification. These documents consisted of a Westinghouse Large Motor Division test report (Reference 5.150), United Engineers equipment specifications (References 5.104 and 5.105), accident environmental data (References 5.137 and 5.136), Westinghouse comments (Reference 5.151) on motor qualification to IEEE Standard 323 guidelines, Class 1E Equipment List (Reference 5.138), and Service Environment Chart (Reference 5.97). The team compared normal and accident environmental service conditions in the pump specification, Class 1E Equipment List, and Service Environment Chart. There was agreement on all environmental service conditions with one exception. The total integrated dose was listed as 44 Mrd. in the equipment specification (Reference 5.104) based on radiation analyses reported in a November 1977 United Engineers memo (Reference 5.223). A more recent study (Reference 5.148) performed in April 1982 indicated 42 Mrd. Since the Westinghouse motor qualification test report (Reference 5.150) showed that the motor insulation system can withstand a total integrated dose of 200 Mrd, the 44 Mrd specification was considered adequate.

We examined the Qualification Task Force's resolution of outstanding containment building spray pump motor environmental qualification items. These items consisted of questions and comments resulting from Impell's assessment report (References 5.152) on motor qualification. Impell identified that clarifications or additional supporting data should be obtained on the extrapolation of motorette environmental test results to large motors, material evaluations performed by Westinghouse, and thermal and radiation aging. In response to these concerns, the Qualification Task Force contacted Westinghouse for additional information. We reviewed a Westinghouse letter (Reference 5.153) which clarified some test program details, and a detailed summary (References 5.132 and 5.154) of a meeting between United Engineers and Westinghouse on motor qualification. The team compared this additional information (References 5.132, 5.153, and 5.154) to the Westinghouse qualification test report (Reference 5.150) and Impell's assessment report concerns (Reference 5.152), and concluded that the containment building spray pump motor qualification appears to be adequately controlled.

The team reviewed the environmental qualification work performed for 2 items of electric equipment associated with the containment spray building system encapsulated sump isolation valve and pressure vessel, the motorized Limitorque valve actuators and the vessel electric feedthrough (penetration) assemblies.

The containment building spray pump suction isolation valves CBS-V8 (Train A) and CBS-V14 (Train B) are encapsulated in steel vessels. These encapsulation vessels are located in the piping penetration area outside containment, and are an extension of the containment pressure boundary since they prevent the release of radioactive fluids or gases to the environment in the event of failure of the enclosed valve or piping during accident conditions, according to the vessel specification (Reference 5.155). The containment building spray pump suction isolation valves must open to provide water from the containment sump to the containment building spray and residual heat removal pumps (CBS-P-9A, 9B, RH-P-8A, 8B) during the recirculation phase following a loss of coolant accident. The valves have motorized actuators located inside the encapsulation vessels, and are powered via electric feedthrough penetrations which penetrate the encapsulation vessel about 6" above its base. The electrical feedthroughs were procured with the valve encapsulation vessel under United Engineers specification 9763-006-248-47 (Reference 5.155). PX Engineering Company fabricated the vessel and procured the feedthroughs from Conax Corporation. Velan Corp. supplied the sump isolation valves for Seabrook to United Engineers specification 9763-006-248-37 (Reference 5.156). The valve actuators were procured by Velan from Limitorque Corporation according to the requirements of United Engineers general valve actuator specification, Specification 9763-006-248-13 (Reference 5.157).

The team compared the normal and accident environmental service conditions in the Class 1E Equipment List (Reference 5.138) and Service Environment Chart (Reference 5.97) to the values given in the encapsulation vessel and valve specifications. We found an inconsistency between the encapsulation vessel specification (Reference 5.155) and plant accident environments. The Service Environment Chart and Class 1E Equipment List show that the maximum service temperature in the pipe penetration area is 148°F; United Engineers specification 9763-006-248-47, Section 2.4 (Reference 5.155), stated that the maximum external ambient temperature for the encapsulation vessel is 140°F. Review of building cooling calculations (Reference 5.158) confirmed the 148°F Service Environment Chart temperature value. The team, therefore, concluded that the 140°F temperature stated in Section 2.4 of the specification was incorrect. The eight degree temperature differential should have no effect on the environmental qualification of the electrical feedthroughs. Conax Test Report No. IPS-503 (Reference 5.159) shows that the feedthrough successfully withstood thermal cycling from 30°F to 150°F (5 cycles) and 30°F to 145°F (120 cycles), followed by thermal aging at 255°F (169 hours) and simulated loss of coolant accident testing at peak steam temperatures of 342°F. The team checked 10 other qualification files and found no similar discrepancies between the accident environments given in the Service Environment Chart and equipment specifications (References 5.149 and 5.160 through 5.168). We considered this an isolated error (Finding 5-12).

The team examined the qualification test reports for the feedthroughs (References 5.159, 5.169, and 5.170) and valve actuators (References 5.171 and 5.172). We compared the Conax and Limitorque test programs to IEEE Standard 317 (Reference 5.174) and IEEE Standard 382 (Reference 5.175), respectively, and determined from the sample provisions examined that the testing was performed in accordance with the guidance given in the standards. The team was able to verify that the Qualification Task Force had obtained additional vendor test reports (References 5.171 and 5.172), thermal aging data (Reference 5.176), and a letter (Reference 5.177) on test report applicability to the valve actuators, and initiated vendor correspondence (Reference 5.173) on serial number identification for the feedthroughs in order to resolve most questions that resulted from Impell's evaluations (References 5.160 and 5.178). The team examined Conax's analysis (Reference 5.159) demonstrating short circuit, short time overload and normal current carrying capability to the Seabrook feedthrough specification requirements (Reference 5.155). We concluded that Conax's technical approach appeared adequate for showing feedthrough current carrying capability. The team's review of the qualification assessments for the feedthroughs disclosed that qualification for submergence was considered unnecessary in Impell's qualification assessment report (Reference 5.178). This position is inconsistent with United Engineers specification Section 2.6.2 (Reference 5.155), which states that the encapsulation vessel internal service environment during accident conditions may reach 296°F/52 psig, and may fill with a borated steam or water solution with an overall pH of 8-10.5. United Engineers letter (Reference 5.179) to PX Engineering Company advised that moisture and some flooding can occur within the vessel, and that this effect should be addressed by performing water immersion tests on the feedthrough conductors. Since the valve actuator is also located inside the encapsulation vessel, the actuators could possibly become submerged. Operation-while-submerged was not a requirement in the actuator specifications (References 5.156 and 5.157) or in the qualification assessment (Reference 5.160). However, the feedthroughs and valve actuators have not been qualified to the general requirements of IEEE Std 323, Sections 5 and 6, or NUREG-0588, Section 2, regarding testing of equipment to all accident service conditions including submergence.

Failure of a feedthrough assembly or a valve actuator due to submergence could cause a sump isolation valve (CBS-V8 or CBS-V14) to fail to open during the recirculation phase of LOCA mitigation. This condition would result in loss of a single containment spray and a single residual heat removal system because both systems remain isolated from the containment sump water supply. The Limitorque actuators and Conax feedthroughs should be qualified for submergence or alternatively, analyses should be performed to show that submergence cannot occur inside the encapsulation vessel. This problem area is unique to equipment associated with the encapsulation vessel, and is not considered systematic with respect to other Seabrook equipment qualification reviews (Finding 5-13).

The team reviewed the environmental qualification report for 480-volt motor control centers (Reference 5.53). Comparing it with the United Engineer's procurement specification (Reference 5.31) and FSAR (Reference 5.63), we noted that Section 3 (Service Conditions) of the environmental report (Reference 5.53) list the radiation environment as 876 rads @ 2.5 mR/hr for the 40-year life of the equipment. FSAR Figure 3.11(b)-1 (Reference 5.63) lists the expected cumulative radiation dose for the motor control center in the switchgear room to be 1000 rads in 40 years. As such, the qualification dose is less than the FSAR specified dose. This is a violation of the FSAR commitment and may result in shortened qualified life of the motor control center components (Finding 5-14).

The team also reviewed the seismic qualification report (Reference 5.54) for motor control centers purchased to the United Engineer's specification (Reference 5.31). In this report, the seismic qualification of the motor control center is based on similarity to a representative motor control center tested by Wyle Lab, according to their test plan (Reference 5.55). The team observed that the test specimen differed from the plant equipment as follows: (1) the height of the pull box mounted on this plant equipment is 12 inches versus 9 inches for the test specimen, (2) the cross section of the ground bus for plant equipment is 1/4 inches x 2 inches versus the test specimen bus of 1/4 inch x 1 inch, and (3) frame JL type circuit breakers are used in the plant equipment and no breaker was included in the test specimen.

Section 8.5 of the IEEE Std 344 (Reference 5.25), cited in the purchase specification (Reference 5.31), requires that a comparison be made between the purchased equipment and the test specimen when qualification is by similarity of the equipment. No comparison between the purchased item and the test specimen justifying the difference was identified in the seismic qualification report. This is a violation of the purchase specification for this equipment. The seismic qualification report should address and justify the differences (Finding 5-15).

American Welding Society Standard (Reference 5.56) cited in this purchase specification specified that the fillet welding requirements for welding plates 1/4 inch or less should be the same size as the plate thickness, and for plates greater than 1/4 inch thickness, the fillet should be 1/16 inch plus the plate thickness. The welding specification drawing (Reference 5.57) included as an attachment to the seismic qualification report (Reference 5.54) specified that the motor control center base plate was 3/16" thick and that it should be anchored by a 1/4" thick fillet weld. Although the specified 1/4" fillet weld is adequate it is contrary to the requirements of American Welding Society Standard D.1.1-81 (Reference 5.56). This is considered a minor error and no equipment changes appear necessary. (Finding 5-16)

We conducted a field walkdown of motor control centers to verify anchoring details. We observed that the motor control centers are anchored in place using a 3/16 inch by 2 inch long weld per United Engineers drawing 300209 (Reference 5.48). No justification, analysis and vendor concurrence for the change in weld configuration from the vendor specified 1/4-inch x 3 inch long fillet weld (Reference 5.57) to a 3/16 inch by 2 inch long weld could be found. This is a violation of the vendor's seismic qualification document welding specification (Reference 5.57) (Finding 5-17).

In reviewing the seismic qualification report attachment C drawing (Reference 5.54), we observed that the weld drawing was checked and approved by the same individual. This is a violation by the motor control center manufacturer's quality assurance procedure, section 3.3.10 (Reference 5.58), which requires that the drawing be checked by one person and approved by management personnel (Finding 5-18).

In summary, our review in this area resulted in 11 findings. Three of the findings (5-9, 5-11, and 5-12) were documentation errors or inconsistencies of information between various design documents; two findings (5-8 and 5-18) were violations of procedures; six findings (5-10, 5-13, 5-14, 5-15, 5-16, and 5-17) resulted from noncompliance with the FSAR, qualification specification or applicable industry standard requirements. In general, the findings were indicative of failure to consider and evaluate all of the technical requirements for adequately demonstrating equipment qualification.

5.6 Schematic and Wiring Diagrams

The objective of the review of the schematic and wiring diagrams was to establish if the requirements of the FSAR, system description, and control loop and logic diagrams were adequately presented in the electrical diagrams used for production and field connection of electric equipment. The team reviewed schematic and wiring diagrams of the containment building spray system electric components, especially of the containment building spray pump circuit breaker and the 5 kV Class 1E bus power source breakers (References 5.59, 5.60, 5.61). Preparation of the drawings is governed by the United Engineers procedure for preparation of drawings GEDP-13 (Reference 5.62). The schematic diagrams are part of the system-based drawing package consisting of an index sheet listing all components and drawing sheets for the system, revision sheets, general notes, legends, references, switch and contact development sheets, and schematic diagrams. The schematic diagrams are developed based on system control loop, logic and electrical single line diagrams. The vendor of the electric equipment uses these schematic diagrams, which are part of the purchase specification, to develop internal details called shop drawings. The wiring diagrams are prepared and submitted to United Engineers by the equipment vendor, e.g., Brown Boveri for the switchgear. These internal detail diagrams are issued by United Engineers as construction drawings to show field cable connections.

Sample drawings (construction and shop drawings) were checked for conformance to drawing preparation and control procedures, and correctness of the information shown on the drawings. We found the information interfaces between United Engineers and the switchgear vendor (Brown Boveri) adequately controlled and procedures generally followed. The team compared the as-built containment building spray pump circuit breaker cubicle drawing (Reference 5.61) with the actual components and a few connection samples, and found the samples to be correct.

In summary, the team did not find problems in this area and had no further questions.

5.7 Response to NRC Communications

The objective of this part of the inspection was to determine how NRC Bulletins, Circulars, and Information Notices were considered in the design process.

Directions for handling IE Information Notices, Bulletins, and Circulars are provided in United Engineers administrative procedure AP-49 (Reference 5.78). This procedure provides directives for review, evaluation, and written response to IE documents. Upon receipt of the IE document, the Yankee Atomic project office forwards the document to the United Engineers project office for review and determination of applicability to the Seabrook project. The United Engineers Document Control Center provides a copy of the document to the Seabrook licensing engineer for evaluation and assignment of responsibility for a response. The assigned cognizant engineering group prepares a response for Yankee Atomic addressing the issue and its impact on the Seabrook project. The licensing engineer, then includes the item in the deficient products list which tabulates components, parts, and materials identified in IE document as unacceptable for use in safety-related applications, or requiring modification to permit their usage. This list is distributed on a monthly basis to key personnel and purchasing representatives in United Engineers as required by administrative procedure AP-49.

The team reviewed four Information Notices and one Bulletin (80-11, Reference 5.73; 80-21, Reference 5.74; 82-53, Reference 5.76; 82-54, Reference 5.77; and 83-05, Reference 5.75). Our review of United Engineers handling of Information Notice 80-11 indicated that the subject deficient ASCO solenoid valve reported to have problems in high humidity/high temperature environments was not listed in the United Engineers deficient products list. Consequently, no determination was made if the subject Asco valves were used in the Seabrook project. Also our review of the handling of Information Notice No. 80-21 (Reference 5.74) indicated that the subject friction type clamps reported deficient for anchoring class 1E equipment were not listed in the United Engineers deficient product list, and were not evaluated for its usage with safety related equipment. Our field inspection confirmed that these friction type clamps were used to anchor safety related horizontal cable trays to tray supports. Both items are violations of administrative procedure AP-49 (Reference 5.78) which requires identification, listing, and evaluation of the deficient item if it is used at the Seabrook plant. Due to time limitations the team was unable to determine whether there were other violations of AP-49 on the project in this regard. The licensee should investigate the matter further and report the results in responding to this item (Finding 5-19).

5.8 Installation of Cables and Documentation

The objective of this portion of the inspection was to determine if raceway and cable routing was in accordance with electrical design documents, and that cable installations were recorded properly on pull and termination cards.

United Engineers uses a computerized cable schedule program (CASP) (Reference 5.180) to control, document, and route cable. The physical design group prepares layout drawings to establish raceway locations, voltage level groupings, and separation of redundant circuits. The wiring design group prepares the schematic diagrams, cable schematics, and cable termination tables. The physical and wiring design groups input this information into the CASP program in order to route cable by separation group, channel, available unfilled raceway, and cable termination point.

The team selected a number of power and control cables, and reviewed the associated electrical drawings which showed the cable routes including raceways between the power supply and load terminations. The team traced two control cables (D41-VQ9/1 and D41-VQ9/2) and two power cables (A61-M15 and D40-Y36) in the containment spray system, and nine other power cables (AB0-HD0, AD0-HE0/1, B78-VE6, ET5-ET9, E42-G4T, AG3-E97, CN5-JU9, A09-EF9/1, and A/5-AM9) on electrical drawings (References 5.181 thru 5.189) that showed the trays, conduits, their physical coordinate points, and termination nodes. We conducted a field walkdown of the same cables to compare the field routing to the design routing. We observed that the: (1) conduit and tray routing was identical to that shown on the design layout drawings, (2) conduit and trays were marked and color coded correctly with respect to separation group, (3) color coded divisional cables entering balance of plant areas from the nuclear island were routed through conduit as specified by CASP, (4) cable jacket markings on Class 1E cable agreed with the identification markings required by cable specifications, (5) cable jacket color codings matched the separation group color identification codes, (6) actual cable lengths were within 10% of the CASP-estimated lengths, and (7) actual cable routing conformed to the CASP-defined route.

The team also examined the pull and termination records of the containment building spray system CBS P-9B pump motor feeder (AGI-M15), the pump suction isolation valve CBS-V14 motorized actuator power cable (D40-Y36), and the containment building spray isolation valve CBS-V17 motorized actuator control cables (D41-VQ9/1 and D41-VQ9/2). The cable pull (References 5.215 thru 5.218) and terminations (References 5.219 thru 5.222) were adequately controlled.

In summary, the design documents that we inspected in this area were in order. The field installation sample inspected by the team was found to be in accordance with the design documents and drawings.

5.9 Site Electrical Design Activities

The team reviewed the design activities of United Engineers' site electrical group to determine the scope of design activities and conformance to project procedures.

The site electrical group supports United Engineers Philadelphia office electrical engineering and site construction efforts by resolving construction-related problems in design documents such as specifications, drawings, and calculations. The site electrical group has 4 principal areas of involvement including physical design aspects such as raceways, raceway supports and support locations, conduit and tray interfaces, grounding, and cathodic protection; wiring aspects primarily clarifying cable termination requirements; equipment aspects including correction of deficiencies or broken components, field modification packages, and resolution of equipment-related questions during startup functional tests; and maintaining the CASP system to reflect all routing changes required by field design and construction activities. Much of the site electrical engineering work can be characterized as resolving raceway and cable physical interferences, and supplying equipment cable termination information for construction. The Request for Information and Engineering Change Authorization are the mechanisms used to perform this work. The requirements for using, filling-out, reviewing, processing, and dispositioning of Requests for Information and Engineering Change Authorizations are defined in United Engineers Administrative Procedure AP-15 (Reference 5.4).

The team selected some sample Requests for Information and Engineering Change Authorizations in order to evaluate the site's handling of these items, the United Engineers site-Philadelphia office electrical group interface, the level of resolution provided by United Engineers via the completed Requests for Information and Engineering Change Authorizations, and general adherence to Administrative Procedure AP-15 requirements.

Engineering Change Authorization number 032312A (Reference 5.190) noted that cable GIO-RZ5 used with the containment building spray system additive tank level switches did not have termination information on drawing number 9763-M-310900, Revision 2 (Reference 5.191). The site electrical group determined the termination requirements and issued a completed Engineering Change Authorization 032312A with the appropriate termination information marked onto a copy of drawing 9763-M-310900, Revision 2. The team observed that the termination data was identified on the drawing as a change item, and that drawing 9763-M-310900 was listed as an affected document requiring revision. We reviewed Revision 3 of the subject drawing (Reference 5.134) and verified that the termination data in Engineering Change Authorization number 032312A had been incorporated.

Engineering Change Authorization number 544658A (Reference 5.192) was issued for installation of grounds on the encapsulated sump isolation valve motorized actuators (CBS-V8 and CBS-V14). The change authorization instructed the electrical construction contractor (Fischbach) that unused power feedthrough pigtail conductors should be used for making ground connections between the valve actuator and power terminal box located outside the encapsulation vessel. Marked up cable drawings (References 5.194, 5.195) showed the applicable changes and were included with the Engineering Change Authorization. These drawings had not been revised by the Philadelphia office electrical group at the time of inspection; however, they were identified by the Engineering Change Authorization as an affected design document requiring change. The team's field inspection of CBS-V14 terminations verified that Engineering Change Authorization number 554658A had been followed. We observed that the termination slip (Reference 5.193) for this work also referenced the Engineering Change Authorization. This change authorization was categorized as a minor Engineering Change Authorization not requiring Philadelphia office concurrence. The team verified that the classification was correct based on the criteria for minor Engineering Change Authorizations given in Attachment 3 to United Engineers Administrative Procedure AP-15.

United Engineers provided the electrical construction contractor Fischbach with cable termination information for monitoring of the containment building spray pump bearing and stator temperatures in Engineering Change Authorization number 032348A (Reference 5.196). The team field inspected the containment building spray pump CBS P-9B. We observed that cables GIG-M16/1, GIG-M16/2, GIG-M16/3, and GIG-M16/4 had been pulled to the motor location, but were not terminated. Cable ends and wire numbers were clearly identified, and matched the cable table (Reference 5.197 and 5.198), CASP, and Engineering Change Authorization information. The motor auxiliary conduit box cover was removed for the team and we verified that the terminal board for the motor bearing temperature elements and stator resistance temperature devices connections were marked as specified on the motor outline drawing (Reference 5.129) and the change authorization. The team inspected the cable table drawings (References 5.197 and 5.198) and verified that the United Engineers Philadelphia office electrical group had issued revised drawings showing the correct termination information supplied by Engineering Change Authorization number 032348A.

Engineering Change Authorization number 032149A (Reference 5.199) involved routing of valve actuator heater cables V46-V35/1 and V22-Y32/1 for the containment building spray system reactor water storage tank isolation valves CBS-V2 and CBS-V5, respectively. Engineering Change Authorization number 032149A permitted installation of a 4 inch x 4 inch wireway to reroute cable V46-Y35/1 from tray section 41U1RB to Section 41U2RB to facilitate cable routing; a similar rerouting was permitted cable V22-Y32/1 between tray sections 41S1RA and 41S2RA by the same change authorization. In order to implement these changes, the United Engineers site electrical group marked the appropriate changes on cable tray drawing 9763-F-310794 (Reference 5.200) and included it as an attachment on the change authorization response. Engineering Change Authorization number 032149B (Reference 5.201) was an additional change authorization which enabled a shift of other cables in order to facilitate group pulling of cables with V46-Y35/1 and V22-Y32/1. The original or "A" version was retained in its entirety on Engineering Change Authorization number 032149B as required by United Engineers Administrative Procedure AP-15 (Reference 5.4). Due to time limitations, the team was unable to perform field inspections of the changes authorized by Engineering Change Authorization numbers 032149A and 032149B; however, we were able to verify that drawing 9763-F-310794 (Reference 5.202) was subsequently revised by the Philadelphia office to show wireway locations.

In addition to the above documents, the team reviewed other Engineering Change Authorizations (References 5.203 and 5.204) and Requests for Information (References 5.205 thru 207). In the sample documents inspected, we observed that the information provided in the responses was clearly stated. Marked up sections of applicable drawings were included with the change authorization information. The team verified that Requests for Information and Engineering Change Authorization master copies were filed and logged-in at the Site Change Coordinator's office. All change authorizations requiring it had United Engineers Philadelphia office concurrence. Electrical drawings had been revised by the electrical group, showing the changes required by the Engineering Change Authorization. Requests for Information and Engineering Change Authorizations were reviewed, approved and signed-off in accordance with United Engineers Administrative Procedure AP-15.

The team learned of a construction incident which resulted in brief flooding of the containment spray pump vault on June 11, 1983 up to the shaft on the Unit 1 CBS-P-9B pump. Site electrical personnel showed us nonconformance reports which described actions taken to evaluate and remedy possible damage (References 5.208 thru 212). We reviewed a Westinghouse-Large Motor Division apparatus service report (Reference 5.213) which reported no apparent damage. Insulation resistance measurements made by the Westinghouse representative showed high (800 meg-ohms) values approximately 1 month after the flooding event. The factory office advised there was no danger of motor damage, but the motor should be started to dry out any remaining moisture. Also see Unresolved Item 3-1 in Section 3.2 of this report.

During our inspection we observed that the motor heaters were energized for moisture control. At this same time, the site electrical group had contacted Westinghouse and obtained written confirmation (Reference 5.214) of the motors suitability for service based on Westinghouse's apparatus service report (Reference 5.213).

In summary, the team reviewed design changes and clarifications made by the Site Electrical group. We observed that the site and home office Electrical groups interfaced effectively in these areas, and that changes to design documents were controlled in accordance with United Engineers Administrative Procedure AP-15 requirements. The sample change-related design documents inspected by the team were found to be in good order.

5.10 Conclusions

In the electrical power area our review included a range of design features, technical issues, and information systems related to various plant systems along with the containment building spray system electrical components. As discussed in the preceding sections, there appeared to be a problem with United Engineer's review of certain design and vendor documents. The team is concerned about 8 of the nineteen findings (5-2, 5-5, 5-8, 5-10, 5-13, 5-14, 5-15, and 5-19) in the electric power area. These findings involve noncompliance with FSAR commitments, specification, and procedural requirements, inconsistencies and errors.

It appeared to the team that certain design and installation features of various electric equipment had not been adequately evaluated.

In general, we found the handling and control of interface information among United Engineers disciplines, Yankee Atomic, contractor and equipment suppliers to be reasonably controlled. United Engineers, as the architect-engineer, had implemented procedures to provide assurance of the quality of the design and procurement activities. These procedures were generally followed and interface information was controlled.

Most of the other findings involved inconsistency of information in various documents, especially the qualification reports, and some involved not following the procedures. However, most of the information reviewed was adequate and our review did not indicate significant breakdowns in the design process or control of interface information.

6.0 INSTRUMENTATION AND CONTROL

The objective of this portion of the inspection was to review the instrumentation and control aspects of the Containment Building Spray System. Design information prepared by Public Service of New Hampshire, Yankee Atomic, United Engineers, Westinghouse, and four component vendors was reviewed. The reviewed information included general and system specific design criteria, functional requirements, control logics, piping and instrument diagrams, instrument specifications, and other detailed design documentation. Portions of the Residual Heat Removal, Safety Injection, Emergency Air Handling, Primary Component Cooling Water, Waste Liquid Drains, and Service Water systems were also reviewed based on findings and observations made during the Containment Building Spray system review. The scope of the review extended from the design input through the installed equipment at the Seabrook Station Unit 1, and included design documentation on selected component assemblies and parts supplied by the component vendors.

6.1 Design Information

This section summarizes the flow of instrumentation and control design information for the Seabrook Station Containment Building Spray system among Public Service of New Hampshire, Yankee Atomic, United Engineers, Westinghouse, and four component vendors. Yankee Atomic's Seabrook project instrumentation and control group provides engineering support to Public Service Company of New Hampshire. This group monitors the United Engineers design of the Seabrook Station by reviewing safety-related piping and instrumentation diagrams, system design descriptions, drawings, and instrumentation equipment specifications. Yankee Atomic approves the instrumentation and control list of acceptable bidders on safety-related equipment specifications, and provides technical input to the Yankee Atomic administered equipment environmental qualification program. Yankee Atomic also provides an engineering interface with the site construction organization and United Engineers and actively participates in various project technical meetings and NRC licensing meetings.

The United Engineers Seabrook project instrumentation and control group, has primary responsibility for the design of the instrumentation and control portion of the Seabrook plant. This group prepares instrument piping drawings, design specifications for instrument piping, main control board layout arrangement drawings, local panel and rack layout arrangement drawings and device lists, system design descriptions for instrumentation systems, instrument data sheets, specifications for instrumentation and control equipment, annunciator arrangement drawings and annunciator lists, the standard instrument schedule, instrument installation details, logic diagrams, loop diagrams, instrumentation system diagrams, control valve calculations, safety-related setpoint calculations, set point data list, instrument air diagrams, the computer input/output list, and boundary interface packages that identify startup and test prerequisites. In addition, this group is responsible for instrumentation and control interfaces in process system design descriptions and piping and instrument diagrams, instrumentation aspects of equipment specifications and input to the

Class 1E instrument list and the valve list, coordination of the Westinghouse local and main control room electronic instrumentation, and technical support for site construction regarding instrumentation and control.

The team conducted reviews with the Yankee Atomic Instrumentation and Control and Electrical groups; United Engineers Instrumentation and Control, Mechanical, Component Qualification, and Electrical Engineering groups; Westinghouse Nuclear Systems Instrumentation and Control group; Tobar, Inc. in Tempe, AZ; ITT Barton in City of Industry, CA; Mercury of Norwood in Brockton, MA; York Electro-Panel Control Company in York, PA, and Public Service Seabrook Station Instrumentation and control personnel during this inspection.

For the Containment Building Spray system, Yankee Atomic provides instrumentation and control design information to United Engineers primarily through a technical review of design drawings and procurement specifications, and by joint technical conferences on major subjects such as electrical separation (References 6.2 and 6.12). The team reviewed the Yankee Atomic instrumentation and control technical correspondence files for the Seabrook project to determine the nature and depth of communication between Yankee Atomic and United Engineers for the period from mid-1976 to the present. The team randomly reviewed correspondence on several technical issues, such as meeting notes on equipment environmental qualification and electrical separation (Reference 6.124). The team also reviewed correspondence (References 6.117 through 6.123) which addressed Yankee Atomic review comments on piping and instrumentation diagrams and equipment specifications, Yankee Atomic comments on Westinghouse supplied Class 1E equipment, and technical discussions concerning the Class 1E equipment list. We found that the Yankee Atomic and United Engineers technical communications on instrumentation and control topics were detailed and reflected an adequate transfer of technical information between these organizations. They also reflected a reasonable level of supervision, technical input, guidance, and review of the instrumentation and control design by Yankee Atomic.

United Engineers prepared the majority of design input information for the Containment Building Spray system instrumentation and control design, and serves as an interface coordinator with Westinghouse and Yankee Atomic. The flow of design information is shown in Figure 6-1. Although by no means comprehensive, Figure 6-1 illustrates the process and the principal documents involved.

On December 12, 1983, the instrument and control team visited Westinghouse Electric Corporation with specific agenda items developed from inspections performed earlier at United Engineers, Tobar, Inc., and ITT Barton. All meeting agenda items were satisfactorily resolved during this visit and by subsequent telephone calls (Reference 6.67). The Westinghouse Solid-State Protection System output relay interface design information is provided to United Engineers in the form of interface interconnection diagrams (Reference 6.24). Westinghouse review of the overall Containment Building Spray system instrumentation and control design is limited to this interface and to satisfaction of Westinghouse functional requirements.

```
   WESTINGHOUSE SSPS      WESTINGHOUSE/UE&C       UE&C CBS SYSTEM          PSNH/YAEC               UE&C CBS SYSTEM
:-->FUNCTIONAL          :--> CBS INITIATION  -->  DESIGN DESCRIPTION-->  FSAR             --> :--> PIPING AND        >-:
:   REQUIREMENTS        :    ESFAS FUNCTIONAL     CRITERIA                REGULATORY           :    INSTRUMENTATION     :
:   (REF 1.77, FIGURE   :    CONTROL DIAGRAM      DOCUMENT                COMMITMENTS          :    DIAGRAM             :
:    7.2-1 SHEET B)     :    (REF 1.67)           (REF 1.11)              (REF 1.77)           :    (REF 1.16)          :
:                       :                                                                      :                        :
:                       :<---------------------------------------------------------------<-:                        :
:                                                                                                                       :
:-<-----------------------------------------------------------------------------------------------------------------<--:
                                                                                                                        :
:-<-----------------------------------------------------------------------------------------------------------------<--:
:
:
:   UE&C ELECTRICAL          WESTINGHOUSE           UE&C ELECTRICAL         UE&C PLANT, MCR          UE&C
:-->ONE LINE DIAGRAMS -->   ESFAS SCHEMATIC ->:--> CBS SYSTEM          :--> BOARD AND ANNUN.  -->  ELECTRICAL       -->-:
:   FOR POWER AND CABLE      AND OUTPUT RELAY  :    SCHEMATIC           :    ARRANGEMENT            CONNECTION           :
:   INTERCONNECTIONS         TABULATION        :    DIAGRAM             :    DRAWINGS               DIAGRAMS             :
:   (REF 1.75)               (REF 6.24)        :    (REF 1.70, 6.28)    :                                                 :
:                                              :                        :                                                 :
:   UE&C I&C                 UE&C I&C          :                        :    WESTINGHOUSE           WESTINGHOUSE         :
:-->CONTROL LOGIC      -->   CONTROL LOOP  -->:                         :--> NSSS INSTRUMENT  -->   INSTRUMENT       -->-:
    DIAGRAM FOR PUMP         INSTRUMENTATION                                 PROCUREMENT SPEC       INSTALLATION         :
    AND VALVE CONTROL        DIAGRAMS                                         (REF 6.40, 6.62,      DETAIL DRAWINGS      :
    (REF 6.30)               (REF 1.72)                                        6.75, 6.76)          (REF 6.41, 6.78)     :
                                                                                                                          :
:-<-----------------------------------------------------------------------------------------------------------------<--:
:
:
:   UE&C I&C STANDARD        WESTINGHOUSE/UE&C      UE&C ELEC./AIR          UE&C ELEC./AIR          UE&C ELEC./AIR
:-->INSTRUMENT SCHED. -->    INSTRUMENT DATA  -->   BOP INSTRUMENT    -->   LOCALLY MOUNTED   -->   BOP INSTRUMENT   -->-:
:   LISTING; RACK AND        SHEETS, SETPOINT       PROCUREMENT SPEC        INSTRUMENT PIPING       INSTALLATION         :
:   LOCALLY MOUNTED          CALC'S, S.P. LIST       (REF 6.87, 6.88,       DRAWINGS                SPECIFICATION        :
:   (REF 6.18)               (REF 6.20, 6.27)         6.89, 6.90)                                    (REF 1.69)           :
:                                                                                                                          :
:                                                                                                                          :
:   UE&C                     UE&C                   UE&C                    UE&C                    UE&C                  :
:-->ELECTRICAL KEY    -->    ELECTRICAL       -->   ELECTRICAL        -->   ELECTRICAL        -->   ELECTRICAL      -->-:
    DIAGRAMS FOR             CABLE INDEX            PROCUREMENT             TRAY AND CONDUIT        INSTALLATION          :
    POWER SOURCES            LISTING                SPECIFICATIONS          ROUTING DIAGRAMS        SPECIFICATIONS        :
                                                                                                                           :
:-<-----------------------------------------------------------------------------------------------------------------<--:
:
:
:   WESTINGHOUSE             UE&C/YAEC              PSNH/YAEC               JCI AS-BUILT            revisions made to
:-->FIELD CHANGE      -->    ENGINEERING      -->   REQUEST FOR       -->   ISOMETRIC         -->   documents after
:   NOTICE                   CHANGE                 INFORMATION             DRAWINGS                change approved
:                            AUTHORIZATION
:
:   PSNH/YAEC                PSNH/YAEC              PSNH
:-->PLANT             -->    PLANT            -->   TECHNICAL
    PRE-OP TEST              STARTUP TEST           SPECIFICATIONS
    PROCEDURES               PROCEDURES
```

Figure 6-1, I&C Information Flow

Four component vendors were visited by the IDI instrumentation and control team to evaluate their engineering organization, design activities, procedures, methods used for design review, conformance with the procurement specification, procurement of safety-related parts, quality assurance controls, communications with United Engineers and Yankee Atomic where applicable, and resolution of problems encountered during design and after shipment to the site.

On November 28-29, 1983, the team visited Tobar, Inc. in Tempe, Arizona which supplies both Group A transmitters for harsh environmental applications and Group B Refueling Water Storage Tank level transmitters to Westinghouse for use on Seabrook. Westinghouse procurement documents (References 6.40 through 6.42, 6.53, 6.61, and 6.62), Tobar design control procedures (References 6.50 through 6.52), Tobar design engineering documents (References 6.45, 6.54, 6.56 through 6.60, and 6.65), and Tobar supplier interface controls (References 6.63, 6.64, and 6.66) were reviewed. Additional information was provided to the IDI team by Tobar in subsequent letters and telephone calls (Reference 6.68).

On November 30-December 1, 1983, the team visited ITT Barton in City of Industry, California which supplies Group A harsh environment sensors to Westinghouse and Group B transmitters and switches to Westinghouse and United Engineers for Seabrook. Using the containment pressure transmitters and several other pressure switches as inspection samples, Westinghouse procurement documents (References 6.75 through 6.79), United Engineers procurement documents (References 6.87 through 6.90), Barton design control procedures (References 6.69 through 6.73, 6.80, and 6.81), and Barton design engineering documents (References 6.74, 6.82, 6.92, and 6.95) were reviewed. Again, additional information was provided to the IDI team by ITT Barton subsequent to this visit (Reference 6.277).

On December 5-6, 1983, the team visited the Mercury Company of Norwood, in Brockton, Massachusetts. Mercury designed and fabricated the Seabrook instrumentation racks under United Engineers Specification 171-1 (Reference 6.252). Mercury's previous nuclear experience consists of design, fabrication, and field installation of safety-related and non-safety related panels and racks. Seabrook Unit No. 1 instrumentation racks were completed and shipped to the site in early 1983. During this inspection, QA procedures, procurement documents, bills of material, engineering drawings, and job description documents were reviewed.

