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

APR 10 1975

R. C. DeYoung, Assistant Director for Light Water Reactors, Group 1, RL
V. A. Moore, Assistant Director for Light Water Reactors, Group 2, RL

STANDARD LETTER TO APPLICANTS CONCERNING PRIMARY SYSTEM PRESSURE RELIEF VALVE LOADS FOR PLANTS WITH MARK II TYPE CONTAINMENTS

Enclosed is a draft of a generic letter requesting applicants of plants with Mark II type containments to describe their design provisions to accommodate loads in the suppression pool resulting from operation of the primary system pressure relief valves. These loads are due to two distinct phenomena. First, pressure waves are generated within the suppression pool when, on first opening, relief valves discharge high pressure air followed by steam into the pool water. These are referred to as the steam vent clearing loads. Second, steam quenching vibrations can accompany extended relief valve discharge into the pool if the pool water is at an elevated temperature.

We have maintained periodic contact with GE on a generic basis regarding their progress in resolving these problems. Specific reviews of plants with Mark I type containments are being coordinated by Operating Reactors (OR) using a standard letter transmittal to each licensee. GE has stated in a letter to R. L. Tedesco from I. F. Stuart, dated March 10, 1975, that it has no contractual involvement in either the design or supply of Mark II containments in the U. S. We consider it necessary that a standard letter be transmitted to all Mark II applicants requesting information on loads due to relief valve actuation which may not have been fully considered at the time that CP's were issued. It is recommended that each applicant be informed of this outstanding issue and that their documentation be completed in a timely manner. The inference in the GE letter would indicate that this category of plants is proceeding on the basis of relief valve discharge line designs and load analyses done by their respective architect/engineers. This precludes a strictly generic review in this area and we therefore recommend that a standard letter, of the type enclosed, should be sent to the applicants for plants with Mark II type containments as listed below:

AFFECTED MARK II PLANTS

Shoreham
Zimmer
Hanford 2
Limerick, Units 1 & 2
Bailly, Unit 1
La Salle
Susquehanna, Units 1 & 2
Nine Mile Point 2





D-12

The review of relief valve loads for each plant covered by the standard letter should be initiated by a TAR from DRL to DTR and should include CSB, SEB, and MEB. The CSB contact for this effort will be Dr. L. Slegers.

Robert L. Tedesco, Assistant Director
for Containment Safety
Division of Technical Review

Enclosure:
As stated

cc: E. Case
F. Schroeder
A. Giambusso
S. Hanauer
R. Boyd
R. Maccary
G. Lainas
J. Glynn
J. Kudrick
J. Shapaker
L. Slegers
R. Cudlin
C. Grimes
C. Anderson
K. Goller
RL B/C's

## SAMPLE LETTER TO APPLICANT WITH MARK II CONTAINMENT

Gentlemen:

An ongoing review area for BWR plants with pressure suppression-type containments has been the capability of the suppression pool retaining structures to tolerate loads due to operation of the primary system pressure relief valves. Experience at several operating BWR plants has indicated that loads due to relief valve actuation may not have been fully considered in the structural design of the suppression chamber. In addition, the General Electric Company is now preparing to start a series of small-scale relief valve tests which will be used to verify analytical predictions of these loads as applicable to all classes of plants.

Pool dynamic loads due to relief valve operation are due to two distinct phenomena. First, pressure waves are generated within the suppression pool when, on first opening, relief valves discharge high pressure air followed by steam into the pool water. These are referred to as steam vent clearing loads. Second, steam quenching vibrations can accompany extended relief valve discharge into the pool if the water is at an elevated temperature. Enclosed are specific requests for information pertaining to these effects which we will require to evaluate your design with regard to these phenomena.

We believe that these developments warrant further consideration of your particular design of the Mark II containment at this time. Therefore, we are requesting that you provide us with the status of your design and planned course of action to ensure that your design will reflect the latest available information. This issue, which was not fully considered at the time that the CP was issued should be resolved prior to issuance of an OL. The attached list of questions is provided for the preparation of your response.

