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U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555-0001

Subject: **Beaver Valley Power Station, Unit No. 1**
Docket No. 50-334, License No. DPR-66
Completion Report for Generic Letter 87-02,
USI A-46 Program

References:

1. BV-1 Summary Report for Resolution of Unresolved Safety Issue A-46, letter dated January 31, 1996
2. BV-1 Response to January 10, 1997 NRC Request for Additional Information Regarding Unresolved Safety Issue A-46, letter dated May 16, 1997
3. BV-1 Response to March 4, 1998 NRC Request for Additional Information Regarding Unresolved Safety Issue A-46, letter dated June 2, 1998
4. NRC Safety Evaluation for USI A-46 Program Implementation at BV-1, letter dated December 9, 1998 (TAC No. M69428)

This letter provides the Beaver Valley Power Station Unit 1 (BV-1) completion report for the closure of Generic Letter (GL) 87-02, "Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors, Unresolved Safety Issue (USI) A-46" as required by the Seismic Qualification Utility Group (SQUG) program.

The Completion Report (Attachment 1) provides the final resolution of specific items identified in References 1 through 3. The Updated Outlier Resolution Tabulation (Attachment 2) provides the final resolution of the outliers identified in Reference 1. Attachments 1 and 2 identify those outliers for which the probable resolution option was not originally identified in References 1 through 3 or a different option was chosen during the resolution process. For those other outliers (not listed in Attachments 1 and 2), the resolution implemented was as previously described. The relay tabulation portion of Attachment 2 includes the resolutions for all of the relays identified in Reference 1, and is included for information due to changes in some of the relays' status from essential to non-essential.

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Where outlier resolution involved the use of the seismic experience database beyond that which the NRC had previously approved for the Generic Implementing Procedure (GIP), the NRC's SSER-2 on the GIP required submittal of such data to the NRC. Therefore, Attachment 3 provides an analysis of the experience database to identify damper configurations that were subject to earthquake input that exceeded anticipated BV-1 seismic levels, without detrimental effect. Since the BV-1 dampers have similar configurations to the dampers that have been found to seismically perform their intended function, they are considered seismically acceptable. The NRC was informed of BV-1's intent to address damper outliers in this manner in Reference 1, Section 5.3.1.4. Attachment 4 provides the analysis for over-sized panels, in which BV-1 committed to submit to the NRC as an outlier resolution in Reference 2.

Reference 4 documented the NRC's safety evaluation regarding USI A-46 program implementation at BV-1 and closed the USI A-46 review for BV-1. With the submittal of this completion report in accordance with the SQUG program, FirstEnergy Nuclear Operating Company (FENOC) considers USI A-46 resolved for BV-1.

If there are any questions concerning this completion report, please contact Mr. T. S. Cosgrove at (724) 682-5203.

Sincerely,

Lew W. Myers

Attachments

c: Mr. D. S. Collins, Project Manager
Mr. D. M. Kern, Sr. Resident Inspector
Mr. H. J. Miller, NRC Region I Administrator

Attachment 1

Beaver Valley Power Station Unit 1 (BV-1)
Generic Letter 87-02, USI A-46 Completion Report

References:

1. BV-1 Summary Report for Resolution of Unresolved Safety Issue A-46, letter dated January 31, 1996
2. BV-1 Response to January 10, 1997 NRC Request for Additional Information (RAI) Regarding Unresolved Safety Issue A-46, letter dated May 16, 1997
3. BV-1 Response to March 4, 1998 NRC Request for Additional Information Regarding Unresolved Safety Issue A-46, letter dated June 2, 1998
4. NRC Safety Evaluation for USI A-46 Program Implementation at BV-1, letter dated December 9, 1998 (TAC No. M69428)

The following provides descriptions of the final resolutions of the Beaver Valley Power Station Unit 1 (BV-1) outliers specifically discussed in the above referenced letters.

1. Reference 1, Section 5.3.1.5 and Reference 3, Item 1 - Loss of air supply to seven (7) essential Air-Operated Valves (AOV) requires operator action. The procedural guidance for required operator action was reviewed and found to be adequate for the affected valves. However, to minimize the effect of having the charging flow control AOV fail open, a procedure was revised to have the operator use associated manual valves to control flow. Since charging will increase pressurizer level until letdown can be established, procedural guidance to allow a 75% pressurizer maximum level prior to boration was added.

2. Reference 1, Sections 5.3.1.8 & 5.3.1.9 - Construction joints in the floor near equipment anchors were treated as free-edges under SQUG criteria, reducing bolt capacity to zero. Analysis of the components involved showed that no uplift existed on the affected anchors. Therefore, joint effects were inconsequential. In addition, rebar scanning proved that reinforcing steel was, in fact, continuous through the joint, which would make the concrete effective for pullout loads were they to occur. The anchors also had Quality Control markings indicating successful tension testing at installation.

3. Reference 2, Item 2 - The calculation of tank deflection proved that an "abandoned strut" (tubing tray) that touches the insulation on tank CH-TK-1A, is not an interaction concern; therefore, it was not removed.

4. Reference 2, Item 4.g - As noted in the RAI response, the AMSAC panel containing a programmable recorder could have been evaluated using a new equipment criteria developed by SQUG. As an alternative, the equipment was reviewed to up-rate its quality category assignment. The equipment was originally seismically qualified by its supplier

to IEEE 344-75 standards. Only minor modifications were necessary to bring the installed configuration into compliance with the tested configuration. Since the equipment meets current seismic standards, the application of the supplemental SQUG data was not needed.

5. Reference 2, Item 4.h - The over-sized heater panels specific to this item are essentially empty, but have at least one dimension that exceeds the current SQUG criteria limits. This outlier condition existed for several other panels as well. Since ample representation of larger panel sizes exists in the experience database, these outliers were resolved by an EQE comparative analysis (included as Attachment 4). This analysis establishes that there is essentially no history of large panel failure. Consequently, the dimensions of these panels are not critical characteristics and the installed configurations are acceptable.

6. Reference 2, Item 4.l - Dampers do not currently have specific acceptance criteria under GIP guidelines. EQE International developed supplemental damper database acceptance criteria and performed an analysis for applicability to BV-1. This analysis is provided as Attachment 3 and confirms that the BV-1 dampers are seismically acceptable.