On December 12-13, 1983, the team visited the Corporate offices of York Electro-Panel Control Company, York, Pennsylvania. York Electro-Panel (YEP) designed and fabricated the Seabrook main control board under United Engineers Specification 170-1 (Reference 6.210). The Seabrook Main Control Board consists of 9 sections (zones A through I). Unit No. 1 Main Control Board sections were shipped to the site during late 1981 and early 1982. During design and fabrication, a United Engineers QA engineer worked on-site at York for a period of four months to expedite panel shipment. York's current work on Seabrook consists of design and fabrication of separation barriers and procurement of equipment to support the Unit No. 1 Main Control Board field modifications.

During this inspection, QA procedures, procurement documents, contract data change documentation, methods of technical exchange with United Engineers, engineering drawings, bills of material, seismic test program documents, and instruction manuals were reviewed.

6.1.1 Design Criteria

Applicable design criteria for the Containment Building Spray system are provided in SD-20 and include USNRC Regulatory Guides 1.22, 1.29, 1.47, 1.53, and 1.62 as well as ANSI/ANS N18.2 and IEEE Stds 279, 308, 323, 338, 344, and 379 as "governing standards" (Reference 1.11). This list was considered by the IDI team to be adequate. The extensive document cross-referencing and descriptive technical material provided in the SD-20 document were considered by the team to be an excellent starting point for Containment Building Spray system design implementation. Other design criteria applicable to the Containment Building Spray system, including Regulatory Guide 1.97, Revision 2 (Reference 6.31) concerning accident monitoring and IEEE Std. 384-1975, are identified in the FSAR (Reference 1.77).

The United Engineers Separation Design Guide for Physical Independence of Electric Systems is not a "controlled" document (Reference 6.1), but appears to have been used in the Seabrook design during the 1976-1982 period. The Separation Design Guide has been superseded by Procedure TP-8 (Reference 6.15) which has a note (3) stating that "Separation Criteria for different trains is given (sic) in 'Notes and Typical Details'." During the inspection, Yankee Atomic personnel stated a philosophy of "the more separation, the better" and chose to eliminate non-safety related cables from Seabrook by substituting associated cables in order to exceed the minimum separation distances by a significant margin. The team noted that the implemented separation distances, as specified in Cable Tray System drawings M-300228 and M-300229, do not fulfill this original Yankee Atomic separation distance objective even though they do satisfy the minimum distances specified in industry standards. Nevertheless, the team considered the design criteria for Seabrook instruments and controls to be adequate, and had no further questions in this area.

6.1.2 Design Control Procedures

Public Service of New Hampshire has design responsibility for the main plant computer system, and has prepared and issued a computer procurement specification 146-01 (Reference 6.16). The preparation, issue, and revision of this specification have not been accomplished using typical engineering design control practices such as those described in United Engineers GEDP.0015 (Reference 1.100). For example, the document does not contain signatures indicating the preparer, reviewer, or approver. Nevertheless, this finding is considered by the team to be minor since Yankee Atomic has indicated that Public Service of New Hampshire letters transmitting computer specification revisions are prepared by the responsible group manager and are signed by the project manager (Reference 6.278), and the technical caliber of the specification was considered by the team to be excellent (Finding 6-1).

On November 12, 1981, Westinghouse submitted the E16A environmental and E16B seismic test report portions of WCAP-8687 Supplement 2, revision 1, to United

Engineers (Reference 6.23); however, this material was not logged into the foreign print document control system in accordance with United Engineers Procedure AP-29, Section IV, step 3 (Reference 6.27) until discovered during the inspection on December 5, 1983. This is considered by the team to be an isolated occurrence, and United Engineers has now logged these reports into the foreign print system (Reference 6.278) (Finding 6-2).

At least two United Engineers computer listing documents, used extensively for various information purposes on the Seabrook project, do not have any formal check of their output report accuracy despite specific requirements placed on the Supervising Design Engineer by United Engineers Procedures GAP-0007, Section III, and AP-27 (References 1.117 and 1.153). The particular documents inspected include the Standard Equipment List (Reference 6.19) and the Standard Instrument Schedule (Reference 6.18). These documents have no provisions for preparer or reviewer signatures, and are not stamped "for information only." Based on discussions with United Engineers personnel, these documents are not reviewed in an effective manner throughout the United Engineers Engineering organization. The user of these documents has no indication that their content may be incorrect.

Two errors were noted in the Containment Building Spray System Standard Instrument Schedule (SIS) for the power assignment by separation group. RPS-1 was shown as the power source for Refueling Water Storage Tank level instrument CBS-LPY-931B rather than RPS-2 power. Similarly, SR-A was shown as the power source for valve Refueling Water Storage Tank V5 limit switch CBS-ZS-2303-1 rather than SR-B power. In both of these instances, the United Engineers loop diagram (Reference 6.29) and United Engineers logic diagram (Reference 6.30) showed the correct separation group power source for these items. Since the loop and logic diagrams are part of the controlling design documents for the electrical cabling program, these two minor errors were confined to the SIS computer listing. Both of these SIS errors have been corrected in SIS issue AP dated 1/27/84 (Reference 6.278) (Finding 6-3).

A number of Safety Class and Seismic Category classification errors were found in the Standard Equipment List (Reference 6.19). The United Engineers instrumentation and control group maintains this list based on input from the other technical disciplines; however, United Engineers personnel indicated that the computer listing is rarely reviewed by the originating disciplines when revised computer output listings are produced. United Engineers Quality Assurance personnel stated that similar errors had been observed several years earlier, but that they were unable to obtain accuracy improvements because of frequent listing changes as the design evolved. United Engineers Procurement personnel did state that these computer listings are not used in any manner for actual procurement of Seabrook equipment. The types of errors observed, in both American National Standards Institute/American Nuclear Society Safety Class and Seismic Category designations, are illustrated by Table 6.1.

To confirm that these errors were confined solely to the computer listing itself, the items listed in Table 6.1 were individually reviewed with responsible United Engineers design personnel to assure that the equipment procurement specifications had appropriate Safety Class and Seismic Category designations. As each specification and drawing inspected had correct Safety Class and

Seismic Category requirements specified, this finding is considered to be minor by the team at this time; however, it should be recognized that future procurement or maintenance activities by Public Service of New Hampshire could be inappropriate if this convenient listing is used as a source for Safety Class or Seismic Category information (Finding 6-4).

Table 6.1 Standard Equipment List Errors

Number	Equipment Name	C-510007 LISTING Saf.Class	C-510007 LISTING Seismic	PROCUREMENT DOCUMENT Saf.Class	PROCUREMENT DOCUMENT Seismic
E-0009A,B	RHR HX shell side	NNS	NS	2	I
E-0041A,B	D/G Lube Oil Cooler	-	-	3	I
F-0064A,B	D/G Prelube Filter	-	-	NSS	I
F-0138A,B	D/G Comp.Intake Filtr	NNS	-	NNS	Passive
F-0139A,B	D/G Dryer Prefilter	NNS	-	NNS	Passive
F-0140A,B	D/G Dryer Afterfltr	NNS	-	NNS	Passive
P-0008A,B	RHR Pump	NNS	NS	2	I
P-0037A,B	Emerg FW Pump	3	-	3	I
P-0115A,B	D/G L.O. Booster Pmp	-	-	MfrStd	I
P-0116A,B	D/G Prelube Oil Pump	-	-	NNS	I
P-0117A,B	D/G Lube Oil Aux Pmp	-	-	MfrStd	I
P-0118A,B	D/G F.O.Aux Bstr Pmp	-	-	MfrStd	I
P-0119A,B	D/G F.O. Booster Pmp	-	-	MfrStd	I
P-0241A,B	Contmt Rad Mon Pump	-	-	NNS	I
CP-0013	SSPS Train B Cabinet	-	-	*	*
CP-0001	Process Prot.Cab. I	-	-	*	*
CP-0002	Process Prot.Cab. II	-	-	*	*
CP-0003	Process Prot.Cab. III	-	-	*	*
CP-0004	Process Prot.Cab. IV	-	-	*	*
IR-0014	Vault 1 Instrum.Rack	-	-	-	I
SKD-0017	D/G Starting Air Compr	NNS	-	-	I

Table 6.1 Legend

Safety Class 2 = Component used in a safety-related system
Safety Class 3 = Component used in a system needed to support a safety-related system
Safety Class NNS = non-nuclear safety
Sesimic Cat. I = Component must meet USNRC RG 1.29 requirements.
Seismic Cat. NS = non-seismic; no seismic requirement
S.Class MfrStd = manufacturer's standard in lieu of SC-3 or ASME Section III Class 3
dashed line (-) = not specified
asterisk (*) = invokes ANSI N18.2-1973 for Safety Class and Seismic Category in Westinghouse Control and Protection System Functional Criteria

Westinghouse has purchased both Group A (harsh environment) and Group B (mild environment) transmitters from Tobar, Inc. as well as Group B transmitters from ITT Barton with special Group A material and process control requirements on the in-containment sensor. United Engineers has purchased Group B devices from ITT Barton. Tobar, Inc. (formerly Westinghouse Veritrak) has delivered the Group B Refueling Water Storage Tank level transmitters used in the Containment Building Spray system, and is currently supplying Group A transmitters qualified to harsh environmental conditions for use in the Nuclear Steam Supply System. Prior to the June 1983 formation of the Tobar organization, Veritrack used Engineering Design Procedures (EDPs) to control the instrumentation engineering design process (Reference 6.50). Westinghouse confirmed that Veritrak EDPs were still in effect at Tobar during a QA audit on June 22-23, 1983. However, during the Seabrook IDI visit on November 28-29, 1983, Tobar Product Integrity manuals (References 6.51, and 6.52) had replaced the Veritrak EDPs for engineering design control and the organizational structure had been significantly changed relative to that shown Westinghouse during their QA audit (Reference 6.39). Tobar PI-1, Section 2.2, requires that controlled copy holders be provided changes; however, action had not been taken to inform Westinghouse of these design control procedure changes at the time of the inspection (Finding 6-5).

The Tobar Product Integrity manuals alter the independence of engineering activities relative to the QA organization by having numerous Engineering Design Practice policies listed under the responsibility of the QA organization. Tobar's President confirmed that this was his intent, as greater operating controls on the independence and freedom of engineering were desired compared to the practice under Veritrak. As described in Section 6.2.4, one particular example that could have safety significance by impacting the qualification basis of Group A harsh environment transmitters was found in that, Tobar Operations had not consulted with engineering on vendor requested test exceptions to a Tobar procurement specification.

For procurement or fabrication of internal parts, ITT Barton uses one column on its bill of materials for each part or assembly to denote the "control level" applied to the procurement or fabrication step (Reference 6.73). One of these levels is identified as "21" where the "requirements of 10CFR Part 21 apply." A number of bill of material lists for seismic category I and electrical Class 1E components were inspected (Reference 6.74), and in no case was the control level 21 choice selected. ITT Barton stated that they address 10CFR21 situations on a case-by-case basis between the President and the Director of Quality Assurance. Ordinarily, these investigations result from field use reports of defects that could impact nuclear safety transmitted from customers. Neither Westinghouse nor United Engineers procurement documentation provided to ITT Barton identified the particular safety functions required of individual instruments. It appears to be unrealistic to expect that ITT Barton alone can accurately allocate safety functions to individual parts on their bill of material listings without this information. Consequently, use of the "21" control level for component parts by subcontractors should be re-examined by the licensee, Yankee Atomic, United Engineers and ITT Barton. (Unresolved Item 6-1)

United Engineers Procedures GEDP-0013 and AP-28 (References 1.98 and 1.126) require that the "nuclear safety related" legend be included on documents that depict equipment performing safety-related functions. During the inspection, individual sheets in a series of United Engineers block diagrams (Reference 6.276) were found to be inconsistent in that some sheets depicting safety-related equipment did contain this legend whereas others did not (Finding 6-6).

Westinghouse has not applied IEEE Std. 494-1974 to implement the identification legend requirement of IEEE Std. 279-1971 Section 4.22. The Westinghouse containment pressure transmitter drawing identifies the device as "Safety Class 1E," however, its associated sensor and instrument piping drawing provides no indication of its safety classification (References 6.77 and 6.78). Considering the importance of this ITT Barton supplied sensor and the recently imposed requirement for a silicon oil fluid medium described in Section 6.2.1, this Westinghouse practice is not prudent (Observation 6-1)

Tobar, Inc. (Veritrak) practice has been to place a statement only on the first page of multi-page drawings and specifications that "this document affects nuclear qualification" and that "no change or deviation is permitted without consultation with the cognizant qualification engineer" (References 6.56 and 6.65). The team had no further questions in this area.

In summary, the team considered that implementation of design control procedures was generally satisfactory as the findings were judged to be relatively minor and easily corrected, without impact on Seabrook equipment design or procurement.

6.1.3 Design Review

The Yankee Atomic Seabrook Project Department is responsible for review of the functional design of the plant including piping and instrumentation diagrams, control and instrumentation loop and logic diagrams, general arrangements, electrical one-line drawings, and electrical schematic drawings (Reference 1.47). During the inspection, numerous attempts to review Yankee Atomic comments on specific United Engineers procurement specifications and revisions of issued drawings were unsuccessful in that records, were not readily retrievable. However, as mentioned in Section 6.1, instrumentation and control coordination between Yankee Atomic and United Engineers appears to be effective.

In Yankee Atomic Project Procedure 5 (Reference 1.47), 36 United Engineers prepared instrumentation and control procurement specifications are listed. Of the 22 identified as involving safety-related equipment, only 8 are required to have a formal documented Engineering Review Record (ERR) form review by Yankee Atomic. In Project Procedure 14 (Reference 1.47.7), only those documents on the ERR list require Yankee Atomic approval for engineering changes. The fourteen safety-related instrumentation and control procurement specifications exempt from formal Yankee Atomic initial or subsequent review are shown in Table 6.2.

Table 6.2 Yankee Atomic I&E Discipline
Safety-Related Purchase Specifications
Exempt from ERR Documentation

120-01, Post-Accident Sampling Panel
170-04, Small Case Recorders
170-05, Panel Mounted Indicators
170-06, Miscellaneous INSTRUMENTATION AND CONTROL
172-01, Radiation Management Data System
173-01, Nuclear Control Valve
173-07, Solenoid Valves
174-01, Electronic Transmitters
174-08, Class 1E Electronic Logic System
248-17, Special Instrument Shutoff Valves
252-10, Level Switches
252-16, Differential Pressure Control Devices
252-38, Class 1E Temperature Switches
501-01, Class 1E Hydrogen Analyzer

Several United Engineers purchase specifications are not listed in this same procedure (Reference 1.47) as involving safety-related I&E equipment, but are nevertheless purchased as Class 1E components for use in various safety related systems, such as component cooling water, service water, and feedwater/emergency feedwater. The following three specifications are therefore also not subject to the Yankee Atomic ERR documented review:

174-07, Class 1E Electronic Transmitters
174-12, Class 1E Level Transmitters
174-13, Class 1E Electronic Transmitters

Within the Westinghouse scope of supply covered by Yankee Atomic Project Procedure 6 (Reference 1.47.1), the Solid-State Protection System specification, 952602, and the Main Control Board mounted equipment specification, 952159, are not subject to the Yankee Atomic ERR procedure. In the latter instance, Yankee Atomic ERR-116B does exist for United Engineers specification 170-01 covering the overall Main Control Board manufactured by York. Similarly, no formal Yankee Atomic ERR review is shown in Project Procedure 9 (Reference 1.47.4) for the design basis criteria provided in System Descriptions involving safety-related or important to safety systems such as:

SD-20, Containment Building Spray System
SD-23, Primary Component Cooling Water
SD-61, EFW Pumphouse HVAC
SD-83, Electric Heat Tracing
SD-90, Radiation Monitoring
SD-91, Leak Detection
SD-96, Post Accident Monitoring
SD-97, Main Control Board

At the outset of the IDI program, the Yankee Atomic practice regarding Engineering Review Records (ERR) was believed to be inadequate from a design review standpoint. However, as the team examined design details of the Containment Building Spray and other Seabrook systems, it became apparent that considerably more informal design review with United Engineers were being accomplished by Yankee Atomic than the documented records would indicate. This conclusion was derived from the relatively minor design errors noted in Section 6.1.2.

Application design reviews performed by Westinghouse for Tobar, Inc. or ITT Barton products were not available for inspection at Westinghouse during the IDI visit. Westinghouse did indicate that component suppliers do not participate in Westinghouse internal design reviews that could involve vendor products. Two design review examples performed by Westinghouse in 1977 and 1983 did indicate an adequate depth and scope of their internal nuclear design review process (References 6.25, 6.20, and 6.21). The team had no further questions regarding the Westinghouse design review process.

As suppliers to the nuclear industry, component vendors such as Tobar and ITT Barton are required to meet nuclear industry quality assurance requirements as specified in procurement documents. Frequently, these include design review and design verification. However, knowledge of the application end-use of their products by these vendors is quite limited. For example, both Tobar and ITT Barton indicated that they have no interaction with the utility or architect-engineer on most of their nuclear procurement orders. Both Tobar, Inc. and ITT Barton have committed to the performance of design reviews in their design control procedures (References 6.50, 6.53 and 6.69); however, the extent and depth of these reviews is not oriented to the end-use application of these products nor do these component vendors have sufficient internal staff resources to perform application design reviews. Rather, these vendors concentrate on limited scope design reviews involving a single issue at a particular point in time, such as material selection, component performance, testing, procurement delivery expediting, or manufacturing processes (References 6.44, 6.60, and 6.91). Problem identification and timely resolution of component or part level problems are the focus rather than global system application considerations. However, ITT Barton does use a detailed risk analysis procedure for certain non-nuclear applications involving toxic, explosion, and other similar hazards (Observation 6-2).

6.1.4 Design Changes and Field Changes

United Engineers specification 252-16 (References 6.87 through 6.89), used to procure both Class 1E and non-Class 1E differential pressure switches from ITT Barton, has been subject to considerable revision of seismic and environmental parameters during the past few years (References 6.90, 6.93, 6.94, 6.97, 6.102, 6.104, 6.106, 6.108, 6.111, and 6.112). Class 1E differential pressure switches procured by United Engineers specification 252-16 have been delivered by ITT Barton and accepted by United Engineers Field QA without an approved qualification test report and without identification in the United Engineers nonconformance reports (Reference 6.99) of the absence of an IEEE Std. 323-1974 environmental qualification test report. This violates the United Engineers vendor surveillance check plan (Reference 6.98) requiring review of the environmental qualification test report as well as the seismic qualification test report provided with the Site Data Package or preparation of a completely descriptive non-conformance report (Reference 6.100, and 6.113 Section IV.C.2) (Finding 6-7).

For several years, ITT Barton has apparently not agreed to meet certain environmental and seismic requirements of the United Engineers specification involving both Class 1E and non-Class 1E devices (References 6.103, 6.107, 6.109, and 6.110). A design qualification test plan (Reference 6.95) proposed by ITT Barton has been accepted by United Engineers with technical comments that still require resolution between ITT Barton and United Engineers. Issues involving inconsistencies in temperature values (320 versus 375 degrees F) and plant specific seismic values for Class 1E devices and radiation exposure (3 versus 20 megarads) for non-Class 1E devices had not been resolved at the time of the inspection. Nevertheless, ITT Barton advised the IDI team that an environmental and seismic qualification test report was submitted to United Engineers on 12-23-83 based on this not-fully-resolved test plan, and United Engineers has subsequently indicated that the seismic test results are indeed satisfactory (Reference 6.278) (Finding 6-8).

To meet construction and pre-operational testing schedule needs, non-Class 1E instrumentation was temporarily installed in the Primary Component Cooling Water system because the Class 1E instruments required by the design were not yet available at the site. United Engineers' specification for instrumentation installation requires that records be maintained of temporary installations, and that verification be made that the installation has been returned to final design conditions (Reference 6.114). A Speed Letter documentation record system is being used by United Engineers and Johnson Controls, Inc. to initiate and subsequently close out temporary instrumentation installations (References 6.83 and 6.84). While no written procedure or work instruction exists to control this process, the IDI team was informed that an identical recordkeeping system had been used at the Salem plant by the same group of individuals prior to being implemented at Seabrook in May 1980. The Speed Letter log system for the 1980-1983 period was inspected at the Seabrook site, and appeared to properly reflect the temporary installation of Primary Component Cooling Water instrumentation. The team had no further questions in this area.

The team reviewed main control board modification design activities by United Engineers instrumentation and control engineering and drafting groups. Installed in late 1982, numerous main control board design changes and additions to wiring and device arrangements were subsequently recommended by the human factors control room design review team (References 6.34 and 6.125). Our review of this activity was performed to determine the degree of conformance to design requirements and project procedures for these design activities.

Shortly after the final draft of the control room design review report was completed in May, 1983 (Reference 6.126), Yankee Atomic identified certain changes that were considered either (1) not cost effective; or (2) the operator already had sufficient information; or (3) the proposed resolution would achieve greater accuracy. In August, 1983, Public Service, Yankee Atomic, and United Engineers representatives met to discuss the previously identified human factor discrepancies (Reference 6.128) and to identify those requiring additional study. Yankee Atomic then directed United Engineers to implement all human factor discrepancies identified in the final Seabrook Control Room Design Review Report (Reference 6.125). The main control board modification effort is a large and complex undertaking requiring detailed work and significant interdisciplinary interfaces. United Engineers formed a dedicated design team consisting of an instrumentation group and an electrical group. The 9 person instrumentation group is responsible for maintaining the device list, material procurement, board arrangement, and overall coordination. The 13 person electrical group is responsible for maintaining the physical wiring, schematics, and cable diagrams.

Each of 9 main control board sections (zones) requires that an engineering change authorization package be issued by engineering prior to the start of the actual field modifications. At present, United Engineers has issued change packages for zones B, E, G, H, and I, and has started modifications for zones G and H. United Engineers has completed engineering on zones D and F, and is presently conducting the engineering and design for the remaining zones (A and C).

United Engineers has developed a comprehensive schedule and status monitoring list to track main control board modifications based on the affected main control board zone (Reference 6.129). Two changes to zone BF (zone B, front) were randomly selected and reviewed for associated documents issued to the site to incorporate these specific change modifications. The first change involved human engineering deficiency VI.A.1 designated as Item 1 in document change notice 650195A (Reference 6.130). Yankee Atomic provided technical assistance to United Engineers by marking up a blueline copy of the main control board arrangement drawing with the required human factors modifications (Reference 6.133). This modification relocated two containment building spray system control switches on zone BF to improve the existing mimic arrangement for the control room operator. The team reviewed the United Engineers change description on DCN-650195A with the recommendations in the final control room review report (Reference 6.125) noting that the proposed change was consistent with the control room review team recommendations. We then reviewed the as built arrangement drawing for zone BF (Reference 6.131) which showed the existing position of those control switches, and the revised arrangement drawing (Reference 6.132) which showed the relocated switches, added separation barriers, and revised mimic representation. The team found that the required change was correctly implemented on the arrangement drawing.

The associated logic diagram, loop diagram, device list, and schematics required no revision due to this change (References 6.134, 6.135, 6.136, 6.139, and 6.140 respectively). The physical wiring drawings (References 6.137 and 6.138) were changed to reflect the revised wiring scheme. United Engineers issued FCA-059008A (Reference 6.141) for zone BF and listed all affected drawings and documents associated with DCN-650195A. In summary, the United Engineers method for handling change VI.A.1 and all affected documents appeared to be in good order.

The second change involved human engineering deficiency VI.A.15 designated as Item 16 in document change notice 650195A. This change consisted of the addition of a Class 1E containment pressure recorder to zone BF of the main control board. This change was compared with the human factors recommendation for a wide range containment pressure recorder (0-60 psig) on the front of zone B to avoid having the reactor operator move to the rear of zone G during an emergency situation. We found that the United Engineers proposed change was consistent with the control room review team recommendations. United Engineers marked up the Containment Pressure Control Functional Block Diagram (Reference 1.67) to reflect the relocation of the Train B containment pressure recorder and pressure indicator from zone GR to zone BF. This drawing is a United Engineers "cut-in" of the Westinghouse containment pressure functional diagram. United Engineers did not mark-up this drawing to reflect the addition to Train A containment pressure recorder SI-PR-937 required by this modification. This omission is considered to be minor (Finding 6-9).

The revised main control board arrangement drawing showed the replacement of the existing 2 shelf recorder unit with a 4 shelf unit and the addition of pressure recorder SI-PR-937 and a cover plate over the spare shelf opening. We noted that the three recorders installed in this shelf unit were classified as Train A or Train A associated devices and therefore separation barriers were not required. United Engineers revised the manfacturer's as-built front view steel cutout arrangement drawing (Reference 6.146) to reflect the addition of the 4 shelf recorder unit. Detail No. 2 on this drawing showed the existing 2 shelf unit cutout and provided cutout dimensions for the extended 4 shelf cutout. These steel cutout details provided to the site were consistent with the manufacturer's recommendations. United Engineers also issued to the field several field modification packages containing drawings and documents such as instructions, arrangement drawings, steel fabrication drawings, panel wiring drawings, fabrication drawings for separation barriers, instruction manuals, device lists, wiring criteria, separation criteria, panel refinishing, mounting and installation, special instructions for barrier wall installation, strain relief details, and use of special tools. Pressure recorder SI-PR-937 was listed as a Foxboro model N2275 dual pen unit procured by United Engineers specification 174-4 (References 6.149 and 6.150). We reviewed this specification and the purchase order (Reference 6.151) and found that they appeared to be technically correct.

In summary, we reviewed UE&C's design modification activities associated with two extensive human factor deficiency modifications to the Seabrook main control board zone BF. The United Engineers redesign group was well organized and staffed, and maintained an efficient tracking system for change status monitoring. The incorporation of changes was well controlled. The team had no further questions in this area.

6.2 Protection System

6.2.1 Containment Building Spray System Automatic Initiation Circuitry

The Containment Building Spray System is automatically initiated on high-high primary containment pressure by the Westinghouse Solid-State Protection System using an Engineered Safety Features Actuation System (ESFAS) signal. Each primary containment pressure sensing channel uses a sealed sensing line filled with a hydraulic fluid medium to form a double barrier. The hydraulic portion involves a Barton model 351 bellows unit and associated instrument piping inside containment that are required to be filled with Dow Corning 702 silicon oil. This particular requirement was first identified in the WCAP-8687 Supplement 2-E21A environmental qualification report published in July 1981 (Reference 6.22) where water filled instrument lines exhibited fluid oscillations and instabilities under accident temperature conditions. The pressure signal is hydraulically transmitted through the containment penetration to a Barton 752-1 electronic Class 1E transmitter located outside containment (References 6.77 and 6.78).

The Barton model 752-1 containment pressure transmitters supplied to Seabrook Unit 1 and the Barton model 351 bellows sensor and its associated piping inside containment are required to meet revision 1 of a Westinghouse specification sheet (Reference 6.76) that permits either silicon oil or water as the transmitter internal bellows process fluid, and specifies air as the sensor input process fluid. It does not specify the fill medium for the sensor bellows or its associated piping inside containment. The spec sheet lists drawing 8765D64 (Reference 6.77) for the Class 1E transmitter which, in turn, refers to drawing 8765D52 (Reference 6.78) for the sensor. Note 5 of Westinghouse drawing 8765D52 revision 2 states that the instrument line is to be filled with water. United Engineers indicated on two separate occasions during the inspection that this revision is the current drawing applicable to Seabrook Unit 1. Subsequently, Westinghouse indicated that revision 3 had been issued on 9-1-82 and transmitted to United Engineers via letter NAH-U-2766 on 5-17-83 to change the process fluid from water to Dow Corning 702 silicon oil. These instruments had not been installed November 1, 1983. Inadvertent use of the incorrect fluid medium could introduce a significant safety problem that might easily go undetected. Application of the revised drawing to Seabrook Unit 1 had not been accomplished two years after this fluid medium problem was first identified by Westinghouse. United Engineers on 1/19/83 informed the team (Reference 6.278) that their letter SBU-82110 dated 12/19/83 approved Rev. 3 of the Westinghouse drawing 8765D52 (Finding 6-10).

The initial containment building spray water source is from the Refueling Water Storage Tank (RWST) with automatic transfer to the containment sump based on RWST low-low level in conjunction with a safety actuation signal. This automatic suction switchover is based on a 2 out of 4 coincidence of RWST level measurements (Reference 1.13) from transmitters 1-CBS-LT-930 through LT-933 supplied by Tobar, Inc. (formerly Westinghouse Veritrak). Once initiated, the actuation signal is latched so that two operator actions are required to defeat the automatic suction transfer to the sump that would otherwise occur approximately 22 minutes after injection begins. In the actuation signal interface between Westinghouse and United Engineers, the Containment Building Spray

System schematic diagram does not agree completely with the Westinghouse Solid State Protection System Interconnection Diagram (References 6.24 and 6.28). Of 23 output relay contacts used by the Containment Building Spray system, 3 errors were identified as follows:

(1) Contact 3-4 of relay K644A on Westinghouse drawing 7247D91 sheet 26 (Reference 6.24) has not yet been changed on revision 7 dated 6-21-83 in accordance with the United Engineers mark up of FP70073-5 dated 2-23-83 (Reference 6.24) or as shown on United Engineers schematic diagram M-310900 (Reference 6.28). The contact should be shown as normally closed rather than as normally open. This minor error appears to be a random Westinghouse checking oversight.

(2) Contact 3-4 of relay K740B on Westinghouse drawing 7247D91 sheet 32 (Reference 6.24) is incorrectly shown as normally open, and was not marked up by United Engineers on FP70073-5 for this correction on 2-23-83. The United Engineers schematic diagram (Reference 6.28) depicts the contact state correctly. This minor error appears to be a random United Engineers checking oversight.

(3) Contact 11-12 of relay K643B on Westinghouse drawing 7247D91 sheet 26 (Reference 6.24) is correctly shown as normally closed. However, the United Engineers schematic diagram incorrectly depicts this contact as originating from relay K643A rather than K643B. This minor error appears to be a random United Engineers drafting oversight.

Because of the error rate observed for the Containment Building Spray system, sample drawings for Residual Heat Removal, Safety Injection, Emergency Feedwater, and Service Water systems were subsequently checked by the team . No errors were found in 156 relay contacts used by these systems. The three errors noted above were therefore not considered to be a pervasive breakdown in design control (Finding 6-11).

Implementation of the Westinghouse design criteria specified on FSAR Figure 7.2-1 sheet 8 to minimize the probability of false containment spray by having one relay actuate the Containment Building Spray pump and another relay actuate valves was confirmed during our review.

6.2.2 Physical Separation and Electrical Isolation

Separation of redundant safety-related equipment and interconnections is a design feature required by industry standards, such as IEEE Std. 279 (Reference 6.38) and IEEE Std. 384 (Reference 6.35) and recommended by regulatory guides such as Regulatory Guide 1.75 (Reference 6.36) and 1.52 (Reference 6.37), to maintain independence of redundant safety-related systems to insure that protective functions are achieved when required. Physical separation and electrical isolation are methods that are used to achieve independence of redundant safety-related systems and equipment and independence of safety-related and non-safety related systems and equipment. These various systems and equipment are often referred to as "circuits" that consist of power source equipment, distribution equipment, wires and cables, and loads such as pump motors, valve actuators, controllers and instruments.

The Seabrook electrical design is unique in that the usual non-safety related electric wires and cables are not separated from the plant's safety-related wires and cables. The Seabrook non-safety-related circuits are classified as "associated" circuits as defined in IEEE Std. 384 (Reference 6.35). The Seabrook design for separation and independence of circuits appears to meet the requirements of IEEE Standard 384-1974, Section 4.5(1), in that the associated circuits are uniquely identified and remain with those safety-related circuits with which they are associated. The majority of these associated circuits are assigned to the "A" separation group wherein non-safety-related loads within both train A and train B systems are powered from or connected to the train A separation group.

The NRC staff has previously requested Public Service of New Hampshire to provide the results of an analysis to prove that challenges to safety-related circuits from associated circuits do not prevent the safe shutdown of the plant. The Seabrook response to this concern is provided in FSAR Volume 14 question RAI 430.149 (reference 6.11) which states, in part, that an analysis of the Seabrook design was performed and that the reliability of safety-related circuits under design bases events has not been compromised by use of associated circuits; therefore, the safe shutdown of the plant has not be impaired. The team learned during this inspection that a detailed circuit analysis of the possible degrading effects of non safety-related instrumentation and control circuits had not been conducted.

The extensive use of associated circuits for instrumentation and control raises the concern of whether failure of the non-safety-related loads on these circuits could degrade the safety-related circuits. The extensive use of associated circuits, particularly where various instrumentation and control circuits encounter other plant system boundaries, raised a concern regarding the possibility of systems interaction effects that could degrade plant safety. The team therefore decided to conduct a detailed review of instrumentation and control circuits classified as "associated" within various safety-related systems to determine whether independence of redundant safety related systems was actually achieved in the Seabrook design. In our review we found several cases where failure of non-safety related loads could degrade redundant safety-related systems. In our judgment, we believe that this is a systematic problem within the Seabrook electrical design and recommend that a detailed analysis be conducted to determine the extent of the degrading effects of non-safety related distribution equipment, wires and cables and loads on safety-related systems. Details of our review our presented below.

The Containment Enclosure Emergency Exhaust Filter System design was reviewed to determine whether failure of the non-safety related control and instrumentation used by United Engineers to modulate air flow rate could degrade system operation below acceptable levels. The Containment Enclosure Emergency Exhaust Filter System is a Seismic Category I Safety Class 2 Engineered Safety Feature system designed to maintain a negative pressure (-0.25"W.C.) within the containment enclosure following a LOCA. The system has redundant filter trains (FN-4A and B) that start automatically upon receipt of an accident signal to ensure cleanup of the containment enclosure atmosphere during an accident. During an accident, at least one filter train is required to operate to accomplish the design safety function.

We reviewed the system design description (Reference 6.26), the system diagrams (References 6.155 and 6.156) the loop diagram (Reference 6.157), logic diagram (Reference 6.158), Class 1E Train A and B schematic diagrams (References 6.159 and 6.160), and instrument piping drawings (References 6.161 and 6.162). The control scheme designed by United Engineers includes control switches for the filter-fans (FN-4A and B) and fan outlet dampers (DP-30A and B), and control switches located at the rear of the main control board for the fan inlet vortex dampers (DP-29A and B). During normal plant operation, filter-fan Train FN-4A and B control switches (CS-5780-1 and CS-5784-1) are placed in the AUTO position; Train fan inlet vortex damper DP-29A and B control switches (CS-5780-2 and CS-5784-2) are two position (OPEN-AUTO) maintained contact switches which are also placed in the AUTO position. On receipt of an accident signal both train filter-fans automatically start and their Class 1E solenoids are deenergized to allow control air to position the respective fan outlet dampers (DP-30A and B) to the full open (fail-safe) position. Also, breaker contacts at the respective fan motor control centers close when the fans are energized permitting their Class 1E solenoids to energize to allow control air to pneumatically modulate the fan inlet vortex dampers DP-29A and B. The inlet vortex damper (DP-29A and B) at each operating filter unit is pneumatically modulated to control filter train air flow by static pressure control system signals. We found that damper DP-29A and B are pneumatically modulated by non-safety related current-to-pneumatic converters (EAH-PDY-5781-2 and EAH-PDY-5787-2). Signal controllers (EAH-PDYY-5781, EAH-PDYY-5787) which transmit static pressure control signals to these current-to-pneumatic converters are also non-safety related. We determined that these converters are located in the containment enclosure area outside of the primary containment at the 21' elevation and are subject to the high radiation and high energy line break severe environments defined in the United Engineers Analysis of High Energy Line Breaks Outside Containment (Reference 6.154). The converters are non-safety related and unqualified (i.e., not demonstrated to remain operable during design basis events); therefore, we postulated that the converters can fail to their worst case condition when exposed to a severe environment or a seismic event. Since the control switches (CS-5780-2 and CS-5784-2) for fan vortex inlet dampers (DP-29A and B) are normally in the AUTO position allowing these dampers to modulate, and since the converters are subject to common mode failures due to environmental stresses, the current-to-pneumatic converters could close both inlet vortex dampers DP-29A and B during a design basis accident thus decreasing air flowrate and rendering both filter-fan Trains A and B simultaneously inoperable.