You should provide us within 30 days after receipt of this letter a schedule for submittal of the requested information. Please contact us if you desire additional discussion or clarification of the material requested.

Enclosure:
Request for Additional Information

## REQUEST FOR ADDITIONAL INFORMATION
## RELIEF VALVE LOADS

1. Specify the number of safety relief valves, their design flow rate, and discharge line size. Provide a listing of operating conditions under which these valves would be operated either manually or automatically. Describe, with the aid of drawings, the routing of the discharge line to, and orientation in, the suppression pool, and the design of the discharge line exit.

2. Provide the load specification for the suppression chamber structure to accommodate actuation of one or more safety relief valves.

3. Provide the design load capability for the suppression chamber structure.

4. Provide justification for the load specification given in (2) above by the use of appropriate experimental data and analysis. If the General Electric (GE) Company is responsible for specifying these loads, a statement to that effect is sufficient.

5. Identify, with the aid of drawings, any components or structures in the suppression pool region, other than the bounding walls of the suppression chamber, and the location of such components relative to the relief valve discharge line exits. Discuss the structural capability of these components to accommodate loads due to relief valve actuation.

6. Estimate the maximum number of single and multiple relief valve openings over the life of your plant.

7. Identify the maximum temperature limits of the suppression pool with the reactor at power. This temperature limit should include provisions for the testing requirements of relief valves.

8. Specify the operator actions that are planned when specified temperature limits are exceeded.

9. Present the temperature transient of the suppression pool starting from the specified limits in (1) for the following transients:

   (a) main steam line isolation;

   (b) semi-automatic blowdown; and,

   (c) stuck open relief valve.

   For purposes of this analysis, the minimum water level should be assumed in the suppression pool.

10. The temperature instrumentation that will be installed in the pool and the sampling or averaging technique that will be applied to arrive at a definitive pool temperature.

SUSQUEHANNA SES
CONTAINMENT MS/RV LOAD DEFINITION PROGRAM

Meeting Agenda

Date:

Place: USNRC Offices
Bethesda, Maryland

Attendees: USNRC, Kraftwerk Union, Bechtel, Stanford Research Institute International, PP&L

Agenda:

I. Opening Remarks — E. M. Mead/PP&L

- A. History of SSES Containment
- B. Modifications
- C. Mark II Program
- D. SRI Effort
- E. KWU Effort
- F. DAR

II. SRI Presentation

- A. Overview — Dr. G. R. Abrahamson/SRI
- B. MS/RV Load Mitigation Assessment — Dr. G. R. Abrahamson/SRI; Dr. T. J. Connolly/SRI; Dr. A. T. Leonard/SRI
- C. Bubble Physics Experiments — Dr. G. R. Abrahamson/SRI

III. Bechtel Assessment — J. A. Weyandt/Bechtel

- A. Design Margin Maximization
- B. Quencher
- C. Susquehanna Program

IV. MS/RV Load Definition — Dr. Becker/KWU; Dr. Koch/KWU

- A. Existing Data Base
- B. Susquehanna Unique Quencher (Thermal Performance)
- C. Design Methodology
- D. Second Pop
- E. Verification Program (Karlstein Test) — Dr. Simons/KWU

V. Method used to Calculate Pool Boundary Loads

A. Overview
B. Computer Models
C. Application

J. A. Weyandt/Bechtel
Dr. B. Harper/Bechtel
Dr. H. Safwat/Bechtel

VI. SSES Quencher Design

J. A. Weyandt/Bechtel

A. Codes
B. Hold Down
(Slip Joint)

VII. Wrap Up

E. M. Mead/PP&L

VIII. Comments

USNRC

SUSQUEHANNA SES
CONTAINMENT MS/RV LOAD DEFINITION PROGRAM

PP&L OBJECTIVES

1. Overall explaration of entire PP&L Containment Program including Mark II interface and schedules.

   a. Review of past history to arrive at present course.
   b. Future activities and schedule.