7. Reference 2, Item 4.m - A damper operator had interaction concerns that could potentially have required a conduit to be relocated. The damper's axle rod extends at a right angle beneath, and touches, a conduit mounted directly to the ceiling slab above. Further review of the geometry involved concluded that the conduit touching the damper's axle at a single point cannot restrict motion of the axle since the axle's only motion is rotation, which it can presently perform. Both the damper and conduit are anchored directly to the ceiling, with essentially no possible relative seismic displacement that could produce detrimental interaction. Therefore, no modification was necessary to resolve this outlier.

8. Reference 2, Item 5 and Reference 3, Item 6 - Operator training. Three (3) simulations of a plant shutdown, with all but SQUG equipment disabled, were run during the course of SQUG development and implementation. The need for additional operator training in this area was evaluated and did not warrant additional training at this time.

9. Reference 3, Item 3 - Resetting 'Bad Actor' relays that trip. Operator actions to reset 'Bad Actor' relays have not been credited as a means of outlier resolution.

Attachment 2

Updated Outlier Completion Tabulation

References:

1. BV-1 Summary Report for Resolution of Unresolved Safety Issue A-46, letter dated January 31, 1996

Outliers included in the following four tables are limited to those for which a specific resolution option was not originally identified or for which a different option was chosen during the resolution process. In each case, the actual resolution still involved either further review of SQUG or original design basis data, refined analysis, or modification. For the other outliers identified in Reference 1 that are not listed here, the resolution implemented was as previously described in Reference 1, Attachment 1, Tables 5.3, 6.2, 7.3 and Attachment 2, Table 2.1-1. Each table refers to the Reference 1 table where the outliers were originally discussed.

Table Location Key

AXLB	Auxiliary Building
DGBX	Diesel Generator Building
INTS	Intake Structure
RCBX	Containment Building
SFGB	Safeguards Building
SRVB	Service Building

Attachment 2, Table 1

(Equipment listed refers to Reference 1, Attachment 1, Table 5.3)

Equipment Number	Outlier Type	Location	Outlier Description	Outlier Resolution
BAT-BKR-4	Interaction (5)	SRVB El. 713	Overhead conduit support may impact top corner of cabinet.	Trimmed conduit support for clearance.
BNCHBD	Caveats (3)	SRVB El. 735	Recorders FR-MS-478, 488, & 498 mounted directly on top of bench board have different support conditions than qualification test.	Recorders without rear support (cantilevered) were seismically qualified to IEEE 344-75 by shaketable testing. Full support such as here is adequate by comparison.
BNCHBD	Interaction (4)	SRVB El. 735	Suspended ceiling panels unrestrained.	Added tie-wraps to positively secure ceiling sections.
DC-SWBD-1	Caveats (1)	SRVB El. 713	Cabinet exceeds the dimensions for the equipment class. Height 98" vs. 90".	Reviewed SQUG experience database. Successfully compared seismic demand to SQUG database capacity levels.
DC-SWBD-2	Caveats (1)	SRVB El. 713	Cabinet exceeds the dimensions for the equipment class. Height 98" vs. 90".	Reviewed SQUG experience database. Successfully compared seismic demand to SQUG database capacity levels.
DC-SWBD-2	Anchorage (5)	SRVB El. 713	Anchorage does not meet GIP criteria due to construction joint in floor near one row of anchors.	Performed additional analysis after verification of continuous rebars through the construction joint; affected anchors are not needed for overturning resistance. Since rebars exist and joint is tight, anchor capacity is assured if needed.
DC-SWBD-3	Caveats (1)	SRVB El. 713	Cabinet exceeds the dimensions for the equipment class. Height 98" vs. 90".	Reviewed SQUG experience database. Successfully compared seismic demand to SQUG database capacity levels.
DC-SWBD-4	Caveats (1)	SRVB El. 713	Cabinet exceeds the dimensions for the equipment class. Height 98" vs. 90".	Reviewed SQUG experience database. Successfully compared seismic demand to SQUG database capacity levels.
FCV-RC-455C1	Caveats (4)	RCBX El. 767	Equipment mounted on 1/2" diameter copper tube which is less than 1" diameter pipe.	Design modification replaced and relocated valves, which eliminated issue.
FCV-RC-455C2	Caveats (4)	RCBX El. 767	Equipment mounted on 1/2" diameter copper tube which is less than 1" diameter pipe.	Design modification replaced and relocated valves, which eliminated issue.

Attachment 2, Table 1

(Equipment listed refers to Reference 1, Attachment 1, Table 5.3)

Equipment Number	Outlier Type	Location	Outlier Description	Outlier Resolution
FCV-RC-455D1	Caveats (4)	RCBX El. 767	Equipment mounted on 1/2" diameter copper tube which is less than 1" diameter pipe.	Design modification replaced and relocated valves, which eliminated issue.
FCV-RC-455D2	Caveats (4)	RCBX El. 767	Equipment mounted on 1/2" diameter copper tube which is less than 1" diameter pipe.	Design modification replaced and relocated valves, which eliminated issue.
FE-CDL-1A	Caveats (10)	DGBX El. 735	Review of relays in panel not complete / lack of documentation. (Fire Protection relay issue)	Performed qualification testing of replacement essential relays; Completed review of panel & anchorage.
FE-CDL-1B	Caveats (10)	DGBX El. 735	Review of relays in panel not complete / lack of documentation. (Fire Protection relay issue)	Performed qualification testing of replacement essential relays; Completed review of panel & anchorage.
FE-WS-3A (added to SSEL as part of Fire Protection relay review)	Caveats (10)	AXLB El. 768	Added relays & panel during FP seismic review.	Performed qualification testing of replacement essential relays; Completed review of panel & anchorage.
FE-WS-3B (added to SSEL as part of Fire Protection relay review)	Caveats (10)	AXLB El. 768	Added relays & panel during FP seismic review.	Performed qualification testing of replacement essential relays; Completed review of panel & anchorage.
FR-MS-478	Caveats	SRVB El. 735	Actual support condition for strip chart recorder mounted on top of the benchboard differs from their tested configuration.	Recorders without rear support (cantilevered) were seismically qualified to IEEE 344-75 by shaketable testing. Full support is adequate by comparison.

