COOPER NUCLEAR STATION
WETWELL-DRYWELL
VACUUM BREAKER VALVES

LONG-TERM PROGRAM
STRUCTURAL EVALUATION

Prepared for:

Kaiser Engineers, Inc.

Prepared by:

EDS Nuclear Inc.
350 Lennon Lane
Walnut Creek, California 94598

April 1983
EDS Report No. 04-0640-0062
Revision 1

TABLE OF CONTENTS

1.0 INTRODUCTION

This report, prepared by EDS Nuclear Inc. (EDS) for Kaiser Engineers, describes the plant-unique structural evaluation of the Cooper Nuclear Station GPE 18" Wetwell-to-Drywell Vacuum Breaker Valves for hydrodynamic loads associated with a postulated Loss-of-Coolant Accident (LOCA). In addition, seismic and normal operating loads are also considered. The evaluation is performed for the existing vacuum breakers which have already been modified once. These modifications include replacement of the hinge shaft and hinge arms with higher strength materials and the securement of all fasteners. The vacuum breaker-vent header intersection has been previously qualified in the vent header evaluation. As a result of this plant-unique final evaluation, the vacuum breaker valves are shown to meet the design requirements.

2.0 SCOPE OF WORK

The objective of this work is to assist Nebraska Public Power District in complying with the Mark I Containment Program requirements by qualifying the GPE vacuum breaker valves installed at Cooper Nuclear Station. In Cooper Nuclear Station, the GPE wetwell-to-drywell vacuum breakers are located in the wetwell, cantilevered from the main vent header. Figure 1 illustrates their relative position inside the Mark I Containment. A schematic of the GPE vacuum breaker is shown in Figure 2. The vacuum breaker is basically a check valve permitting gas to flow into the drywell only. During a postulated Loss-of-Coolant Accident (LOCA), the vacuum breaker will be exposed to a drywell/wetwell pressure differential as shown in Figure 3. This pressure transient is comprised of a number of different phenomenon which result in different loadings to the vacuum breakers valves and their components. This report describes the structural evaluation of the vacuum breaker valves.

3.0 APPLICABLE CODES

The Code of Record as per Reference 1 is the ASME Code, Section III, Subsection NC-3500, for Class 2 components up to and including the Summer 1977 Addenda.

In addition, Code Case N-62-2 (1621-2), "Internal and External Valve Items Section III, Division 1, Class 1, 2, and 3 Line Valves", approved May 15, 1980, was used in the evaluation.

4.0 DESIGN LOADS

The loads acting on the vent system and on the vacuum breaker valves are extensively described in Reference 2, which is based upon the Mark I Program Load Definition Report (Reference 3) and the NRC Acceptance Criteria (Reference 4). The loads acting on the vacuum breakers include gravity, seismic, and hydrodynamic loads. The hydrodynamic loads consist of direct fluid loads acting on the vacuum breakers and hydrodynamically-induced vent header accelerations at the vacuum breaker penetrations. The hydrodynamically-induced pallet impact loads were also considered. These loads were based on the pallet impact velocities provided in Reference 5. A table of the load cases and load combinations considered is provided in Reference 6.

5.0 VACUUM BREAKER EVALUATION

The evaluation is performed for the following valve components:

1. Pallet
2. Hinge Arm
3. Hinge Shaft
4. Hinge Arm Studs
5. Valve Seat Bolts

These components are considered critical from the point of view of responding at a significant level to at least one of the design loads.

The loads are combined in the structural evaluation as per Reference 6, and the resulting stress values obtained are compared to the stress limits as per References 7 and 8.

A summary of the governing stresses for the five valve components is provided in Table 1 for the significant design loads. Table 2 provides the critical stresses together with the stress allowables for the governing load combinations. Stresses induced to the pallet, hinge shaft, and hinge arm by impact loading from chugging were evaluated by finite element analyses using the ANSYS computer program. A detailed finite element model of the pallet, hinge arm, and hinge shaft was developed using plate and beam elements. A transient analysis was performed to compute the stresses in these components due to the impact load. Stresses associated with the remaining load cases were evaluated by a static or equivalent static analysis. Stresses in the hinge arm studs and valve seat bolts were evaluated based on the corresponding response of the hinge arm and pallet to the static and dynamic induced loadings. A summary of the evaluations for each of the components is provided next.