2. PP&L will discuss load definitions rather than structural response.

3. Explain PP&L approach to total design margins.

4. Explain PP&L unique quencher design.

5. Explain existing analytical and test basis to support unique quencher approach.

6. Explain PP&L unique verification program at Karlstein.

7. Explain Stanford Research International bubble physics experiments.

NRC FEEDBACK

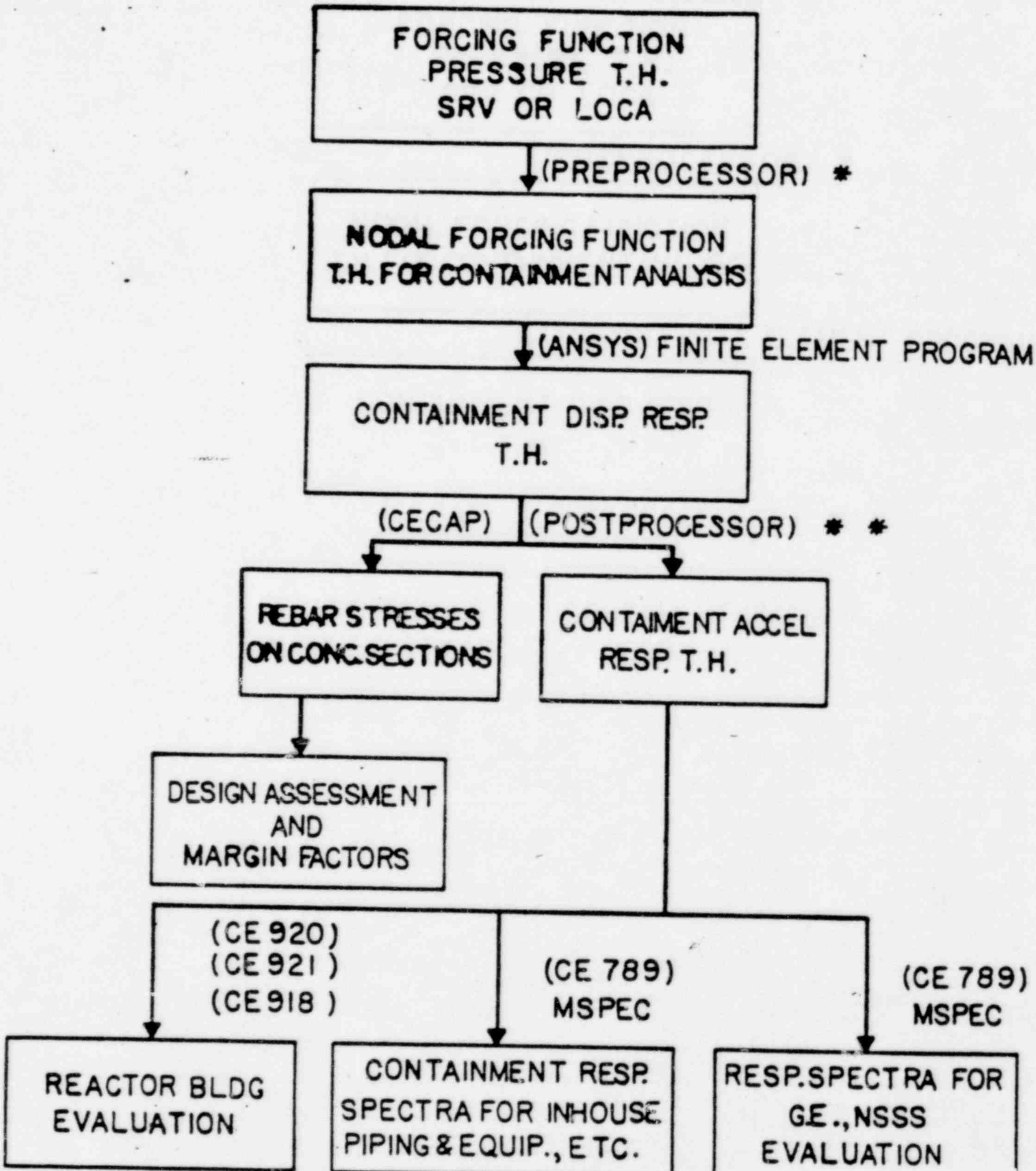
1. Comments from NRC on Overall program and schedule.