Attachment 2, Table 1

(Equipment listed refers to Reference 1, Attachment 1, Table 5.3)

Equipment Number	Outlier Type	Location	Outlier Description	Outlier Resolution
FR-MS-488	Caveats	SRVB El. 735	Actual support condition for strip chart recorder mounted on top of the benchboard differs from their tested configuration.	Recorders without rear support (cantilevered) were seismically qualified to IEEE 344-75 by shaketable testing. Full support is adequate by comparison.
FR-MS-498	Caveats	SRVB EL. 735	Actual support condition for strip chart recorder mounted on top of the benchboard differs from their tested configuration.	Recorders without rear support (cantilevered) were seismically qualified to IEEE 344-75 by shaketable testing. Full support is adequate by comparison.
HCV-CH-389	Caveats (4)	RCBX El. 707	Caveat 4 - Limits valves to piping 1" and larger. This valve is three-way 3/4" AOV.	Analysis of ¾" pipe for 3% damped 1.5PSA seismic valve loading was successful.
HCV-CH-389	Caveats (5)	RCBX El. 707	Caveat 5 - Figure B.7-1 restrictions preclude this valve and the 3g static load yoke stresses are unknown.	Yoke analysis for 3g was successful.
HCV-MS-104	Caveats (5)	SFGB El. 752	Valve is outside of GIP Figure B.7-1 dimensions for centerline of pipe to top of valve.	Yoke analysis for 3g was successful.
LR-QS-100	Caveats	SRVB El.735	Cantilevered strip chart recorder lacks rear support required by the vendor's seismic qualification. Problem Report No. 1-95-605	Recorders without rear support (cantilevered) were seismically qualified to IEEE 344-75 by shaketable testing.
MOV-MS-105	Caveats (5)	SFGB El. 735	Existing vendor calculation checks yoke to "G" values that are less than those found in the pipe stress calculation.	Further review and analysis determined yoke was acceptable.
MOV-RC-537	Interaction (1)	RCBX El. 767	Motor operator is 1/2" clear of copper air tubing.	Air line was moved during a design modification.
PCV-IA-108	Caveats (4)	RCBX El. 767	Valve is mounted on a 3/4" threaded pipe.	Reanalysis by EQE determined the valves to meet the intent of GIP caveats.

Attachment 2, Table 1
(Equipment listed refers to Reference 1, Attachment 1, Table 5.3)

Equipment Number	Outlier Type	Location	Outlier Description	Outlier Resolution
PCV-IA-109	Caveats (4)	RCBX El. 767	Valve is mounted on a 3/4" threaded pipe.	Reanalysis by EQE determined the valves to meet the intent of GIP caveats.
PNL-AC-E1	Caveats (1)	SRVB El. 713	Panel exceeds the dimensions for the equipment class. Height 50" vs. 40" and Depth 16" vs. 12".	Reviewed SQUG experience database. Successfully compared seismic demand to SQUG database capacity levels.
PNL-AC-E2	Caveats (1)	SRVB El. 713	Panel exceeds the dimensions for the equipment class. Height 50" vs. 40" and Depth 16" vs. 12".	Reviewed SQUG experience database. Successfully compared seismic demand to SQUG database capacity levels.
PNL-AC-E3	Caveats (1)	SRVB El. 713	Panel exceeds the dimensions for the equipment class. Height 50" vs. 40" and Depth 16" vs. 12".	Reviewed SQUG experience database. Successfully compared seismic demand to SQUG database capacity levels.
PNL-AC-E4	Caveats (1)	SRVB El. 713	Panel exceeds the dimensions for the equipment class. Height 50" vs. 40" and Depth 16" vs. 12".	Reviewed SQUG experience database. Successfully compared seismic demand to SQUG database capacity levels.
PNL-PR-HTR-A	Caveats (1)	SRVB El. 735	Panel exceeds the dimensions for the equipment class. Height 64" vs. 40" and width 44 1/2" vs. 40".	Reviewed SQUG experience database. Successfully compared seismic demand to SQUG database capacity levels.
PNL-PR-HTR-B	Caveats (1)	SRVB El. 735	Panel exceeds the dimensions for the equipment class. Height 64 1/4" vs. 40" and width 44" vs. 40".	Reviewed SQUG experience database. Successfully compared seismic demand to SQUG database capacity levels.
PNL-PR-HTR-D	Caveats (1)	SRVB El. 735	Panel exceeds the dimensions for the equipment class. Height 64" vs. 40" and width 44 1/2" vs. 40".	Reviewed SQUG experience database. Successfully compared seismic demand to SQUG database capacity levels.
PNL-PR-HTR-E	Caveats (1)	SRVB El. 735	Panel exceeds the dimensions for the equipment class. Height 64 1/4" vs. 40" and width 44" vs. 40".	Reviewed SQUG experience database. Successfully compared seismic demand to SQUG database capacity levels.
PNL-VITBUS-1	Caveats (1)	SRVB El. 735	Panel exceeds the dimensions for the equipment class. Length 72" vs. 40".	Reviewed SQUG experience database. Successfully compared seismic demand to SQUG database capacity levels.

Attachment 2, Table 1

(Equipment listed refers to Reference 1, Attachment 1, Table 5.3)