FSAR Section 6.2.3.1(b) and Table 6.5-1 Section C.2(h) states that the Containment Enclosure Emergency Exhaust Filter System is designed in accordance with Regulatory Guide 1.52 Revision 2 (Reference 6.37) which recommends that all instrumentation and controls be designed to the single failure requirements of IEEE Std 279 (Reference 6.38) and to the qualification recommendations of Regulatory Guide 1.89 (Reference 6.46). In addition, Section B-4 of system description SD-53 (Reference 6.26), states that no single component failure will result in loss of this Engineered Safety Features System. We conclude that concurrent postulated failure of both filter-fan trains due to a design using unqualified components (EAH-PDY-5781-2 and EAH-PDY-5787-2) violates FSAR Section 6.2.3.1(b), Regulatory Guide 1.52 Revision 2 Section C.2(h), and IEEE Std 279-1971 Section 4.2 (Reference 6.38) concerning the single failure criterion (Finding 6-12).

Section B3 of system design description, SD-53 states that if the pneumatic devices of the static pressure control system malfunction (because they are non-safety related), the Containment Enclosure area will experience a loss of negative pressure which is alarmed via the plant computer. Upon receipt of this alarm, the operator is required to place control switches CS-5780-2 (or 5784-2) in the OPEN position which deenergizes the solenoids and allows the fan inlet vortex damper DP-29A or DP-29B to move to the full open (fail-safe) position thus increasing negative pressure in the containment enclosure area. However, administrative controls (such as requiring the operator to move to the rear of the main control board to reposition a control switch) should not be relied on to recover from common mode failure events on engineered safety feature trains. Moreover, the alarm that alerts the operator also uses non-safety-related devices which are themselves subject to inoperability due to a seismic event. We believe that United Engineers should have considered use of either mechanical stops installed on the fan vortex inlet dampers to prevent full closure, or an accident signal to deenergize the Class 1E solenoids thus positioning the fan vortex inlet dampers to the full open position (Observation 6-3).

In summary, we found that both containment enclosure emergency exhaust filter-fan trains can be rendered inoperable by common mode failure of non-safety related current-to-pneumatic converters which modulate the fan vortex inlet dampers. We also found that United Engineers relies solely on administrative procedures to recover from this postulated failure. This design violates the fundamental principles of the single failure criterion.

The Residual Heat Removal System design was reviewed to determine whether failure of the non-safety related control and instrumentation used by United Engineers to modulate system flow could degrade system operation below acceptable levels. The residual heat removal system's primary function is to remove heat from the core during plant cooldown and refueling operations. System components are also used as part of the Emergency Core Cooling System (ECCS) following a LOCA or steam line break accident. An air-operated butterfly valve (RH-HCV-606 and RH-HCV-607) is provided at the outlet of each train heat exchanger (E-9A and E-9B) to permit regulation of the system flow during long term cooldown and decay heat removal. Each train heat exchanger also employs an air operated bypass flow control valve (RH-FCV-618 and RH-FCV-619) in the heat exchanger bypass line to regulate the RH system temperature in conjunction with outlet valves 606 and 607. Valve control switches are located on the main control board.

We reviewed the Westinghouse system design description for the Residual Heat Removal and Safety Injection Systems (References 1.12 and 1.13), associated system diagrams (References 1.18 and 1.19), loop diagrams, logic diagrams, and Train A and B schematic diagrams (References 6.163 through 6.170).

The control scheme designed by United Engineers uses control switches (CS-606 and CS-607) for RH heat exchanger E-9A and B outlet valves which are two position (OPEN-MODULATE) maintained contact switches that are placed in the OPEN position during normal plant operation to allow Class 1E solenoids to deenergize and position the valves to the full open (fail-safe) position. During long term plant cooldown, these switches are placed in the MODULATE position to allow Class 1E solenoids to energize thus allowing non-safety related current-to-pneumatic converters (RH-HY-606-2 and RH-HY-607-2) to modulate outlet valves 606 and 607 to control system flowrate and temperature. Similarily, control switches (CS-618 and CS-619) for RH heat exchanger bypass valves (618 and 619) are two position (CLOSE-MODULATE) maintained contact switches which are placed in the CLOSE position during normal plant operation to allow Train Class 1E solenoids to deenergize and position the valves to the closed (fail-safe) position. During long term plant cooldown, these switches are also placed in MODULATE position to allow Class 1E solenoids to energize thus allowing non-safety related current-to-pneumatic converters (RH-FY-618 and RH-FY-619) to modulate bypass valves 618 and 619 to control system flowrate and temperature in conjunction with outlet valves 606 and 607. The converters receive control signals from non-safety related manual electronic control stations located on the main control board.

We determined that these current-to-pneumatic converters are located in their respective vault areas (No. 1 or No. 2) within the Primary Auxiliary Building and are subject to the high radiation environment defined in the United Engineers Analysis of High Energy Line Breaks Outside Containment (Reference 6.154). The converters are non-safety related and therefore unqualified (i.e., not demonstrated to remain operable during design basis events); therefore, we postulated that these converters can fail to their worst-case condition when exposed to a radiation environment or a seismic event. When these control switches are in their MODULATE position, the postulated occurrence of a design basis event could cause heat exchanger outlet valves (606 and 607) to be pneumatically modulated to the full closed position and/or heat exchanger bypass valves (618 and 619) to be modulated to the full open position because the converters are subject to common mode failure due to environmental or seismic effects. Misalignment or failure of the non-safety related remote manual electronic controllers that provide electric signals to these converters can also create a similar failure mode. Failure of valves 606 and 607 to remain open under accident conditions will result in loss of both residual heat removal Trains A and B simultaneously; similarly, failure of valves 618 and 619 to remain closed could seriously degrade system performance by reducing the heat removal capacity of the heat exchangers.

Westinghouse system description SD-NAH/NCH-284 (Reference 1.13) Section 3.2.4.3 requires that valves 606 and 607 be left in the open position during normal operation to maximize flow from this system to the reactor coolant system; and valves 618 and 619 be closed during normal operation. United Engineers did not use an accident signal to automatically position these air operated valves (606, 607, 618 and 619) to their fail-safe position. Since the Residual Heat Removal pumps and their associated valves (606 and 607) in the heat exchanger flow paths are used as part of the Safety Injection Emergency Core Cooling System during the recirculation phase using water from the containment sump, the lack of an automatic protection signal to assure that valves 606 and 607 are open and that valves 618 and 619 are closed is a violation of IEEE Std. 279-1971, Section 4.1 (Reference 6.38) and 10 CFR 50, Appendix A, General Design Criteria 20, 21, 22, 23, and 24. (Finding 6-13)

United Engineers pointed out that the residual heat removal system line-up procedure (Reference 6.171) requires that the heat exchanger control switches be placed in the non-modulate position for normal plant operation. Therefore, the solenoids will be deenergized and the valves will be in their fail-safe position prior to the onset of a postulated accident. United Engineers also stated that this procedure is sufficient to maintain adequate administrative control over these valves to preclude system failure, and pointed out that the Westinghouse system flow diagram 1099E07 (Reference 1.19) does not indicate that a protection signal should be used to automatically position these valves to assure they are in the proper position for automatic operation of the Residual Heat Removal and Safety Injection Systems. United Engineers maintained that the current control design is a standard Westinghouse design and that valve position status lights and system status monitoring lights are available to the operator for determination of valve position. The team acknowledges these design considerations; however, as described above, the circuit design violates the requirements of IEEE Std 279-1971. United Engineers has used a protection signal to position similarly configured air operated valves in the Primary Component Cooling Water System. A protective signal is also required for this residual heat removal system application.

In summary, we found that the Emergency Core Cooling function of both Residual Heat Removal trains can be rendered inoperable due to the valves not being in their proper position. Additionally, the Residual Heat Removal System can be rendered inoperable or seriously degraded during normal or emergency plant cooldown by common mode failure of non-safety-related current-to-pneumatic converters due to environmental or seismic effects. This situation can cause the heat exchanger outlet valves to close and/or heat exchanger bypass valves to open rather than positioning the valves to their fail-safe position as required for accident mitigation. The United Engineers control system design violates IEEE Std 279-1971 and General Design Criteria 20, 21, 22, 23, and 24.

The Primary Component Cooling Water System design was also reviewed to determine whether failure of the non-safety-related control and instrumentation used by United Engineers to regulate cooling water temperature could degrade system operation below acceptable levels. The system transfers heat loads generated by various safety-related plant equipment to the service water system under all modes of plant operation. The system also serves as an intermediate fluid barrier between the reactor coolant system and the service water system. Two completely independent and redundant cooling water flow loops are provided. The Primary Component Cooling Water System temperature is controlled by pneumatically operated heat exchanger outlet valves (TV-2171-1 and TV-2271-1) and bypass valves (TV-2171-2 and TV-2271-2). Control switches for these valves are located on the main control boards.

We reviewed the system design description, SD-23 (Reference 6.26), system diagrams (References 6.172 and 6.173, system loop diagrams logic diagram, and Train A and B schematic diagrams (References 6.174 through 6.179).

The control scheme designed by United Engineers for operation of the pneumatically controlled heat exchanger valves uses control switch CS-2171 and CS-2271 which are three position switches (FULL-AUTO-NORMAL), spring returned from the right, that are placed in the AUTO position during normal plant operation. In the AUTO position, these switches allow Class IE solenoids within each train to energize thus allowing the nonsafety-related current-to-pneumatic converters (TY-2171-4 and 5, and TY-2271-4 and 5) to modulate the heat exchanger outlet valve and bypass valve to control temperature. The control valves operate in conjunction with one another so that the bypass valve closes as the outlet valve opens (and vice versa). The nonsafety-related converters for each set of heat exchanger valves normally receive control signals from nonsafety-related temperature control instrumentation located in the control room. Remote manual control of the converters for each train can also be achieved by operation of nonsafety-related electronic control stations at the remote shutdown panel. Train A Class 1E selector switch SS-2171 or Train B Class 1E selector switch SS-2271 is available to transfer control of the respective converters from the control room to remote shutdown panels CP-108A or CP-108B. During design basis event conditions, an accident signal deenergizes the Class 1E solenoids within each train thus allowing the heat exchanger valve operators to position the outlet valves to the open position and the bypass valves to the closed position (the fail-safe position).

We determined that the current-to-pneumatic converters are mounted on instrument rack IR-93 located at the 25' elevation of the Primary Auxiliary building. UE&C's Analysis of High Energy Line Breaks Outside Containment (Reference 6.154) indicates that this area is not subject to harsh environments as a result of an accident. However, the converters are nonsafety-related and are not seismically qualified (i.e., not demonstrated to remain operable during seismic events). Therefore, these converters can fail to their worst-case condition when subjected to a seismic event. We also found that the wiring for the nonsafety-related converters and temperature control instrumentation within a train is in close proximity at the remote shutdown panel to the Class 1E wiring (within the same train) for the solenoids which are used to control the position of the heat exchanger outlet and bypass valves. This situation exists in both A and B trains because the wiring for circuits connected to the nonsafety-related components is designated as "Train A (or B) associated" wiring and is run with and connected to the GE type SB1 switches (SS-2171 and SS-2271) of the respective Class 1E circuits.

Based on our review of the GE Control Catalog SB series switches (Reference 6.180), we determined that the physical separation distance between wiring terminations on adjacent wafers on the SB1 series switch is approximately 3/4 of an inch. In addition, the physical separation distance between terminations for switch contact sets on the same wafer is approximately 2 inches. Therefore, we concluded that the minimum physical separation distance on the selector switch between train associated wiring connected to nonsafety-related components and Train Class 1E wiring connected to the safety-related solenoids is approximately 3/4" to 2" depending on the configuration of interest. We also concluded that the train associated control wiring connected to the nonsafety-related components is physically routed and bundled together within the respective remote shutdown panel with Train Class 1E wiring connected to the safety-related solenoids. With regard to separation criteria, IEEE Std 384 (Reference 6.35) Sections 5.6.2 and 5.6.5 requires a 6-inch minimum physical separation distance between redundant Class 1E wiring and between Class 1E and non-class 1E wiring within panels. IEEE Std 420 (Reference 6.47) Section 4.2.1 establishes an identical 6-inch minimum separation distance criterion. Because the United Engineers design does not provide the required 6-inch separation distance or suitable isolation between the Class 1E circuits and the circuits connected to non-safety-related components, and with the postulated failure of the non-safety-related current-to-pneumatic converters and the temperature controller due to a seismic event, we postulated that the resultant circuit faults could potentially cause excessive currents and consequential hot shorts between bundled conductors or hot shorts between selector switch terminals within the remote shutdown panel. Such failures could cause energization of the safety-related solenoids within each train thus defeating the accident signal. Energizing the solenoids will allow the failed converters (TY-2171-4 and 5 and TY-2271-4 and 5) to pneumatically position the heat exchanger outlet valves (TV-2171-1 and TV-2271-1) to the full closed position and/or the bypass valves (TV-2171-2 and TV-2271-2) to the full open position. Closing both of the heat exchanger outlet valves will cause failure of both primary component cooling water trains; opening both the heat exchangers bypass valves will seriously degrade system performance by reducing the heat exchanger heat removal capacity.

Failure of both primary component cooling water loops due to common mode failure of system components violates the single failure criterion stated in IEEE Std 279-1971 Section 4.2 (Reference 6.38). IEEE Std 384 (Reference 6.35) Sections 4.5(3), 5.6.2, and 5.6.5 do allow engineering analysis to justify deviations from the required 6" separation criterion to demonstrate that Class 1E circuits are not degraded below acceptable levels by nonsafety-related circuits. We also note the Seabrook design for separation and independence of circuits appear to meet the requirements of IEEE Std 384 Section 4.5.(1) in that associated circuits (in this case, the converter and temperature controller circuits) are uniquely identified and remain with those safety-related circuits with which they are associated. However, for the postulated failure scenario, the Seabrook design does not comply with IEEE Std 384 Section 4.1 which requires separation of circuits to maintain "independence" so that protective functions required during design basis accidents can be accomplished. United Engineers did not conduct an analysis of the potential degrading effects of the circuits connected to non-safety-related components to ensure that safety-related circuits are not degraded below acceptable levels. Regulatory Guide 1.75, Revision 2 (Reference 6.36) is referenced in the Seabrook FSAR Section 8.1.5 as a design commitment. Regulatory Position C.4 states, in part, that associated circuits installed in accordance with IEEE Std 384 Section 4.5 (1) should be subjected to all the requirements placed on Class 1E circuits, such as environmental qualification, unless it can be demonstrated that the absence of such requirements cannot significantly reduce the availability of the Class 1E circuits. The Seabrook design violates position C.4 of Regulatory Guide 1.75 Revision 2 in that the loads on the associated circuits are unqualified and an analysis has not been conducted to address the potential degrading effects of the unqualified components to ensure that Class 1E circuits are not degraded below acceptable levels (Finding 6-14).

The team further reviewed the Primary Component Cooling Water heat exchanger automatic temperature control instrumentation circuits (TTY-2171-2 and TTY-2271-2) to determine whether these nonsafety-related instrumentation loops are adequately isolated from the safety-related circuits located within the main control room. Loop A temperature control instrumentation (TYY-2171-2) is contained within nonsafety-related cabinet CP-153. However, loop B temperature control instrumentation (TYY-2271-2) is located at card frame 08 within Balance of Plant process control cabinet CP-152B which contains both Train B safety-related instrumentation card frames and one nonsafety-related instrumentation card frame (08). United Engineers specification 174-2 requires in Sections 2.5.1 and 2.5.2.4 (Reference 6.181) that whenever an interface occurs between a Class 1E instrument loop and a non-Class 1E component, a Class 1E isolation device shall be provided to ensure that malfunction of the non-Class 1E component will not affect the proper operation of the Class 1E instrument loop.

On August 2, 1979 United Engineers advised Westinghouse that "Train B associated (BA) loops in CP-152B will be powered from the cabinet Class 1E power supplies. All nonisolated Train B associated (BA) inputs and outputs of these loops will be analyzed to show that no damaging voltages will come in contact with these loops (through external field wiring) that could affect operation of the Class 1E loops located in CP-152B" (Reference 6.186).

The temperature control loop B data sheet (Reference 6.182) supplied by United Engineers to Westinghouse did not specify isolation cards for the nonsafety-related TTY-2271-2 temperature control loop circuitry connected to the current-to-pneumatic converters. Westinghouse panel wiring diagrams (Reference 6.183 through 6.185) do not show use of safety-related isolation devices to isolate the non-safety-related circuit TTY-2271-2, or its associated card frame (08), from the safety-related card frames within CP-152B. This violates the requirements of Specification 174-2 Sections 2.5.1 and 2.5.2.4. United Engineers also had not performed the analysis of non-safety-related circuits within CP-152B to demonstrate that safety-related circuits would not be degraded under accident conditions as previously stated in Reference 6.186. (Finding 6-15).

Because of the lack of isolation devices, postulated failure of the nonsafety-related temperature control loop TYY-2271-2 or other nonsafety-related circuits within card frame 08 could result in fault currents causing automatic trip of both CP-152B internal power supply circuit breakers, thus losing all safety-related instrumentation powered from panel CP-152B. In this event, the following Train B Class 1E instrumentation would be lost: Refueling Water Storage Tank level No. 8, service water pump discharge header pressure, Primary Component Cooling Water head tank 19B level, containment enclosure static pressure control B, and diesel generator 1B post accident monitoring. The redundant Train A safety-related process instrumentation would not be affected by this failure because CP-152B is the only process cabinet in the control room that contains both safety and non-safety related instrumentation.

United Engineers engineers contacted Westinghouse to determine whether CP-152B card frame 08 has fuses to provide isolation within the panel. Westinghouse drawing 8835D86 (Reference 6.187) shows two 15A fuses inside a typical card frame; however, the Westinghouse Certificate of Qualification for Safety-Related Process Instrumentation (Reference 6.188), Sections 4.2 and 4.3, does not specifically list card 08 frame circuitry and instrumentation for card 08 as being seismically qualified. Therefore, the seismic qualification of card frame 08 and the suitability of card frame 08 fuses as safety-related isolation devices have not been established.

In summary, we found that non-safety-related converters TY-2171-4, -5 and TY-2271-4, -5 are not seismically qualified and therefore can fail to the worst case condition when exposed to a seismic event. We also found that the wiring for the non-safety-related converter circuits within a train was bundled with Class 1E wiring (within the same train), and is connected to solenoids used to control the position of heat exchanger outlet and bypass valves. In addition, the wiring for both the non-safety-related converter circuits and the Class 1E wiring connected to the solenoids is terminated at the same selector switch within a train (SS-2171 or SS-2271). Because the design does not provide the required 6" separation distance between Class 1E circuits and circuits connected to non-safety-related loads, postulated equipment failures and circuit faults could potentially cause excessive currents and hot shorts between bundled conductors or between selector switch terminals. Such failures could cause energization of the safety-related solenoids within each train thus defeating the accident signal and allowing the failed I/P converters to pneumatically position the heat exchanger outlet valves (TV-2171-1 and TV-2271-1) to the full closed position and/or heat exchanger bypass valves (TV-2171-2 and TV-2271-2) to the full open position. This situation would cause simultaneous failure or serious degradation of performance of both Primary Component Cooling Water water loops. We concluded that this design violates position C.4 of Regulatory Guide 1.75 revision 2 in that the loads on associated circuits are unqualified and an analysis has not been conducted to address the potential degrading effects of unqualified components to ensure that safety-related circuits are not degraded below acceptable levels. In addition, we found that isolation devices were not used to isolate the non-safety-related instrumentation circuit TYY-2271-2 or its associated card frame (08) from safety-related card frames and instrumentation within panel CP-152B.

Lack of isolation devices used for interface between safety-related and non-safety-related instrumentation loops violates the requirements of Specification 174-2 Section 2.5.1 and 2.5.2.4. We additionally determined that this lack of qualified isolation devices could result in automatic trip of both circuit breakers within CP-152B thus creating the loss of all safety-related instrumentation loops powered from CP-152B.

During the inspection, the team found that certain valve position switches for air-operated valves within the Residual Heat Removal System are nonsafety-related. We reviewed the electrical circuitry for these position switches to determine whether their failure could degrade system operation below acceptable levels.

Residual Heat Removal system heat exchangers E-9A and E-9B have air-operated butterfly valves at their outlet (RH-HCV-606 and RH-HCV-607 respectively) to permit regulation of system flow during long-term cooldown and decay heat removal. We found that the stem mounted valve position switches for valves 606 and 607 were non-safety-related based on our review of United Engineers Standard Instrument Schedule (Reference 6.18) and the valve manufacturer's drawing F43425 (Reference 6.189). These Namco switches are located in their respective vault area within the Primary Auxiliary Building and are subject to the high radiation environment defined in the United Engineers Analysis of High Energy Line Breaks Outside Containment (Reference 6.154). The switches are non-safety-related and therefore unqualified (for example, not demonstrated to remain operable during design basis events) and can be postulated to fail to their worst-case position when exposed to a radiation environment or a seismic event. We also determined that the worse-case failure of these switches is grounding of one or both field conductors to the switch internal housing.

The circuit for valve position switch RH-HCV-606 is classified as "Train A associated" and is wired to the main control board (MCB) status monitor light panel MM-UL-4. This status monitor light panel is safety-related and is powered from the Class 1E Train A 120V ac vital instrument panel through 10A fuses (References 6.191 and 6.192). The circuit for valve position switch RH-HCV-607 is classified as "Train B associated," and is wired to status monitor light panel MM-UL-2 powered from Class 1E Train B load group 120 VAC vital instrument panel through two 10A fuses (References 6.190 and 6.193). A backlighted test pushbutton switch (P.B. 289) and diode circuit is provided for status monitor light panel MM-UL-4, and a similar test circuit (P.B. 322) exists for light panel MM-UL-2 (References 6.194 and 6.195).

The status monitor light panel test pushbuttons are Master Specialities Company series 90K devices. The test circuit diodes are located in zone A of the main control board; therefore, circuitry for both status light panels MM-UL-2 and 4 are terminated on ETC terminal blocks at the shipping split points on the main control board. As described in Section 6.2.3, neither United Engineers nor the control board manufacturer has seismic qualification documentation for the test pushbuttons or the terminal blocks. Therefore, these components could fail to their worst-case condition when exposed to a seismic event. We also determined that the worst-case failure of these components is grounding a terminal lead to the main control board. Under this postulated failure scenario, the valve position switches 606 and 607 could fail and ground one side of the 120Vac line, and the test pushbuttons or the terminal blocks could fail and ground the other side of the line because the components are vulnerable to a seismic event. These failures will result in loss of safety-related Train A and B status monitor light panels MM-UL-4 and MM-UL-2 as the Class 1E 10A circuit fuses or the circuit breaker open under faulted conditions. The control room operator would lose Emergency Core Cooling System valve position indication, containment isolation status indication, and Emergency Core Cooling System pump run status indication for both Trains A and B. United Engineers did not conduct an analysis of the potential degrading effects of the circuits connected to these non-safety-related components to ensure that Class 1E circuits are not degraded below acceptable levels. Regulatory Guide 1.75, revision 2 (Reference 6.36) is referenced in the Seabrook FSAR Section 8.1.5 as a design commitment, and position C.4 states in part that associated circuits installed in accordance with IEEE Std 384 Section 4.5 (1) should be subject to all the requirements placed on Class 1E circuits such as environmental qualification, unless it can be demonstrated that the absence of such requirements cannot significantly reduce the availability of the Class IE circuits. The Seabrook design violates position C.4 of Regulatory Guide 1.75, revision 2 in that the loads on the associated circuits are unqualified and an analysis has not been conducted to address the potential degrading effects of the unqualified components to ensure that Class 1E circuits are not degraded below an acceptable level (Finding 6-16).

United Engineers pointed out that discussions with Westinghouse on the safety classification of valves RH-HCV-606 and 607 have been continuing for several years, and that United Engineers suggested to Westinghouse (References 6.202 and 6.203) that the electrical portion of these valves should be Class 1E. Westinghouse maintained that these valves were not required to change position under accident conditions (Reference 6.204). Recently, Westinghouse proposed to provide Class 1E environmental qualified valve accessories, such as Namco Series EA180 valve position switches and ASCO NP series solenoids for these valves (References 6.205 through 6.207). Yankee Atomic has accepted the Westinghouse proposal (Reference 6.208) and a Westinghouse procurement change order was issued on August 5, 1983 (Reference 6.209).

In summary, we found that unqualified valve position switches, test pushbuttons, and terminal blocks could fail under a seismic event. Failure of these components could lead to loss of safety-related Train A and B MCB status monitor light panels MM-UL-4 and 2. This violates position C.4 of Regulatory Guide 1.75 revision 2 in that the loads on associated circuits are unqualified and an analysis had not been conducted to address the potential degrading effects of unqualified components to ensure that Class 1E circuits are not degraded below acceptable levels. As of August 5, 1983, a change order has been issued for Westinghouse to supply Class 1E environmentally qualified valve position switches for NSSS supplied valves, including RH-HCV-606 and 607 (Reference 6.209).

On numerous occasions, Yankee Atomic and United Engineers stated orally to the team that non-Class 1E loads on Class 1E power sources identified as "A associated" and "B associated" circuits depend on the fault current interruption characteristic of series circuit breakers to prevent harmful effects to the Class 1E circuits (References 6.2, 6.9, 6.12, and 6.13). In the Seabrook design, approximately equal numbers of safety-related and non-safety-related circuit breakers are used (References 6.4 through 6.6). Equipment qualification reports for safety-related circuit breakers used in 120 VAC and 125V dc control circuits do not provide information regarding the fault current interruption performance of the breakers prior to, during, or after the seismic qualification test (Reference 6.7). The circuit breaker manufacturer has provided a Certificate of Compliance with respect to NEMA standards. Motor control center performance tests in accordance with IEEE Std 649-1980 were conducted by Gould after the seismic and aging portions of the qualification test; however these performance tests did not include confirmation of fault current interruption capability of the E22 and BQ breakers subjected to the qualification tests (Reference 6.14). Consequently, test data does not exist to verify that the circuit breakers used in control cirucits at Seabrook will provide acceptable circuit isolation under fault current conditions to justify the Yankee Atomic and United Engineers position.

Despite that fact that the basis for associated circuit acceptability at Seabrook is directly dependent upon fault current interruption by circuit breakers (References 1.77, 6.2 and 6.9), this basic assumption regarding circuit breaker performance in both safety-related and non-safety-related circuits has not been verified by either analysis or by fault current interruption test results for the actual E22 and BQ breakers used in numerous control circuits at Seabrook. Hence, the technical basis for this aspect of using associated control circuits at Seabrook is unverified at this time (Finding 6-17).

The team also noted that the interface between the plant and particular signal inputs to the plant computer was receiving considerable attention (Reference 6.13). Technical discussions were conducted with United Engineers personnel to better understand the electrical isolation features provided in the design to permit plant signals originating in separation group B cabinets to be connected into computer input cabinets having only separation group A power sources. The technical rationale provided by United Engineers for acceptance of such circuits was based on the low energy levels present with the input signal circuits in conjunction with high impedance isolation to the power source. The team, however, continues to question UE&C's retention of a separation group B designation for these plant interface cables since the power source appears to be the only logical determinant for separation group assignments. United Engineers should provide written criteria for assignment of separation group to circuits powered from one train and connected into panels and circuits of another train. These criteria should address the criteria of IEEE Std 279-1971 sections 4.2, 4.6 and 4.7 (Unresolved Item 6-2).

In this section discussing the physical separation and electrical isolation provisions incorporated into the Seabrook instrumentation and control design, the team has attempted to evaluate the achievement of "independence" of one redundant safety system train from its counterpart. Such independence is necessary to satisfy the single failure criterion under various postulated plant conditions and design basis events. We noted that Yankee Atomic and United Engineers exercised considerable care in their application of associated circuits to Seabrook particularly with regard to switchgear, motor control centers, and electric cable. We also noted that insufficient attention had been given to non-safety-related loads and the consequential effects of their postulated failure. A number of specific instances have been identified that do not fulfill the single failure criterion of IEEE Stds. 279 and 379. One type of non-safety-related component, namely current-to-pneumatic converters, appears to have been overlooked in the design process with respect to its postulated failure modes and the resultant impacts on safety systems at the Seabrook plant. We also noted that specific single failure analyses had not been performed by either Yankee Atomic or United Engineers. Finally, because of the close coupling (i.e., increased potential for harmful interaction effects) of safety-related circuits to associated circuits at Seabrook, we noted that dependence on the fault current interruption characteristic of series circuit breakers is needed to assure that safety functions will not be impaired by failures postulated in non-safety-related control circuits. Again, a design process oversight was noted in that during qualification testing of these circuit breakers this needed characteristic was not verified by either test or analysis by United Engineers' vendors. The team concluded that the objective of design "independence" has not yet been achieved for the Seabrook instrumentation and control system design. Based on these considerations we believe that lack of independence is a systematic problem within the Seabrook design. Therefore, the team recommends that an analysis be conducted to determine if other non-safety-related equipment, such as the current-to-pneumatic converters, could be the source of common cause failure of safety-related systems.

6.2.3 Equipment Qualification

A tantalum capacitor vendor to Tobar, Inc. took exception to the Tobar request for quotation in one qualification test area and was ambiguous in its response for another area (Reference 6.66). Rather than test 50 units for 2000 hours at elevated temperatures, Acushnet Electronics Company requested an exception so that 100 units could be tested for 1000 hours. The ambiguity concerned whether the IV 175 degrees C elevated temperature leakage tests were either waived or would indeed be performed (Reference 6.65). Tobar acceptance of the test ambiguity and the vendor requested exception was granted by the Tobar Vice President of Operations without review or concurrence by appropriate engineering personnel. This action violated the qualification design basis for harsh environment transmitters using this capacitor (Reference 6.43) (Finding 6-18).

In this instance, a Tobar internal request for engineering action (REA) was not prepared to evaluate the vendor request nor was a revision notice (RN) prepared to modify the Tobar capacitor specification (Reference 6.52) to match the vendor proposed tests. The effect on design had not been evaluated by Tobar; however, capacitor leakage current was determined from Westinghouse tests to be a critical performance parameter during qualification of the baseline transmitter design (Reference 6.43). On December 16, 1983, Acushnet agreed to perform the thermal tests which resolves the item of ambiguity (Reference 6.68).

The team reviewed the process by which main control board design information is conveyed between York Electro-Panel and United Engineers. York is responsible for the design and fabrication of the main control board in accordance with United Engineers Specification 170-1 (reference 6.210) and preparation of the drawings and documents associated with each main control board section. In addition, York is fully responsible for the structural design of the main control board.

We selected main control board front section BF because the majority of Emergency Core Cooling System circuits are located within this panel. We reviewed the United Engineers device list (Reference 6.217) and determined that York is responsible for furnishing GE and Westinghouse control switches, Microswitch PTW and Ronan X18 indicating lights, Master Specialities Company Series 90K and 800 pushbuttons and indicating lights, States and ETC terminal blocks, wiring, Raychem wire makers, fire barriers, AMP terminal lugs, and miscellaneous resistors and diodes. We reviewed the seismic qualification for these components by evaluating the adequacy of the main control board seismic test program and the York procurement packages.

We reviewed the main control board seismic simulation test program conducted on Section E by Wyle Laboratories and documented in test report 45657-1 (Reference 6.214). The seismic test program consisted of single axis resonance search and bi-axial random multifrequency testing in each of two orientations. The main control board was welded to the test fixture, instrumented with accelerometers, electrically powered, and monitored during the seismic test program. The main control board was equipped with dummy loads to duplicate the weight and center of gravity of instruments, devices, accessories and wiring. Devices installed, wired, and functionally monitored during the test included GE SBM and SB1 switches, Westinghouse OT2 switches, PTW and Ronan status lights, States 12 and 24 point terminal blocks, and Underwriter 2 pole fuse blocks and fuses. The test report stated that main control board Section E demonstrated sufficient integrity to withstand the prescribed seismic requirements without compromise of structure or function. In addition, no cracking, chipping, or other degradation was found in the post inspection test of the devices. The main control board seismic analysis conducted by Analytical Engineering Associates and presented in report 80127-407 (Reference 6.214) stated that all electrical devices performed without failure of their intended function throughout the test program.

We noted that the seismic simulation test program did not include test or analysis of ETC terminal blocks or Master Specialties Company Series 90K backlighted pushbutton switches. Since these components are used in Class 1E circuits within the main control board, we reviewed the York procurement packages for these components to determine whether they were procured as safety-related components and whether seismic qualification documentation was received, reviewed, and determined to be adequate. United Engineers device list DL-170-1-BF

(Reference 6.217) items 289 and 290 specifies that Master Specialties Company series 90K lamp test push buttons be provided for the containment isolation and safety injection status monitor light panels M-MUL-5 and MM-UL-4. We found that the York bill of material for main control board Zone B (Reference 6.219) did not identify the Master Specialties Series 90K switches as safety-related, and noted United Engineers had approved this bill of material. However, the York Purchase Order 34834 (Reference 6.220) specified that the Master Specialties Series 90K switches were to be supplied as Class 1E devices in accordance with the seismic and environmental qualification requirements of IEEE Stds 323 and 344. We found, however, that the switches were supplied to York with only a certificate of conformance (Reference 6.221) which simply stated in part that "the parts were furnished in accord with the P.O. requirements and test data is in our file." No seismic qualification data, report, or documentation was included. York provided to United Engineers a status report on procurement of materials (Reference 6.222) for the main control board in which item 16 was a general catalog sheet on Master Specialties switches stating that the switches meet the requirements of IEEE Std 323 and 344 and 10 CFR 21. United Engineers notified York that this information was acceptable (Reference 6.223). Nevertheless, we concluded that seismic qualification documentation for the Master Specialties switches was not obtained by York in accordance with United Engineers Specification 170-1 Sections 2.5.2.5, 3.11.3.5, and 3.14 (Finding 6-19).

We then reviewed York's application of ETC terminal blocks. The York bill of material for main control board Zone B rear (Reference 6.224) specified ETC type 39TB-16 terminal blocks for termination of Class 1E circuits transversing the main control board zones at the zone shipping split points. York did not procure these terminal blocks as Class 1E seismically qualified devices (Reference 6.225), and had not obtained seismic qualification documentation to substantiate their use in Class 1E circuits. York provided a status report on procurement of materials (Reference 6.222) to United Engineers for the main control board in which item R was a general catalog sheet on ETC terminal blocks. United Engineers notified York that this information was acceptable (Reference 6.223). Neverless we concluded that York did not procure the ETC terminal blocks as Class 1E devices and did not obtain seismic qualification documentation in accordance with the requirements of Sections 2.5.2.5, 3.11.3.5, and 3.14 of Specification 170-1 (Finding 6-20).

The team reviewed York physical wiring drawings for main control board zones A and B to determine which safety-related circuits are terminated on the ETC terminal blocks (References 6.226 through 6.229). We found that the electrical circuitry associated with the Master Specialities Co. Series 90K test pushbutton and the main control board status monitor light panels are terminated on the ETC terminal blocks. The team discussed with United Engineers the issue of non-qualified ETC terminal blocks used within the main control board for termination of Class 1E circuits. We were primarily concerned with the ability to mitigate the consequences of design events and maintain the plant in a safe condition under a seismic event where unqualified terminal block failures could potentially lead to open, shorted, or grounded circuits. The review concentrated on main control board sections A and B because these panels contain most of the Class 1E Emergency Core Cooling System circuits such as safety injection, residual heat removal, and containment spray. Based on this review, we concluded that the following safety-related Train A and B circuits would be potentially rendered inoperable due to failure of the ETC terminal blocks: Emergency Core Cooling System valve position status lights; system status monitoring lights for light boxes associated with Emergency Core Cooling System cold leg and hot leg injection, recirculation, and containment isolation; instrumentation controller power supplies; status lights for the reactor trip circuit breakers RTA and RTB (Reference 6.230 through 6.233); controls for normally closed safety injection pump cross-over valve 1-V-112 (References 6.234 and 6.235); controls for containment isolation valve NG-FY-4609 (References 6.236 and 6.237); controls for containment isolation valve RC-FV-2830 (References 6.238 and 6.239); and controls for safety injection cold leg test line valve SI-FV-2427 (References 6.240 and 6.241).

The team did not examine all the safety-related circuits terminated on the ETC terminal blocks since a review of this magnitude would be tedious, complex and labor intensive. Based on the results of our brief review, it is our opinion that failure of the ETC terminal blocks under a seismic event would probably not inhibit mitigation of design basis events or prevent the plant from achieving and maintaining a safe shutdown. This does not imply that the results of our limited review are not significant; on the contrary, we believe that common mode failure due to a lack of qualification for critical devices such as terminal blocks is a serious concern, and that either a complete analysis should be performed or the terminal blocks used at Seabrook should be qualified as safety-related devices (Unresolved Item 6-3).