2. Comments from NRC on the Karlstein verification program for Susquehanna SES unique quencher.

INFORMATION SUBMITTAL

1. Give proprietary documentation to the NRC that is supportive to the Susquehanna SES unique quencher design.

## SRV AND LOCA LOADS
## STRUCTURAL ANALYSIS FLOW CHART




* A COMPUTER PROGRAM TO CONVERT PRESSURES TO FORCES

** A COMPUTER PROGRAM TO CALCULATE ACCELERATIONS FROM DISPLACEMENTS

Name: Dr. Manfred Becker

Present Position: Senior Supervising Engineer
Kraftwerk Union
Berliner Strasse 295-299
D-6050 Offenback (Main) FRG

Education: Technical University Aachen
Post-Graduate work and Ph.D.
Institut fur Luft-und Raumfahrt
Technische Hochschule Aachen
(Institute for Aeronautics and Space Research, Technical University Aachen)

Experience: 1972 - Present - Kraftwerk Union
1965-1972 Assistant at Institute for Aeronautics and Space Research, Technical University
1958-1965 Student at Technical University Aachen

Name: Jack A. Weyandt

Present Position: Assistant Project Engineer
Susquehanna Project
Bechtel San Francisco Power Division

Education: BSME - University of California - Berkelery

General: Registered Professional Engineer - State of California

Experience: 1965 - Present - Bechtel Corporation

1951 - 1965 - Kaiser Engineers

Name: B. E. Harper

Present Position: Head of Mechanical Analysis Groups
Mechanical/Nuclear/Plant Design Staffs
Bechtel San Francisco Power Division

Education: Ph.D. University of California
M.S. Mass. Institute of Technology
B.S. University of Mississippi

General: Registered Professional Engineer - California
Publications with American Nuclear Society and American Society of Mechanical Engineers

Experience: Bechtel Power Corporation 1970 - Present.
Atomics International 1958-1970
MIT Research Laboratories 1954-1958
U.S. Navy - Electronics Officer 1951-1954

Name: Girish Shah

Education: Received M.S. and Engineer's degrees from Stanford University in 1965 and 1966.

General: Has Professional Licenses in states of California and Pennsylvania

Experience: Joined Bechtel in June 1965. Has worked on Palisades, Turkey Point, Point Beach, Arkansas and Quanicessee Nuclear Plants. Deeply involved in the design of of Prestressed PWR Containment.

Present Position: Civil Group Supervisor on SSES project

Name: Wm. L. Penn

Education: BS, Mechanical Engineering, U.S. Naval Academy,
JD, University of San Francisco

Experience: 1965 - 68 Engineering Department officer of a nuclear powered submarine

1968 - 70 Chief Engineer of a nuclear powered submarine

1970 - 72 Special Assistant to Commander-in-Chief Atlantic for undersea warfare, nuclear powered (submarines), special weapons, and intelligence

1972 - 77 In charge of Bechtel Standard Safety Analysis Report (BESSAR)

**Name**: George Abrahamson

Present Position: SRI International
Director, Poulter Laboratory

Education: Stanford University
Ph.D. Engineering Mechanics, 1958

General: Member, ANS, ASME

Experience: 1953 to present - SRI International
1958 - 1968 - Head, Engineering Mechanical Group
1969 - present - Director, Poulter Laboratory

Poulter Laboratory is a group of 70 persons specializing in theoretical and experimental research in explosions, shock waves, and structural responses.