Pallet

The pallet was evaluated for the impact loading due to chugging and for the pressure differential following a postulated LOCA. The pallet was found to qualify.

Hinge Shaft

The hinge shaft was analyzed for seismic, gravity, and hydrodynamically-induced loads. The shaft was found to qualify.

Hinge Arm

The hinge arms were evaluated for gravity, seismic, and hydrodynamically-induced loads. The hinge arms were found to qualify.

Hinge Arm Studs

The studs for the hinge arm were evaluated for gravity, seismic, and hydrodynamically-induced loads. The studs were found to qualify.

Valve Seat Bolts

The twenty valve seat bolts were evaluated for loads due to seismic, to pressure differential across the vacuum breaker pallet, and to pallet impact on the pallet seat. The bolts were found to qualify.

6.0 CONCLUSIONS

The existing 18" GPE Wetwell-to-Drywell Vacuum Breaker Valves at Cooper Nuclear Station have been found to meet the design requirements; no modifications are required.

7.0 REFERENCES

1. "Mark I Containment Program Structural Acceptance Criteria, Containment System Design Rules and Classification, Task Number 3.1.3", General Electric Report NEDO-24522, April 1978.

2. "Cooper Nuclear Station, Thermal Hydraulic Load Definition for Vent System, Torus Shell, and Structures within the Torus (Worker Order No. 14)", EDS Nuclear Report No. 01-0640-1071, Revision 1, November 1981.

3. "Mark I Containment Program, Load Definition Report", NEDO-21888, Class I, Rev. 1, March 1980.

4. "Safety Evaluation Report, Mark I Containment Long-Term Program", U.S. Nuclear Regulatory Commission, NUREG-0661, July 1980.

5. "Improved Dynamic Vacuum Breaker Valve Response for Cooper", Rev. 0, Continuum Dynamics, Inc., Tech Note 82-31, October 1982.

6. "Mark I Containment Program Structural Acceptance Criteria Plant-Unique Analysis Applications Guide, Task Number 3.1.3", General Electric Report NEDO-24583-1, October 1979.

7. ASME Code Case N-62-2 (1621-2), "Internal and External Valve Items, Section III, Division I, Class 1, 2, and 3 Line Valves," approved May 15, 1980.

8. ASME Code, Section III, Subsection NC-3500, up to and including the Summer 1977 Addenda.

TABLE 1

Load	STRESSES (psi)				
	Pallet	Hinge Arm	Hinge Shaft	Hinge Arm Studs	Pallet Seat Bolts
1. Gravity	-	799	1,959	729	-
2. Earthquake (SSE)	-	165	392	302	-
3. S/RV	-	-	-	-	-
4. Pool Swell	-	6,641	17,991	12,115	-
5. Condensation Oscillation	106	1,475	10,299	7,896	169
6. Chugging	20,984	14,750	25,000	13,491	13,371
7. Pressure (LOCA-induced following DBA)	1,276	-	-	-	2,032

TABLE 2

	STRESSES (psi)				
	Pallet	Hinge Arm	Hinge Shaft	Hinge Arm Studs	Pallet Seat Bolts
Material	SA-516 Gr 70	SA-516 Gr 70	SA-479 MX19	SA-516 Gr 70	SA-320 B8
Allowable S_h	17,500	17,500	25,000	17,500	15,000
Service Level A					
Load Combination (1 + 6 + 7)	22,260	15,549	26,959	14,220	15,403
Allowable (1.5 x S_h)	26,250	26,250	37,500	26,250	22,500
Stress Ratio	0.85	0.59	0.72	0.54	0.68
Service Level B					
Load Combination (1 + 0.5 * 2 + 6 + 7)	22,260	15,632	27,155	14,371	15,403
Allowable (1.65 x S_h)	28,875	28,875	41,250	28,875	24,750
Stress Ratio	0.77	0.54	0.66	0.50	0.62
Service Level C					
Load Combination (1 + 2 + 6 + 7)	22,260	15,714	27,351	14,522	15,403
Allowable (1.8 x S_h)	31,500	31,500	45,000	31,500	27,000
Stress Ratio	0.71	0.50	0.61	0.46	0.57