Equipment Number	Outlier Type	Location	Outlier Description	Outlier Resolution
PNL-VITBUS-2	Caveats (1)	SRVB El. 735	Panel exceeds the dimensions for the equipment class. Length 72" vs. 40".	Reviewed SQUG experience database. Successfully compared seismic demand to SQUG database capacity levels.
PNL-VITBUS-3	Caveats (1)	SRVB El. 735	Panel exceeds the dimensions for the equipment class. Length 72" vs. 40".	Reviewed SQUG experience database. Successfully compared seismic demand to SQUG database capacity levels.
PNL-VITBUS-4	Caveats (1)	SRVB El. 735	Panel exceeds the dimensions for the equipment class. Length 72" vs. 40".	Reviewed SQUG experience database. Successfully compared seismic demand to SQUG database capacity levels.
QS-RACK-3	Interaction (4)	YARD El. 735	Wood roof on adjacent weather shelter could fall on instrument lines.	Determined that a seismic restraint (cable) for the roof existed. No interaction threat exists.
RK-RAD-MON-7	Caveats (3, 5)	SRVB El. 735	Two strip chart recorders are mounted in the cabinet. (RR-RM-700 and RR-RM-800).The rear of the recorders are not supported in the manner recommended by the vendor.	Recorders without rear support have been seismically qualified to IEEE 344-75 by shaketable testing. Added redundant cable ties to rear mount plate/strut.
RK-RAD-MON-7	Interaction	SRVB El. 735	Cabinet touches adjacent cabinet (RK-RAD-MON-1) in the middle. At outside edges of the cabinets there is 3/8" clearance. Sheet metal sides bulge outward to touch.	Evaluated side wall movement; no interaction concern exists.
RV-EE-201A	Caveats (4)	DGBX El. 735	Valve is mounted on 1/2" diameter pipe.	Analytical review performed satisfactorily.
RV-EE-201A	Caveats (9)	DGBX El. 735	Connections between tank and pipe and valve are threaded.	Secured joint against rotation using Loctite 262.
RV-EE-201B	Caveats (4)	DGBX El. 735	Valve is mounted on 1/2" diameter pipe.	Analytical review performed satisfactorily.

Attachment 2, Table 1
(Equipment listed refers to Reference 1, Attachment 1, Table 5.3)

Equipment Number	Outlier Type	Location	Outlier Description	Outlier Resolution
RV-EE-201B	Caveats (9)	DGBX El. 735	Connections between tank and pipe and valve are threaded.	Secured joint against rotation using Loctite 262.
RV-EE-201C	Caveats (4)	DGBX El. 735	Valve is mounted on 1/2" diameter pipe.	Analytical review performed satisfactorily.
RV-EE-201C	Caveats (9)	DGBX El. 735	Connections between tank and pipe and valve are threaded.	Secured joint against rotation using Loctite 262.
RV-EE-202A	Caveats (4)	DGBX El. 735	Valve is mounted on 1/2" diameter pipe.	Analytical review performed satisfactorily.
RV-EE-202A	Caveats (9)	DGBX El. 735	Connections between tank and pipe and valve are threaded.	Secured joint against rotation using Loctite 262.
RV-EE-202B	Caveats (4)	DGBX El. 735	Valve is mounted on 1/2" diameter pipe.	Analytical review performed satisfactorily.
RV-EE-202B	Caveats (9)	DGBX El. 735	Connections between tank and pipe and valve are threaded.	Secured joint against rotation using Loctite 262.
RV-EE-202C	Caveats (4)	DGBX El. 735	Valve is mounted on 1/2" diameter pipe.	Analytical review performed satisfactorily.
RV-EE-202C	Caveats (9)	DGBX El. 735	Connections between tank and pipe and valve are threaded.	Secured joint against rotation using Loctite 262.
RV-EE-203A	Caveats (4)	DGBX El. 735	Valve is mounted on 1/2" diameter pipe.	Analytical review performed satisfactorily.
RV-EE-203A	Caveats (9)	DGBX El. 735	Connections between tank and pipe and valve are threaded.	Secured joint against rotation using Loctite 262.
RV-EE-203B	Caveats (4)	DGBX El. 735	Valve is mounted on 1/2" diameter pipe.	Analytical review performed satisfactorily.

Attachment 2, Table 1
(Equipment listed refers to Reference 1, Attachment 1, Table 5.3)

Equipment Number	Outlier Type	Location	Outlier Description	Outlier Resolution
RV-EE-203B	Caveats (9)	DGBX El. 735	Connections between tank and pipe and valve are threaded.	Secured joint against rotation using Loctite 262.
RV-EE-203C	Caveats (4)	DGBX El. 735	Valve is mounted on 1/2" diameter pipe.	Analytical review performed satisfactorily.
RV-EE-203C	Caveats (9)	DGBX El. 735	Connections between tank and pipe and valve are threaded.	Secured joint against rotation using Loctite 262.
RV-EE-204A	Caveats (4)	DGBX El. 735	Valve is mounted on 1/2" diameter pipe.	Analytical review performed satisfactorily.
RV-EE-204A	Caveats (9)	DGBX El. 735	Connections between tank and pipe and valve are threaded.	Secured joint against rotation using Loctite 262.
RV-EE-204B	Caveats (4)	DGBX El. 735	Valve is mounted on 1/2" diameter pipe.	Analytical review performed satisfactorily.
RV-EE-204B	Caveats (9)	DGBX El. 735	Connections between tank and pipe and valve are threaded.	Secured joint against rotation using Loctite 262.
RV-EE-204C	Caveats (4)	DGBX El. 735	Valve is mounted on 1/2" diameter pipe.	Analytical review performed satisfactorily.
RV-EE-204C	Caveats (9)	DGBX El. 735	Connections between tank and pipe and valve are threaded.	Secured joint against rotation using Loctite 262.
TR-RC-410	Caveats	SRVB El. 735	Cantilevered strip chart recorder lacks rear support required by the vendor's seismic qualification. Problem Report No. 1-95-605	Recorders without rear support (cantilevered) were seismically qualified to IEEE 344-75 by shaketable testing
TR-RC-413	Caveats	SRVB El. 735	Cantilevered strip chart recorder lacks rear support required by the vendor's seismic qualification. Problem Report No. 1-95-605	Recorders without rear support (cantilevered) were seismically qualified to IEEE 344-75 by shaketable testing

Attachment 2, Table 1

(Equipment listed refers to Reference 1, Attachment 1, Table 5.3)