Name: A. Leona.'

Present Position: Research Scientist in computational fluid dynamics, NASA Ames Research Center, Moffett Field, California Consulting Associate Professor, Mechanical Engineering, Stanford University Consultant, SRI International and Nuclear Energy Division, General Electric Company

Education: California Institute of Technology, B.S. Mechanical Engineering Stanford University, M.S. Engineering Science, Ph.D. Nuclear Engineering

General: Registered Professional Engineer (Nuclear), State of California Member, American Physical Society, Society for Industrial and Applied Mathematics

Experience: 1963-66 RAND Corporation, Santa Monica, Cal., Technical Staff
1966-73 Assistant and Associate Professor in Nuclear and Mechanical Engineering, Stanford University
1973-Present NASA Ames

Additional Consulting: RAND Corporation, Calspan Corporation, Buffalo, N.Y.

Name: T. J. Connolly

Present Position: Professor and Associate Chairman
Mechanical Engineering Department
Stanford University
Stanford, CA 94305

Education: B.Ch.E. Syracuse University
M.S.Ch.E. Carnegie Tech.
PhD, Ch.E. California Institute Tech.

General: Registered Professional Engineer, State of California
Member, American Nuclear Society

Experience: Engineering Faculty, UCLA 1950-59
Engineering Faculty, Stanford, 1959 - Present
One year leaves at:
- Atomics International
- Joint Establishment for Nuclear Energy Research (Norway)
- Kernforschungszentrum Karlsruhe

Name: E. M. Mead

Present Position: Project Engineering Manager - Susquehanna Steam Electric Station, Pennsylvania Power & Light Co., 2 North 9th Street, Allentown, Pennsylvania

Education: Bucknell University
B.S. in Electrical Engineering

General: Registered Professional Engineer, Commonwealth of Pennsylvania
Member, American Nuclear Society
Member, American Society of Mechanical Engineers
Member, Institute of Electrical and Electronic Engineers

Experience: 1963 to Present - PP&L Co. - Nuclear related work
1952 to 1963 - PP&L Co.

Name: H. W. Holland

Present Position: Nuclear Mechanical Project Engineer - Susquehanna Steam Electric Station, Pennsylvania Power & Light Co., 2 North 9th Street, Allentown, Pennsylvania

Education: B.S. ME Drexel University
M.S. ME Stanford University

General: Registered Professional Engineer, State of Pennsylvania
Member, American Nuclear Society
Member, American Society of Mechanical Engineers
Member, American Welding Society

Experience: 1972 to present - PP&L Co. - Susquehanna Steam Electric Station Design
1971 - Mobil Oil Corporation - New Refinery Construction Co-ordination

Name: Dietrich Gobel

Present Position: Kraftwerk Union
Offenbach (West Germany)
Berliner Str. 297-299

Education: Technische Hochschule
Darmstadt
Allgemeiner Maschinenbau

Experience: Employed by Kraftwerk Union
Since April 1972

History

A. SRV stuck open during startup in April 1972

   1. Suppression pool water heated to 170°F in 30 minutes.
   2. Large pulsating forces developed.
   3. 30 sq. in. leak in bottom liner plate.

B. NRC issued Bulletin 74-14 to all BWR Operators November 14, 1974, alerting them to the "Wurgassen effect."

C. GE identified several dynamic loading conditions in January, 1975, one of which was SRV discharge thermo-hydrodynamic phenomena, concerning Mark II design criteria.

D. PP&L altered Containment construction sequence to ascertain the effect of the new phenomena.

E. Task force formed with PE/Bechtel/PP&L in March, 1975.

F. Part of the brute force approach, the following civil-structural modifications were incorporated into the Susquehanna in May, 1975.