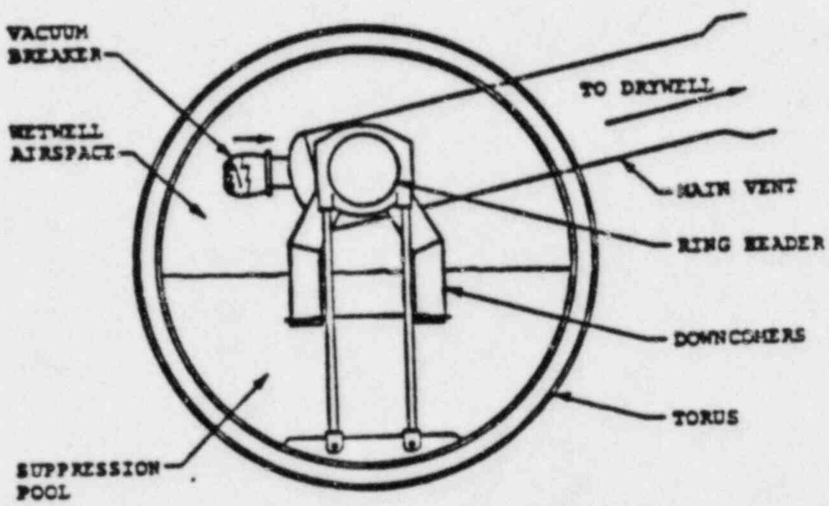

FIGURE 1
Location of Mark I Wetwell-to-Drywell Vacuum Breaker

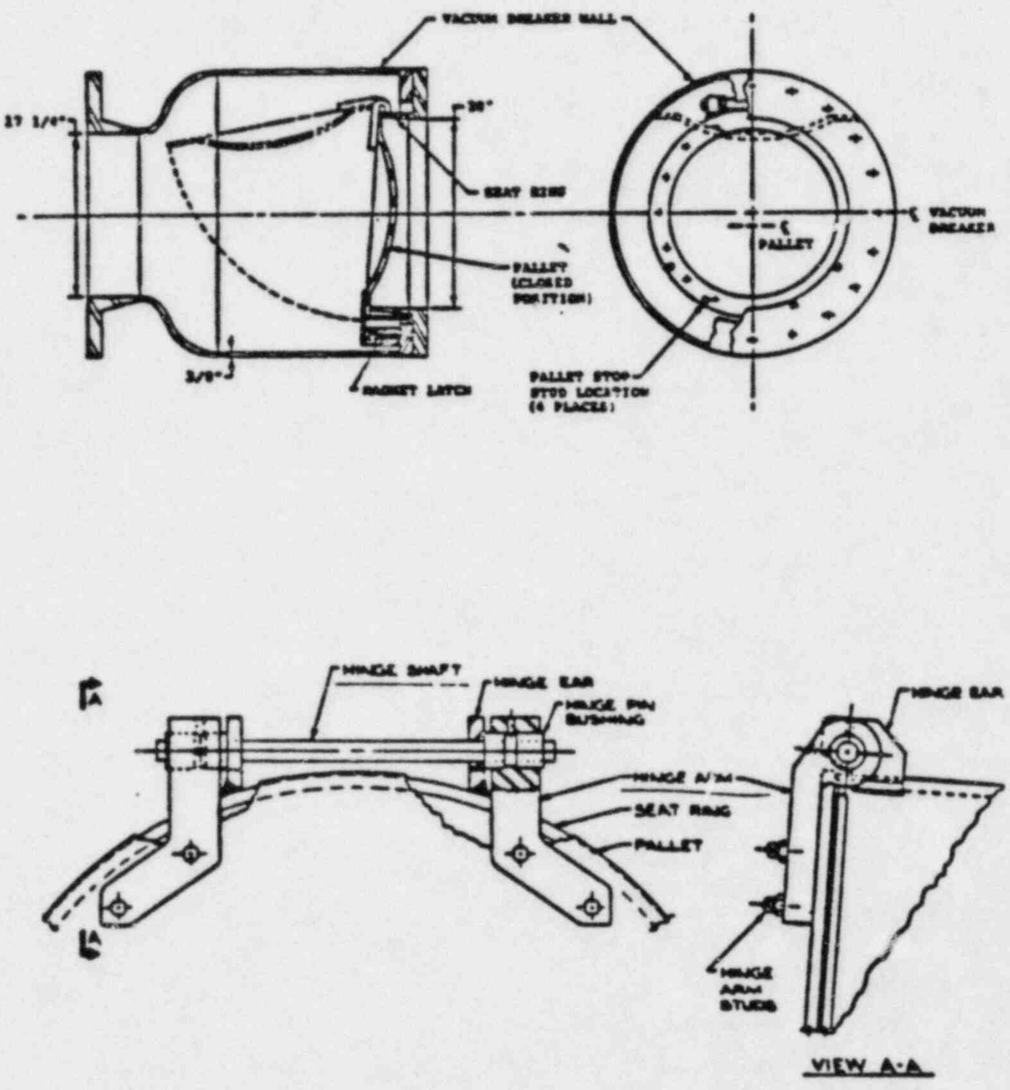

FIGURE 2