Equipment Number	Outlier Type	Location	Outlier Description	Outlier Resolution
VERTBD	Caveats (11)	SRVB El. 735	Strip chart recorders TR-RC-410 & 413 and LR-QS-100 are not seismically qualified or mounted. Problem Report 1-95-605.	Recorders without rear support (cantilevered) were seismically qualified to IEEE 344-75 by shaketable testing.
Dampers listed VS-AD-10 thru VS-AFD-9	Anchorage	SRVB El. 713	Damper is not in SQUG Earthquake Experience Equipment Class	EQE successfully generated and applied new damper experience-based acceptance criteria.
Dampers listed VS-AD-10 thru VS-AFD-9	Capacity vs. Demand	SRVB El. 713	Damper is not in SQUG Earthquake Experience Equipment Class	EQE successfully generated and applied new damper experience-based acceptance criteria.
VS-AFD-5	Interaction	SRVB El. 713	Conduit support rod in contact with operator.	Evaluated contact and no interaction concern exists; damper configuration OK (EQE).
VS-AFD-5	Interaction	SRVB El. 713	Conduit in contact with damper drive rod.	Evaluated contact and no interaction concern exists; damper configuration OK (EQE).
Dampers listed VS-D-16A thru VS-D-57C2	Anchorage	SRVB El. 725	Damper is not in SQUG Earthquake Experience Equipment Class	EQE successfully generated and applied new damper experience-based acceptance criteria.
Dampers listed VS-D-16A thru VS-D-57C2	Capacity vs. Demand	SRVB El. 725	Damper is not in SQUG Earthquake Experience Equipment Class	EQE successfully generated and applied new damper experience-based acceptance criteria.
WR-P-1A	Caveats (2)	INTS El. 705	Overall shaft length exceeds length in database.	Performed engineering review of existing pump qualification and new computer analysis, which confirms pump adequacy; EQE analyzed. Inspected lower support during bay cleaning, 8-21-97.
WR-P-1A	Capacity vs. Demand	INTS El. 705	IRS 3% damping curves are above the Bounding Curves.	3% IRS was converted to 5% IRS for comparison to 5% 1.5BS, and is bounded by 1.5BS, resolving the outlier.
WR-P-1B	Caveats (2)	INTS El. 705	Overall shaft length exceeds length in database.	Performed engineering review of existing pump qualification and new computer analysis, which confirms pump adequacy; EQE analyzed. Inspected lower support during bay cleaning, 4-25-97.

Attachment 2, Table 1
(Equipment listed refers to Reference 1, Attachment 1, Table 5.3)

Equipment Number	Outlier Type	Location	Outlier Description	Outlier Resolution
WR-P-1B	Capacity vs. Demand	INTS El. 705	IRS 3% damping curves are above the Bounding Curves.	3% IRS was converted to 5% IRS for comparison to 5% 1.5BS, and is bounded by 1.5BS, resolving the outlier.
WR-P-1C	Caveats (2)	INTS El. 705	Overall shaft length exceeds length in database.	Performed engineering review of existing pump qualification and new computer analysis, which confirms pump adequacy; EQE analyzed. Inspected lower support during bay cleaning, 5-14-97.
WR-P-1C	Capacity vs. Demand	INTS El. 705	IRS 3% damping curves are above the Bounding Curves.	3% IRS was converted to 5% IRS for comparison to 5% 1.5BS, and is bounded by 1.5BS, resolving the outlier.

Attachment 2, Table 2

(Equipment listed refers to Reference 1, Attachment 1, Table 6.2)

Equipment Number	Outlier Type	Location	Outlier Description	Outlier Resolution
GN-TK-1A	Anchorage	RCBX El. 767	Loose concrete expansion anchors.	Original tank anchors ok by analysis. Tank and support were replaced with new ASME tank as part of the PORV N_2 air-backup system design modification.
GN-TK-1B	Anchorage	RCBX El. 767	Loose concrete expansion anchors.	Original tank anchors ok by analysis. Tank and support were replaced with new ASME tank as part of the PORV N_2 air-backup system design modification.

Attachment 2, Table 3

(Equipment listed refers to Reference 1, Attachment 1, Table 7.3)

Equipment Number	Outlier Type	Location	Outlier Description	Outlier Resolution
RC-P-1A, 1B, 1C (Power cable tray)	Anchorage	RCBX El. 738	Support has questionable anchorage at base (not attached)	Analyzed - ceiling support sufficient, base attachment unnecessary.

Attachment 2, Table 4

(Equipment listed refers to Reference 1, Attachment 2, Table 2.1-1)

Relay Type	Outlier Basis	Outlier Resolution
CURTIS RS8	Fire protection - no qualification test report	Circuit review established that relay was not "essential" and chatter was not detrimental; no qualification or change-out required.
GE HGA	Bad actor	All Bad Actor configuration relays (2) were replaced with IEEE 344-75 qualified relays.
GE IAC60	Not in SQUG database	Original testing using license basis IEEE 344-71 was successful; no known industry problems; more recent testing of relay type satisfactory; EQE review (capacity determination) satisfactory.
T.S. (HAD) (Heat sensors)	Fire protection - no qualification test report	Replaced with IEEE 344-75 qualified contactors.
HOLD RELAY (Relay "RH" in FE-CDL-1A & 1B)	Fire protection - no qualification test report	Replaced with IEEE 344-75 qualified relays.
HONEYWELL RP403	Not in SQUG database	Further review identified devices as wall-panel mounted, damper control, electro-pneumatic solenoid valves (not a relay) which have Capacity equal to the Bounding Spectrum and are; therefore, acceptable.
(K1 & K4)	Fire protection - no qualification test report	Replaced with IEEE 344-75 qualified relays.
ELECTRO-PNEUMATIC	Fire protection - no qualification test report	Circuit review established that device was not "essential" and chatter was not detrimental; no qualification or change-out required.
MASTER VALVE RELAY (Relay "MVR" in FE-CDL-1A & 1B)	Fire protection - no qualification test report	Circuit review established that relay was not "essential" and chatter was not detrimental; no qualification or change-out required.
MASTER VALVE AUX (Relay "VR1 & 2" in FE-CDL-1A & 1B)	Fire protection - no qualification test report	Replaced with IEEE 344-75 qualified relays.
SQ-D 7001	Not in SQUG database	Original testing using license basis IEEE 344-71 was successful; no known industry problems; more recent testing of relay type satisfactory; EQE review (capacity determination) satisfactory.
SQ-D 8504 (EQ1965G13)	Not in SQUG database	Further review identified device as contactor with 4.5g GERS (NP-5223) Capacity, which exceeds Demand; therefore, acceptable.
SQ-D 9050 (EQ19335G2 & EQ2423G1)	Not in SQUG database	Original testing using license basis IEEE 344-71 was successful; no known industry problems; more recent testing of relay type satisfactory; EQE review (capacity determination) satisfactory.