   1. Added 60 vertical reinforcing bars in suppression chamber (each containment).
   2. Added embedments and anchor bolts in suppression chamber walls and Diaphragm Slab.
   3. Diaphragm Slab reinforcement changed from 45° to 90° to increase uplift loadings.

G. In June, 1975, the Mark II Owners Group were formed to define suppression pool dynamic loads and find ways of mitigating them.

H. A generic Dynamic Forcing Function Information Report (Rev. 1) was jointly issued by GE/Sargent & Lundy/Mark II Owners to the NRC on March 15, 1976.

I. More supportive data issued in DFFR Rev. 2 on September 1, 1976.

## THE PROBLEM

1. It is our opinion, that the greatest load amplitudes for containment are from the SRV's.

2. Mark II program has an SRV mitigating device called a quencher.

3. There is a testing program task(s) for this mitigating device.

4. We felt these program tasks have not been timely for our construction schedule.

5. We were concerned that some testing is not directly within Mark II control.

6. Mark II lead plants presently need all the resources available to complete their analysis, testing and licensing. This is for completion of the short term program. Socn the resources will be turned toward the long term program.

7. On April 21, 1977 these items were informally discussed with the NRC.

## OUR APPROACH

1. All quencher designs are based on KWU data..

2. PP&L has purchased from KWU a quencher design for SSES.

3. PP&L has contracted with KWU for additional verification testing of their device to provide additional design margin verification.

(Continued)

## KWU TESTS AND REPORTS

| Activity | Documentation | Status |
|---|---|---|
| 1. Formation and Oscillation of a sperical gas bubble | AEG - Report No. 2241 | Complete |
| 2. Analytical model for clarification of pressure pulsation in the westwell after vent clearing | AEG - Report No. 2208 | Complete |
| 3. Tests on mixed condensation with model quenchers | KWU - Report No. 2593 | Complete |
| 4. Condensation and vent clearing tests at GKM with quenchers | KWU - Report No. 2594 | Complete |
| 5. Concept and design of the pressure relief system with quenchers | KWU - Report No. 2703 | Complete |
| 6. KKB vent clearing with quencher | KWU - Report No. 2796 | Complete |
| 7. Tests on condensation with quenchers when submergence of quencher arms is shallow | KWU - Report No. 2840 | Complete |
| 8. KKB - Concept and task of pressure relief system | KWU - Report No. 2871 | Complete |
| 9. Experimental approach to vent clearing in a model tank | KWU - Report No. 3129 | Complete |
| 10. KKB - Specification of blowdown tests during non-nuclear hot functional test - Rev. I dated Oct. 4, 1974 | KWU/V 822 Report, Not Numbered | Complete |

(Continued)