We reviewed York activities associated with procurement of Class 1E instrument, control, and power wiring for use within the main control board. United Engineers Specification 170-1 Section 2.7.1.1 specifies the required wire size, type, and insulation. York Purchase Order No. 32958 (Reference 6.242) procured Rockbestos (Firewall SIS, 19/S, 20 AWG) wire in accordance with all requirements of the specification, and York QA personnel reviewed and approved this Purchase Order. We found, however, that the engineering bill of material from which the purchase order was developed could not be located. Lack of a documented bill of material is a violation of the York QA Manual (Reference 6.211) Sections 2.4.1.3 and 3.5.1 concerning engineering documentation. The team considers this finding to be random based on review of other bills of materials. (Finding 6-21)

York procured and installed Rockbestos (Firewall SIS, 20 AWG), Helistrand (?/C, 16 AWG), and Anaconda (SIS, 12 and 14 AWG) wiring within the main control board (References 6.242 through 6.244 respectively). York received certificates of conformance (COC) and test reports pertaining to wire and cable qualification from Helistrand pertaining to IEEE Std 323 qualification and 383 flame test data (Reference 6.245), a test report on Tefzel 280 flame test data (Reference 6.246), an Anaconda qualification test report of Type FR-EP wire (Reference 6.247), an Anaconda Certificate of Conformance for IEEE Stds 323 and 383 flame test data (Reference 6.248) and a Rockbestos Certificate of Conformance and attached test report (Reference 6.249). Section 3.14 of United Engineers Specification 170-1 requires York to submit for United Engineers engineering review and approval wire flame test reports per IPCEA-S-19-81 and IEEE Std 383, and qualification documentation per IEEE Std 323; however York did not submit Rockbestos, Helistrand, and Anaconda wire flame test and qualification reports to United Engineers for review and approval (Finding 6-22).

We also found that the York as-built main control board drawing package and the instruction manuals do not list the wiring manufacturer, size, or type. Therefore, it appears that United Engineers is not aware of the exact wiring within the main control board. York stated that general wiring detail drawing E-5505 will be revised and reissued to United Engineers to specifically identify the size and type. In addition, York stated that all COC's, flame test reports, and qualification reports will be issued to United Engineers for review and approval.

United Engineers Quality Assurance Procedure QA-7-2 (Reference 6.251) Sections IV.A.2 and IV.A.3 require that the specification be reviewed by both QA personnel and the responsible discipline engineer to identify documentation requirements, appropriate specifications, and codes and standards documentation for the equipment vendor and the United Engineers vendor surveillance representative. The Vendor Surveillance Check Plan (Reference 6.250) for main control board Specification 170-1 identifies that United Engineers review is required for IEEE Std 323 qualification test procedures, flame test procedures and flame test reports prior to panel shipment. We conclude that the Rockbestos, Helistrand, and Anaconda flame test and IEEE Std 323 qualification reports for Class 1E wiring within the main control board were not received, reviewed, and approved by United Engineers engineering personnel in violation of the QC vendor surveillance check plan for Specification 170-1 and QA procedure QA-7-2 Sections IV.A.2 and IV.A.3 (Finding 6-23).

The team reviewed the process by which instrument rack design information is conveyed between Mercury of Norwood and United Engineers. Mercury bills of material and procurement packages for components within Mercury's scope of supply were reviewed to determine whether these components were procured as safety-related in accordance with the technical requirements of United Engineers Specification 171-1. (Reference 6.252) Our review focused on the Class 1E cable and terminal blocks procured and installed by Mercury on safety-related instrument racks located inside containment to determine whether environmental qualification documenation was received, reviewed, and found to be adequate.

United Engineers Specification 171-1 Section 2.5.6.2 requires Mercury to procure and install safety-related terminal blocks within junction boxes for in-containment and outside containment instrument racks. The specification called for States Company type ZWM sliding link style terminal blocks. We determined that the Mercury bill of material for the as-built instrument racks, DW-N19691-702 (Reference 6.256) was labeled "seismic-nuclear safety-related." This bill of material specified ZWM sliding link terminal blocks, Dekoron ECI type 1952 instrument low level signal wiring, Rockbestos Firewall SIS switchboard power wiring and AMP preinsulated diamond grip terminal lugs.

We reviewed the Mercury Purchase Orders (Reference 6.258 and 6.260) and the purchase requisitions developed by the project engineering group, and determined that the States terminal blocks were not procured as safety-related components. Purchase requisitions 66180 (Reference 6.257) and 68306 (Reference 6.259) were clearly designated "not nuclear" and Mercury QA personnel reviewed and approved these purchase requisitions. The Mercury QA Manual (Reference 6.253) Section 5.2.3 requires purchase requisitions to be reviewed and accepted by QA. We concluded that Purchase Requisitions 66180 and 68306 for States terminal blocks were not procured as nuclear safety-related devices in violation of United Engineers Specification 171-1 as well as the Mercury bill of material DW-N19691-702, and that Mercury QA personnel review and approval of these purchase requisitions violates Section 5.2.3 of the Mercury QA Manual (Finding 6-24).

These terminal blocks used in safety-related circuits within containment were not procured as safety-related components and the environmental qualification documentation is not available. If this condition was not corrected, potential common mode failure of safety-related protection circuits could result under accident conditions. On March 23, 1977 Mercury received a statement from States Company (Reference 6.261) that the ZWM terminal block was not qualified to IEEE Std 323 requirements. Mercury informed United Engineers on May 9, 1980 (Reference 6.262) that States terminal blocks were not qualified; however United Engineers directed Mercury to furnish the blocks per the specification. On March 30, 1981, Mercury again notified United Engineers by letter (Reference 6.263) that the terminal blocks were not qualified and that States had not furnished information that the blocks were free of certain defects identified in NRC IE Information Notice 80-08 that described crack defects in approximately 5% of the blocks checked (Reference 6.264). On April 13, 1981, United Engineers directed Mercury (Reference 6.265) to obtain information from States regarding IE Notice 80-08. Subsequently, Mercury received from States Company (Reference 6.266) confirmation that the blocks procured by Mercury for Seabrook are not affected by the problems identified under IE Notice 80-08. This information was forwarded to United Engineers on December 7, 1982 (Reference 6.267). On September 23, 1982, the United Engineers Electrical Engineering Group learned from Acton Corp. (Reference 6.268) that the States terminal blocks undergoing Loss-of-Coolant-Accident testing for Specification 129-1 (Reference 6.269) exhibited severe anomalies. On November 18, 1982, Yankee Atomic directed United Engineers (Reference 6.270) to abandon the use of States blocks for Class 1E applications inside containment based on the Acton testing program results, and suggested Weidmuller terminal blocks as a replacement. United Engineers issued DCN-630057A (Reference 6.272) which provided field change details for replacement of the States blocks. In addition, nonconformance report NCR-1914 (Reference 6.271) was also issued by United Engineers. We noted that United Engineers later informed Yankee Atomic by letter dated May 26, 1983 (Reference 6.273) that the Acton testing program qualified the States terminal blocks for areas outside the containment. On September 20, 1983 (Reference 6.274) and on November 7, 1983 (Reference 6.275), the equipment qualification issue relating to the Mercury instrument racks was transferred to the United Engineers task force conducting the equipment qualification review program.

United Engineers stated that they were aware of the fact that the instrument racks were shipped to the site without qualification documentation for the States terminal blocks, and that they had always intended to use the results of the Acton Corp Loss-of-Coolant-Accident testing of States blocks under specification 129-1. Based on the above considerations, the team concludes that Mercury should have written a nonconformance report for the unqualified States terminal blocks in accordance with Mercury QA Manual Section 12.2 which requires that a nonconformance report be written and items be tagged on "hold" when nonconforming materials and services are suspected (Finding 6-25).

We then reviewed Mercury's design and procurement activities associated with Class 1E wiring. Section 2.5.6.3 of United Engineers specification 171-1 (Reference 6.252) requires Mercury to procure and install Class 1E low level signal and power wiring for inside containment and outside containment instrument racks. We reviewed the Seabrook containment post accident temperature curve (Figure 5.1.2) and pressure curve (Figure 5.1.1) provided in United Engineers document 171-IS (Reference 6.196) in which peak containment temperature is shown to be 375°F for approximately 10 minutes duration, and the peak containment pressure is 52 psig. Mercury's purchase order No. 66166 (Reference 6.197) to Rockbestos and order No. 66165 (Reference 6.198) to Dekoron contained a QA requirement form (Form 284) specifying that the vendor submit a certificate of compliance to meet radiation requirements; and that the cable meet IEEE Std 383. These purchase orders did not provide for the vendor the Seabrook containment post accident temperature and pressure profiles and the Seabrook containment radiation dose level for the cable as required by sections 2.4.2 and 2.4.2.3 of specification 171-1 (Finding 6-26).

Section 2.3.3.3 of IEEE Std 383-1974 requires qualification to a total dose of 5 x E07 rad which is less than the Seabrook specification of 2 x E08 rad. IEEE Std 383-1974 references IEEE Std 323-1974 for Loss-of-Coolant-Accident simulation profiles that provides a peak temperature of 340°F which is less than the Seabrook peak temperature of 375°F. Mercury QA personnel signed off the QA review and approval section of the purchase requisition for the Rockbestos and Dekron Cable. This violates section 5.2.3 of the Mercury QA manual (Finding 6-27).

This procurement issue focused on the fact that adequate environmental qualification documentation would not be obtained from the cable vendor which substantiates operability of this safety-related wiring under the Seabrook containment post accident environmental conditions. The lack of adequate qualification documentation could potentially result in procurement of unqualified equipment and the potential for common mode failure of safety-related protection circuits under accident conditions. Therefore, we reviewed the actual qualification documentation package submitted by the respective vendors to Mercury. Upon receipt of the Dekoron low level signal cable and documentation, Mercury QA personnel completed the QC receiving inspection report (Reference 6.199) and signed off the report that the QC documentation was acceptable. Eaton Corporation, Dekoron Division, submitted a Certificate of Compliance (Reference 6.200) No. D-3510 which simply stated that "this cable is capable of passing on IEEE Std 383 flame test." We concluded that this certificate of compliance addressing flame test does not comply with United Engineers specification 9763-006-171-1 sections 2.4.2 and 2.7.3 which requires full environmental qualification to meet the criteria of IEEE Std 323-1974 and 383-1974. We also concluded that Mercury QA personnel had determined that the Dekoron Certificate of Compliance was acceptable documentation when, in fact, the documentation did not meet the requirements of the specification (Finding 6-28).

United Engineers Quality Assurance Procedure QA-7-2 (Reference 6.251) Sections IV.A.2 and IV.A.3 requires that the specification be reviewed by QA personnel and the responsible discipline engineer to identify documentation requirements, appropriate specifications, and codes and standards documentation for the equipment vendor and the United Engineers vendor surveillance representative. We found that the Vendor Surveillance Check Plan (Reference 6.201) for Instrumentation Racks Specification 171-1 (Reference 6.252) does not list or identify that Mercury is to obtain and submit for United Engineers review equipment environmental qualification documentation in accordance with IEEE Stds 323-1974 and 383-1974. United Engineers specification 171-1 sections 2.2, 2.4.2, 2.7.3, and 3.0 requires that Mercury procure and install safety related class IE equipment (such as terminal blocks, power and signal cable, and insulated terminal lugs), and submit qualification documentation to United Engineers. The QC vendor surveillance check plan for specification 171-1 did not identify the required IEEE Std 323-1974 and IEEE Std 383-1974 qualification documentation in violation of United Engineers QA procedure QA-7-2 Sections IV.A.2 and IV.A.3. Mercury did not obtain and send to United Engineers qualification test reports for the Dekoron ECI type 1952 low level signal cable, the Rockbestos SIS switchboard wires, or the AMP pre-insulated terminal lugs (Finding 6-29).

This section discussed qualification of instrumentation and control equipment in which the team identified a number of environmental and seismic qualification deficiencies involving United Engineers and three vendors; namely, Mercury of Norwood, York Electro-Panel, and ITT Barton. These deficiencies involved incorrect procurement of safety-related components as non-safety-related, use of unqualified components in safety-related applications, incomplete or unsubmitted qualification reports, and field acceptance of equipment that had not been demonstrated to be qualified for the intended application. The team concluded that the United Engineers design process involving instrumentation and control equipment qualification was not being adequately controlled.

6.2.4 Conduit Markings

During our site inspection, the team observed that the conduit for Refueling Water Storage Tank level transmitter CBS-LT-933 was marked to designate the safety-related separation group identification by a white colored plastic tag (conduit MUT/UD, Separation Group B) located at the point where the conduit terminates on the transmitter. We noted that this conduit did not have separation group marking identification along its length as required by IEEE Std 384-1974 every 15 feet (Reference 6.35). The team observed numerous cases where the conduit separation group was identified only at the ends where the conduit terminates. We also observed that instrumentation conduits which exit the Refueling Water Storage Tank farm area through conduit penetrations were identified solely by brass tags located on the wall beneath the penetrations. We subsequently learned from Yankee Atomic personnel that all conduit at Seabrook is identified to designate safety-related separation group only at each end.

We reviewed the Seabrook FSAR to determine licensing commitments and compliance with industry standards with respect to identification of separation group for exposed conduit. Section 8.3.1.3 of the FSAR (Reference 1.77) provides raceway marker color assignment for identification of four safety-related separation groups. Section 8.3.1.4(a) of the FSAR (Reference 1.77) states in part that the design criteria employed for the separation of circuits and equipment comply with the requirements of Attachment C to AEC (NRC) letter dated December 14, 1973, Physical Independence of Electric Systems, and are described in Appendix 8A of the FSAR. Section 5.1.2 Appendix 8A states that "exposed Class 1E raceways shall be marked in a distinct permanent manner at intervals not to exceed 15 feet and at points of entry to and existing from enclosed areas." Section 5.1.2 of IEEE Std 384-1974 (Reference 6.35) provides these same requirements for identification of exposed Class 1E raceways. Raceways are defined in the FSAR Appendix 8A Section 3.9, Section 8.3.1.4(g), and IEEE Std 384-1974 Section 3 as cable trays and conduit.

In the Seabrook response to NRC questions on interactions between circuits of different voltage level, RAI 430.149 (Reference 6.152), it is stated that the Seabrook Station complies with the requirements of FSAR Appendix 8A, IEEE Std 384-1974 and Regulatory Guide 1.75, Rev. 2 (Reference 6.36). Although the Seabrook FSAR Section 8.1.5, Design Criteria, does not specifically reference IEEE Std 384-1974, Regulatory Guide 1.75 Rev. 2 is referenced as a design commitment. This Regulatory Guide endorses IEEE Std 384-1974 (including Section 5.1.2) with respect to identification of exposed conduit. While the Seabrook FSAR states design compliance with FSAR Appendix 8A, IEEE Std 384-1974 and Regulatory Guide 1.75, Revision 2, the Seabrook installed and exposed Class 1E conduit is not marked distinctly and in a permanent manner to identify the separation group at intervals not to exceed 15 feet and at points of entry to and exit from enclosed areas in accordance with requirements of the FSAR Appendix 8A, Section 5.1.2, IEEE Std 384-1974, Section 5.1.2, and Regulatory Guide 1.75, Revision 2, Position C11 (Finding 6-30).

We further noted that raceway identification in Section 8.3.1.4 (i) of the FSAR (Reference 1.77) states that "conduit raceways are identified at each end where conduit terminates and at both sides of walls, floors and in-line boxes." A telecon between Yankee Atomic and United Engineers personnel in June, 1980 (Reference 6.153) acknowledged that Seabrook installed conduit was not marked at 15 foot intervals in accordance with PSAR Appendix 8A, Section 5.1.2; however, it was felt that the 15 foot markings along the length of the conduit was excessive and unnecessary. While United Engineers agreed to provide the justification for this exception to the licensing commitment, it was never developed. We therefore concluded that the conduit raceway identification requirements for separation groups stated in Section 8.3.1.4(i) of the FSAR are in conflict with the licensing commitments presented in FSAR Appendix 8A, Section 5.1.2.

The team believes that this entire issued is not minor, since the IEEE Std 384-1974 criteria of raceway markings at 15 foot intervals is based on the need to readily distinguish the physical separation between redundant Class 1E circuits in order to minimize separation conflicts during plant construction and during plant modification throughout the life of the plant. We note that Regulatory Guide 1.75, Revision 2 position C11 states in this regard "The method of identificaiton used should be simple and should preclude the need to consult any reference material to distinguish between Class 1E and non-Class 1E circuits, and between redundant Class 1E systems." We believe that the present Seabrook conduit markings violate the intent of Regulatory Guide 1.75, Revision 2 position C11 and that United Engineers should provide suitable justification for this deviation which ensures physical separation or provide markings in accordance with the requirements of IEEE Std 384.

6.3 Control System

The Containment Building Spray System is designed to function automatically under accident conditions. Manual operation of Containment Building Spray equipment is not required during an accident (Reference 1.77 Amendment 48). Manual actuation requires that two control switches be operated, so as to prevent spurious manual initiation of the Containment Building Spray System. The team reviewed these provisions during the site inspection, and had no further questions in this area.

Containment Building Spray System operator displays powered from safety-related sources include: (1) spray additive tank outlet valve position, (2) RWST level transmitters, (3) RWST to pump suction MOV position, (4) sump to pump suction MOV position, (5) CBS pump running, (6) recirculation line valve position, and (7) CBS spray nozzle isolation valve position.

Non-safety-related Containment Building Spray system indications provided to the main control room operator include pump discharge pressure, pump motor amperage, circuit breaker close position light, and breaker trip alarm. During the inspection the team noted that the Containment Building Spray System did not have instrumentation to measure system flow through each spray flow train. Since the System is an Engineered Safety Feature (ESF), the Post Accident Monitoring system description (Reference 6.26) was examined to identify how the operator would determine that the Containment Building Spray System was performing its intended safety function.

The Post Accident Monitoring system description, SD-96, states that the system provides instrumentation to monitor plant variables and systems during and following postulated accidents. It further states that the system provides operators with information to assist in evaluation of the nature of an accident and functioning of ESF actuation systems. Seabrook FSAR Section 1.8 identifies Yankee Atomic's conformance to Regulatory Guide 1.97, rev. 1 (Reference 6.31). The FSAR states that presently identified post-accident monitoring instrumentation complies with the guidance provided by Reference 6.31 (rev. 1) with exceptions for radiation measurement inside containment, reactor coolant system pressure, and radiation monitoring on the primary vent stack. Yankee Atomic is in the process of upgrading the post-accident monitoring instrumentation vis-a-vis the guidance of ANSI/ANS-4.5-1980 (Reference 6.280) as modified by Regulatory Guide 1.97, Revision 2 (Reference 6.31). Reference 6.31 expanded the number of variable types to five by adding Type D and E variables. Variables in the Type D category are those that provide information to indicate the operation of individual safety systems and other systems important to safety. For containment cooling systems, Reference 6.31 identifies containment spray flow as a type D, qualification category 2 variable and recommends that the instrumentation be qualified in accordance with Regulatory Guide 1.89, "Qualification of Class 1E Equipment for Nuclear Power Plants," and the methodology described in NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment."

Since Yankee Atomic indicated to the NRC in June 1982 that they intended to upgrade the post-accident monitoring instrumentation to comply with the guidance of ANSI/ANS-4.5-1980 as modified by Regulatory Guide 1.97 Rev. 2, the team examined the actions taken to date by United Engineers to support that commitment. On July 20, 1983 (Reference 6.49) Yankee Atomic informed United Engineers that in the response to NUREG-0737, Supplement 1, they committed to providing a list of Seabrook accident monitoring instruments and a comparison to Regulatory Guide 1.97 by September 1983. The letter further clarified that recent discussions with the NRC have established that Regulatory Guide 1.97 Rev. 3 (Reference 6.31) should be used for the comparison. On October 5, 1983 United Engineers informed Yankee Atomic that they have reviewed the list of Seabrook post-accident monitoring instrumentation and compared it with revision 3 of Regulatory Guide 1.97 concluding as a result of this review that only a few non-compliances with Regulatory Guide 1.97 were found and that the intent of Regulatory Guide 1.97 has been met through backup instrumentation or inferred readings. United Engineers' review verified that containment spray flow was not included in the design; however, PI-2312, 13, 14, and 15 were identified by United Engineers as instruments that provide adequate indication of flow through containment spray pumps 9A and 9B further noting that these indications are backed up by suction pressure low alarms.

The team reviewed the electrical qualification status of PI-2312, 13, 14, and 15 as well as their source of electrical power. No electrical qualification documentation exist and all of the instruments are powered from non-safety related train A power. The instrumentation is located in the Primary Auxiliary Building in a potentially harsh environment. Since the instrumentation is powered from non-safety-related sources and is exposed to a potentially harsh environment for which it is not qualified, the pressure instrumentation cannot be assumed to be available for operator use following a loss of coolant accident which initiates containment spray cooling. The suction pressure low alarms would also not be available because suction input is obtained from PI 2312 and 2314 for train A and B respectively. Therefore, the inspection team has concluded that United Engineers' assessment that the intent of Regulatory Guide 1.97 revision 3 has been met is incorrect since the instrumentation is not adequately powered or environmentally qualified for its intended service.

When the team's conclusion was communicated to United Engineers, they indicated that the operator can monitor the safety systems by looking at the status monitoring panel in the control room. Whether or not sufficient Containment Building Spray System valve position indications are provided on the status monitoring panel for the operator to assess proper system function was not further investigated. Additional investigation was not performed because the inspection team had determined that numerous Class 1E status lights and valve position indication would be potentially rendered inoperable due to failure of the ETC terminal blocks. The team also noted that the quality assurance requirements for other type D category 2 variables, such as Residual Heat Removal System flow (RH-FT-618, -619), Safety Injection high pressure flow (SI-FT-918, -922), and Residual Heat Removal Heat Exchanger Outlet Temperature (RH-TE-604, -605), are commercial grade. The team believes that the accident monitoring instrumentation at Seabrook is not currently adequate for its intended service; however, since the Yankee Atomic has not informed NRC that the post-accident monitoring system meets the requirements of Regulatory Guide 1.97 revision 2 or 3, the inspection team considers this issue to be an unresolved item (Unresolved Item 6-4).

6.4 Annunciation System

The objectives of the Containment Building Spray portion of the plant annunciation system are twofold; namely, provide system status information prior to an actual need, and provide both current status and operator information needs during system test or actual operation.

The alarm setpoint calculation for Refueling Water Storage Tank low-low-1 level contained errors due to numeric value discrepancies involving level transmitters LT-930 through LT-933 (Reference 6.17). The three minor errors identified are given below (Finding 6-31).

(1) a subtraction error that produced a 78.75 percent of span value having two significant digits rather than just one;

(2) a subsequent transcription error by use of 78.3 percent of span rather than the correct value of 78.8 percent, and

(3) the resultant calculation of 110.25 inches of water above the centerline of the level transmitter rather than the correct value of 110.32 inches of water.

6.5 Conclusions

For the instrumentation and control aspects of the Seabrook design, the most significant finding is actually a composite result derived from six individual findings. The central issue involves achievement of sufficient "independence," as defined in Section 4.6 of IEEE Std 279-1971, involving redundant safety-related equipment needed for accident mitigation and for safe shutdown. Based on the six individual findings, the team has concluded that sufficient independence of the instrumentation and control systems has not been demonstrated.

The team believes that these six individual problems identified with the present Seabrook instrumentation and controls design can be rectified by additional attention focused on non-safety-related loads and the consequential failure effects on various plant systems. It should be noted that correction of only the identified problems will probably be insufficient, as the Integrated Design Inspection program is of necessity a sampling process rather than a complete survey of the Seabrook plant design. The team recommends that a detailed failure modes and effects analysis of the Seabrook design be performed with emphasis on postulated failures of non-qualified, non-safety-related instrumentation and controls.

The use of "associated circuits" to the degree chosen for this plant is uncommon within the nuclear industry and is certainly a significant contributing factor in the specific problems identified at Seabrook. Nevertheless, the team believes that the Seabrook associated circuit philosophy can, with implementation diligence, be made acceptable relative to the issue of independence.

Independence is the principal means by which the single failure criterion is met. The team found, however, that the Seabrook design is deficient in this regard in three important safety-related systems that were examined (Findings 6-12, 6-13, and 6-14). The team found that Residual Heat Removal System design is deficient in that valves 606, 607, 618 and 619 are not automatically positioned for Safety Injection system operation as required by IEEE Std. 279 and the General Design Criteria. (Finding 6-13) Yankee Atomic and United Engineers have failed to show lack of vulnerability to common cause failure of the Seabrook Containment Enclosure Exhaust Filter System, Residual Heat Removal System and Primary Component Cooling Water System. The common cause failures could be caused by a seismic event or accident environment. Pneumatic-to-current converters which have not been qualified as safety-related equipment are used in each of these systems. Associated indicators and displays that could be used in coping with events of concern also could be lost (Findings 6-12 and 6-16). Adequate isolation of safety-related and non-safety-related circuits were not provided in at least one case that we investigated (Finding 6-15) and the fault current interrupting capability of important circuit breakers on which dependence is placed to prevent harmful effects on safety-related circuits has not been demonstrated. (Finding 6-17)

The team was able to identify these six individual findings despite Yankee Atomic and United Engineers statements that the Seabrook design met the single failure criterion and that no points of vulnerability exist to affect the design independence of the "B" train due to association of Balance-of-Plant Non-safety-related circuits with the "A" train. The absence of detailed failure analyses is another contributing factor, in that the team believes that insufficient attention has been given to postulated failures of nonqualified non-safety-related instrumentation and control devices used in the Seabrook design.

The second most significant finding is again a combination of individual findings related to equipment qualification involving United Engineers and three component vendors, ITT Barton, Mercury of Norwood, and York Electro-Panel. United Engineers acceptance of Class 1E equipment at the site, given that seismic and environmental qualification had not been satisfactorily demonstrated by the vendor, was repeatedly found. This design control problem is illustrated by the following tabulation:

Qualification Test Report	Finding 6-7
Qualification Test Conditions	Finding 6-8
Switch Qualification	Finding 6-19
Terminal Block Qualification	Finding 6-20
Cable Flame Test Report	Finding 6-22
Vendor Surveillance Check Plan	Finding 6-23
Terminal Block Procurement	Finding 6-24
Nonconformance Report	Finding 6-25
Cable Purchase Order	Finding 6-26
QA Review of Cable Requisition	Finding 6-27
Cable Flame Test Report	Finding 6-28
Vendor Surveillance Check Plan	Finding 6-29

As the Seabrook plant is still in a construction stage, the impact of these equipment qualification findings could be serious, if left uncorrected, or could be relatively insignificant if appropriate corrective action is taken in a timely manner. Nevertheless, the team remains concerned with the apparent pervasiveness of these quality assurance deficiencies in the qualification design process for instrumentation and control equipment. Corrective steps should be taken to assure that seismic and environmental qualification is demonstrated by all vendors of safety-related equipment.

The remainder of instrumentation and control findings were, for the most part, except for conduit marking, Finding 6-30, considered by the team to be isolated random errors, inconsistencies, and omissions. In a number of instances, corrective action has already been taken by United Engineers or the individual vendors for these identified findings.

7. ORGANIZATION AND PROCEDURES

The purpose of this section of the report is to describe our review of the Seabrook project organization and management, and the procedures used for control of the design process.

7.1 Organization and Management

Public Service Company of New Hampshire is the principal owner and holds the construction permit for Seabrook Station, Unit 1. Public Service of New Hampshire also has the responsibility for the design, construction, and quality of the station. In order to carry out its responsibilities, Public Service of New Hampshire obtained the assistance of the Nuclear Services Division of the Yankee Atomic Electric Company through a service contract. Included among the services provided by Yankee Atomic are project administration, facility design control, construction coordination, and quality assurance. Westinghouse Electric Corporation was contracted to design, fabricate and deliver the nuclear steam supply system, and United Engineers and Constructors, Incorporated, is providing engineering design and procurement of the balance of plant as well as acting as the construction manager for construction of the station.

The Executive Vice President of Public Service of New Hampshire is responsible for all executive functions of the project. He reports directly to the president of that company. The Vice President, Seabrook, reports directly to the Executive Vice President. Both are officials of Public Service of New Hampshire. Working directly under the Vice President, Seabrook are: Director of Quality Assurance; Manager, Start-up Testing; Director of Construction; and the Project Manager. These four positions are staffed by the Yankee Atomic personnel. There are three additional positions in the top tier of the organization, the Manager, Construction Support and the Construction Manager (from Public Service of New Hampshire) and the Vice President of United Engineers who is responsible for design and construction management.

The Yankee Atomic organization for the Seabrook Station consists of four main groups: engineering and licensing, headed by the Project Manager, construction, quality assurance, and start-up. The major focus during this inspection was the group involved in engineering. The Yankee Atomic engineering group reports to the project manager and it is subdivided into four groups headed by the following positions: Assistant Project Manager of Construction, Engineering Manager, Senior Project Engineer, and Assistant Project Manager (for licensing and operation). The Yankee Atomic Engineering Manager has four lead engineers reporting to him: Systems Lead Engineer, Mechanical Lead Engineer, Instrumentation and Controls Lead Engineer, and Electrical Engineer. These personnel and their subordinates are employed in the Framingham, Massachusetts offices of Yankee Atomic with numerous days spent at the site which is within a 1-1/2 hour drive of their offices.

United Engineers and Constructors main engineering effort for the Seabrook Project is being carried out in the home office in Philadelphia, Pennsylvania. United Engineers is organized into several operating divisions with the nuclear power work in the United States being performed in the Power division under the direction of a Vice President. One of the managers reporting to him is the Manager of Power Engineering. Power Engineering is subdivided into four technical disciplines each with a chief engineer as the technical lead. United Engineers defines four specific disciplines: structural, electrical, instrumentation and control, and power. The power discipline is further subdivided into power systems, piping engineering, process engineering, mechanical engineering, nuclear engineering, and fluid/hydraulic engineering. The engineering personnel involved in a given project such as Seabrook all report, technically, to one of the four discipline chief engineers. Some may serve in a specialist capacity or in a group under the chief engineer of that discipline to support a specific project. Others may be within the project group under a supervising discipline engineer or other engineering supervisor reporting to a particular project engineering manager. The staff groups and specialist personnel apparently become involved in project work only at the request of the project engineering personnel. Based on the team's information this concept has been used within United Engineers for a number of years.

The Seabrook Project at United Engineers functions within this framework in the following manner. The Seabrook Project Manager reports to the Vice President of the Power Division, just as does the Manager of Power Engineering. In the course of the project there have been numerous changes in the functional organization of the project as well as changes in personnel. The team found some difficulty in tracing the organizational changes as well as how responsibilities shifted and were transferred from one group or individual to another. Documentation was obtained of the organization that indicated the overall project organization since 1976. Numerous changes were implemented about the time the team's effort began. The team found that the organizational charts obtained in the background study in October were out of date by the beginning of November when the team began its inspection.

Within United Engineers the project is led by the Project Manager and reporting directly to him until sometime after March of 1981 was the Project Engineering Manager. There also existed at least one Assistant Project Engineering Manager. Up through March of 1981 there was a liaison engineer assigned to the field to perform the site liaison to the United Engineers home office engineering organization. That function was performed under the supervision of the one Project Engineering Manager for Seabrook. In March of 1981 a separate organization was created under the direction of the Project Engineering Manager (Site) as opposed to the previous position under the Project Engineering Manager for the project. By January of 1983 four separate Project Engineering Manager positions were in existence in the home office with some 1100 personnel in the groups in Philadelphia. Additionally, nearly another 1100 personnel were at the site under the control of the Project Engineering Manager for Site Engineering. These personnel were involved with supporting construction on changes, nonconformances, and construction engineering functions.

United Engineers also acts as the construction manager for the Seabrook Project. Major contractors were employed for general structural work, the containment liner, piping and mechanical equipment and electrical work. The efforts of a number of subcontractors employed by the project in various capacities were reviewed by the IDI team during this inspection.

7.2 Procedures and Design Control

In order to assess the technical performance of the major design organizations for the design of the Containment Building Spray System and associated systems and components, the team spent some time both in preparation and during the inspection dealing with various United Engineers procedures related to design control. United Engineers Quality Assurance Topical Report (Reference 1.138) and the Quality Assurance Manual (Reference 1.55) are the highest level corporate documents addressing the NRC Quality Assurance regulations contained in 10 CFR 50, Appendix B. QA-3, Design Control, (Reference 1.55) is the principal procedure contained in the Quality Assurance Manual related to control of the design of the Seabrook Project within United Engineers.

The team reviewed QA-3 which provides for the creation of corporate level procedures in order to implement design control. It was under this authority that the corporate level procedures and project procedures relating to individual projects and activities were developed. In reviewing the United Engineers Project Manual of Procedures (Reference 1.54) it was found that the document was inconsistent with certain Administrative Procedures. Section I, Exhibit A, dated August 22, 1980, Revision 13 of the Project Manual of Procedures contains a matrix known as the Correspondence and Document Distribution Index. This matrix contains some 800 entries of which 15 were found to be inconsistent with those of a similar matrix in Administrative Procedure AP-1, Correspondence - Reproduction and Distribution, pages 1-3, dated March 25, 1983 (Reference 1.139). The discrepancies ranged from whether or not Pre-Operational Test and Operating Manuals would be distributed to the number of copies of specifications to be sent to various individuals. This was judged to have been an oversight in project administrative actions as various revisions to the two documents have been made. It is not considered to be systematic failure. If cross-references between the two documents were contained in each document a change in one might have not been overlooked as necessitating a change in the other, if in fact it is necessary to have duplicative information. (Finding 7-1)

Within the same Project Manual of Procedures we found that Section II, Project Management, was revised on March 7, 1983 yet the organization chart on page 2-3 did not yet reflect the organization of the Seabrook Project in effect at that time. Based on material given to the team a different project organization has been in existence at least since January of 1983. As of the date of our review of this matter, which was the week of November 14, 1983, no revisions to insert the current organization had been made to the Project Manual of Procedures. (Finding 7-2)

In attempting to ascertain whether a seismic requirements blanket specification had been prepared following the project's various procedures addressing specifications, it was determined that all revisions to the procedures controlling the preparation of specifications were not available. Consequently it was not possible to audit activities related to the preparation of specifications prior to late 1975 or early 1976. The team found this situation to not be in conformance with American National Standards Institute, ANSI N45.2.11-1974, "Quality Assurance Requirements for the Design of Nuclear Power Plants" (Reference 1.137) to which the licensee committed in the FSAR, Sections 1.8 and 17.1. ANSI N45.2.11-1974 requires, in Section 2.2, that design activities be "carried out in a planned, controlled, orderly and correct manner" and that the program procedures assure that the conduct of audits of design activities be completed. United Engineers project quality procedure "Design Control", QA-3 (Reference 1.55), in Section IV, incorporates the Project Administrative Procedures and the Power Division design control procedures (the General Engineering and Design Procedures) into the design control program. Revision 4 of QA-3, dated July 19, 1974, referred to "Specifications", United Engineers Administrative Procedure No. 9 (AP-9) (Reference 1.140) by specific reference in Section IV.A.1. In addition, Revision 5 of QA-3, dated October 25, 1974 added a specific reference in Section IV.E.2.a. to "Preparation of Specifications", United Engineers General Engineering and Design Procedure No. 0015 (GEDP-0015) (Reference 1.100). The following versions of two of these documents were not available at United Engineers.

AP-9, "Specifications":	Revision 0, July 8, 1974 Revision 1, August 1, 1974 Revision 2, September 18, 1974
GEDP-0015, "Prepartion of Specifications":	Revision 0, August 1, 1974 Revision 1, February 25, 1975 Revision 2, April 28, 1975

Since each of these series of documents was necessary to audit design controls and whether they have been properly implemented, the non-availability represents a deficiency in the design controls. Based on conversations with personnel at United Engineers this is apparently a generic problem across all Administrative Procedures and General Engineering and Design Procedures in that these procedures, which constitute the implementing procedures for the design control program, are not available for the time period prior to late 1975 or early 1976. The team recommends that United Engineers procedures clearly state the need to have all revisions of all procedures available within their system of records. (Finding 7-3)

While assessing project documents the team found that United Engineers issued "Subject File System," Administrative Procedure No. 7 (AP-7) (Reference 1.61). This procedure required the supervising discipline engineers to transmit to engineering management, with copies to project administration, periodic updates to the subject file index for their discipline. The procedure also states that no changes can be made to file numbers without prior approval. The structural supervising discipline engineer periodically submitted revisions to the subject file system while AP-7 was revised four times over the last 6½ years. None of the suggested additions were incorporated in the subject file system. During this period the Structural Group utilized the file system with the additional indicies. The subject file system should be reviewed to determine whether other discipline records have been omitted, and report the results in responding to this finding. (Finding 7-4)

The team found that within the Seabrook project's Administrative Procedures several errors exist. The team also noted that these procedures actually address more than administration. The deficiencies noted below do not appear to be significant but should be corrected. (Finding 7-5)

AP-2, "Correspondence Control System" (Reference 1.82) existed with Attachment 8 out of date as of the time of the inspection in that design calculation originals were not maintained by the responsible discipline but were maintained in the Calculation Control Centers.