General Configuration of Vacuum Breaker

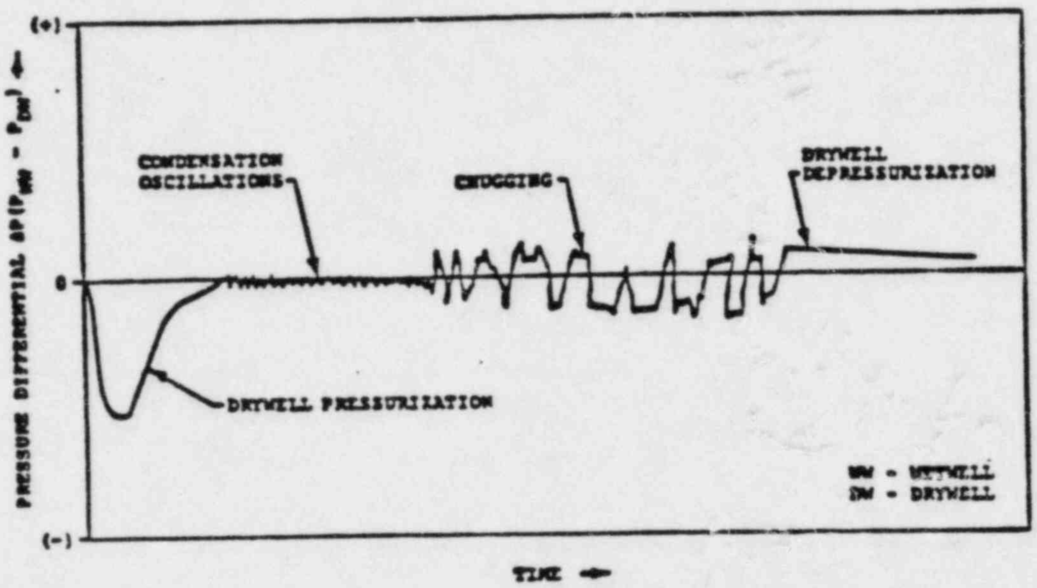

FIGURE 3
Typical Pressure Differential Across Vacuum Breaker During LOCA