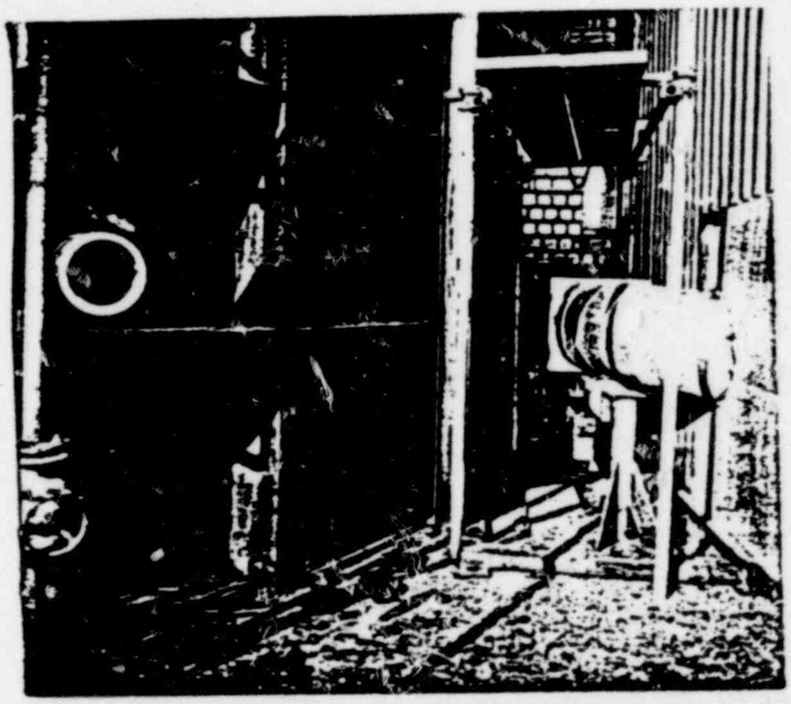
## KWU TESTS AND REPORTS

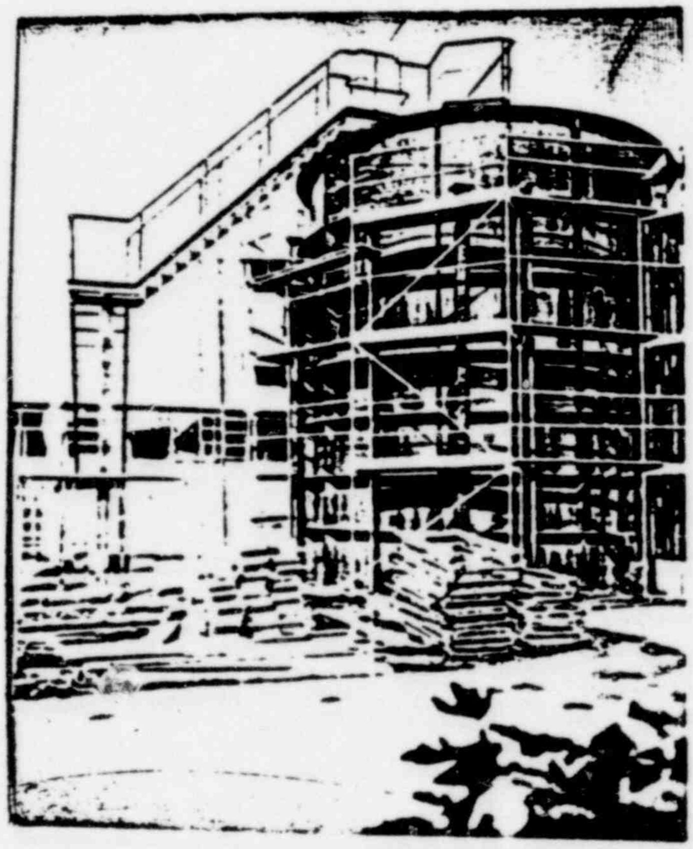
| Activity | Documentation | Status |
|---|---|---|
| 11. Anticipated data for blowdown tests with pressure relief system during the non-nuclear hot functional test at nuclear power station Brunsbuttel | KWU - Report No. 3141 | Complete |
| 12. Results of the non-nuclear hot functional tests with the pressure relief system in the nuclear power station Brunsbuttel | KWU - Report No. 3267 | Complete |
| 13. Analysis of the loads measured on the pressure relief system during the non-nuclear hot functional test at KKB. | KWU - Report No. 3346 | Complete |
| 14. KKB - Listing of test parameters and important test data of the non-nuclear hot functional tests with the pressure relief system | KWU - Working Report R 521/40/77 | Complete |
| 15. KKB - Specification of additional tests fo testing of the pressure relief valves during the nuclear start-up Rev. 1 | KWU/V 822 TA, Not Numbered | Complete |
| 16. KKB - Results from nuclear start-up testing of pressure relief system | KWU - Working Report R 142-136/76 | Complete |

(Continued)