AP-14, "Review and Control of Contractor Drawings/Documents", (Reference 1.84) was shown by the Administrative Procedure Manual Index for Seabrook, dated November 1, 1983 as "Review and Control of Contractor Drawings/Documents", whereas the actual document AP-14, Rev. 2, March 23, 1983 is titled, "Instructions to Bidders, Review and Control of Field Documents".

AP-28, "General Engineering Design Procedures" (Reference 1.126) existed but, however no Detailed Engineering Design Procedures are listed or referenced in the document. These are contained in AP-24, "Detailed Engineering and Design Procedures", (Reference 1.141).

AP-35, "Transmittal of Reports and Studies" (Reference 1.142) was not applicable to the Seabrook project.

The team observed that United Engineers "Management Level Design Review By Chief Discipline Engineers", General Engineering and Design Procedure No. 0025 (GEDP-0025) (Reference 1.104) requires management level design reviews prior to the submittal of safety analysis reports but there is no cross reference to this procedure in the procedure addressing the safety analysis report preparation. The team's judgment was that "Preparation of Safety Analysis and Environmental Reports for Nuclear Power Plants," General Engineering and Design procedure No. 0017 (GEDP-0017) (Reference 1.102) should cross-reference GEDP-0025. This is not a finding or an unresolved item, but an item which the licensee may wish to consider. (Observation 7-1)

During the review of certain procedures it was found that "Controlled Documents", United Engineers Administrative Procedure No. 23 (AP-23) (Reference 1.85) requires that controlled documents will have attached to them a form stating that the document is complete in accordance with the index. The team found that this practice is not utilized, but instead the form is signed by the individual who is responsible for a particular unique copy of the controlled document and returned to the issuing party for retention. United Engineers indicated orally during the inspection that their intent is to revise AP-23 accordingly. (Finding 7-6)

The team concluded that in general, United Engineers has developed various levels of procedures over the evolution of the project to control design which were judged to be adequate. The team believes that the project can be controlled using these procedures. It appeared that the design engineers have followed these procedures yet in some instances the rapidity and number of revisions may have placed a burden on the design engineers.

8 REFERENCE MATERIAL

8.1 General

8.1.1 Documents

Ref. No.	Document Type	Description/Title	Rev.	Date
1.1	Organization Charts	UE&C, Yankee and PSNH Organization Charts (Including Site)		
1.2	UE&C Design Procedure	DEDP-2607, "Procedure for Computerized Piping Analyses"	2	6/10/83
1.3	UE&C Design Criteria	SD-66, "Structural Design Criteria for Seabrook Station"	1	11/10/82
1.4	UE&C Design Guidelines	Pipe Support Design Guidelines	1	6/17/81
1.5	UE&C Design Guidelines	Additional Information for Pipe Support Design Guidelines	1	6/17/81
1.6	UE&C Technical Guidelines	Seabrook Station Technical Guide for the Design and Analysis of Seismic Category 1 Cable Tray Support Systems	0	7/83
1.7	UE&C Design Guidelines	Separation Design Guide for Physical Independence of Electric Systems	1	1/7/76
1.8	UE&C Design Guidelines	Wiring Design Guide	3	11/1/76
1.9	UE&C Design Guidelines	Technical Guide for the Design and Analysis of the Electrical Conduit Support System	1	9/17/83
1.10	UE&C Indexes	Listing of Design, QA, Administrative, and Engineering Procedures, and System Descriptions		
1.11	UE&C System Description	SD-20, "Containment Building Spray System"	6	3/4/83
1.12	Westinghouse System Description	SD-NAH/NCH-283, "Residual Heat Removal System"	1	8/78

Ref. No.	Document Type	Description/Title	Rev.	Date
1.13	Westinghouse System Description	SD-NAH/NCH-284, "Safety Injection System"	2	8/76
1.14	UE&C Drawing	804880, "Material Balance Diagram Containment Spray System Nuclear"	0	6/29/83
1.15	UE&C Drawing	804881, "Material Balance Containment Spray System Tabulation Sheet"	0	6/29/83
1.16	UE&C Drawing	805023, "Containment Spray System P&I Diagram"	8	Open
1.17	UE&C Drawing	805001, "Lead Sheet Nuclear P&I Diagrams"	7	6/24/83
1.18	UE&C Drawing	804978, 981, 982, 984, 805008-010, 012, 014, 017, 021 (P&I Diagrams for Interfacing Systems)		
1.19	Westinghouse Drawings	1099E05-1099E07, Flow Diagrams for Chemical & Volume Controls, Safety Injection and Residual Heat Removal Systems		
1.20	YAEC Photographs	Numbers 100483.1.6, 100483.1.9, 100483.1.2, 093083.1.6, 093083.9.5, 093083.9.9		
1.21	UE&C Drawings	Isometric Piping Drawings 801201-11, 13-20, 22-24, 28, 29, 34, 37, 54, 56-60, 66		
1.22	UE&C Listing	Engineering, Design and Purchase Specifications (Piping)		
1.23	UE&C Listing	Listing of ASME Code Cases		
1.24	UE&C Letter	SBU-14879, "ECCS Design Verification Piping Drawings"		10/28/77
1.25	UE&C Letter	MM-4080A, "Refueling Water Storage Tank Problem"		10/5/78
1.26	UE&C Letter	"Design Deficiency of Refueling Water Storage Tank"		9/29/78

Ref. No.	Document Type	Description/Title	Rev.	Date
1.27	UE&C Letter	SBU-21475, "Design Criteria for Refueling Water Storage Tank"		10/6/78
1.28	YAEC Letter	SB-12841, "Class 1E Containment Sump Level Indicators"		2/28/82
1.29	UE&C Letter	SBU-21503, "Review of Refueling Water Storage Tank Design Criteria"		10/9/78
1.30	YAEC Letter	SB-6830 - Report on the Seabrook Station Refueling Water Storage Tank Design Deficiency		10/27/78
1.31	Westinghouse Letter	NAH-U-1641, "Design Criteria for RWST"		12/12/78
1.32	UE&C Letter	SBU-24859, "Containment Data for ECCS Analysis"		3/13/79
1.33	UE&C Letter	SBU-30707, "Refueling Water Level Instrumentation"		10/10/79
1.34	UE&C Letter	SBU-29398, "Instrumentation Information Exchange"		8/22/79
1.35	YAEC Letter	SB-10815, "Exclusion of Containment Spray Headers and Spray Rings from ISI"		1/14/81
1.36	Alden Research Lab Letter	"Seabrook Containment Sump Model"		1/18/79
1.37	Westinghouse Letter	NAH-U-1642, "RWST Design Criteria Meeting"		12/12/78
1.38	UE&C Letter	SBU-45242, "NRC-IE Information Notice No. 81-10 Inadvertent Containment Spray Due to Personnel Error"		5/27/81
1.39	YAEC Letter	SB-15281, "Containment Differential Pressure Monitoring"		2/28/83
1.40	UE&C Letter	SBU-56829, "RWST Area Temperature Monitoring"		6/1/82

Ref. No.	Document Type	Description/Title	Rev.	Date
1.41	UE&C Listing	Listing of Calculations and Analyses		
1.42	UE&C Listing	Listing of Engineering Support and Consulting Services Contracts		10/5/83
1.43	UE&C Report	Purchase Order Report		10/4/83
1.44	UE&C Report	Site Engineering Scope of Work		10/6/83
1.45	YAEC QA Procedures	1.1, Program - Design and Procurement	9	12/08/82
1.45.1	YAEC QA Procedures	1.2, Program - Construction	7 IC 1 IC 2	9/30/80 8/21/81 7/30/82
1.45.2	YAEC QA Procedures	3.1, External Interface Controls	6	3/31/78
1.45.3	YAEC QA Procedures	3.2, Review Controls	5	3/30/79
1.45.4	YAEC QA Procedures	3.3, Review Procedure	8 IC 1	3/30/79 8/21/81
1.45.5	YAEC QA Procedures	3.3, Engineering Specification Appendix A	3	3/31/78
1.45.6	YAEC QA Procedures	3.3, Engineering Drawing Appendix B	3	3/31/78
1.45.7	YAEC QA Procedures	3.3, Purchase Documents Appendix C	2	3/31/78
1.45.8	YAEC QA Procedures	3.3, QA/QC Program/Manual/ Procedure Appendix D	2	9/15/78
1.45.9	YAEC QA Procedures	4.1, Document Control	5	3/31/78
1.45.10	YAEC QA Procedures	5.1, Control of Purchased Material, Equipment and Services	5 IC 1	3/31/78 8/21/81
1.45.11	YAEC QA Procedures	8.1, Corrective Action	7 IC 1	12/5/79 8/21/81

Ref. No.	Document Type	Description/Title	Rev.	Date
1.45.12	YAEC QA Procedures	9.1, General Audit Procedure	8 IC 1	2/8/80 8/21/81
1.45.13	YAEC QA Procedures	9.2, Internal Audits	6	12/8/82
1.46	YAEC Project Policies	PP1-Handling of Engineering Documents		
1.46.1	YAEC Project Policies	PP2-Quality Assurance Program		
1.46.2	YAEC Project Policies	PP3-Design Review Documentation		
1.46.3	YAEC Project Policies	PP4-Filing of Documents		
1.46.4	YAEC Project Policies	PP22-Control of Design Changes		
1.46.5	YAEC Project Policies	PP23-Processing and Resolving of Records Deficiencies Identified by PSNH		
1.47	YAEC Project Policies	PP5-UE&C Specification Review List		
1.47.1	YAEC Project Policies	PP6-W Specification Review List	4	1/82
1.47.2	YAEC Project Policies	PP7-Drawing Review List	2	9/81
1.47.3	YAEC Project Policies	PP8-QA Procedures Review List	3	9/81
1.47.4	YAEC Project Policies	PP9-System Description Review List	1	8/77
1.47.5	YAEC Project Policies	PP12-Control of Consulting Services		
1.47.6	YAEC Project Policies	PP13-Control of NRC Bulletins and Circulars	2	9/81
1.47.7	YAEC Project Policies	PP14-Engineering Change Approvals (ECA)		

Ref. No.	Document Type	Description/Title	Rev.	Date
1.47.8	YAEC Project Policies	PP15-Control of Project Policies	2	9/82
1.47.9	YAEC Project Policies	PP16-FSAR Section Review		
1.47.10	YAEC Project Policies	PP20-"Control and Follow of Letter Correspondence"		
1.48	YAEC Project Policies	PP-11, "Westinghouse Contract Change Acceptance Procedure"	1	5/79
1.49	YAEC Project Policies	PP-24, "Review of Main Control Board Drawings"	0	7/83
1.50	UE&C Valve Tabulation	PCS Report 15 - Automated Valve Schedule by System	Issue 538	7/8/83
1.51	UE&C Calculation Index	Calculation Indicies from Calc. Control Centers - 4 Volumes		
1.52	UE&C Corporate Procedure	Operations Manual - Power Engrg. Dept. Vol. 1, Book 3-5, Copy 63, General Engineering and Design Procedures (GEDP's) 0-48		
1.53	UE&C Corporate Procedure	Operations Manual - Power Engrg. Dept. General Administrative Procedures (GAP's) 0-17 (no #13)		
1.54	UE&C Seabrook Project Manual	Manual of Procedure - Seabrook		
1.55	UE&C Seabrook Project QA Manual	Seabrook Project QA Procedures, Copy No. 61		
1.56	UE&C Seabrook Administrative	Administrative Procedures Seabrook, Copy No. 38		
1.57	UE&C Seabrook Project Manual	Standard Documents Related to Specs for Seabrook, Copy No. 15		
1.58	UE&C Procedure	Administrative Procedure No. 47, "Engineering Assurance Program"	1	10/26/82
1.59	UE&C Letter	SBU: 78379, "Engineering Assurance Program Status Report"		9/16/83

Ref. No.	Document Type	Description/Title	Rev.	Date
1.60	UE&C Memorandum	MM 15283A, "Engineering Assurance Evaluation Report No. NHE-14 Containment Spray System"		10/5/83
1.61	UE&C Procedure	Administrative Procedure No. 7, "Subject File System"	12	8/18/83
1.62	YAEC Audit	Seabrook Audit Report No. SA744UE023		6/21-24/83
1.63	NRC Memorandum	Memorandum from D. G. Eisenhut (NRR) to R. L. Spessard (RIII), "Acceptability of Specific Cable Separation Configuration at LaSalle County Station, Units 1 and 2"		10/12/83
1.64	NRC Regulatory Guide (RG)	RG 1.82, "Sumps for Emergency Core Cooling and Containment Spray Systems"		6/74
1.65	ANS Standard	ANSI/ANS 56.5-1979, "PWR and BWR Containment Spray System Design Criteria"		11/7/79
1.66	UE&C Procedure	Administrative Procedure No. 15, "Changes to Project Documents, Engineering Change Authorization (ECA) and Request for Information (RFI)"	18	8/17/83
1.67	UE&C Drawing	509022, "Containment Pressure Protection Set I through IV Process Control Block Diagram"	1	5/24/83
1.68	UE&C Drawing	503247-249-CBA Logic Diagrams		
1.69	UE&C Design Specification	Spec. No. 9763-006-501-3, "Nuclear Power Plant Instrument Piping Systems"	1	3/9/83
1.70	UE&C Schematic Diagram	310900 - Schematic Diagram, Containment Spray System		
1.71	UE&C Schematic Diagram	310864 - Schematic Diagram Instrument Air System		

Ref. No.	Document Type	Description/Title	Rev.	Date
1.72	UE&C Drawing	506169-506174, 503250-503261 - CBS Control Loop and Logic Diagrams		
1.73	UE&C Drawing	500006 - P&ID General Information Sheets		
1.74	UE&C Drawing	503100, "Symbols Logic Diagram"	2	4/21/78
1.75	UE&C Drawings	310007, 8, 27, 33, 41-43 - One Line Diagrams for 4160V Switchgear Buses, 460 V MCC's, 125 VDC/120 VAC Instrument Buses and Vital Distribution System/Instrument Buses		
1.76	NRC SER	NUREG-0896 and Supplements 1 and 2, "Safety Evaluation Report Related to the Operation of Seabrook Station, Units 1 and 2		3/83 4/83 6/83
1.77	FSAR	Seabrook Station Final Safety Analyses Report	Amendment 50	8/83
1.78	NRC NUREG	NUREG-0800, 6.2.2, "Containment Heat Removal Systems"	3	7/81
1.79	NRC NUREG	NUREG-0800, 6.5.2, "Containment Spray as a Fission Product Cleanup System"	1	7/81
1.80	NRC Paper	SECY 82-352, "Assurance of Quality", Page 5 and Enclosure 1, Pages 6 and 7		8/10/82
1.81	UE&C Corporate Organization Chart	Power Division, Power Engrg., Functional Responsibility Chart		
1.82	UE&C Procedure	AP-2, Correspondence Control System	10	4/5/83
1.83	UE&C Procedure	AP-11, Transmittal and Control of Issued Documents	4	9/9/77

Ref. No.	Document Type	Description/Title	Rev.	Date
1.84	UE&C Procedure	AP-14, Instructions to Bidders, Review and Control of Field Procedures	2	3/23/83
1.85	UE&C Procedure	AP-23, Controlled Documents	5	5/30/80
1.86	UE&C Procedure	AP-21, Conduct of Design Reviews	4	4/30/82
1.87	UE&C Procedure	AP-36, Control of Seismic Design	2	5/20/80
1.88	UE&C General Engineering and Design Procedure (GEDP)	GEDP 0, Glossary of Terms Used in GEDPs	1	1/14/81
1.89	UE&C GEDP	GEDP 1, Preparation of Engineering and Design Procedures	2	9/26/75
1.90	UE&C GEDP	GEDP 2, Execution of Project Definition	0	10/29/76
1.91	UE&C GEDP	GEDP 3, Preparation of System Descriptions	1	3/20/75
1.92	UE&C GEDP	GEDP 4, Preparation of Structural Design Criteria Document	3	8/2/76
1.93	UE&C GEDP	GEDP 5, Preparation, Documentation and Control of Calculations	3	9/9/75
1.94	UE&C GEDP	GEDP 6, Preparation of Study Reports, Topical Reports and Allied Publications	2	9/26/75
1.95	UE&C GEDP	GEDP 7, Preparation and Review of Stress Report for Nuclear Plant Components (ASME B&PV Code, Section III, Division 1)	3	12/5/75
1.96	UE&C GEDP	GEDP 9, Preparation of Flow Diagrams	1	3/14/75
1.97	UE&C GEDP	GEDP 12, Development and Use of Amplified Response Spectra for Seismic Design of Structures and Systems	1	2/20/75
1.98	UE&C GEDP	GEDP 13, Preparation of Drawings	3	3/30/81

Ref. No.	Document Type	Description/Title	Rev.	Date
1.99	UE&C GEDP	GEDP 14, Preparation of Design Specifications for Nuclear Power Plant Components (ASME B&PV Code, Section III, Division 1)	3	5/9/80
1.100	UE&C GEDP	GEDP 15, Preparation of Specifications	3	9/11/80
1.101	UE&C GEDP	GEDP 16, Instructions for the Preparation of Construction Specifications for Concrete Reactor Vessels and Containments (ASME B&PV Code, Section III, Division 2)	2	8/3/81
1.102	UE&C GEDP	GEDP 17, Preparation of Safety Analysis and Environmental Reports for Nuclear Power Plants	2	10/3/75
1.103	UE&C GEDP	GEDP 22, Project Level Design Review and Design Verifications	5	5/9/80
1.104	UE&C GEDP	GEDP 25, Management Level Design Review by Chief Discipline Engineers	3	12/29/78
1.105	UE&C GEDP	GEDP 31, Preparation of Testing Procedures for Nuclear Power Plants Components	2	2/11/75
1.106	UE&C GEDP	GEDP 32, Control, Evaluation and Implementation of Design Changes	3	10/29/76
1.107	UE&C GEDP	GEDP 33, Control, Evaluation and Implementation of Review Comments on Design Documents	2	11/20/78
1.108	UE&C GEDP	GEDP 34, Response to Audits, Corrective Action Requests and Other Quality Assurance Reports	3	6/1/83
1.109	UE&C GEDP	GEDP 35, Engineering and Design Interface Control	1	3/17/75
1.110	UE&C GEDP	GEDP 39, Technical Bid Evaluation	2	12/10/79
1.111	UE&C GEDP	GEDP 40, Preparation of Containment Design Report (CDR)	3	3/12/82

Ref. No.	Document Type	Description/Title	Rev.	Date
1.112	UE&C GEDP	GEDP 43, Preparation of Design Specifications for Concrete Reactor Vessels and Containments (ASME B&PV Code, Section III, Division 2)	6	3/12/82
1.113	UE&C GEDP	GEDP 44, Documentation and Verification of Digital Computer Programs	2	9/16/80
1.114	UE&C GEDP	GEDP 46, Response to Potential Significant Deficiencies as Defined in 10 CFR 50 Paragraph 50.55(e)	0	5/9/80
1.115	UE&C GEDP	GEDP 47, Qualifications and Duties of PE Personnel Engaged in ASME Code Certifying Activities	0	7/10/81
1.116	UE&C GEDP	GEDP 48, Processing and Review of NRC Requirements	0	5/12/82
1.117	UE&C Administrative Procedure	AP-27, "General Administrative Procedures"	4	5/18/82
1.118	UE&C Administrative Procedure	AP-46, "Design Change Notices	3	4/29/83
1.119	Industry Standard	American National Standards Institute, ANSI N45.2, "Quality Assurance Programs for Nuclear Power Plants"		1974
1.120	NRC Regulatory Guide (RG)	RG 1.117, "Tornado Design Classification"	1	April 1978
1.121	UE&C Procedure	Administrative Procedure No. 20, "Control of FSAR Commitments"	0	10/31/77
1.122	UE&C Procedure	Administrative Procedure No. 30, "Control of PSAR Deviations"	0	4/16/75
1.123	UE&C Procedure	Administrative Procedure No. 53, "Safety Related Calculation Closeout Program"	0	8/8/83

Ref. No.	Document Type	Description/Title	Rev.	Date
1.124	NRC Regulatory Guide (RG)	RG 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants"	1	Dec. 1973
1.125	NRC Regulatory Guide (RG)	RG 1.61, "Damping Values for Seismic Design of Nuclear Power Plants"	0	Oct. 1973
1.126	UE&C Procedure	Administrative Procedure No. 28, "General Engineering and Design Procedures (Seabrook)"	6 7	1/4/83 10/25/83
1.127	NRC Regulatory Guide (RG)	RG 1.122, "Development of Floor Design Response Spectra for Seismic Design of Floor - Support Equipment or Components"	1	Feb. 1978
1.128	UE&C Procedure	Administrative Procedure No. 22, "Calculations"	8 9	6/2/83 9/12/83
1.129	NRC Regulatory Guide (RG)	RG 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants"	3	Nov. 1978
1.130	UE&C Procedure	Administrative Procedure No. 29, "Document Control - Foreign Print System"	7	4/12/83
1.131	UE&C Procedure	Administrative Procedure No. 38, "Cutting Reinforcing Steel in Permanent Concrete Structures"	1	7/31/81
1.132	UE&C Procedure	Administrative Procedure No. 39, "As-Built Documents"	4	4/29/83
1.133	UE&C Procedure	Technical Procedure No. 11, "Minimum As-Built Record Drawing Listing"	0	4/29/83
1.134	UE&C Procedure	Technical Procedure No. 23, "Project Reference Manual, Supplemental Information to Design Change Program"	1	11/28/83
1.135	UE&C Procedure	Field Administrative Construction Procedure No. 1, "Project Instruction for Handling UE&C/Contractor Nonconformance and/or Deficiency Reports"	2	10/4/82

Ref. No.	Document Type	Description/Title	Rev.	Date
1.136	UE&C Procedure	Field Administrative Construction Procedure No. 10, "Procedure for Site Calculations"	1	10/27/83
1.137	Industry Standard	American National Standards Institute, ANSI N45.2.11, "Quality Assurance Requirements for the Design of Nuclear Power Plants"		1974
1.138	UE&C Topical Report	Topical Report No. UE&C-TR-001, "Quality Assurance Program"		
1.139	UE&C Procedure	Administrative Procedure No. 1, "Correspondence - Reproduction and Distribution"	16	8/18/83
1.140	UE&C Procedure	Administrative Procedure No. 9, "Specifications"	0	7/8/74
1.141	UE&C Procedure	Administrative Procedure No. 24, Detailed Engineering and Design Procedures"		8/25/83
1.142	UE&C Procedure	Administrative Procedure No. 35, "Transmittal of Reports and Studies		11/27/78

8.1.2 Meeting Attendance

Name	Organization	Title	Meeting Attended 10/06/83	11/01/83	11/04/83	12/12/83	12/21/83
E. Wenzinger	NRC, OIE	IDI Team Leader	X	X	X		X
L. Stanley	Zytor, Inc.	Team Member		X	X	X	X
C. Crane	Westec Services	Team Member		X	X		X
L. Lewis	NRC, OIE	Team Member		X	X		
I. Ahmed	NRC, NRR	Team Member		X	X		X
K. Weise	Westec Services	Team Member		X	X		X
R. Paolino	NRC, RI	Team Member			X		X
R. Shewmaker	NRC, OIE	Team Member		X	X		X
R. Lipinski	NRC, NRR	Team Member		X	X		X
G. Harstead	Harstead Engineering	Team Member		X	X		X
D. Norkin	NRC, OIE	Team Member	X	X	X	X	X
D. Breaux	NRC, RIV	Team Member		X	X		X
R. Young	NRC, OIE	Team Member		X	X		X
A. duBouchet	Harstead Engineering	Team Member		X	X		X
W. Chen	ETEC	Team Member		X	X		X
S. Gula	Harstead Engineering	Team Member		X	X		X
A. Legendre	Yankee	Licensing Engineer	X				
D. Gregg	Westinghouse	Project Engineer	X			X	
G. Tsouderos	Yankee	Principal Engineer	X	X			X
F. Baxter	Yankee	Engineer Manager	X	X			X
T. Cizauskas	Yankee	Lead Mech. Engineer	X				X
F. N. Zinkevich	Yankee	Sr. Engineer QA	X				
H. Wingate	Yankee	Asst. Project Manager	X	X	X		X
V. Nerses	NRC, NRR	Licensing Project Mgr.	X	X			X
D. Allison	NRC, OIE	Technical Assistant		X			
G. Thomas	PSNH	Vice President		X			
J. DeVincentis	Yankee	Project Manager		X			X
P. Evans	INPO	Design Evaluation Mgr.		X	X		X
J. Milhoan	NRC, OIE	Section Chief		X			X
R. Guillette	Yankee	Supv. CQAE		X			
D. Pepe	Yankee	Startup Test Department		X			
D. Maidrand	Yankee	Assistant Project Mgr.		X			
J. Mayer	Yankee			X			X
W. Fadden	Yankee	Lead I&C		X			
B. Boykle	PSNH	I&C		X			
R. Gallo	NRC, RI	Chief, Projects Section ?			X		X
J. Slotterback	UE&C	Dep. Project Manager			X		X
A. Ebner	UE&C	Project Manager			X		X
P. Fredricks	UE&C	Chief, I&C Engineer			X		
H. Katz	UE&C	Licensing			X		X
D. Rhoads	UE&C	P.E.M.			X		X
J. Stacey	Yankee	Lead Systems Engineer	X	X			

Name	Organization	Title	Meeting Attended 10/06/83	11/01/83	11/04/83	12/12/83	12/21/83
D. McGarrigan	UE&C	Manager/Project QA			X		X
G. Aggarhal	UE&C	SDE - Electrical			X		X
O. Kalani	UE&C	PSG			X		X
R. Heere	UE&C	Group Chief Buyer			X		
F. Egner	UE&C	SDE Mech. Service			X		X
H. Kreider	UE&C	Manager/Power Engineering			X		
J. Cravens	UE&C	Eng. Project Control Mgr.			X		X
K. Robertson	UE&C	Project Eng. Mgr./Piping			X		X
G. Rigamonti	UE&C	Chief Power Eng.			X		X
G. Sarsten	UE&C	Vice President/Power			X		
L. Nascimento	UE&C	Chief Struct. Eng.			X		
K. Kalawadia	UE&C	SDE Structural			X		X
G. Duerr	UE&C	Mgr. FMEA Group			X		
R. Mabry	UE&C	Supv. Mech. Eng.			X		
D. Boyle	UE&C	Asst. Proj. Eng. Mgr.			X		
M. Shannon	Westinghouse	Senior Engineer				X	
F. Shaffer	Westinghouse	Senior Engineer				X	
P. Barilla	Westinghouse	Principal Engineer				X	
W. Henninger	Westinghouse	Principal Engineer				X	
W. Scarbrough	Westinghouse	Sr. QA Engineer				X	
D. Adomaitis	Westinghouse	Manager				X	
T. Miller	Westinghouse	Manager				X	
B. Lorenz	Westinghouse	Licensing Engineer				X	
R. Bryans	UE&C	Site Eng. Mgr.					X
J. Cady	PSNH	Compliance Manager					X
G. McDonald	Yankee	Construction QA Manager					X
L. Briggs	NRC, RI	Lead Reactor Engineer					X
M. McKenna	UE&C	Manager/Site Tech. Staff					X
F. Polek	UE&C	Piping Engineer					X
G. Keer	UE&C	Assist. Proj. Eng. Mgr. Piping					X
W. Choudhury	INPO						X
M. Braccio	UE&C	PSG-SSE Lead Engineer					X
H. Flora	UE&C	SDE/Nuclear Mechanical					X
J. Parisano	UE&C	SDE/Piping					X
H. Wescott	NRC, RI	Resident Inspector					X
A. Cerne	NRC, RI	Senior Resident Inspector					X
H. Kister	NRC, RI	Chief, Reactor Projects Branch					X
T. Ankrum	NRC, OIE	Chief, QA Branch					X
R. Starostecki	NRC, RI	Director, DPEP					X
J. Partlow	NRC, OIE	Acting Director, QASIP					X
B. Prince	PSNH	Acting Exec. VP					X
W. Johnson	PSNH	Vice President					X
J. Gramsammer	UE&C	Project Eng. Mgr. System					X

8.2 Mechanical Systems

8.2.1 Documents

Ref. No.	Document Type	Description/Title	Rev.	Date
2.1	Regulatory Guide	R.G. 1.1, "Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal System Pumps"		12/1/70
2.2	UE&C Calculation	4.3.5.11, "Containment Spray Pump NPSH Calculations"	1	1/15/81
2.3	UE&C Specification	Specification No. 9763-006-238-3, "Specification for Containment Spray Pumps"	7	3/10/83
2.4	UE&C Letter	SBU 13320, "Containment Spray Pumps Thermal Transient Test"		7/25/77
2.5	UE&C Calculation	4.3.5.10F, "CBS Hydraulic Analysis"	1	9/22/83
2.6	UE&C Calculation	4.3.22-F07, "Water Height in Containment Following a LOCA"	3	8/25/83
2.7	UE&C Calculation	4.3.5.10F, "CBS Hydraulic Analysis"	2	12/1/83
2.8	Alden Report	"Investigation of Vortexing and Swirl Within a Containment Recirculation Sump Using a Hydraulic Model"		1/80
2.9	Alden Report	"The Effect of Swirl Flow on Pipe Friction Losses"		2/80
2.10	UE&C Calculation	4.3.5.41F, "Evaluation of Alden Swirl Study"	0	12/1/83
2.11	Westinghouse Calculation	SD/SA-NAH-114, "ECCS Analysis"		11/10/78
2.12	UE&C Calculation	737-15, "Emergency Feedwater Pump Suction $NPSH_A$"	0	8/19/83
2.13	Regulatory Guide	R.G. 1.82, "Sumps for Emergency Core Cooling and Containment Spray Systems"		6/74

Ref. No.	Document Type	Description/Title	Rev.	Date
2.14	UE&C Calculation	CI-2, "Design Screen and Supporting Structure for Recirculation Sump"	0	10/2/79
2.15	UE&C System Description	SD-20, "System Design Description for Containment Building Spray System"	6 7	3/4/83 11/8/83
2.16	Conference Report	SBU-21503, "Review of Refueling Water Storage Tank Design Criteria"		10/9/78
2.17	NUREG	NUREG-0869, For Comment, "USI A-43 Resolution Positions"		4/83
2.18	NUREG	NUREG-0897, For Comment, "Containment Emergency Sump Performance"		4/83
2.19	Public Service Co. Letter	SM-603, "Containment Spray Pumps - Spec. No. 9763-006-238-3"		6/26/74
2.20	UE&C Letter	SBU-57133, "Seal Cooler Data Package"		6/9/82
2.21	McDonald Engineering Analysis Report	ME-991, "Pressure Boundary Calculations of Horizontal Pumps"		2/9/83
2.22	Bingham-Willamette Analysis	Seismic Analysis Containment Spray Pumps		8/16/76
2.23	Bingham-Willamette Letter	Containment Spray Pump Nozzle Loads		4/26/83
2.24	UE&C Letter	SBU-68976 - Increase in Nozzle Loads		2/17/83
2.25	Bingham-Willamette Test Data	Foreign Prints 53200-01-238-3 through 53205-01-238-3 - Test Data and Characteristic Curves		8/18/78
2.26	UE&C Specification	9763-006-128-1, "General Specification for Alternating Current Induction Motors"	4	4/23/75

Ref. No.	Document Type	Description/Title	Rev.	Date
2.27	Westinghouse Analysis	Seismic Analysis of Containment Spray Pump Motors for Seabrook		2/25/81
2.28	Westinghouse Calculated Data	Foreign Print 51849-02-238-3, "Containment Spray Pumps Motor Acceleration Data"		11/11/77
2.29	Westinghouse Test Data	Report of Commercial Tests - Induction Motor - Bingham Pump		2/24/78
2.30	NUREG	NUREG 0800, Standard Review Plan 3.6.1, "Plant Design for Protection Against Piping Failures in Fluid Systems Outside Containment"	1	7/81
2.31	NUREG	NUREG 0800, Standard Review Plan 3.6.2, "Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping"	1	7/81
2.32	UE&C Procedure	TP-3, "Seabrook Station Summary of Failure Modes and Effects Analyses"		7/82
2.33	UE&C FMEA Report	Piping failure analysis for Zone 32A		
2.34	UE&C FMEA Report	Piping failure analysis for Zone 32B		
2.35	UE&C Computation Sheet	FMEA Zone 32A		8/29/80
2.36	UE&C Computation Sheet	FMEA Zone 32B		9/10/80
2.37	Published Literature	Denny, DF and Young, GAJ, "The Prevention of Vortices and Swirl at Intakes," 7th General Meeting Transactions, IAHR, Lisbon		1957
2.38	UE&C Internal Memorandum	MM-17059A, "Containment Recirculation Sump Air Venting During Accident"		12/8/83
2.39	UE&C Calculation	737-05, "Emergency Feed Pumps (238-10)"	0	2/25/74

Ref. No.	Document Type	Description/Title	Rev.	Date
2.40	UE&C System Description	SD-1, "System Design Description for Condensate, Feedwater and Heater Drain System"	6	11/8/83
2.41	NUREG	NUREG-0800, Standard Review Plan, 6.2.2, "Containment Heat Removal Systems"	3	7/81
2.42	UE&C Memorandum	MM #18206A from H. E. Flora to J. J. Gramsammer, "Containment Recirculation Sump Design Water Flow Velocities		1/18/84
2.43	UE&C Memorandum	MM #14358A, N. M. Shah/H. Y. Rajagopal to H. E. Flora, "Minimum Submergence Required for Vortex - Free Operation of RWST		8/24/83
2.44	UE&C Calculation	4.3.5.30, "RWST Level Alarm Setpoints"	0	3/1/82
2.45	UE&C Calculation	4.3.5.30, "CBS System Setpoints"	2	10/20/83
2.46	UE&C Calculation	4.3.5.37F, "RWST Time to Vortex"	1	11/4/83
2.47	UE&C Design Change Notification	DCN 650205 "CBS-Standpipe for RWST & SAT"	A	8/12/83
2.48	UE&C Specification	Specification No. 9763-006-258-3, "Containment Spray and Spent Fuel Pool Heat Exchangers"	5	7/8/78
2.49	UE&C Calculation	4.3.22F, NU-505, "Containment Transient and Steady State - DEPS"		2/26/80
2.50	UE&C Procedure	GEDP-0048, "Processing and Review of NRC Requirements"	0	5/12/82
2.51	UE&C Letter	"Review of NRC IE Information Notices"		12/5/83
2.52	NRC-IE Information Notice	IE-IN 81-10, "Inadvertent Containment Spray Due to Personnel Error"		3/24/81

Ref. No.	Document Type	Description/Title	Rev.	Date
2.53	UE&C Letter	SBU-45242, "NRC-IE-Information Notice No. 81-10, Inadvertent Containment Spray Due to Personnel Error"		5/27/81
2.54	Seabrook Station Routing Sheet	IMS B4.1.2, "IE Information Notice 81-10"		4/6/81
2.55	Seabrook Station Operating Procedures	No. OS1006.04, "Operation of Containment Spray System" (draft)	0	
2.56	Seabrook Station Operating Procedures	No. OX1406.02, "Containment Spray Pump Test" (draft)	0	
2.57	Seabrook Station Training Document	HO-CBS, "Containment Building Spray System"	0	8/3/83
2.58	Seabrook Station Training Document	HO-RHRS, "Residual Heat Removal System"	0	8/3/83
2.59	UE&C Design Change Notice	DCN 68/168	A	3/14/83
2.60	UE&C Letter	SBU-83667, "Containment Spray Pumps Nozzle Loads"		1/31/84
2.61	Hydraulic Institute Standard	Hydraulic Institute Standards for Centrifugal, Rotary, and Reciprocating Pumps	13th Edition	1975
2.62	UE&C Status Report	FMEA Progress Chart as of November 23, 1983		11/23/83
2.63	UE&C Schedule	Schedule Study B FMEA Group		11/15/82

8.2.2 Personnel Interviewed

Name	Title	Organization
J. Stacey	Lead Systems Engineer	Yankee
D. Gregg	Project Engineer	Westinghouse
D. Adomaitis	Project Manager	Westinghouse
P. Barilla	Principal Engineer	Westinghouse
J. Gramsammer	Project Engineer Manager Systems	UE&C
H. Flora	SDE/Nuclear/Mechanical	UE&C
W. Brown	Systems Engineer	UE&C
M. Shlyamberg	Engineer	UE&C
G. Duerr	Manager, FMEA Group	UE&C
R. Maddock	Project Supervisor	Bingham-Willamete
S. Washburn	Seismic Engineer	Bingham-Willamete
G. Rigamonti	Chief Engineer, Power	UE&C
J. DeVincentis	Project Manager	Yankee
H. Wingate	Assistant Project Manager	Yankee
M. Padmanabhan	Lead Research Engineer	Alden Research
G. Hecker	Director	Alden Research
S. Floyd	Operational Services Supervisor	Public Service of New Hampshire