Attachment 2, Table 4
(Equipment listed refers to Reference 1, Attachment 2, Table 2.1-1)

Relay Type	Outlier Basis	Outlier Resolution
SYNCRO START Speed Switch	Not in SQUG database	Replaced with IEEE 344-75 qualified devices for non-seismic reasons.
TIMING RELAY (Relay "62" in FE-CDL-1A & 1B)	Fire protection - no qualification test report	Replaced with IEEE 344-75 qualified relays.
VAPOR (2 models)	Not in SQUG database	Original testing using license basis IEEE 344-71 was successful; no known industry problems; EQE review (capacity determination) satisfactory.
W ARS	Not in SQUG database	Original testing using license basis IEEE 344-71 was successful; no known industry problems; more recent testing of relay type satisfactory; EQE review (capacity determination) satisfactory.
W IRV	Not in SQUG database	Circuit review established that relay was not "essential" and chatter was not detrimental; no change-out required.

Attachment 3

(Note: Appendices B through G of the attached calculation are not included to minimize the length of the attachment. These appendices are maintained on file at BVPS and are available upon request.)

EQE INTERNATIONAL

CALCULATION COVER SHEET

Calculation No. 250540-C-021

Project: BEAVER VALLEY A-46 OUTLIER RESOLUTION

Calculation Title: OUTLIER RESOLUTION FOR DAMPERS

References: SEE SECTION 3.0

Appendices: A, B, C, D, E, F, G

Total Number of Pages (Including Cover Sheet): 15 + 139 = 154

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0	4/25/00	ORIGINAL ISSUE	F.R. BEIGI FBeigi	R.W.CUSHING R. W. Cushing	R.W.CUSHING R. W. Cushing

Table of Contents

1.0 PURPOSE AND SCOPE

During the implementation of the USI A-46 program at Beaver Valley Power Station Unit No.1 (BVPS-1) dampers included on the SSEL (Safe Shutdown Equipment List) were classified as Outliers since dampers are not included in the Twenty Classes of Equipment defined in the SQUG GIP (Reference 1).

The purpose of this calculation is to resolve Outliers associated with the dampers that are in the in the scope of this calculation (see Table in Section 4.0).

2.0 METHOD

The GIP provides several options for the resolution of outliers as described in its Section 5. Among these is the option of providing more detailed seismic experience data to address the particular issue that creates the outlier. Specifically the GIP states: "The earthquake experience equipment class may be expanded to include the equipment or specific equipment features of interest" (Ref. 1, page 5-7). This will be done by finding a significant number of independent dampers which have experienced earthquakes of Magnitude 6.0 or greater without loss of function. The average of the two horizontal free-field ground motion spectra at each site will be plotted. A weighted average of the spectral ordinates at each frequency will be plotted, and the resulting spectrum will be broadened and smoothed. This will be the reference capacity spectrum for this equipment class. If it is greater than the SQUG Reference Spectrum, then the SQUG Reference Spectrum will be used. The reference spectrum shall be divided by 1.5 to obtain a bounding spectrum for comparison to the nuclear plant ground response spectrum.

On-site recordings may used as the basis for the free field spectra at the site if the recording instrument was within two structure diameters of the building containing the equipment item. More distant recording may be used if the resulting estimated site response spectra are appropriately justified. Site spectra which have been reviewed by NRC may be used without justification.

Two equipment items are independent if they are located at different places (including different locations/orientations in the same structure), are not of identical construction, or have different mounting details. Items which have experienced more than one strong-motion earthquake may be counted once for each earthquake. 30 independent items are considered a significant number. If less than 30 items are used, then the capacity spectrum must be lowered to account for the uncertainty.

The class description (inclusion rules) will be based on the characteristics of the equipment in database. These characteristics include the physical structure of the equipment; the means by which the primary components, in particular moving parts, perform their function; the typical range of operating parameters; and the function that the equipment normally serves in a power plant.

A search of earthquake data will be performed to identify and perform root cause evaluations of any instances of seismic damage to equipment covered by the equipment class. This will include equipment outside of the sample used to determine the capacity reference spectrum. If any instances of damage are noted, caveats will be developed to preclude the characteristics responsible for the damage. In addition, engineering judgement will be used to develop caveats to preclude possible vulnerabilities even if not observed in the database equipment.

Even though presently the GIP does not include a specific class of equipment for dampers the seismic experience data base, in fact, does include numerous examples of dampers that have gone through major earthquakes. Therefore the following steps are performed in this calculation in order to resolve the Outliers associated with dampers.

1. Expand the seismic experience database to include examples of similar dampers that have gone through major earthquakes and document any vulnerabilities (i.e., "Caveats") that they might have exhibited in a seismic event (see Appendix A).

2. Compare BVPS-1 ground response spectrum or applicable in-structure floor response spectrum to the Bounding or Reference Spectrum (see Ref. 1 or Appendix A for definition of these terms) in order to determine the applicability of the seismic experience database to the dampers at BVPS-1 (see Appendix D).

3. Evaluate the dampers in the scope of this calculation to the caveats developed in step 1 above and document the results (see Section 4.0).

4. Resolve any additional Outliers that may be identified as a result of step 3 above (see Section 4.0).

3.0 REFERENCES

1. "Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Plant Equipment", February 1992, Prepared by Winston & Strawn et al, for the Seismic Qualification Utility Group (SQUG).

2. "USI A-46 Seismic Evaluation Report for Beaver Valley Power Station Unit No. 1 (BVPS-1)," January 1996.

3. DLC Calculation No. 8700-DSC-9014, " EDG Damper VS-D-22-2C Missing Bolts," Rev.0.

4. S & W Drawing No. 11700-RB-27A, Rev. 9.

5. Schneider Sheet Metal, Inc. Drawing No. SM-26-1, Rev.3.

6. S & W Drawing No. 11700-RB-26C, Rev. 5.

7. S & W Drawing No. 11700-RB-26A, Rev. 9.

8. BVSP Calculation No. NM(B)-404-CZC, " Intake Structure Amplify Response," Rev. 0.

4.0 EVALUATION

All dampers in the scope of this calculation were walked-down and evaluated for the caveats documented in Appendix A for dampers. The results of the walkdown are summarized below and in Table 1.