KWU TESTS AND REPORTS

| Activity | Documentation | Status |
|---|---|---|
| 17. Nuclear Power Station Phillipsburg - Unit 1 Hot Functional Test: Specification of pressure relief valve tests as well as emergency cooling and wetwell cooling systems | KWU/V 822/RF 13, Not Numbered | Complete |
| 18. Results of the non-nuclear hot functional tests with the pressure relief system in the nuclear power station Phillipsburg | KWU - Working Report R 142-38/77 | Complete |
| 19. KKPI - Listing of test parameters and important test data of the non-nuclear hot functional tests with the pressure relief system | KWU - Working Report R 521/41/77 | Complete |
| 20. Air oscillations during vent clearing with single and double pipes | AEG - Report No. 2327 | Complete |





SUSQUEHANNA STEAM ELECTRIC STATION

DRAFT

Contents of DAR — Submittal to NRC

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| 4.4 | KWU Testing Program | January, 1978 |
| 4.5 | Mark II Owners Supporting Program | January, 1978 |
| 5.0 | Design Assessment | |
| 5.1 | Loads | January, 1978 |
| 5.2 | Design Load Combinations | |
| 5.2.1 | Containment | 3Q 1978 |
| 5.2.2 | Structural Steel | 3Q 1978 |
| 5.2.3 | Liner Plate | 3Q 1978 |
| 5.2.4 | Downcomer Pipes | 3Q 1978 |
| 5.2.5 | Quencher Support | 3Q 1978 |
| 5.2.6 | Piping Systems | 3Q 1978 |
| 5.2.7 | NSSS (RPV, Recirc. Line & Pumps) | 3Q 1978 |
| 5.2.8 | Equipment | 3Q 1978 |
| 5.3 | Components Evaluated | |
| 5.3.1 | Containment Structure | 3Q 1978 |
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| 5.4 | Reactor Building Evaluation | 3Q 1978 |
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| 6.2 | Steel Structures | January, 1978 |
| 6.3 | Liner Plate | January, 1978 |
| 6.4 | Downcomer Pipes | January, 1978 |
| 6.5 | Quencher Support | January, 1978 |
| 6.6 | Piping Systems | 3Q 1978 |

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|---|---|---|
| 6.7 | NSSS | 3Q 1978 |
| 6.8 | Equipment | 3Q 1978 |
| 6.9 | Reactor Building | January/3Q 1978 * |
| 7.0 | Analysis Methodology | |
| 7.1 | Load Definition | January, 1978 |
| 7.2 | Containment | January, 1978 |
| 7.3 | Downcomer Pipes | January, 1978 |
| 7.4 | Quencher Support | January, 1978 |
| 7.5 | Piping | 3Q 1978 |
| 7.6 | NSSS | 3Q 1978 |
| 7.7 | Equipment | 3Q 1978 |
| 7.8 | Reactor Building | January/3Q 1978 |
| 8.0 | Margins Evaluation | 3Q 1978 |
| 9.0 | Computer Program Verification | January/3Q 1978 |
| 10.0 | References | January/3Q 1978 |
| 11.0 | NRC Questions and Answers | January/3Q 1978 |

*January/3Q 1978 signifies partial completion for the first submittal (In the case of the reactor building, the structure analysis will be completed before the systems analysis).

# REASONS FOR GOING TO QUENCHER FOR MSRV DISCHARGE

- LOWER LOADS ON CONTAINMENT, STRUCTURES, PIPING & EQUIPMENT
- INCREASED DESIGN MARGINS AND REDUCED BACKFITTING
- INCREASED POOL OPERATING TEMPERATURE
  FEWER OPERATION RESTRICTIONS
- LINER PLATE STIFFENING NOT REQUIRED
- MARK III PLANTS USING QUENCHERS
- ADEQUATE BACKGROUND FOR QUENCHER DESIGN
  (TESTING & ANALYSIS)
- LOWER "SECOND POP" LOADS
- CONTROL SCHEDULE IS BETTER

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