8.3 Mechanical Components

8.3.1 Documents

Ref. No.	Document Type	Description/Title	Rev.	Date
3.1	Standard (UE&C)	Piping Guidelines Standard PGL-1	1	08/01/83
3.2	Specification	UE&C Spec. for Containment Spray Pumps, Spec No 9763-006-238-3	7	03/10/83
3.3	Specification	UE&C Spec. for Actuators for Valves and Dampers, Spec No 9763-006-248-13	6	05/23/80
3.4	Specification	UE&C Spec. for Seismic Requirements, Spec. No. 9763-SD-248-13	1	04/04/75
3.5	Specification	UE&C Spec for General Valves (Gate, Globe & Check), Spec. No. 9763-006-248-41	2	08/08/80
3.6	Specification	UE&C Spec for Butterfly Valves, Spec. No. 9763-006-248-45	1	08/16/76
3.7	Guidelines	UE&C Active Valve Test Guidelines No 9763-VTG-1	4	04/17/75
3.8	Specification	UE&C Spec. for General Valves (Gate Globe & Check), Spec No 9763-006-248-37	1	07/09/76
3.9	Calculation	Calc 4.3.5.18F Refueling Water Storage Tank Transient Temperature Analysis		01/29/80
3.10	Calculation	Calc 4.3.5.17F Pressure Transient Following Isolation Valve Closure and Pump Trip		01/03/80
3.11	Calculation	Calc 4.3.5.27F Determination of the Minimum Temperature Expected within the Refueling Water Storage Tank Building in Extreme Winter Conditions with an Outside Temperature of -17°F		05/20/82

Ref. No.	Document Type	Description/Title	Rev.	Date
3.12	Purchase Order	UE&C Change Order No 42 to PO No 9763-006-248-8		06/01/82
3.13	Calculation	Calc 4.3.5.35F Tank Nozzle Displacement Due to Thermal Growth, CBS-TK-8: S.C.2, CBS-TK-13:S.C.3	0	08/04/83
3.14	Specification	9763-006-246-6 Safety Class 3 Field Fabricated Tanks	7	02/10/83
3.15	Specification	9763-SD-246-6 Seismic Requirements	3	10/17/80
3.16	Specification	9763-SD-238-3 Seismic Requirements	4	05/31/79
3.17	Specification	9763-006-246-1 RWST for PSNH SB STA Unit Nos 1&2	7	02/09/83
3.18	Specification	9763-SD-246-1 Seismic Requirements for PSNH SB STA Unit Nos 1&2	3	07/05/79
3.19	Procedure	UE&C Procedure No. FACP-7	2	06/22/83
3.20	Specification	UE&C Spec for Pipe Support Equipment, Spec. No. 9763-006-248-8	4	01/19/81
3.21	Procedure	DEDP-2607, Procedure for Computerized Piping Analyses	1	1/19/81
3.22	Calculation	UE&C Calc MCD 550.02		02/04/81
3.23	Drawing	UE&C Dwg 9763-D-801214, Issue	3	04/25/80
3.24	Calculation	Waterhammer Loading Analysis in Containment Spray Rings, PIN: 9763-FA-0602.3022		11/04/83
3.25	Calculation	4.3.5.36F, Nozzle Thermal Disp CBS-P-9A CBS-P-9B		11/15/83
3.26	Procedure	UE&C Technical Procedure TP-22	0	11/07/83

Ref. No.	Document Type	Description/Title	Rev.	Date
3.27	Procedure	UE&C Proc for Prep., Documentation and Control of P.S.G. Calculations	0	03/30/83
3.28	Spec	ITT Grinnell Corp Tech Spec SB-001	2	07/12/82
3.29	Calculation	Velan Eng Co Seismic Analysis of 16" Forged Bolted Bonnet Gate Valve	1	06/30/81
3.30	Procedure	Velan Eng Co Seismic Test Proc for Qual of Active Valves	4	05/22/81
3.31	Calculation	Velan Eng Co Seismic Analysis Theory for Velan Nuclear Valves	C	11/23/73
3.32	Drawing	Velan Eng Co Dwg No P3-6040-N15	F	01/22/80
3.33	Drawing	Bingham-Willamette Dwg B-33844 Double Bearing-Double Suction Process Pump-Bingham Type CD		
3.34	List	Bingham-Willamette Technical Requirements List H90.23	0	06/20/75
3.35	Spec	Max Allow Nozzle Loads		
3.36	Drawing	Bingham-Willamette H-3944 Foundation Dwg 6x10x14B CD	H	10/30/74
3.37	Procedure	Pullman Power Products Doc No VI-4, Pipe Support Drawing and Document Control	5	06/07/83
3.38	Instruction	Velan: Manufacturing & Inspection Instructions VEL-OCI-437	5	09/14/83
3.39	Calculation	Pipe @ Stanchion 1217-RG-8	0	09/21/83
3.40	Spec	Prep Doc, and Control of Pipe Stress & Load Calculations	0	03/30/83
3.41	Calculation	Calc Set No 1217-4-4" 365	0	09/24/82
3.42	Manual	ITT Grinnell Corp Engineering Services QA Manual	1	02/14/83
3.43	Purchase Order	UE&C Change Order No 42 to Purchase Order No 9763-006-248-8		06/01/82

Ref. No.	Document Type	Description/Title	Rev.	Date
3.44	Calculation	ITTG Calc Set for Supp No 1203-RG-3	5	09/03/82
3.45	Calculation	ITTG Calc Set for Supp No. 1203-RG-8	8	09/03/82
3.46	Calculation	PDM Design Calculation for Refueling Water Storage Tank	F	06/81
3.47	Drawing	PDM Dwg 2, Contract 14084 RWST Penetration Details	D	11/18/81
3.48	Drawing	PDM Dwg E4, Contract 14084 RWST Shell-Erection Roll Out	G1	11/16/82
3.49	Design Calc	PDM File 28424, Contract 14085	E	10/28/83
3.50	Drawing	PDM Dwg 1, Contract 14085 SAT General Arrangement	J	07/03/83
3.51	Drawing	PDM Dwg 4, Contract 14085 SAT Penetrations	K	07/13/83
3.52	Dwg	PDM Dwg 7, Contract 14085 SAT Shell Roll Out	G	07/13/83
3.53	SD	SD-3 Main & Aux Steam System	0	07/15/74
3.54	SD	SD-3 Main & Aux Steam System	1	06/28/77
3.55	SD	SD-3 Main & Aux Steam System	2	11/18/81
3.56	Calculation	CBS Heat Exchanger Nozzle Thermal Displacement Due to Thermal Growth Calc 43539-F		10/13/83
3.57	Calculation	UE&C Calc MCD 550.03		02/04/81
3.58	Drawing	UE&C Dwg 9763-D-801216, Issue	4	07/01/80
3.59	Calculation	UE&C Calc MCD 551.00		07/30/82
3.60	Drawing	UE&C Dwg 9763-D-801218	2	02/27/82
3.61	Drawing	UE&C Dwg 9763-D-801217	2	02/27/82
3.62	Calculation	UE&C Calc MCD 584.60		02/07/83

Ref. No.	Document Type	Description/Title	Rev.	Date
3.63	Calculation	UE&C Calc MCD 584.20		02/09/83
3.64	Calculation	UE&C Calc MCD 585.40		04/29/83
3.65	Calculation	UE&C Calc MCD 550.00, Part A		07/22/75
3.66	Drawing	UE&C Dwg 9763-F-805146, -805147	P-1	04/24/75
3.67	Calculation	UE&C Calc MCD 550.00, Part B		08/04/75
3.68	Calculation	UE&C Calc MCD 550.00, Part C		08/04/75
3.69	Calculation	UE&C Calc MCD 550.00, Part D		08/12/75
3.70	Calculation	UE&C Calc 550.00, Part E		04/09/79
3.71	Drawings	UE&C Dwgs 9763-F-805147 and 9763-F-805146	3 2	11/20/78 11/20/78
3.72	Technical Paper	Local Stresses in Spherical and Cylindrical Shells due to External Loadings, Welding Research Council Bulletin No 107		3/79
3.73	Spec	UE&C Spec for Con't Recirculation Sump Isolation Valve Encapsulations, No 9763-006-248-47	2	2/10/77
3.74	Calculation	PX Engineering, Stress Report for Containment Recirculation Sump Isolation Valve Encapsulation	4	2/23/81
3.75	Spec	UE&C Spec for Seismic Requirements No 9763-SD-248-47		06/20/73
3.76	Procedure	PX Eng Hydro Test Procedure HTP-578		04/07/81
3.77	Procedure	PX Eng Halogen Leak Test Procedure HLT-578		04/07/81
3.78	Procedure	PX Eng Quality Assurance Manual	9	06/15/82
3.79	Drawing	PX Engineering General Arrangement Drawing No 578 Sheet 1	5	01/13/81
3.80	Drawing	UE&C Dwg SK-9763-CBS-1217 Sht 1 of 1	4	09/16/82

Ref. No.	Document Type	Description/Title	Rev.	Date
3.81	Report	B/W Report No 14210477 Seismic Analysis, Containment Spray Pumps	5	08/06/76
3.82	Report	McDonald Eng Analysis Co Inc Report ME-991	0	02/09/83
3.83	Report	Walworth Aloyco Seismic Report ASF-7	0	03/29/82
3.84	Report	Acton Environmental Testing Corp Test Report 17062	1	05/20/82
3.85	Report	Walworth Aloyco Stress Report ASDR-21	0	07/08/83
3.86	Report	Acton Environmental Testing Corp Test Report 17062-82N-1	0	04/29/82
3.87	Standard	American Petroleum Inc Std API Std 610	5	03/--/71
3.88	Calculation	UE&C Calc Ste No/Support No M/S-1214-SG-63	3	08/15/83
3.89	Drawing	UE&C Containment Steel Framing Plan Dwg 9763-F-102316	6	03/17/82
3.90	Procedure	Pullman Power Products Document No III-4	19	10/14/83
3.91	Drawing	Pullman Power Products Isometric Dwg. No CBS-1213-01	9	11/01/83
3.92	Drawing	Pullman Power Products Isometric Dwg No CBS-1213-02	2	01/14/83
3.93	Computer Output	ITT Grinnell STRUDL run for Support 1201-RG-07, Run 1 of 2	7	
3.94	Computer Output	ITT Grinnell STRUDL run for Support 1201-SH-1, Run 1 of 1	3	
3.95	Calculation	UE&C Calc Set/Support No 326-SG-01	1	05/12/83
3.96	Calculation	UE&C Calc Set/Support No 179-SG-04	3	09/22/83
3.97	Regulatory Guide	U.S. Nuclear Regulatory Commission, Regulatory Guide 1.92	19	2/76

Ref. No.	Document Type	Description/Title	Rev.	Date
3.98	ASME Code	ASME Boiler and Pressure Vessel Code Section III, Division 1, Subsection NC, Class 2 Components		
3.99	Computer Program	ADLPIPE-D, United Engineers Program No ME-434		1982
3.100	Computer Program	ADLPIPE-2, Original version of ADLPIPE on in-house Honeywell computer		
3.101	Computer Program	ADLPIPE Computer Program Arthur D. Little Co, Cambridge, Mass.		
3.102	Letter	UE&C Letter SBU-13320		07/25/77
3.103	Letter	PSNH Letter SB-5178		08/10/77
3.104	Letter	Binghamm-Willamette to UE&C		02/14/77
3.105	Purchase Order File	UE&C CBS Pump Purchase Order File		
3.106	Letter	UE&C Letter SBU-74799		07/01/83
3.107	Noncon-formance Report	Pullman Power Products NCR 4647		06/13/83
3.108	Noncon-formance Report	UE&C NCR 2109		06/13/83
3.109	Letter	UE&C Letter MM #9156A		05/24/82
3.110	Drawing	UE&C Drawing 9763-F-804881		
3.111	Drawing	Bingham-Willamette Drawing B-35614		02/07/78
3.112	Drawing	Bingham-Willamette Drawing A-50329		05/08/75
3.113	Drawing	Bingham-Willamette Drawing A-47638		08/15/74
3.114	Drawing	Bingham-Willamette Drawing A-47639		08/15/74
3.115	Regulatory Guide	U.S. Nuclear Regulatory Commission Regulatory Guide 1.48		05/73

Ref. No.	Document Type	Description/Title	Rev.	Date
3.116	Correspondence	PX Engineering - UE&C		
3.117	Specification	Spec No. 9763-006-248-1, "Shop Fabrication of Pipe"	6	03/23/83
3.118	Purchase Order	UE&C Purhcase Order 248-41		
3.119	Manual	YAEC Seabrook Station QA Procedure 5-1	2	03/31/78
3.120	Test Report	UE&C Foreign Print No. 53202-01 238-3		
3.121	Test Report	UE&C Foreign Print No. 53205-01 238-3		

8.3.2 Personnel Interviewed

Name	Title	Organization
T. M. Cizauskas	Seabrook Lead Mechanical Engineer	Yankee
A. L. Paliulis	Mechanical Engineer Seabrook Project	Yankee
F. A. Polek	Lead Piping Engineer	UE&C
O. P. Kalani	Supervising Structural Engineer	UE&C
J. J. Parisano	Supervising Piping Engineer	UE&C
M. Braccio	Lead Engineer	UE&C
H. Flora	Supervising Nuclear Engineer	UE&C
S. A. Buia	Site Power Engineer, As-Built Supervisor	UE&C
R. F. Perry	Manager - Mechanical Analysis	UE&C
Z. B. Olszewski	Supervising Engineer - Pipe Stress Analysis	UE&C
D. Karper	Lead Designer	UE&C
T. Kilfeather	Lead Engineer, Piping	UE&C
W. Brown	Systems Engineer	UE&C

8.4 Civil and Structural

8.4.1 Documents

Ref. No.	Document Type	Description/Title	Rev.	Date
4.1	Industry Code	American Society of Mechanical Engineers, Boiler and Pressure Vessel Code, Section III, Division 2, "Code for Concrete Reactor Vessels and Containments"	Winter 1975 and Winter 1976 Addenda	1975
4.2	Industry Code	American Concrete Institute, ACI 318-71, "Building Code Requirements for Reinforced Concrete"	With Commentary	1971
4.3	Industry Specification	American Institute for Steel Construction, AISC, "Specification for the Design, Fabrication and Erection of Structural Steel Buildings," 1969 Edition	Supp. 1, 2, and 3	1969
4.4	UE&C Spec.	Spec. No. 006-12-5, "Fabrication of Safety Related Structural Steel Work"	5	3/4/83
4.5	UE&C Spec.	Spec. No. 006-13-2, "Containment Concrete Work"	1	8/22/75
4.6	UE&C Spec.	Spec. No. 006-13-3, "Category I Concrete Work Other Than Containment"	1	8/25/75
4.7	UE&C Spec.	Spec. No. 006-14-2, "Installation of Reinforcing Bars in Containment Structure"	8	11/12/82
4.8	UE&C Spec.	Spec. No. 006-14-3, "Installation of Reinforcing Bars in Category I Structures (Other Than Containment)"	7	11/12/82
4.9	UE&C Spec.	Spec. No. 006-18-1, "Finishing of Miscellaneous Embedded Steel and Weldments"	4	4/1/80

Ref. No.	Document Type	Description/Title	Rev.	Date
4.10	UE&C Purchase Order	P.O. No. 006-18-14, "Anchor Plates and Embedded Plates in Containment"	0	7/10/79
4.11	U&EC Spec.	Spec. No. 006-80-1, "Containment Design"	0	6/27/75
4.12	PSNH/YAEC Letter	SB-6347, ASME Code Cases		6/16/78
4.13	UE&C Letter	SBU-22367, ASME Code Cases		11/20/78
4.14	PSNH/YAEC Letter	SB-7028, ASME Code Cases		12/7/78
4.15	UE&C Letter	SBU-24252, ASME Section III, Division 2 Code		2/15/79
4.16	UE&C Letter	SBU-44666, ASME Code Cases and Addenda		5/8/81
4.17	PSNH/YAEC Letter	SB-12282, ASME Code Cases and Addenda		10/20/81
4.18	YAEC Audit	SB-426, Letter transmitting YAEC Audit Report of Audit on 7/26/73 at UE&C on QA-3, Design Control		8/8/73
4.19	UE&C Letter	SBU-791, Quality Assurance and Response to SB-426 and Audit Report of 7/26/73		8/30/78
4.20	UE&C Calculation	WB-61, "Waste Processing Building, Tank Farm Area, Structural Steel"	4 5	5/25/83 7/29/83
4.21	UE&C Internal Memo	Administration and Service Building Tornado Wind Loads		10/15/79
4.22	UE&C Internal Memo	Administration and Service Building Seismic Loads		6/18/79
4.23	UE&C Internal Memo	Metal Siding Blow Out Panels		11/23/82
4.24	UE&C Structural Audit	Audit by Chief Structural Engineer on Calculations, Specifications, Drawings and Project Level Design Review and Design Verification		6/15/79

Ref. No.	Document Type	Description/Title	Rev.	Date
4.25	UE&C Internal Memo	Design Review Master List per GEDP-0025		2/3/75
4.26	UE&C Internal Memo	Design Review		12/31/74
4.27	UE&C Internal Memo	Chief Engineer's Design Review of Primary Auxiliary Building		9/23/75
4.28	UE&C Internal Memo	Document Review		5/5/78
4.29	Commercial Computer Program	Stardyne "State and Dynamic Structural Analysis Program," Mechanics Research, Inc. and Control Data Corporation, Publication 76079900		
4.30	UE&C Computer Program	SAG 058, "Response Spectra"		
4.31	UE&C Computer Program	SAG 054, "Amplified Floor Response Envelope		
4.32	UE&C Calculations	SBSAG-5WB, Seismic Analysis Calculations in Tank Farm Area	0 Update	5/12/78 10/11/83
4.33	UE&C Drawing	F-111818, Tank Farm and Pipe Tunnel Concrete	9	11/12/82
4.34	UE&C Drawing	F-111819, Tank Farm and Pipe Tunnel Concrete	11	2/2/82
4.35	UE&C Drawing	F-111824, Tank Farm and Pipe Tunnel Structural Steel	2	2/27/81
4.36	UE&C Drawing	F-111825, Tank Farm and Pipe Tunnel Structural Steel	5	8/19/83
4.37	UE&C Calculation	SBSAG-4CS4, Seismic Analysis of the Containment Structure	0	3/17/76
4.38	UE&C Calculation	CI-2, Design of Screen and Supporting Structure for Containment Sump	0 1	2/1/80 8/29/83
4.39	UE&C Drawing	F-101486, Containment Steel, Recirculation Sump Screen Details	5	11/24/81

Ref. No.	Document Type	Description/Title	Rev.	Date
4.40	Cives Corporation Drawing	E1001, Containment Steel	1	6/19/80
4.41	Cives Corporation Drawing	E1002, Containment Steel	1	6/19/80
4.42	Cives Corporation Drawing	6816-X163B, Containment Building Erection Plan	2	6/1/83
4.43	UE&C Drawing	F-102320, Containment Steel Framing Plan Below Elev. 0, North	10	1/28/83
4.44	UE&C Calculation	CI-70, Annular Steel Design Below Elev. 0	0	11/24/80
4.45	Cives Corporation Drawing	6816-X102A, Containment Building Erection Plan	2	5/7/83
4.46	UE&C Calculation	CS-22, Attachments to Liner Supporting Ducts, Pipes, and Electrical Equipment	0 1	7/5/83 11/11/83
4.47	UE&C Computer Program	SHELL I	0	11/75
4.48	UE&C Calculation	CS-15, Design of Main Reinforcing for Containment Shell and Dome	1 2	12/11/81 10/6/83
4.49	UE&C Calculation	SBSAG-4CS3, Seismic Analysis of Containment Structure		3/17/76 3/29/76 reissue
4.50	UE&C Internal Memo	MM #5511A, Containment Structure Analysis and Design Status		10/12/79
4.51	UE&C Internal Memo	Seismic Analysis of Containment Structure, SBSAG-4CS64		3/17/76
4.52	UE&C Computer Program	SHELL II	0	3/1/77
4.53	UE&C Calculation	WB-68, "Waste Processing Building, Tank Farm Area, Walls and Slabs"	1	9/13/83
4.54	Industry Design Handbook	American Concrete Institute, Special Publication, SP-17 (73), "Design Handbook in Accordance with the Strength Design Method of ACI 318-71"		1973

Ref. No.	Document Type	Description/Title	Rev.	Date
4.55	UE&C Drawing	M-8018335, Support No. RG-04, Sheets 13-17	5	8/16/83
4.56	UE&C Calculation	PIN SQ-00121-3-A-438, Section SW-3, Control Building, Cable Tray Bracing Calculation (Preliminary)	0	8/2/83
4.57	UE&C Calculation	SBSAG-22PB, Seismic Analysis of RHR and CBS Equipment Vault	0	5/2/83
4.58	UE&C Drawing	F-101558, RHR and CBS Equipment Vault, Steel, Plan of Stairs and Platforms, Sheet 1	6	7/9/82
4.59	UE&C Drawing	F-101562, RHR and CBS Equipment Vault, Steel, Plan of Stairs and Platforms, Sheet 2	3 4	6/22/82 9/23/83
4.60	UE&C Calculation	PB-76, Primary Auxiliary Building Equipment Vault Steel Framing (030)	0	12/1/83
4.61	UE&C Purchase Order	No. HO 56971, Containment Liner Anchor Load Test with Change No. 1	1	10/17/80
4.62	UE&C Procedure	Procedure for Containment Liner Anchor Load Test	0 1	7/11/80 8/25/80
4.63	Calibration Certificate	Tinius Olsen, Testing Machine Verification Certificate for 120,000 lb. Super L, Serial No. 60096-1, TMR 26241, 8003S-11717		6/10/80
4.64	UE&C Purchase Order	PO 210-9, Prying Factor Load Tests	1	2/12/82
4.65	UE&C QA Procedure	QA-3, Design Control	5	2/28/77
4.66	UE&C QA Procedure	QA-12, Control of Measurement and Test Equipment	5	12/13/77
4.67	UE&C Spec.	Spec. No. 006-12-1, Structural Steel		4/2/77
4.68	UE&C Spec.	Spec. No. 006-12-4, Structural Steel Detailing		9/11/78

Ref. No.	Document Type	Description/Title	Rev.	Date
4.69	Willard J. Lester, Inc. Procedure	Structural Steel Detailing Policies and Procedures	0	7/14/80
4.70	UE&C Spec.	Spec. No. 006-14-1, Furnishing, Detailing, Fabricating and Delivering Reinforcing Bars	10	10/25/82
4.71	Bethlehem Steel Drawing	017RM31, Reactor Pit Walls, Wall Stirrups, Layer #7	3 4	5/25/78 12/5/78
4.72	UE&C Drawing	F-101402, Containment Concrete Mat Sections	13	3/24/81
4.73	UE&C Guideline	Guidelines for Beam Verification		9/19/83
4.74	Engrg. Change Authorization	ECA 02/0772 D, Interference of Service Air Lines with Fire Walls	D	11/2/82
4.75	Engrg. Change Authorization	ECA 06/1670B, Core Drilling in Concrete Stair Walls for Fire Protection Lines	B	10/18/83
4.76	Engrg. Change Authorization	ECA 59/4010A, Reinforcing Bar Cutting to Anchor Base Plate	A	12/17/82
4.77	Engrg. Change Authorization	ECA 73/4572C, Reinforcing Bar Cutting to Anchor Base Plate	C	3/23/83
4.78	Engrg. Change Authorization	ECA 01/4217D&E, Concrete and Reinforcing Steel Removal on Tank Farm Roof	D E	8/23/83 11/17/83
4.79	UE&C Internal Memo	MM #1457A		9/6/83

8.4.2 Personnel Interviewed

Name	Title	Organization
Tom M. Cizauskas	Mechanical Lead Engineer Mechanical Group (for Civil/Structural and Mechanical Engineering) - Engineering Department	YAEC - Seabrook Project
Henry E. Wingate	Assistant Project Manager, Construction Department	YAEC - Seabrook Project
Jerome J. Wojcik	Structural Engineer, Mechanical Group, Engineering Department	YAEC - Seabrook Project
Robert Tucker	Lead Mechanical Engineer Mechanical Group, Engineering Department	YAEC - Seabrook Project
Donald E. Johnson	Structural Engineer Mechanical Group Engineering Department	YAEC - Seabrook Project
Walter K. Perterson	Supervisor, Engineering/QA Audits	YAEC - QA Department
R. E. Guillette	Supervisor, Construction Quality Assurance Engineering	YAEC - QA Department
Janet Allen	QA Technician	YAEC - QA Department
M. H. Ossing	Staff Engineer for Assistant Project Engineer of Construction	YAEC - Seabrook Project
K. M. Kalawadia	Supervising Discipline Engineer - Structural	UE&C - Seabrook Project Structural
Daniel E. McGarrigan	Manager, Project QA for Seabrook	UE&C - Reliability and QA Department
V. D. Patel	General Design Supervisor Structural	UE&C - Seabrook Project
James K. Cravens	Manager	UE&C - Seabrook Project Engineering Project Controls

Name	Title	Organization
J. J. Connelly	Supervisor	UE&C - Seabrook Project Calculation Control Center (1 of 5)
H. P. Sivertsen	Leader/Liaison SCAT Team Cognizant Engineer	UE&C - Seabrook Project Beam Verification Program and SCAT Team
Joel Blackman	Assistant Manager	UE&C - Power Department, Mechanical Analysis Group
E. Skolnick	Lead Engineer, EQ/COMP Qualification	UE&C - Power Department, Mechanical Analysis Group
Leon S. Nascimento	Chief Structural Engineer	UE&C - Power Division
Anil T. Shah	Cognizant Engineer	UE&C - Seabrook Project Structural, Major Cat I
D. K. Ghosh	Cognizant Engineer	UE&C - Seabrook Project Structural, Containment
Pares N. Datta	Design Supervisor, Engineer II	UE&C - Seabrook Project Structural
John A. Mott	Design Engineer	UE&C - Seabrook Project Structural
Om P. Kalani	Manager Structural Supervising Engineer	UE&C - Seabrook Project Pipe Support Group
Richard H. Toland	Manager	UE&C - Structural Department Structural Analysis Group
Noshir C. Karanjia	Seismic Consultant	UE&C - Structural Department Structural Analysis Group
Dipak K. Majumder	Lead Engineer	UE&C - Structural Department Structural Analysis Group
Branko Galunic	Engineer I	UE&C - Structural Department Structural Analysis Group
Z. B. Olszewski	Mechanical Supervising Discipline Engineer	UE&C - Mechanical Analysis Group
M. K. Sanghavi	Lead Pipe Support Engineer	UE&C - Seabrook Project Pipe Support Group

Name	Title	Organization
Girish C. Hatwal	Structural Engineer	UE&C - Seabrook Project Structural
Amar S. Dalawari	Engineer II	UE&C - Seabrook Project Pipe Supports Duct Supports
Thomas F. Clouser	Design Supervisor	UE&C - Seabrook Project Pipe Supports HVAC Supports
J. Alberto Rios	Engineer III	UE&C - Seabrook Project I&C
Alan W. Cole	Project Administrator	UE&C - Seabrook Project Project Controls
R. B. Livingston	Administrator	UE&C - Document Control Center - Seabrook Project
Robert A. Bosshardt	Administrator III, Lead, Records Control Group	UE&C - Document Control Center - Seabrook Project
D. Melitz	Supervising Structural Engineer	UE&C - Document Control Center, Seabrook Project
G. B. Christina	Administrator	UE&C - Seabrook Project Engineering Project Controls
N. I. Desai	Engineer I - Structural	UE&C - Field Change Completion Group
Rick E. Daniels	Cognizant Engineer for Program Guidelines	UE&C - Beam Verifica- tion Program
Robert N. Kuelin	Engineering Manager	UE&C - Field Systems Group Site Engineering
Douglas G. McClellan	Lead Engineer - Civil/ Structural	UE&C - Civil/Mechanical Services, Site Engineering
Richard A. Arell	Designer	UE&C - Technical Assis- tance Group Civil/Structural Engrg. Civil/Mech. Services Site Engineering

Name	Title	Organization
C. E. Morales	Draftsman	UE&C - Technical Assistance Group Civil/Structural Engrg. Civil/Mech. Services Site Engineering
R. P. Kosian	Lead Field Engineer	UE&C - Project Field Engineering Group Civil/Structural Engrg. Civil/Mech. Services Site Engineering
S. N. Caruso	Lead Engineer	UE&C - Cable Tray Bracing Task Group Site Technical Staff Piping & Supports Site Engineering
Julie Drozd	Seismic Analyst	UE&C - Structural Analysis Group
John Alle	Structural Engineer	UE&C - Structural Analysis Group
Susan Hayecki	Field Engineer - Civil/Structural	UE&C - Project Field Engineering Group Civil/Structural Engrg. Civil/Mech. Services Site Engineering
Robert Shappell	Civil/Structural Engineer	UE&C - Technical Assistance Group Civil/Structural Engrg. Civil/Mech. Services Site Engineering
J. R. Lindguist	Field Engineer - I&C	UE&C - Project Field Engineering Group I&C I&C Systems Site Engineering
Frank Dadabo	Construction Superintendent Painting Subcontracts	UE&C - Field Construction
Colin H. Coles	Design Engineer II	UE&C - Seabrook Project Structural

Name	Title	Organization
A. A. Haldar	Job Engineer Civil-Structural	UE&C - Civil/Mech. Services Site Engineering
C. Holtzworth	Field Engineer Civil-Structural	UE&C - Civil/Mech. Services Site Engineering
Dexter Olsson	Senior Metallurgical Engineer Corporate QA Manager	Bethlehem Steel Corporation
Michael Bedics	Supervisor, Quality Assurance Reinforcing Bars, Piling and Construction Specialty Sales	Bethlehem Steel Corporation
Clarence Redman	Contract Administrator Reinforcing Bars, Piling and Construction Specialty Sales	Bethlehem Steel Corporation
Dennis Reid	Chief Detailer - Engineering	Bethlehem Steel Corporation
Denny Vassa	Detailer - Engineering	Bethlehem Steel Corporation

8.5 Electrical Power

8.5.1 Documents

Ref. No.	Document Type	Description/Title	Rev.	Date
5.1	Procedure	Yankee Atomic project procedure #13 control of NRC bulletins, circulars, and information notices	3	10/8/83
5.2	Letter	Yankee Atomic to United Engineers Forwarding QA report #SA711CS269		5/4/83
5.3	Letter	Fischbach to United Engineers Reply to QA report #SA711CS269		6/6/83
5.4	Procedure	United Engineer's administrative procedure. AP-15, Changes To Project Documents	18	8/17/83
5.5	Calculation	13.8 kv and 5 kv bus short circuit current, 9763-3-ED-00-01-F	3	2/16/83
5.6	Calculation	13.8 kv, 4.16 kv and 480 volts electrical distribution - voltage regulation	Prelim 1	6/6/75 10/21/83
5.7	Drawing	Station main electrical buses one line diagram. 9763-F-310003-9		
5.8	Letter	Fault Duty at Seabrook - PSNH to United Engineers		5/24/74
5.9	Letter	PSNH letter to United Engineers		9/24/81
5.10	Procedure	United Engineers QA procedure (see reference 5.143)		
5.13	Procedure	GEDP-0005, Preparation, Documentation and Control of calculations	3	9/9/75
5.14	Calculation	Medium voltage protective relay coordination -9763-3-ED-00-23-F	2	10/3/83
5.15	FSAR	Supporting documentation for RAI.430.5 (voltage study)		Ammend. 50

Ref. No.	Document Type	Description/Title	Rev.	Date
5.16	FSAR	Mitigating the effects of grid degradation on safety related electric equipment. RAI 430.15		Ammend. 50
5.17	Letter	PSNH to United Engineers, (SB-3127) Comments on short circuit current and voltage regulation calculation		10/7/75
5.18	Letter	United Engineers to Yankee Atomic (SBU-5613) - response to SB-3127		12/4/75
5.19	Letter	United Engineers letter to Yankee Atomic (SBU-4490) Forwarding s. circuit rev:1 and voltage regulation study rev:0		7/15/75
5.20	Letter	United Engineers to Yankee Atomic Voltage regulation rev:0 of preliminary unchecked calculation by chief engineer's staff for NRC question RFI 430.5 (SBU-54977)		4/20/82
5.21	Letter	Yankee Atomic to United Engineers Medium voltage relay coordination (SB-12056)		8/24/81
5.22	Letter	Yankee Atomic to United Engineers Medium voltage relay coordination (SBU-12726)		1/28/82
5.23	Letter	United Engineers to Yankee Atomic Medium voltage relay coordination (SBU-51223)		12/28/81
5.24	Standard	ANSI C37-20, standard for switchgear assemblies		
5.25	Standard	IEEE-344 - Recommended practices for seismic qualification of class IE equipment		1975
5.26	Standard	IEEE-323 - Standard for qualifying class IE equipment		1971

Ref. No.	Document Type	Description/Title	Rev.	Date
5.27	Procedure	Preparation of Specification GEDP-0015		9/11/80
5.28	Procedure	Management-level design review by chief discipline engineer GEDP-0025		12/29/78
5.29	Procedure	Administrative procedure, conduct of design reviews AP-21		4/30/82
5.30	Specification	5 kv switchgear - 9763-006-145-2	6	1/31/83
5.31	Specification	480 volt motor control center 9763-006-143-1	1	6/30/75
5.32	Data Sheets	Motor control center vendor specifications Data sheet D1 thru D7 - (Part of reference 5.33)		
5.33	Letter	Gould to United Engineers. Containing qualification report #CC-323.74-3 Rev. 8 dated 2/1/79 - (United Engineers control #VU-013991)		3/8/79
5.34	System Description	Containment spray system (CBS) SD-20	6	3/04/83
5.35	System Description	4160 volt distribution system (ED, EDE) - SD-74	5	5/18/83
5.36	System Description	Diesel generator - SD-76	1	7/13/76
5.37	Specification	Engineering diesel generator 9763-006-201-1	3	10/19/77
5.38	Procedure	Administrative procedure AP-41 for FSAR deviation procedures		3/30/81
5.39	Design Change Notice	Design change notice DCN #030303B		7/6/78
5.40	Procedure	Administrative procedures AP-15 for changes to project documents	7	3/6/78

Ref. No.	Document Type	Description/Title	Rev.	Date
5.41	Procedure	General engineering design procedures for evaluation and implementation of design changes (EDP-032)	3	10/29/76
5.42	System Description	480 volts distribution System description, SD-75	5	6/10/83
5.43	System Description	4160 volt distribution system SD-74	3	6/9/80
5.44	Report	Seismic certification report for switchgear order #9763-SD-145, report #33-50750-SSA	1	10/83
5.45	Report	Environmental qualification report No. 33-50750-QS - for 5kv, 350 MVA switchgear	8	9/29/83
5.46	Test Plan	Switchgear seismic qualification test plan - 541/4860/ES	A	3/31/76
5.47	Letter	Brown Boveri to United Engineers BBEL-FMTG		9/16/83
5.48	Drawings	United Engineers weld drawing #300208/300209	5	8/31/83
5.49	Vendor Document	Bill of Material from ITE Imperial Corp. switchgear div. for shop order #703-50750-5 kv, 350 MVA switchgear	3	11/8/77
5.50	Standard	IEEE-383-Type test of class 1E electric cables		1974
5.51	Standard	ICEA STANDAR 5-19-81 for vertical flame test: para 6-19.6		81 addition
5.52	Letter	G.E. letter to Gould - Control cable qualification		9/22/78
5.53	Report	Environmental qualification report #RCC-373-74-64 for motor control center	3	3/10/82
5.54	Report	Siesmic qualification report #SC-275 for motor control center	3	3/10/83