Bounding Spectrum Comparison

The dampers in the scope of this calculation are listed in Table 1. They are located in various locations in SRVB, AXLB, SFGB, DGBX, and INTS. As shown in Reference 2, the 1.5 X Bounding Spectrum (BS) envelops the 5% damped SSE in-structure response spectrum corresponding to all elevations at the above buildings, with the exception of the spectra for the Intake Structure at elevation 730' (See Appendix D). The exceedence of the in-structure spectra at elevation 730' of the INTS over the 1.5XBS occurs in the frequency range of 2.5 to 5 Hz.

Anchorage of Dampers

In general, as described in Appendix A, attachment of dampers to the HVAC ducting is through bolting, riveting or welding that is provided around the perimeter of the damper housing. With the exception of dampers in DGB and INTS, all other dampers in the scope of this calculation (see Table 1) are in-line components to the HVAC ducting they are attached to. As explained in Appendix A, the experience database contains no instances of seismic damage to dampers. The anchorage of a bounding damper (i.e., Damper VS-D-22-2C, with one missing bolt) in the DGBX was previously evaluated as seismically adequate in Reference 3.

The roof mounted dampers VS-D-22-1A & -1B in DGBX have a perimeter angle which is part of the damper housing. This angle rests on a perimeter concrete curb and is anchored to it by 1/4"∅ anchor bolts at about every 12" (16 anchors total). Since the angle sits atop the concrete curb and the applicable vertical acceleration at the location of this damper is much less than 1.0g, there would be no net uplift on the 1/4"∅ anchor bolts due to dead load effects. Also, considering the horizontal peak acceleration of 0.5g (i.e., SSE @El.755' of DGBX, 5%) the 16-1/4"∅ anchors are easily adequate to resist the expected shear loads due to seismic loading (i.e., Shear per anchor ≅ $(0.5gX \sim 200lbs. X\sqrt{2})/16 = 9lbs. << V_{all}$).

The complete anchorage configuration of dampers VS-D-57-A1, -B1, & -C1 in Intake Structure could not be 100% field verified due to inaccessibility. These outside air dampers are at elevation 725' of the Intake Structure and are mounted inside a concrete plenum (i.e., concrete missile shield). From the details on the Reference 5 thru 7 drawings and the field observations, it is judged that these dampers are connected to perimeter angles at the edge of the opening in the ceiling at the location of the dampers.

Anchorage of Damper Controls

The base of the damper controls are generally bolted (typically by channel nuts) to unistrut members and these members are either welded to the duct stiffeners at the damper location or are attached to the ceiling by expansion anchors. These controls are very light (about 10 to 25 lbs) and their anchorage capacity by inspection and engineering judgment is much greater than the seismic demand loads (i.e., the maximum SSE peak horizontal acceleration at 5% damping and at any of the damper locations listed in Table 1 is 1.4g, which corresponds to INTS spectra). See also notes 1, 2 and 4 on the bottom of the Table 1 for exceptions to the above.

Caveats

The Caveats to be considered in the evaluation of dampers and their controls are as follows:

DMPR/BS Caveat 1 - Earthquake Experience Equipment Class. The damper should be similar to and bounded by the DMPR class of equipment described above. The equipment class descriptions are general and the Seismic Capability Engineers should be aware that worst case combination of certain parameters may not be represented in the generic equipment class. These worst case combinations may have reduced seismic capacity and should be carefully evaluated on a case-by-case basis.

DMPR/BS Caveat 2 - Damper Operator/Actuator Not of Cast Iron. The intent of this caveat is to avoid the brittle failure mode of cast iron as evidenced by poor performance of some cast iron components in the past earthquakes. Note that the database does not contain actuators with cast iron components; therefore, it is not necessary to determine the material of the damper control components unless it appears to the seismic capability engineers to be made of cast iron.

DMPRS/BS Caveat 3 - Sufficient Slack and Flexibility of Attached Lines. Sufficient slack and flexibility should be present in attached lines (e.g., air tubing, electrical conduit) to preclude a line breach due to differential seismic displacement of the equipment and the line's nearest support. Also, for damper controls with independent supports (i.e., not mounted integrally on the duct) the effect of differential displacement on the actuator (with actuator defined as the rod connected at one end to the damper control and at the other end to the duct louver controls) needs to be considered. The issue here is to identify cases where the actuator is connected to a rigidly mounted controller at one end and to a rod hung duct system at the other.

DMPRS/BS Caveat 4 - Adequate Anchorage. Damper controls when mounted on the ground or nearby structures should be properly anchored in accordance with the guidelines of GIP section 4.4. When the motor or pneumatic operator is mounted on the duct at the damper location the adequacy of the attachment point to the duct skin or its stiffeners should be ensured.

DMPR/BS Caveat 5 - Duct Distortion. The duct at the damper location should be carefully investigated for any signs of distortion as this could interfere with the damper operation.

DMPR/BS Caveat 6 - Interactions. All credible and significant interactions in the immediate vicinity of the dampers and their controls should be identified and evaluated. Evaluation of Interaction effects should consider detrimental effects on the capability of dampers and their controls to function. In the evaluation of proximity effects and overhead or adjacent equipment failure and interactions, the effects of intervening structures and equipment which would preclude impact should be considered.