Ref. No.	Document Type	Description/Title	Rev.	Date
5.55	Drawing	Wyle lab, motor control center test plan, drawing #84-62917-01	1	4/4/79
5.56	Standard	American Welding Society Standard D.1.1-81, Section 2.7.1.2		1981
5.57	Drawing	Attachment C of the Seismic Qualification Report for the motor control center specifying weld (part of reference 5.54)	2	10/24/79
5.58	QA Procedure	Gould QA procedure for motor control center (section 3.3-10)		
5.59	Drawing	Schematic diagram, containment spray pump breaker, cubicle IE5-11 Drawing #9763-M-310900	3	7/25/80
5.60	Drawing	Schematic diagram 4160 volts bus IE5, incoming line breakers, Drawing #9763-M-310102	4	2/13/81
5.61	Drawing	Connection diagram, CBS pump breaker cubicle 11, Bus #IE5 Drawing #33-50750-D-287	4	5/13/81
5.62	Drawing	General engineering design procedure for preparation of drawings (GEDP-13)	3	3/30/81
5.63	FSAR	Service environmental chart chapter 3 figure 3.11(B)-1	50	8/83
5.64	FSAR	Chapter 8 "Electric Power" Section 8.1.1 - Amendment 50	50	8/83
5.65	Test Procedure	Containment spray system test procedures (Sheets 1 thru 63) Document No. TPI-51-F01	1	12/3/82
5.66	Test Procedure	Verification of equipment installation, GT-E-01	10	11/9/83

Ref. No.	Document Type	Description/Title	Rev.	Date
5.67	Test Procedure	Verification of name plate data GTE-E-02	10	11/9/83
5.68	Test Procedure	Procedure for testing current transformers, GT-E-03	3	12/17/82
5.69	Test Procedure	Procedure for initial run of large motors, GT-E-06	2	3/17/83
5.70	Test Procedure	Procedure for meggar test GT-E-07	10	11/9/83
5.71	Test Procedure	Procedure for Dielectric Test GT-E-08	1	1/28/82
5.72	Test Procedure	Procedure for Wiring Verification and functional check, GT-E-21	10	10/13/83
5.73	IE Information Notice	80-11, ASCO valves in nuclear application		3/19/80
5.74	IE Information Notice	80-21, Friction type clamps on electrical equipment		5/20/80
5.75	IE Bulletin	83-05, Use of Haywood pumps		5/13/83
5.76	Information Notice	82-53, Main transformer failure		12/22/82
5.77	IE Information Notice	82-54, Application of RPS circuit. Supplied by Westinghouse		12/27/82
5.78	Procedure	Administrative procedure AP-49 procedures for handling US NRC Office of Inspection & Enforcement (IE Bulletins, circulars and information notices)		11/16/82
5.79	Calculation	Calculation No. 9763-3-ED-00-03-F Power Cable Application Criteria and Sizing		8/12/83
5.80	Standard	ICEA Publication No. P-32-382 Short Circuit Characteristics of Insulated Cable		1969

Ref. No.	Document Type	Description/Title	Rev.	Date
5.81	Standard	IEEE Std. 242-1975 Protection and Coordination of Industrial and Commerical Power Systems		1975
5.82	Specification	Specification No. 9763-006-113-2 15 KV Power Cable	3	1/11/80
5.83	Specification	Specification No. 9763-006-113-1 5,000 Volt Power Cable	3	1/11/80
5.84	Standard	ICEA Publication P 46-426 Power Cable Ampacities		1962
5.85	Standard	ICEA Publication P 54-440 Ampacities - Cables in Open Top Trays		1979
5.86	Standard	IEEE Std. 485 Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations		1975
5.87	Vendor Data	FP 21423-03 EFW Pump Motor Data		6/23/78
5.88	Telecon	9763-006 H.E. Flora RC Pump Motor		5/12/77
5.89	Vendor Data	FP 21073-05 Circulating Water Pump Motor Data		-
5.90	Site Package	Site Package No. 790226 Velan Co., Valve CBS -014		-
5.91	Drawing	Drawing No. 9763-M-310900 Sh. B51a RWST to Pump 1-P-9B Isolation Valve V5 Schematic	1	7/25/83
5.92	Drawing	Drawing No. 9763-M-310900 Sh. D40a Containment Sump Isolation Valve V14 Schematic	4	6/29/83
5.93	Drawing	Drawing No. 9763-M-310900 Sh. D41a Containment Spray Valve V17 Schematic	1	7/25/80

Ref. No.	Document Type	Description/Title	Rev.	Date
5.94	Drawing	Drawing No. 9763-M-310900 Sh. D39 Spray Additive Tank Discharge Valve V43 Schematic	2	9/9/82
5.95	Specification	Specification No. 9763-006-249-7 Wall and Floor Penetration Sealant	3	6/10/83
5.96	List	CASP Report Power Cables ... Circuits H, J, K, L and P	8	11/1/83
5.97	Drawing	Drawing No. 9763-F-300219 Service Environment Chart	13	6/24/83
5.98	Calculation	Calculation No. 9763-3-ED-00-14F Batteries, Chargers, and Motor Feeders	5	8/8/83
5.99	Drawing	Drawing No. 9763-F-310042 125 VDC Vital Distribution System One Line Diagram	8	3/13/83
5.100	Calculation	Calculation No. 9763-3ED-00-34-F UPS Loading	1	9/9/83
5.101	Vendor Letter	VU 01390 Seabrook Station Storage Batteries		2/28/79
5.102	Vendor Data	FP 31495 Cell Size Worksheets - Cell Sizes 7, 8, 15 and 16		3/13/79
5.103	Specification	Specification No. 9763-006-137-1 Storage Batteries	6	9/21/83
5.104	Specification	Specification No. 9763-006-238-3 Containment Spray Pumps	5	11/19/79
5.105	Specification	Specification No. 9763-006-128-1 Alternating Current Induction Motors	4	4/23/75
5.106	Standard	NEMA MG-1 Motors and Generators		7/82
5.107	Speed Letter	United Engineers J. Zola Spec 128-1 Motor Tab Sheets - Bingham-Willamette		6/6/74

Ref. No.	Document Type	Description/Title	Rev.	Date
5.108	Letter	VU 01689 Bingham-Willamette to United Engineers PSNH Seabrook Containment Spray Pumps		10/14/75
5.109	Review	Review Route Sheet No. 973		10/22/75
5.110	Letter	SBU-5574 United Engineers to Yankee Atomic P.O. SNH-13, 9763-006-238-3 Containment Spray Pumps		12/1/75
5.111	Review	Review Route Sheet No. 369 Motor Outline Drawing		4/16/75
5.112	Letter	SBU-4255 United Engineers to Bingham-Willamette P.O. 9763-006-238-3 PSNH Containment Spray Pump Motor		6/13/76
5.113	Review	Review Route Sheet No. 1415 CBS Spray Pump Motor Outline		3/13/76
5.114	Letter	SBU-6813 United Engineers to Bingham-Willamette P.O. 9763-006-238-3 PSNH Containment Spray Pumps		4/5/76
5.115	Review	Review Route Sheet No. 2572 Containment Spray Pump Motor Outline		8/31/76
5.116	Letter	SBU-9387 United Engineers to Bingham-Willamette P.O. 9763-006-238-3 Containment Spray Pump Motor		10/14/76
5.117	Review	Review Route Sheet No. 7739 Motor Outline Drawing		10/11/78
5.118	Vendor Letter	VU 12026 Bingham-Willamette to United Engineers P.O. SNH-13.9763-006-238-3 Seabrook Containment Spray Pumps		9/29/78
5.119	Review	Review Route Sheet No. 1635 Motor Data		3/25/76

Ref. No.	Document Type	Description/Title	Rev.	Date
5.120	Letter	SBU-7107 United Engineer to Bingham-Willamette P.O. 9763-006-238-3 PSNH Containment Spray Pump Motor		4/23/76
5.121	Review	Review Route Sheet No. 3602 Motor Data Sheets Pages 2-5		1/24/77
5.122	Letter	SBU-12617 United Engineers to Bingham-Willamette P.O. 9763-006-238-3 Containment Spray Pump Motor Data		6/1/77
5.123	Review	Review Route Sheet No. 4796 Containment Spray Pump Motor Data		10/6/77
5.124	Letter	SBU-15089 United Engineers to Bingham-Willamette P.O. 9763-006-238-3 Containment Spray Pump Motor Certified Data		11/8/77
5.125	Vendor Data	FP-52794-01 Containment Spray Pump Supplemental Motor Data Sheets		8/23/77
5.126	Vendor Data	FP-52795-01 Containment Spray Pump Motor Safe Time vs Current		8/23/77
5.127	Vendor Data	FP-51848-02 Containment Spray Pump Motor Horsepower vs Temperature		8/23/77
5.128	Vendor Data	FP-51849-02 Containment Spray Pump Motor Acceleration Data		8/23/77
5.129	Vendor Drawing	FP-51022-04 Containment Spray Pump, Motor Outline		6/9/78
5.130	Transmittal	VU-12099 Bingham-Willamette Data Transmittal		10/6/78

Ref. No.	Document Type	Description/Title	Rev.	Date
5.131	Manual	FP 52764 Containment Spray Pump Installation, Operation and Maintenance Manual		5/9/83
5.132	Letter	SBU-78480 United Engineers to Westinghouse Review of Qualification Documentation - Westinghouse LMD		9/20/83
5.133	List	Drawing No. 9763-M-510004 Seabrook Computer I/C List Data (Preliminary)		12/1/83
5.134	Drawing	Drawing 9763-M-310900 Sh. E25/29b Spray Additive Tank TK-13 Level Switches	3	6/29/83
5.135	NUREG	NUREG 0588 Interim Staff Position on Environmental Qualifications of Safety-Related Electrical Equipment	1	7/81
5.136	Calculation	4.3.33.FQ1 Analysis of High Energy Line Breaks Outside Containment	0	No date
5.137	Report	Extractions - Post Accident Dose Engineering Manual		6/1/82
5.138	Drawing	Drawing No. 9763-M-505300 Class 1E Equipment List	10	4/27/83
5.139	Speed Letter	C.D. Grieman (United Engineers) to J. O'Connor (Yankee Atomic) QTF Purchase Order Qualification Documentation Procedures		11/10/83
5.140	Procedure Draft	J. Fox Procedure for Review & Maintaining the Class 1E Equipment List		11/83
5.141	Memo	MM-12510A Class 1E Equipment List, Drawing 9763-M-505300, Rev. 10, Dated 4-27-83		5/10/83

Ref. No.	Document Type	Description/Title	Rev.	Date
5.142	Letter	SBU-72706 United Engineers to Yankee Atomic Class 1E Equipment List, Drawing 9763-M-505300, Rev. 10, Dated 4-27-83		5/10/83
5.143	Procedure	QA Procedure QA-3 Design Control for Seabrook Station	11	2/14/83
5.144	Speed Letter	S. Molchanow (United Engineers) Class 1E Update		10/2/83
5.145	Memo	MM-16435A D. Neustadter Class 1E Equipment List		11/7/83
5.146	Memo	MM-15653A H.E. Flora Class 1E Equipment List		10/18/83
5.147	Procedure	QA Procedure QA-5 Instructions, Procedures and Drawings for Seabrook Station	9	5/25/81
5.148	Report	Post-accident Dose Engineering Manual (Part of the Post-Accident Radiation Design Review Report)		4/28/82
5.149	Qualification File	P.O. 9763-006-238-3 Containment Spray Pump Motors		--
5.150	Test Report	FP 52343 Environmental Qualification of Class 1E Motors for Nuclear Out of Containment Use, WCAP-8754		6/76
5.151	Vendor Letter	FP 51578-01 Westinghouse Comments to Qualification to Spec. 323		12/23/75
5.152	Impell Report	P.O. 9768-006-238-3 Environmental Qualification Assessment Report: Containment Spray Pump Motors		9/30/82

Ref. No.	Document Type	Description/Title	Rev.	Date
5.153	Vendor Letter	VU 034005 Equipment Qualification		4/19/83
5.154	Vendor Letter	D.A. Sciubba Westinghouse to United Engineers Equipment Qualification - Review of Qualification Documentation		11/7/83
5.155	Specification	Specification No. 9763-006-47 Containment Recirculation Sump Isolation Valve Encapsulation	3	4/28/81
5.156	Specification	Specification No. 9763-006-248-37 General Valves (Gate, Globe & Check)	1	7/9/76
5.157	Specification	Specification No. 9763-006-248-13 Actuators for Valves and Dampers	6	5/23/80
5.158	Calculation	6.01.53.07 Containment Enclosure Cooling Units		1/20/83
5.159	Test Report	FP-54661 Conax Report No. IPS-503 Power & Control Feedthru Modules for Seabrook Station		5/6/80
5.160	Impell Report	P.O. 9763-006-248-37 Environmental Qualificaation Assessment Report: Velan Gate Globe & Check Valve (Valve Actuators)		10/13/82
5.161	Qualification File	P.O. 9763-006-552-1 Buffalo Forge/Westinghouse Class 1E Medium AC Meters		
5.162	Qualification File	P.O. 9763-006-113-6 Instrument Cable (Brand Rex)		-
5.163	Qualification File	P.O. 9763-006-173-7 Solenoid Valves		-
5.164	Qualification File	P.O. 9763-006-248-41 Walworth Valves & Actuators		-

Ref. No.	Document Type	Description/Title	Rev.	Date
5.165	Qualification File	P.O. 9763-006-248-45 Posiseal Butterfly Valves & Actuators		-
5.166	Qualification File	P.O. 9763-006-248-65 MSIVs		-
5.167	Qualification File	P.O. 9763-006-113-3 600V Power Cable		-
5.168	Qualification File	P.O. 9763-006-225-5 Tornado Dampers		-
5.169	Test Report	FP-54662 Conax Report No. IPS-325 Materials Used in Conax Electric Penetration Assemblies and Electric Conductor Seal Assemblies		11/2/79
5.170	Test Report	FP-54664 Conax Report No. IPS-353.2 Conax Low Voltage Control Classification Conductor Feedthrough Assembly		6/20/79
5.171	Test Report	FP-91965 Limitorque Project Report No. 600456 Limitorque Actuators for PWR Service		12/9/75
5.172	Test Report	FP-91935 Limitorque Project Report No. 600508 Limitorque Valve Actuator Temperature Related to High Superheat Ambient Temperature		10/10/78
5.173	Memo	MM 14793A Feedthrough Assemblies for Valve Encapsulation		10/10/83
5.174	Standard	IEEE Std. 317 IEEE Standard for Electric Penetration Assemblies in Containment Structures for Nuclear Power Generating Stations		1976
5.175	Standard	IEEE Std. 382 IEEE Trial-Use Guide for Type Test of Class I Electric Valve Operators for Nuclear Power Generating Stations		1972

Ref. No.	Document Type	Description/Title	Rev.	Date
5.176	Data	FP-91790 Limitorque RH Motor Insulation		11/13/79
5.177	Letter	VU-035267 Limitorque to United Engineers Qualification Information; Seabrook Station		6/10/83
5.178	Impell Report	P.O. 9768-006-248-47 Environmental Qualification Assessement Report: Conax/PX Engineering Feedthrough Assemblies for Valve Encapsulation		12/3/82
5.179	Letter	SBU-31125 United Engineering to PX Engineering Isolation Valve Encapsulations Electrical Penetration Qualification Program		10/25/79
5.180	Guide	CASP Design Guide for PSNH	4	8/4/78
5.181	Drawing	Drawing No. 9763-F-310442 Control Building Conduit Plan EL 21'6"	24	10/27/83
5.182	Drawing	Drawing No. 9763-F-310769 Mechanical Penetration Area Conduit Plan	17	10/12/83
5.183	Drawing	Drawing No. 9763-F-310476 Control Building Cable Trays, Node Plan Elev. 21'-6"	7	10/28/82
5.184	Drawing	Drawing No. 9763-F-310797 PAB Pits & PNTN EL.(-) 8' Cable Tray Node Plan	7	4/23/80
5.185	Drawing	Drawing No. 9763-F-310800 Primary Aux. Bldg. EL.25' North Cable Tray Node Plan	6	10/10/83
5.186	Drawing	Drawing No. 9763-F-301048 Service and Circulating Water Intake Discharge Shafts Tray and Node Plan	1	1/20/83

Ref. No.	Document Type	Description/Title	Rev.	Date
5.187	Drawing	Drawing No. 9763-F-310290 Non-essential Switchgear Room Underground Conduit Plan	8	2/4/83
5.188	Drawing	Drawing No. 9763-F-310298 Non-essential Switchgear Room Tray Node Plan and Sections	2	10/22/79
5.189	Drawing	Drawing No. 9763-F-310435 Control Building Embedded Conduit Plan	18	11/10/83
5.190	ECA	ECA 032312A Termination Information		7/7/83
5.191	Drawing	Drawing No. 9763-M-310900 Sh. 25/29b Spray Additive Tank TK-13 Level Switches	2	3/25/83
5.192	ECA	ECA 544658A Grounding for Valves; V35, V36		7/20/83
5.193	Termination Slip	Termination Slip: Cable V36-Y36 CBS TK-10B Isol CBS-V14	2	-
5.194	Drawing	Drawing No. 9763-M-310900 Sh. B84e Containment Sump Isolation Valve V8 Cable Table	2	3/25/83
5.195	Drawing	Drawing No. 9763-M-310900 Sh. D40e Containment Sump Isolation Valve V14 Cable Table	2	3/25/83
5.196	ECA	ECA 032348A TC & RTD Cables Missing Terminal Board Numbers		7/16/83
5.197	Drawing	Drawing No. 9763-F-310181 Sh. GY5s Station Computer System IRTU-4	4	7/27/83
5.198	Drawing	Drawing No. 9763-F-310181 Sh. JW4K Station Computer System IRTU-4	4	7/27/83
5.199	ECA	ECA 032149A CASP Cable Routing Not Possible		5/4/83

Ref. No.	Document Type	Description/Title	Rev.	Date
5.200	Drawing	Drawing No. 9763-F-310794 Primary Aux Building Cable Tray Layout Section	10	3/24/83
5.201	ECA	ECA 032149B CASP Cable Routing Not Possible		5/10/83
5.202	Drawing	Drawing 9763-F-310794 Primary Aux Building Cable Tray Layout Section	11	8/12/83
5.203	ECA	ECA 544585B Termination Information Required		6/21/83
5.204	ECA	ECA 544502B Verify Conduit and Pullbox	B	-
5.205	RFI	RFI 544069A Cables Not in CASP		3/23/83
5.206	RFI	RFI 542911A Non-CASP Cables		8/12/82
5.207	RFI	RFI 542485A Surface Mounted Plate Clarification		9/2/82
5.208	Letter	SBU-74799 United Engineers to Bingham-Willamette Containment Spray Pump 1-CBS-P-9B		6/20/83
5.209	NCR	Nonconformance Report 2109 CBS Pump 1-CBS-P-9B	2	9/2/83
5.210	Summary	NCR 2109-NCR Review Board Response CBS Pump 1-CBS-P-9B		6/13/83
5.211	Summary	NCR 2109-NCR Review Board Response CBS Pump 1-CBS-P-9B		6/21/83
5.212	Speed Letter	JJ Carrabba (United Engineers) NCR 2109		7/25/83

Ref. No.	Document Type	Description/Title	Rev.	Date
5.213	Letter	K.A. Olsen Westinghouse to United Engineers P.O. 9763.011-36519 Apparatus Service Report BSL-799		7/22/83
5.214	Letter	K.A. Olson Westinghouse to United Engineers P.O. 9763.011-36519		12/12/83
5.215	Pull Slip	Cable No. A61-M15 CBS Pump Motor		10/3/83
5.216	Pull Slip	Cable No. D40-Y36 MCC E621 to CBS-V14		10/6/83
5.217	Pull Slip	Cable No. D41-VQ9/1 MCC E621 to CBS-V17		8/26/83
5.218	Pull Slip	Cable No. D42-VQ9/2 MCC E621 to CBS-V17		8/26/83
5.219	Termination Card	Cable No. F61-M15 CBS Pump Cable (Switchgear end terminated, only)		11/26/83
5.220	Termination Card	Cable No. D40-Y36 MCC-E621 to CBS V14 (Both ends terminated)		10/11/83
5.221	Termination Card	Cable No. D41-VQ9/1 MCC E621 to CBS-V17 (MCC end terminated, only)		9/19/83
5.222	Termination Card	Cable No. D41-VQ9/2 MCC-E621 to CBS-V17 (MCC end terminated, only)		9/19/83
5.223	Memo	MM-2830A Radiation Environment for Equipment Design		11/77
5.224	Calculation	Calculation No. 4.3.23.25F Long-term Containment Temperature Transient Following a Design Basis LOCA		8/23/82

8.5.2 Personnel Interviewed

Name	Title	Organization
G. M. Aggarwal	Electrical SDE	UE&C
G. W. Morris	Electrical Assistant SDE	UE&C
C. D. Greiman	Electrical Assistant SDE	UE&C
S. M. Molchanow	Electrical Engineer	UE&C
D. W. Knox	Electrical Engineer	UE&C
A. N. Pal	Electrical Engineer	UE&C
P. F. Milliken	Electrical Engineer	UE&C
D. P. Ganguly	Electrical Engineer	UE&C
J. Fox	Electrical Engineer	UE&C
D. P. Patel	Electrical Engineer	UE&C
D. H. Flannigan	Electrical Design Supervisor	UE&C
J. R. Jennings	Electrical Design Supervisor	UE&C
J. J. Vinnacombe	Electrical Design Supervisor	UE&C
W. R. Brown	Mechanical Engineer	UE&C
T. C. Kilfeather	Piping Engineer	UE&C
G. Carl	Piping Engineer	UE&C
J. J. Parisano	Piping SDE	UE&C
R. P. Neustadter	I&C SDE	UE&C
L. R. Varindairi	I&C Engineer	UE&C
T. K. Darwish	Site Electrical Lead Engineer	UE&C
R. R. Cox	Site Electrical Engineer	UE&C
B. Pai	Site Electrical Engineer	UE&C
E. G. Bourgeois	Site Electrical Engineer	UE&C
R. L. Garnett	Site Electrical Engineer	UE&C
R. A. Rose	Site Electrical Engineer	UE&C
A. L. Garrett	Site Electrical Engineer	UE&C
H. Patel	Electrical Const. Lead Engineer	FBM
P. Ruh	Document Control Supervisor	FBM
F. D. Baxter	Engineering Manager	YAEC
G. Tsouderos	Electrical Lead Engineer	YAEC
T. W. Glowacky	Electrical Engineer	YAEC
R. C. Jamison	Electrical Engineer	YAEC
R. McCoy	Electrical Engineer	YAEC
P. Johnson	Electrical Engineer	YAEC
H. E. Wingate	Asst. Project Const. Manager	YAEC
E. W. Rhodes	Manager Quality Assurance	BBC
C. E. Kunkel, Jr.	Manager, Product Analysis and Qualification	BBC
J. W. Detwiller	Supervisor, Product Qualification	BBC
D. W. Pratt	Quality Assurance Engineer	BBC
F. J. Wuzzardo	Qualification Engineer	BBC
J. Cosgrove	Supervisor QA (Plant)	BBC
J. V. Myshko	Site Support Lead Engineer	UE&C
T. H. Rhodes	Project Engineering Manager	UE&C
S. Dunphy	NSSS Lead System Engineer	UE&C
C. Pletcher	Lead Start-up Engineer (Site)	UE&C
D. Chapman	Start-up Engineer (Electrical)	NEPSCO

8.6 Instrumentation and Control

8.6.1 Documents

Ref. No.	Document Type	Description/Title	Rev.	Date
6.1	UE&C Guide	Separation Design Guide for Physical Independence of Electric Systems	1	1/7/76
6.2	Conf. Notes	Conference Notes E-76, YAEC, UE&C, and NRC	-	10/17/78
6.3	UE&C Spec.	145-3, 480VAC Unit Substations	5	7/15/81
6.4	UE&C Spec.	120-1, 120VAC, 125VDC, and 460VAC Power and Control Circuit Breakers	4	7/13/82
6.5	UE&C Data Sheet	120-1D, Circuit Breakers	1	8/20/82
6.6	UE&C Spec.	SD-120-1, Circuit Breaker Seismic Requirements	1	6/29/82
6.7	Gould Report	CC-323.74-93, Qualification Report for E22 and BQ Breakers	1	11/9/82
6.8	UE&C Spec.	143-1, 460VAC Motor Control Ctr	8	11/30/82
6.9	YAEC Report	Preliminary Appendix 8B; Review and Analysis of Associated Circuits (withdrawn)	-	7/19/82
6.10	NRC Memo	M. Srinivasan from J. Knox; Docket 50-443/444; Summary of June 20, 1982 Meeting	-	9/24/82
6.11	PSNH Letters	SBN-427, Open Item Responses; revision of RAI 480.149	-	1/20/83
		SBN-587, Elec. Interconnections Between Redundant Divisions	-	12/1/83
6.12	UE&C Letter and attached conference notes	SBU-75015, Electrical Notes of Conference E-131, YAEC, PSNH, and UE&C, Review of Physical Separation in Equipment	-	6/30/83

Ref. No.	Document Type	Description/Title	Rev.	Date
6.13	UE&C Draft Calculations	9763-3-ED-00-38P, Review of Physical Separation in Equipment (preliminary) unnumbered preliminary draft of report on cables between redundant separation groups	-	unissued
6.14	Telephone Call	Mr. G. Kennedy, Gould, with L. Stanley, instrumentation and control IDI team, regarding E22 and BQ circuit breaker qualification tests	-	1/6/84
6.15	UE&C Proc.	TP-8, Equipment Separation Criteria	0	11/5/82
6.16	UE&C FP Dwg.	FP71132, Computer Specification 146-01 prepared by PSNH	9	6/3/82
6.17	UE&C Calc.	4.3.5.30F, RWST Level Alarm Setpoint Calculation	1	8/25/83
6.18	UE&C Listing	M-510000, Standard Instrument Schedule Report AA, CBS System and RH System	AN	9/23/83
6.19	UE&C Listing	C-510007, Standard Equipment List, PCS Report 48	70	5/19/83
6.20	Westinghouse Design Review	DR-77-1, Flux Mapping, C. E. Rossi, Chairman	-	2/14/77
6.21	Westinghouse Design Review	DRF-82-17, Class 1E Incore T/C System, J. S. Fuoto, Chairman	-	5/16/76
6.22	Westinghouse Qualification Report	WCAP-8687, Supplement 2, Equipment Qualification Test Report, Report, Group A	1	3/83
6.23	Westinghouse Letter	NAH-U-2473, WCAP-8687 Supp. 2 Submittal to UE&C	-	11/12/81
6.24	Westinghouse Drawing	7247D91, Solid State Protection System Interconnection Diagram, UE&C FP70073-7	4	6/21/83

Ref. No.	Document Type	Description/Title	Rev.	Date
6.25	Westinghouse Procedure	NTD-DPP-3C, Design Review Procedure	3	7/24/81
6.26	UE&C System Design Descriptions	SD-91, Leak Detection System	1	3/28/83
		SD-25, Equip. and Floor Drains	3	6/2/83
		SD-96, Post Accident Monitoring	5	6/17/81
		SD-53, Containment Enclosure Cooling and Exhaust Filter Systems	6	10/4/83
		SD-23, PCCW System	4	9/2/82
6.27	UE&C Procedure	AP-28, General Engineering and Design Procedures (Seabrook)	6	1/4/83
6.28	UE&C Schematic	M-301107, Service Water System	7	10/14/83
	UE&C Schematic	M-301216, Waste Liquid Drains	5	12/12/83
	UE&C Schematic	M-310844, Feedwater System	9	12/9/83
	UE&C Schematic	M-310887, RHR System	12	10/28/83
	UE&C Schematic	M-310890, SI System	6	7/18/83
	UE&C Schematic	M-310900, CBS System	9	6/29/83
	UE&C Schematic	M-310953, Non-Vital Instrum.	5	7/28/83
	UE&C Schematic	M-310955, Leak Detection Sys.	1	7/20/83
6.29	UE&C CLD Index	M-506479, FW Control Loop	8	7/5/83
	UE&C CLD Index	M-506649, RHR Control Loop	8	9/8/82
	UE&C CLD Index	M-506653, RHR Pump P-8B	7	9/8/82
	UE&C CLD Index	M-506789, SIS Control Loop	10	10/10/83
	UE&C CLD Index	M-506950, Waste Liquid Drains	6	12/1/82
6.30	UE&C Logic Diagram	M-503764, RHR Valves	5	12/15/80
		M-503250, CBS Valves	10	9/14/83
6.31	USNRC Regulatory Guide	RG 1.97, Instrumentation for Light Water Cooled Nuclear Plants to Assess Plant and Environs Conditions During and Following an Accident	1 2 3	8/77 12/80 5/83
6.32	UE&C FP Dwg.	FP72415, Cote Shield Review Comments per AP-37, PO 174-6	-	10/22/82
6.33	UE&C Chart	F-300219, Service Environments	13	6/24/83
6.34	USNRC NUREG	NUREG-0737, Clarification of TMI Action Plan Requirements	-	11/80

Ref. No.	Document Type	Description/Title	Rev.	Date
6.35	IEEE Trial Use Standard	IEEE 384-1974, Criteria for Separation of Class 1E Equipment and Circuits	-	1974
6.36	USNRC Reg. Guide	RG 1.75, Physical Independence of Electric Systems	2	9/78
6.37	USNRC Reg. Guide	RG 1.52, Design, Testing, and Maintenance Criteria for Post Accident ESF Atmosphere Cleanup System Air Filtration and Absorption Units of Light Water Cooled Nuclear Power Plants	2	3/78
6.38	IEEE Std.	IEEE Std. 279-1971, Criteria for Protection Systems for Nuclear Power Generating Stations	-	1971
6.39	Organiz. Chart	Tobar Inc. (Veritrak)	-	11/7/83
6.40	W Spec Sheet	NAH325 11411, Electronic DP Transmitters, Group B	12	3/18/81
6.41	Westinghouse Drawing	2650C49, Level Systems Installation Schematic	3	3/12/82
6.42	Westinghouse Drawing	8765D67, Seismically Qualified Elec. DP Transmitter, Group B	4	2/1/83
6.43	Westinghouse Engineering Report	78-1G4-TRAMP-R1 [RD988], "A Strain Gage Amplifier for Safety Related Class 1E Applications," R.A. Johnson et. alia.	-	6/21/78
6.44	Westinghouse and Veritrak Test Reports	ETR-212, Failure Analysis, BW-3 Absolute Pressure Transmitter	-	9/1/82
		ETR-216, Model 76 Series 2/ Model 32 Series 1 Baseline Cross-Reference Listing	-	9/28/82
		ETR-222, Activation Energies for Model 32XX1 Transmitter	-	10/14/82
		ETR-226, Model 32 Series 2 Baseline Cross Reference	-	9/28/82

Ref. No.	Document Type	Description/Title	Rev.	Date
6.45	Veritrak Qualification Procedure	5518A55, Transmitter Environmental Qualification Plan and Procedures	1	7/13/82
6.46	USNRC Reg. Guide	RG 1.89, Qualification of Class 1E Equipment for Nuclear Power Plants	-	11/74
6.47	IEEE Trial Use Std.	IEEE 420-1973, Trial Use Guide for Class 1E Control Switch-Boards for Nuclear Power Generating Stations	-	1973
6.48	Letter	Letter of A.M. Ebner (UE&C) to J. DeVincentis (UAEC), Accident Monitoring Instrumentation Review Regulatory Guide 1.97	-	10/5/83
6.49	Letter	Letter of J. DeVincentis (YAEC) to D.H. Rhoads (UE&C) Accident Monitoring Instrumentation Review	-	7/20/83
6.50	Veritrak Proc.	EDP-04, Design Verification	2	3/10/82
6.51	Tobar Manual	PI-1, Product Integrity Dept. Nuclear Quality Program	0	9/16/83
		PI-1, Section 3, Design Control	0	9/16/83
6.52	Tobar Manual	PI-2, Nuclear Quality Program Procedures Manual	0	7/22/83
6.53	W Base Order	546-ALC-427950-XN, Group B Class 1E Transmitters	0 1 2 3	11/3/80 12/23/80 2/17/81 9/18/81
6.54	Tobar Design Specification	5514A71, PT Model 76DP2	1	6/29/81
	Tobar Design Specification	5514A72, PD Model 76PH2	1	6/29/81
	Tobar Design Specification	5518A29, PT Model 76PA1	1	6/29/81
	Tobar Design Specification	5518A57, PT Model 32PA1	2	6/[illegible]/81

Ref. No.	Document Type	Description/Title	Rev.	Date
6.54 (Cont'd)	Tobar Design Specification	5518A58, PD Model 32PG1	2	6/29/81
	Tobar Design Specification	5518A59, PT Model 32DP1	3	6/29/81
	Tobar Design Specification	5518A60, PT Model 76PG1	1	6/29/81
	Tobar Design Specification	5518A61, PT Model 32PG2	2	6/29/81
	Tobar Design Specification	5518A62, PD Model 32PA2	2	6/29/81
	Tobar Design Specification	5518A63, PT Model 76DP1	1	6/29/81
	Tobar Desgin Specification	5518A64, PT Model 32DP2	2	6/29/81
6.55	Letter	Westinghouse letter NAH-1092 to J.D. Haseltine (YAEC), Post Accident Monitoring	-	5/16/78
6.56	Veritrak Manufacturing	1730B74, Resistor Network	1	8/4/75
		1502D90, Amplifier Assembly	15	11/19/81
	Drawings	1505D10, Amplifier Assembly	11	10/3/83
		1505D22, Zero Span Compensation	6	3/26/81
6.57	Veritrak Engineering Release Memos	ERM-33755, Engineering Release Memo for Model 76 Amplifier	-	2/12/78
		ERM-N34060, Release for Model 76 Transmitter	-	5/17/78
6.58	Veritrak Revision Notices	N36071, changed part number	-	2/8/79
		R37468C, changed header assy	-	7/21/80
		N39258, model 76 resistors	-	9/18/80
		N39281B, model 76 hardware	-	9/23/80
		N39314, sensor schematic	-	10/10/80
		RN-40969, spec. release	-	11/2/81
		RN-40991, changed insulator	-	11/9/81
		RN-41110, spec. changes	-	12/7/81
		RN-41007, added index	-	12/9/81
		RN-41091, 800 inch H20 column	-	7/12/82
		RN-41110, spec. changes	-	3/7/83
		RN-41166A, strain relief added	-	7/12/83

Ref. No.	Document Type	Description/Title	Rev.	Date
6.59	Veritrak Data Sheet	Certified Data Sheet, Diff. Pressure Transmitter 1-LT-933	-	3/25/81
6.60	Veritrak Report	5519A32, Model 32 Series 2 Qualification program Post-Test Analysis and Summary Report	-	6/82
6.61	Westinghouse Design Spec.	955270, Class 1E Instrument Design and Test Requirements (Groups A and B)	0 1	9/2/80 9/10/81
6.62	Westinghouse Design Spec.	953328, Qualification of Pressure and Differential Pressure Class 1E Transmitters	0 3 4	4/1/77 12/15/80 10/29/82
6.63	Tobar Memo	Vendor Audit Schedule, 1983	-	7/21/83
6.64	Tobar Vendor Audit Reports	Uni-tek Vendor Audit Checklist Unitrode Vendor Audit Checklist	- -	10/13/83 11/15/83
6.65	Veritrak Vendor Part Drawings	5516A85, JAN1N914 Sig. Diode 5519A54, Capacitor Fixed Tantalum Electrolytic	3 2	3/29/82 8/3/83
6.66	Tobar Purchase Orders	OV-47597, JAN1N914 Diodes OV-47737, Tantalum Capacitor	- -	8/9/83 8/29/83
6.67	Telephone Call	D. Gregg, Westinghouse Project Engineer with L. Stanley, IDI	-	12/13/83
6.68	Telephone Call	A. E. Ellis, Tobar/Westinghouse with L. Stanley, IDI	-	12/16/83
6.69	Barton Manual Barton Manual	QU-3, Design Control QU-4, Procurement Doc. Ctrl.	4 4	
6.70	Barton Engineering Procedures	EN-1, Design Release of Engineering Documentation EN-2, Change Control EN-4, Design Change Request/ Engineering Order Procedure EN-5, Configuration Management Plan EN-8, Product Development Management	- - - - -	3/1/80 9/1/79 2/24/77 2/24/77 2/1/80
6.71	Barton Document Chg. Requests	DCR 11717, changed model number to 583A and instrument weight DCR 12858, added outline dwg.	-	7/8/82 10/26/82

Ref. No.	Document Type	Description/Title	Rev.	Date
6.72	Barton Eng. Orders	EO-12873, released new drawings	-	11/15/82
		EO-12493, changed relay ratings	-	7/28/82
6.73	Barton Eng. Instruction	EI-16, Baseline Parts List Preparation Instructions	0	3/25/81
6.74	Barton Manufacturing Drawings, Procedures, and Vendor Purchase Part Drawings	0353.1116.5, Bellows Baseline	1	2/83
		0351.0001.B, Bellows Assembly	-	-
		0752.1180.5, Transmtr. Baseline	4	11/9/82
		0752.1053.2, Ckt. Bd. Test Proc.	3	9/26/79
		0752.1178.2, Calib. Instruction	1	10/31/80
		0752.1056.B, Ckt. Bd. Assembly	11	9/3/83
		0197.1049.T, Zener Diode 1N5375	1	10/14/76
		0064.1002.T, Bulk Silicon Gages	2	7/27/73
		0752.1040.2, Calib. Test Proc.	4	
		0580.1128.5, Model 580 Baseline		
6.75	W Spec.	953333, Group B Transmitters	0	7/18/77
6.76	W Spec Sheet	NAH325 11411, Specification for Electronic DP Transmitters, Group B	1 7 9	10/17/79 6/9/82 1/24/83
6.77	W Drawing	8765D64, Differential Pressure Electronic Transmitter, Group B	3 4 5	10/23/78 4/10/79 2/11/80
6.78	W Drawing	8765D52, Containment Pressure Transmitter Installation	2 3	2/22/78 9/1/82
6.79	W Quality Release	QRN-53923, Quality Release of Lot 3 Transmitters List QR-4674, 4676, 4678, 4680 for PT-934 through PT-937	0	12/1/81
6.80	Barton Registers	090560-01-00	-	1/23/81
		066161-01-14 for UE&C C.O. 15	-	11/11/83
6.81	Barton Design Checklists	DCCL for Register 090560-A	-	5/15/81
		DCCL for Register 066161-01-14	-	11/8/83
		DCCL for Register 209553-C	-	8/4/83
6.82	Barton Purch. Part Drawing	0068.1096.T, Electrical Switch, Snap-Acting, SPDT	2	4/28/83
6.83	JCI Letter	JCM-1926, Johnson Controls letter confirming temporary installation of 1-CC-LT-2172-1 and 1-CC-LT-2272-1	-	11/30/83

Ref. No.	Document Type	Description/Title	Rev.	Date
6.84	UE&C Memo	Speedletter 663, R. D. Stockamore to JCI for temporary instrument installation	-	7/14/83
6.85	UE&C FP Dwg	FP54640, UE&C Comments on Barton Model 752 Technical Manual per AP 37	0	2/23/83
6.86	UE&C FP Dwg	FP54793, UE&C Comments on Barton Transmitters on Westinghouse Spec Sheet NAH 325 11411	7	9/21/82
6.87	UE&C Spec.	251-16, Diff. Pressure Instrumentation	7 8	8/5/82 2/15/83
6.88	UE&C IDS	252-16D, Diff. Pressure Instrumentation Data Sheets	10	2/15/83
6.89	UE&C Spec.	252-16S, Seismic and EQ Figures	4	11/17/80
6.90	UE&C Spec.	SD-252-16, Seismic Requirement	2	11/2/83
6.91	UE&C FP Dwg	FP72264, Barton Model 580 and 581 Qualification Test Results, report R3-580-6, unissued	-	1/29/81
6.92	Barton Test Plan	9999.3083.2, IEEE 323-1974 Qualification Program for ITT Barton Switch	6	3/81
6.93	UE&C Letter	SBU-43401, Spec. 252-16 rev 5 and 252-16D rev 7 submittal	-	3/24/81
6.94	UE&C Letter	SBU-47457, acceptance of Barton exception to LOCA qualification	-	8/14/81
6.95	Barton Test Procedure	9999.3155.2, Models 580A, 581A and 583A Des. Qual. Test Plan	1	1/29/82
6.96	Barton Letter	VU-027804, Design Qualification Test Plan 9999.3155.2 Submittal	-	2/4/82
6.97	UE&C Memo	Speed Letter, E. Pilhuj to R.P. Neustadter regarding seismic discrepancies in Figures 6 & 9	-	3/29/82
6.98	UE&C Form	4505, Quality Control Vendor Surveillance Check Plan	2	11/26/79

Ref. No.	Document Type	Description/Title	Rev.	Date
6.99	UE&C Non-Conformance Reports	NCR-1397, Four Pressure Switches On-Site without Seismic Qualif. Test Report	-	4/19/82
		NCR-1497, Site Data Package without Seismic Qual. Report	-	6/23/82
		NCR-1513, Site Data Package without Seismic Qual. Report	-	7/1/82
		NCR-1730, Site Data Package without Seismic Qual. Report	-	10/27/82
		NCR-1828, Site Data Package without Seismic Qual. Report	-	12/20/82
		NCR-2190, Site Data Package without Seismic Qual. Report	-	7/25/83
6.100	UE&C Procedure	QA-7-2, Control of Purchased Material-Vendor Surveillance	15	10/31/81
6.101	UE&C Letter	SBU-55499, UE&C Comments on Barton 580A, 581A, 583A Design Qualification Test Plan	-	4/29/82
6.102	UE&C Purchase Change Orders	C.O. 9 changing RHR and SI instrument flange ratings	-	8/3/82
		C.O. 11 incorporating 252-16D rev 9 and rev 10	-	4/12/83
		C.O. 15 to Barton for 252-16	-	10/11/83
6.103	Barton Letter	VU-030877, Comments on UE&C Spec. 252-16 rev 7, 8/05/82; exception taken to 252-16S.	-	9/15/82
6.104	UE&C Letter	SBU-61725, Transmittal of revised Vendor Surviellance Check Plan for 252-16 to Barton	-	9/22/82
6.105	UE&C Memo	MM-10511A, E. Pilhuj and T. C. Chang to R. P. Neustadter for comparison of Barton Design Qualification Test Plan 9999.3155.2 to Spec. 252-16	-	11/18/82
6.106	UE&C Letter	SBU-67994, UE&C Response to Barton Comments, VU-030877	-	1/26/83
6.107	Barton Letter	VU-033215, Barton Response to UE&C SBU-67994	-	2/21/83

Ref. No.	Document Type	Description/Title	Rev.	Date
6.108	UE&C Letter	SBU-70094, Transmittal of UE&C Spec. 252-16 rev. 8 and 252-16D Rev. 10 to Barton	-	3/14/83
6.109	Barton Letter	unnumbered, Barton Response to UE&C SBU-70094	-	3/29/83
6.110	Barton Letter	VU-034588, Barton Response to SBU-55499, Proc. 9999.3155.2	-	5/11/83
6.111	UE&C Memo	MM-14560A, S. Rubin to R. P. Neustadter evaluating Barton Letter Response VU-033215	-	8/31/83
6.112	UE&C Memo	MM-14574A, S. Rubin to R. P. Neustadter evaluating Barton Letter Response VU-034588	-	8/31/83
6.113	UE&C Procedure	QA-15, Non-Conforming Material, Parts, or Components	10	8/24/82
6.114	UE&C Spec.	46-1, Instrument Installations	7	6/28/83
6.115	UE&C Diagram	M-503259, CBS Logic Diagram		
6.116	Letter	Letter of B. F. Cole (UE&C) to J. D. Haseltine (YAEC) Post Accident Monitoring Instrumentation	-	8/22/77
6.117	Letter	Letter of J. D. Haseltine and W. H. Reed (YAEC) to D. H. Rhoads (UE&C), UE&C Specification 170-3, Multipoint recorders. SB-4774	-	3/22/77
6.118	Memo	YAEC internal memo of W. H. Reed to J. D. Haseltine, Class 1E BOP recorders. File ECE-SB-18176	-	5/3/76
6.119	Letter	Letter of J. D. Haseltine and W. H. Reed (YAEC) to D. H. Rhoads (UE&C) Westinghouse supplied IE equipment SB-5193	-	8/18/77
6.120	Letter	Letter of G. F. Cole (UE&C) to J. D. Haseltine (YAEC), Class 1E equipment list, notes of conference held 12/6/77. SBU-15771	-	12/17/77

Ref. No.	Document Type	Description/Title	Rev.	Date
6.121	Letter	Letter of J. DeVincentis (YAEC) to D. H. Rhoads (UE&C), RCS/RH/RC comments. ERR No. 206A13	-	5/20/83
6.122	Letter	Letter of J. DeVincentis (YAEC) to D. H. Rhoads (UE&C), CBS system	-	3/9/82
6.123	Memo	Internal memo of J. M. O'Connor to J. DeVincentis (YAEC)	-	3/11/83
6.124	Letter	Letter of A.M. Ebner (UE&C) to J. DeVincentis (YAEC). SBU-77816. Meeting notes.	-	9/6/83
6.125	Letter	SBN-530 Letter of J. DeVincentis (YAEC) to G. W. Knighton (NRC), Seabrook Station Control Room Design Review.	-	7/7/83
6.126	Letter	SB-15903 Letter of J. DeVincentis (YAEC) to B.B. Beckly (PSNH), Final Draft Control Room Review Report dated 5/2/83.	-	6/13/83
6.127	YAEC Memo	Memo of V. W. Sanchez and W. Fadden to J. DeVincentis (YAEC), Final Draft Report of the Seabrook Control Room Design Review dated 5/2/83.	-	6/20/83
6.128	Letter	Letter of J. DeVincentis (YAEC) to D.H. Rhoads (UE&C), Main Control Board changes, notes of meeting 8/15/83	-	8/18/83
6.129	UE&C Drawing	Unit 1 Main Control Board, Redesign Summary Post Human Factors.	-	-
6.130	Design Change Notice	DCN 650195A Modification of Main Control Board Zone B.	-	11/2/83
6.131	UE&C Drawing	9763-F-510102, Main Control Board Arrangement LPSI, MCB Zone BF as built	7	12/9/82
6.132	UE&C Drawing	9763-F-510102, Main Control Board Arrangement LPSI MCB Zone BF	8	10/28/83

Ref. No.	Document Type	Description/Title	Rev.	Date
6.133	UE&C Drawing	9763-F-510102, Main Control Board Arrangement LPSI MCB Zone BF	8	OPEN
6.134	UE&C Diagram	UE&C logic diagram 9763-M-503251 CBS system	4	10/28/83
6.135	UE&C Diagram	UE&C loop diagram 9763-M-506171	6	10/28/83
6.136	List	UE&C Device list, Main Control Board Zone BF, DL-170-1-BF	7	10/28/83
6.137	York Drawing	York Electro-Panel MCB Zone BF Physical Wiring Drawing E-5507 sh 1 of 17, UE&C VP 72260-5	3	2/12/82
6.138	York Drawing	York Electro-Panel MCB Zone BF Physical Wiring Drawing E-5507 sh 4 of 17, UE&C VP 72260-5	3	2/12/82
6.139	UE&C Drawing	UE&C Schematic 9763-M-310900 sh E87/18a, CBS system	2	11/23/83
6.140	UE&C Drawing	UE&C Schematic 9763-M-310900 sh E88/8a, CBS system	4	11/23/83
6.141	Eng. Change Authorization	ECA-059008A, Main Control Board Zone B	-	12/9/83
6.142	UE&C Diagram	UE&C Control Loop Diagram 9763-M-506801, SI Containment Pressure	4	7/17/81
6.143	Notes	UE&C handwritten meeting notes, Main Control Board meeting	-	8/23/83
6.144	UE&C Drawing	Schematic Diagram M-310942 Process Protection Control SI-PR-937	-	-
6.145	York Drawing	York Electro-Panel MCB zone B wiring drawing E-5507 sh 5 of 17, as-built, UE&C VP 72260-5	3	2/12/82
6.146	York Drawing	York Electro-Panel Front View Steel cutout arrangement drawing E-5133, MCB zone BF, as-built UE&C VP 70764-07	6	1/25/82

Ref. No.	Document Type	Description/Title	Rev.	Date
6.147	York Manual	York Electro-Panel Main Control Board Instruction Manual UE&C VP 7109-04	-	6/25/82
6.148	Instructions	FM No. 35880 File 170-1 Main Control Board Field Modifications of MCB zone B	-	11/21/83
6.149	UE&C Spec.	UE&C Specification 9763-006-174-4 Panel mounted small case recorders	4	2/26/82
6.150	UE&C Data Sheets	UE&C Specification 9763-006-174-0 data sheets for panel mounted small case recorders	5	6/14/83
6.151	UE&C Purchase Order	UE&C Purchase Order 174-0 to Foxboro SBU-81212. Panel mounted small case recorders	-	11/28/83
6.152	Letter	Letter of J. DeVincintis (YAEC) to G. W. Knighton (NRC). SBN-427 RAI 430-149, Interaction between circuits	-	1/20/83
6.153	Memo	Telecon memo of (YAEC) and (UE&C) Conduit Separation Markings		6/20/80 and 6/23/80
6.154	Analysis	UE&C Analysis of High Energy Line Breaks Outside Containment Ca.-culation 4.3.33-F-1, Figure 3-10 Radiation zone map - CE area, and Figure 3.3-1A zone 41B - CE area	0	8/11/83
6.155	System Diagram	UE&C System Diagram, PAB Building Ventilation System Air Flow Diagram 9763-F-604108 Sh 1	-	-
6.156	System Diagram	UE&C System Diagram, PAB bldg and Fuel Storage Building Ventilation System Air Flow Diagram 9763-F-604116 sh 2	- -	- -
6.157	Diagram	EAH Containment Enclosure Emergency Exhaust Filter Fan and Static Pressure Control System Control Loop Diagram 9763-M-506422	4	8/25/83

Ref. No.	Document Type	Description/Title	Rev.	Date
6.158	Diagram	EAH Containment Enclosure Emergency Exhaust Filter Fan and Logic diagram 9763-M-503515	2	7/15/80
6.159	Schematic	Containment Enclosure Emergency Exhaust Fan 1-FN-4A Schematic Diagram 9763-M-310932 sh BB3a	3	9/14/83
6.160	Schematic	Containment Enclosure Emergency Exhaust Fan 1-FN-4B Schematic Diagram 9763-M-310932 sh BB3a	3	9/14/83
6.161	UE&C Drawing	Containment Enclosure Ventilation Area Elevation 21'6", Instrument Piping drawing 9763-F-500169	2	6/16/83
6.162	UE&C Drawing	Containment Enclosure Ventilation Area Elevation 25'0", Instrument Piping Drawing 9763-F-500179	8	9/8/83
6.163	UE&C Diagram	UE&C RH Heat Exchanger E-9A Control Loop Diagram 9763-M-506651	7	9/8/82
6.164	UE&C Diagram	UE&C RH Heat Exchanger E-9A Bypass Line, Control Loop Diagram 9763-M-506652	6	12/19/80
6.165	UE&C Diagram	UE&C RH Heat Exchanger E-9B Control Loop Diagram 9763-M-506654	7	9/8/82
6.166	UE&C Diagram	UE&C RH Heat Exchanger E-9B Control Loop Diagram 9763-M-506655	6	12/19/80
6.167	UE&C Diagram	UE&C RH Heat Exchanger E-9A And B Outlet Valves, Logic Diagram 9763-M-503767	2	2/19/80
6.168	UE&C Diagram	UE&C RH Test Line Isolation/ Bypass Valves, Logic Diagram 9763-M-503762	5	5/4/82
6.169	UE&C Diagram	UE&C Schematic Diagram, RH Train B Vital Control, 9763-M-310887 sh E88/2a	4	10/28/83

Ref. No.	Document Type	Description/Title	Rev.	Date
6.170	UE&C Diagram	UE&C Schematic Diagram, RH Train A Vital Control 9763-M-310887 sh E87/2a	4	10/28/83
6.171	YAEC Procedure	YAEC RH System Line Up Procedure OS-1013-01A (Draft)	-	-
6.172	UE&C Diagram	UE&C P&I Diagram 9763-F-805018 sh 1 PCCW Loop A	7	OPEN
6.173	UE&C Diagram	UE&C P&I Diagram 9763-F-805016 sh 1 PCCW Loop B	7	2-6-83
6.174	UE&C Diagram	UE&C Control Loop Diagram CC-HX E-17A Loop A PCCW System 9763-M-506199	5	1-26-83
6.175	UE&C Diagram	UE&C Control Loop Diagram CC-HX E-17B Loop B PCCW System 9763-M-506198	5	1-26-83
6.176	UE&C Diagram	UE&C Logic Diagram CC-PCCW Heat Exchanger Temperature Control Valves 9763-M-503276	2	10-10-80
6.177	UE&C Drawing	UE&C Schematic Diagram PCCW System, Switch Developments 9763-M-310895 sh 4c	3	8-25-83
6.178	UE&C Drawing	UE&C Schematic, CC System HX-E17A Temperature Control Valves TV-2171-1&2 9763-M310895 sh E2T/3a	0	4-13-83
6.179	UE&C Drawing	UE&C Schematic, CC System HX-E17B Temperature Control Valves 9763-M-310895 sh E2V/3a	0	4-13-83
6.180	Catalog	General Electric Control Catalog GEA4746G, SB Series Switches	-	12-78
6.181	UE&C Spec.	UE&C Specification for Electronic Controllers and Accessories 9763-006-174-2	10	7-1-83
6.182	UE&C Data Sheets	UE&C Data Sheets for Electronic Controllers and Accessories 9763-006-174-2D	10	7-1-83

Ref. No.	Document Type	Description/Title	Rev.	Date
6.183	W Drawing	Westinghouse Interconnecting Wiring Diagram CP-152B, card frame 08, 8829012 sh 17, UE&C VP 71276-2 PCCW LP-B supply header temperature control	2	3-31-81
6.184	W Drawing	Westinghouse Interconnecting Wiring Diagram CP-152B, card frame 08 8829D12 sh 16, UE&C VP 71276-2 PCCW LP-B supply header temperature control	3	7-22-82
6.185	W Drawing	Westinghouse Power & Ground Wiring, CP-152B panel, 8829D24 UE&C VP 71456-02	2	8-27-82
6.186	Letter	Letter of S. Kasturi (UE&C) to T. Brozick (Westinghouse), Electronic Controllers and accessories, Specification 174-2 SBU-28860	-	8-2-79
6.187	Instruction Manual	Westinghouse Instruction Manual for Process Instrumentation and Control Volume 1 - Equipment UE&C VP 72769-02 Drawing 8835D86 dated 4-4-80	-	3-17-83
6.188	W Document	Westinghouse Certificate of Qualification for Safety-Related Process System Instrumentation	-	3-15-83
6.189	Vendor Drawing	Fisher Control Co. F43425 Valve RH-HCV-606 and 607 UE&C VP 50726-04	B	-
6.190	UE&C Drawing	UE&C Schematic Diagram 9763-M-310951 sh EH0/3Ad MCB Status Monitor Lights MM-UL-2, Train B Load Group	0	12-5-80
6.191	UE&C Drawing	UE&C Schematic Diagram 9763-M-310951 sh EH9/3Ad MCB Status Monitor Lights MM-UL-4, Train a Load Group	0	12-5-80
6.192	UE&C Drawing	UE&C Schematic Diagram 9763-M-310951 sh EH9/3a MCB Status Monitor Lights 120Vac Supply	1	4-16-82

Ref. No.	Document Type	Description/Title	Rev.	Date
6.193	UE&C Drawing	UE&C Schematic Diagram 9763-M-310951 sh EHO/3a MCB Status Monitor Lights 120Vac Supply	1	4-16-82
6.194	UE&C Drawing	UE&C Schematic Diagram 9763-M-310951 sh EH9/3Aa MCB Status Monitor Light MM-UL-4	1	4-16-82
6.195	UE&C Drawing	UE&C Schematic 9763-M-310951 sh EHO/3Aa MCB Status Monitor Lights MM-UL-2	1	4-16-82
6.196	UE&C Spec.	UE&C Sketches/Figures/Drawings for instrument racks 9763-006-171-1S	5	9-10-82
6.197	Mercury Purchase Order	Mercury Purchase order No. 66166 Rockbestos Firewall SIS 600V #14 AWG 7/S	-	12-10-80
6.198	Mercury Purchase Order	Mercury Purchase order No. 66165 Dekoron type 1952 signal cable 7/S hypolon jacket	-	12-10-80
6.199	Mercury Report	Mercury Receiving Inspection Report P.O. No. 66165 (Form 183) Dekoron Cable	-	1-12-81
6.200	Vendor Certificate	Eaton Corporation, Samuel Moore Operations, Dekoron Division, Certificate of Compliance No. D-3510 Customer's order 66165	-	1-5-81
6.201	UE&C Check Plan	UE&C Quality Control Vendor Surveillance Check Plan Specification 9763-006-171-1	2	9-15-82
6.202	Letter	Letter of D. H. Rhoads (UE&C) to W. E. Wright (Westinghouse), Westinghouse Class 1E Equipment, SBU-7511	-	6-1-76
6.203	Letter	Letter of D. H. Rhoads (UE&C) to W. E. Wright (Westinghouse), Westinghouse Class 1E Equipment, SBU-11739	-	3-28-77

Ref. No.	Document Type	Description/Title	Rev.	Date
6.204	Letter	Letter of W. E. Wright (Westinghouse) to D. H. Rhoades (UE&C), Class 1E Equipment, N4SA-NAH-322	-	6-6-77
6.205	Letter	Letter to K. B. Hanahan (Westinghouse to J. DeVincentis (YAEC), Qualified Valve Accessories NAH-1996	-	8-10-82
6.206	Letter	Letter of R. L. Hofer (Westinghouse) J. DeVincentis (YAEC), Qualified Valve Accessories NAH-2151	-	2-21-83
6.207	Letter	Letter of R. L. Hofer (Westinghouse to D. H. Rhoads (UE&C), Qualified Valve Accessories Equipment Listing, NAH-U-2844	-	7-28-83
6.208	Letter	Letter of J. DeVincentis (YAEC) to K. Hanahan (Westinghouse), Qualified Valve Accessories, SB-16150	-	7-22-83
6.209	Letter	Letter of B. B. Beckley (PSNH) to R. L. Hofer (Westinghouse) Westinghouse Change Order, SM-3780	-	8-5-83
6.210	UE&C Spec.	UE&C Specification 9763-006-170-1 Main Control Board	6	10-22-82
6.211	York Manual	York Electro-Panel Controls Co., Inc. Quality Assurance Manual	0	8-75
6.212	Document	York Electro-Panel, Contract Y-3637 P.O. SNH-86, 9763-006-170-1 Contract Data Document YEP Quote Y-10300 thru U-1300-4	-	12-5-77
6.213	Document	York Electro-Panel Contract Data Change Document File Change Order No. 1 thru 75	-	-

Ref. No.	Document Type	Description/Title	Rev.	Date
6.214	Test Report	Wyle Laboratories, Seismic Simulation Test Program on an Electrical Control Panel Section E Report 45657-1	-	7-23-81
6.215	-	Deleted	-	-
6.216	Analysis	Analytical Engineering Associates Final Report 80127-407 Seismic Qualification of MCB Zone "E", Seabrook, PSNH	-	8-28-81
6.217	Document	UE&C Device List for Main Control Board Front Section BF. DL-170-1-BF 9763-006-170-1D	-	10-28-83
6.218	York Drawing	York Electro-Panel as built drawing E-5133 MCB Front View Arrangement Zone B	6	1-25-82
6.219	Instruction	York Main Control Board Instruction Manual B/M Y-3860 MCB Zone B front sh 6 of 8	3	-
6.220	York Purchase Order	York Electro-Panel Purchase Order 34834, Master Specialties Co. Series 90K tellite lighted pushbuttons	-	11-17-80
6.221	Vendor Certificate	Harvey Electronics Certificate of Conformance P.O. #34834 Master Specialties Co. Series 90K switches	-	3-18-81
6.222	Letter	Letter of B. Jacobs (YEP) to D. H. Rhoads (UE&C), Status of Procurement of Materials YC-72 (Y-3637)	-	10-3-30
6.223	Letter	UE&C Letter to YEP, SBU-39779 MCB response to YC-72	-	10-15-80
6.224	Instruction	York Electro-Panel Main Control Board Instruction Manual B/M-Y-3860 MCB Zone B rear sh 7 of 7	3	-

Ref. No.	Document Type	Description/Title	Rev.	Date
6.225	York Purchase Order	York Electro-Panel, Purchase Order No. 36204 ETC Terminal Blocks Type 39TB-16	-	5-21-81
6.226	York Drawing	York Electro-Panel Physical Wiring Drawing MCB Zone B E5507 sh 6 of 17	3	2-12-82
6.227	York Drawing	York Electro-Panel Physical Wiring Drawing MCB Zone A E5507 sh 7 of 17	3	2-12-82
6.228	York Drawing	York Electro-Panel Physical Wiring Drawing MCB Zone A E5507 sh 7 of 17	2	2-10-82
6.229	York Drawing	York Electro-Panel Physical Wiring Drawing MCB Zone A E5507 sh 11 of 17	2	2-10-82
6.230	York Drawing	York Electro-Panel Physical Wiring Drawing E5506 sh 8 of 14 Terminal Block TA Points 2 and 5	2	2-10-82
6.231	UE&C Drawing	UE&C Schematic 9763-M-310944 Sh HD3a	2	12-17-82
6.232	York Drawing	York Electro-Panel Physical Wiring Drawing E5506 sh 9 of 14 Terminal Block TE Points 2 and 23	2	2-10-82
6.233	UE&C Drawing	UE&C Schematic 9763-M-310944 sh HD2a	2	12-17-82
6.234	York Drawing	York Electro-Panel Physical Wiring Drawing E5506 sh 8 of 14 Terminal Blocks TA Points 90, 91, 92	2	2-10-82
6.235	UE&C Drawing	UE&C Schematic Diagram 9763-M-310890 sh B48a	3	2-18-83
6.236	York Drawing	York Electro-Panel Physical Wiring Drawing E5507 sh 12 of 17 Terminal Block TA Points 106 and 107	3	2-12-82

Ref. No.	Document Type	Description/Title	Rev.	Date
6.237	UE&C Drawing	UE&C Schematic 9763-M-310868 sh E93/6a	1	8-8-83
6.238	York Drawing	York Electro-Panel Drawing E5507 sh 17 of 17 Terminal Block TW	3	2-12-82
6.239	UE&C Drawing	UE&C Schematic Diagram 9763-M-310882 sh E88/1a Pressurizer Steam Inboard	3	9-8-83
6.240	York Drawing	York Electro-Panel Physical Wiring Drawing E-5506 sh 8 of 14 Terminal Block TA Terminals 5, 7, 13, 18 and 2	2	2-10-82
6.241	UE&C Drawing	UE&C Schematic 9763-M-310890 Sh E87/7f SI Cold Leg Injection Valve FV-2427	1	1-18-83
6.242	York Purchase Order	York Electro-Panel Purchase Order 32958, Job Y-3637 Rockbestos Wire, Firewall SIS 19/S 20 AWG	-	4-1-80
6.243	York Purchase Order	York Electro-Panel Purchase Order 37036 Helistrand 2/C #16 T/P Wire (including P.O. 36374 dated 6-18-81)	-	9-25-81
6.244	York Purchase Order	York Electro-Panel Purchase Order 37041 Anaconda (SIS #12) (including P.O. 32696 dated 3-10-80)	-	9-28-81
6.245	Vendor Certificate	Helistrand Certificate of Conformmance IEEE-323(74) and IEEE-383(74) Qualification and Flame Test Data P.O. No. 37036	-	10-20-81
6.246	Test Report	Test Report of Electric Cables Insulated and Jacketed with Tefzel 280 Fluropolymer under IEEE-383(1974) P.O. 36374	-	9-1-74

Ref. No.	Document Type	Description/Title	Rev.	Date
6.247	Test Report	FIRL Test Report F-C4836-4 Qualification Test of FR-EP General Purpose Control Hookup and Switchboard Wire. P.O. 37041, 36064, 32696	-	1-78
6.248	Vendor Certificate	Certificate of Conformance Anaconda Ericson IEEE-323 and 383 Flame Test P.O. 32696	-	11-7-80
6.249	Vendor Certificate	Certificate of Conformance and Test Report Rockbestos P.O. 32958	-	1-30-81
6.250	UE&C Check Plan	UE&C Quality Control Vendor Surveillance - Check Plan Form 4505, 170-01	3	9-29-82
6.251	UE&C Procedure	UE&C Quality Assurance Procedure QA-7-2 Control of Purchased Material Vendor Surveillance	16	9-21-83
6.252	UE&C Spec.	UE&C Specification9763-006-171-1 Instrument Racks	3	3-14-80
6.253	QA Manual	Mercury Quality Assurance Manual Control Copy No. 34 Instrument Racks 9763-006-171-1 SBU-52069 UE&C VP 70732-06	3	2-13-81
6.254	Document	Mercury Job Description Rack and Panel Projects SNH-88-9763-006-171-1 Seabrook Unit No. 1 PSNH	2	10-11-83
6.255	Document	Mercury Document Status List Seabrook Unit No. 1	5	5-12-80
6.256	Mercury Drawing	Mercury Bill of Material Drawing DW-N19691-702, as built, Instrument Racks	3	12-3-82
6.257	Mercury Purchase Requisition	Mercury Purchase Requisition P.O. 66180, D. Yost States Company Terminal Blocks	-	12-12-80

Ref. No.	Document Type	Description/Title	Rev.	Date
6.258	Mercury Purchase Order	Mercury Purchase Order P.O. 66180-N19691 States Company Terminal Blocks	-	12-16-80
6.259	Mercury Purchase Requisition	Mercury Purchase Requisition P.O. 68306, D. Yost States Company Terminal Blocks	-	5-10-82
6.260	Mercury Purchase Order	Mercury Purchase Order P.O. 68306 States Company Terminal Blocks	-	5-10-82
6.261	Letter	Letter of W.C. Wright (States) to W. Pelrine (Mercury) ZWM Terminal Blocks	-	3-23-77
6.262	Memo	Telecon of D. Yost/W. Valday (Mercury) to S. Kasturi (UE&C) States Terminal Blocks	-	5-9-80
6.263	Letter	Letter of W. H. Valday (Mercury) to D. H. Rhoads (UE&C) Terminal Blocks	-	3-30-81
6.264	Notice	NRC IE Information Notice No. 80-08 The States Company Sliding Link Electrical Terminal Block	-	3-7-80
6.265	Letter	Letter of R. P. Neustadter (UE&C) to W. H. Valday (Mercury) SBU-43972 States Terminal Blocks	-	4-13-81
6.266	Letter	R. D. Libby (States) to D. Yost (Mercury) P.O. 66180 Terminal Blocks	-	5-12-81
6.267	Letter	Letter of W. H. Valday (Mercury) to D. H. Rhoads (UE&C) States Terminal Blocks	-	12-7-82
6.268	Telecon	Telecon of D. R. Michaud (Acton) to K. K. Parikh (UE&C). States Terminal Block Testing	-	9-23-82

Ref. No.	Document Type	Description/Title	Rev.	Date
6.269	UE&C Spec.	UE&C Specification 9763-006-129-1 Misc. Control Panels and Class 1E Terminal Boxes	-	-
6.270	Letter	Letter of G. Tsouderos (YAEC) to D. H. Rhoads (UE&C) States Terminal Blocks	-	11-18-82
6.271	NCR	UE&C QA Non-Conformance Report 1914 States Terminal Blocks	-	5-9-83
6.272	DCN	Design Change Notice 630057A States Terminal Blocks		2-9-83
6.273	Letter	Letter of A.M. Ebner (UE&C) to J. DeVincentis (YAEC) States Terminal Blocks SBU-73542	-	5-26-83
6.274	Letter	Letter of A. M. Ebner (UE&C) to J. DeVincentis (YAEC) Equipment Environmental Qualification SBU-78443	-	9-20-83
6.275	Memo	UE&C Memorandum from R.P. Neustadter to C.D. Greiman Class 1E Equipment List		11-7-83
6.276	U&EC Drawing	C-509037, Block Diagram	0	10-5-81
6.277	Barton Letter	ID16380, Mrs. R. Brenton to Mrssrs. Lewis & Stanley regarding anticipated aging and performance limits of Barton supplied instruments	-	12-12-83
6.278	Telephone Call	W.N.Fadden (YAEC), R.P.Neustatder (UE&C) with L. Stanley (IDI)	-	1-19-84
6.279	FSAR	RAI 420.3 (7.5.3.1)	45	6-82
6.280	Standard	ANSI/ANS-4.5-1980, "Criteria for Accident Monitoring Functions in Light-Water-Cooled Reactors"	-	1980

8.6.2 Personnel Interviewed

Name	Title	Organization
R. Bergeron	Sr. I&C Engineer	PSNH
E. Desmarais	Sr. Mechanical Engineer	PSNH
B. Beuchel	Sr. I&C Engineer	PSNH
W. N. Fadden	Sr. I&C Engineer	YAEC
F. D. Baxter	Engineering Manager	YAEC
W. Reed	Supervising Engineer	YAEC
W. G. Alcusky	I&C Engineer	YAEC
W. V. Sanchez	C&I Engineer	YEAC
J. O'Conner	Sr. Engineer	YAEC
G. Tsouderos	Lead Electrical Engineer	YAEC
H. E. Wingate	Asst. project Manager, Const.	YAEC
R. P. Neustadter	I&C SDE	UE&C
L. R. Varindairi	I&C Engineer	UE&C
V. N. Belavadi	I&C Engineer	UE&C
W. T. Laybourn, Jr.	I&C Engineer	UE&C
C. Balasubramanian	I&C Engineer	UE&C
H. Norton Parker	SDE, I&C BIPS	UE&C
J. Alberto Rios	I&C Engineer	UE&C
F. Tan	I&C Engineer	UE&C
G. Gupta	I&E Engineer	UE&C
C. Mariani	I&C Engineer	UE&C
G. Randall	I&C Engineer	UE&C
R. Sarker	I&C Engineer	UE&C
G. Trautman	I&C Design Supervisor	UE&C
A. Gallardo	I&C Engineer	UE&C
S. Ritger	I&E Engineer	UE&C
R. Cowperthwaite	I&C Engineer	UE&C
M. Scott	I&C Engineer	UE&C
G. M. Aggerwal	Electrical SDE	UE&C
G. Morris	Electrical Engineer	UE&C
C. Greiman	Lead EQ Engineer	UE&C
P. Milliken	EQ Engineer	UE&C
S. Molchanow	Electrical Engineer	UE&C
W. Brown	Mechanical Engineer	UE&C
I. R. Reed	Mechanical Engineer	UE&C
S. Rubenstein	QA Engineer	UE&C
R. Patel	Electrical Engineer, Wiring	UE&C
R. Chhilabhai	Electrical Engineer, Wiring	UE&C
V. K. Gupta	Main Control Board Coord.	UE&C
F. Lyons	Main Control Board Designer	UE&C
J. Jennings	Electrical Design Supervisor	UE&C
P. Fredericks	Chief I&C Engineer	UE&C
J. J. Gramsammer	Project Engineering Manager	UE&C

Name	Title	Organization
T. K. Darwish	Lead Elec. Site Engineer	UE&C
J. Linquist	I&C Site Engineer	UE&C
C. Baczewski	I&C Site Engineer	UE&C
J. Blankenstein	Lead I&C Site Engineer	UE&C
R. D. Stockamore	I&C Site Engineer	UE&C
S. Long	Site Support Engineer	UE&C
V. Bartasuis	Site Support Engineering	UE&C
T. R. Fisher	President, General Manager	Tobar, Inc.
J. H. Murphy	Vice President, Operations	Tobar, Inc.
K. Saylor	Supervisor, Product Integrity	Tobar, Inc.
A. E. Ellis	Acting Liaison, CCD to Tobar	Westinghouse CCD
K. McLean	Contract Administrator	ITT Barton
R. C. Brenton	Contract Administrator	ITT Barton
D. Hernandez	Technical Services Engineer	ITT Barton
E. A. Romo	Mgr., Transmitter Development	ITT Barton
L. Leyrer	Sr. Associate Engineer	ITT Barton
V. Nguyen	Sr. Electrical Engineer	ITT Barton
V. N. Lawford	Mgr., DPU/DCI Development	ITT Barton
W. E. Rushton	Sr. Project Engineer, Mech.	ITT Barton
M. Strayhorn	Mgr., Engineering Services	ITT Barton
G. R. Welt	Director, QA	ITT Barton
T. N. Miller	Acting Mgr. Class 1E Instrum.	West. NSID
R. Beacom	Lead Engineer	West. NSID
S. Oelich	Electrical Engineer	West. NSID
H. Merkel	President	Mercury
W. H. Valday	Project Manager	Mercury
L. P. Capron	QA Manager	Mercury
L. F. Maher	Design Supervisor	Mercury
D. Yost	Designer	Mercury
W. H. Pelrine	Electrical Engineer	Mercury
A. A. Pennewill	Electrical Engineer	York
J. M. Myers	QA Manager	York
S. Sauter	Mechanical Project Engineer	York
D. Enerode	Human Factors Engineer	NRC/NRR
D. Tondi	Supervising Engineering, H. F.	NRC/NRR
J. Knox	Electrical Engineer	NRC/NRR