TABLE 1

DAMPER I.D.	BLDG. & EL.	MANUFACT-URER	MODEL NO.	CAVEAT 1 O.K.?	CAVEAT 2 O.K.?	CAVEAT 3 O.K.?	CAVEAT 4 O.K.?	CAVEAT 5 O.K.?	CAVEAT 6 O.K.?
VS-AD-3	SRVB 713'	HONEYWELL	MP904-B-1028-3	YES	YES	YES	YES	YES	YES
VS-AD-4				YES	YES	YES	YES	YES	YES
VS-AD-5				YES	YES	YES	YES	YES	YES
VS-AD-6				YES	YES	YES	YES	YES	YES
VS-AD-7				YES	YES	YES	YES	YES	YES
VS-AD-8				YES	YES	YES	YES	YES	YES
VS-AD-9				YES	YES	YES	YES	YES	YES
VS-AD-10				YES	YES	YES	YES	YES	YES
VS-AFD-1	SRVB 713'	HONEYWELL	MP909-E-1356	YES	YES	YES	YES (1)	YES	YES
VS-AFD-2				YES	YES	YES	YES	YES	YES
VS-AFD-3				YES	YES	YES	YES	YES	YES
VS-AFD-4				YES	YES	YES	YES	YES (2)	YES
VS-AFD-5				YES	YES	YES	YES	YES	YES (3)
VS-AFD-6				YES	YES	YES	YES	YES	YES
VS-AFD-7				YES	YES	YES (7)	YES	YES	YES
VS-AFD-8				YES	YES	YES	YES	YES	YES
VS-AFD-9				YES	YES	YES	YES	YES	YES
VS-AFD-10				YES	YES	YES	YES	YES	YES
VS-AFD-11				YES	YES	YES	YES	YES	YES
VS-AFD-12				YES	YES	YES	YES	YES	YES
VS-AFD-13				YES	YES	YES	YES	YES	YES
VS-AFD-14				YES	YES	YES	YES (4)	YES	YES
VS-AFD-15				YES	YES	YES	YES	YES	YES
VS-D-16A				YES	YES	YES	YES	YES	YES
VS-D-16B				YES	YES	YES	YES	YES	YES
VS-D-4-7A	AXLB 768'	AMERICAN WARMING & VENT	DAA-P-3274	YES	YES	YES	YES	YES	YES
VS-D-4-7B				YES	YES	YES	YES	YES	YES
VS-D-4-8A				YES	YES	YES	YES	YES	YES(5)
VS-D-4-8B				YES	YES	YES	YES	YES	YES

DAMPER I.D.	BLDG. & EL.	MANUFACT-URER	MODEL NO.	CAVE AT 1 O.K.?	CAVEAT 2 O.K.?	CAVEAT 3 O.K.?	CAVEAT 4 O.K.?	CAVEAT 5 O.K.?	CAVEAT 6 O.K.?
VS-D-4-12A	SFGB 735'	AMERICAN WARMING & VENT	DAA-P-40	YES	YES	YES	YES	YES	YES
VS-D-4-12B				YES	YES	YES	YES	YES	YES
VS-D-4-15A				YES	YES	YES	YES	YES	YES
VS-D-4-15B				YES	YES	YES	YES	YES	YES
VS-D-22-1A	DGBX 756'	American Warming & vent	A340	YES	YES	YES	YES	YES	YES
VS-D-22-1B				YES	YES	YES	YES	YES	YES
VS-D-22-2A				YES	YES	YES	YES	YES	YES
VS-D-22-2B				YES	YES	YES	YES	YES	YES
VS-D-22-2C				YES	YES	YES	YES	YES	YES
VS-D-22-2D				YES	YES	YES	YES	YES	YES
VS-D-40-1F	SRVB 713'	HONEYWELL	MP909A-C	YES	YES	YES	YES (8)	YES	YES
VS-D-40-1G				YES	YES	YES	YES	YES	YES
VS-D-40-1H				YES	YES	YES	YES	YES	YES
VS-D-40-1K				YES	YES	YES	YES	YES (6)	YES
VS-D-40-1M				YES	YES	YES	YES	YES	YES
VS-D-57-A1	INTS (9) 725'	American Warming & vent	A340	YES	YES	YES	YES	YES	YES
VS-D-57-A2				YES	YES	YES	YES	YES	YES
VS-D-57-B1				YES	YES	YES	YES	YES	YES
VS-D-57-B2				YES	YES	YES	YES	YES	YES
VS-D-57-C1				YES	YES	YES	YES	YES	YES
VS-D-57-C2				YES	YES	YES	YES	YES	YES

NOTES:

(1) The control for this damper is mounted on two unistrut members that are bolted to two 2" X 16.5" X 1/8" cantilevered plates. These plates are bolted to P1000 members that are welded to duct stiffeners. The damper control is very light (~ 12#) and the effective cantilever length of the plates is only 5-1/4". Conservatively, considering a 0.3g as the SSE vertical acceleration at El. 735' of the SRVB, the calculated bending stress in the plates is well within the allowable bending stress.

M=(1/2) (12# X 5.25") (1+0.3g)= 41 lb-in (Max. moment per plate due to DL+V. Seis.)

S= (2" X 1/8"^{2}) / 6= 0.00521 in^3 (Section modulus of one plate)

f_b = M/S = 0.041 / 0.00521 = 7.9 Ksi < $F_b \cong$ 1.33X0.75X36 = 35.9 Ksi <u>O.K.</u>

(2) The control for this damper is attached to 2-P3300 unistrut members. These members are anchored to the ceiling by 4-1/4"∅ expansion anchors . Two of these anchor bolts have an edge distance of 1". Per reference 1 guidelines the anchor bolt capacity must be reduced for an edge distance less than 10 X bolt diameter. In this case a reduction factor of 0.40 must be applied. However, the above situation is accepted as-is based on very small demand load per anchor bolt (i.e., Demand Pullout Load per Anchor = 12# X (1+0.35gX2/3) / 4 = 4#, Demand Shear Load per Anchor = 12# X 0.35g x(2)$^{1/2}$ / 4 = 1.5#. As shown the demand loads, conservatively calculated based on the peak accel. at El. 735' of SRVB, are very small).

(3) Two credible interactions are identified for this damper: (a) A conduit support rod is in contact with the damper operator. (b) A conduit is in contact with the damper drive rod. These interactions have been resolved by the Memorandum included in Appendix F.

(4) Similar comment as (2) above with the exception that only on ¼"∅ anchor bolt has the concrete edge distance of 1".

(5) A rod hung piping is in the proximity of the control for this damper, however, it is judged to be a non-credible interaction hazard since other plant features and the pipe anchor points will restrain this pipe in its axial direction and any interaction concern with respect to this damper control is precluded.

(6) Slight dent observed at the damper location. This condition is accepted as the distortion has not affected the damper's operability.

(7) This damper is mounted in-line on a small (12" X 12" duct) by-pass line that is supported by a rod hanger. The control for this damper is mounted rigidly to the side of the main duct that is rigidly supported. Even though the 12 X 12 duct is rod hung, since it is attached at either end to the main larger duct that is rigidly supported, the differential movement between this duct and the duct that the control is mounted on is insignificant . Therefore it is judged that the attached copper air line to the damper control has adequate flexibility.

(8) The original SEWS for this equipment identified that the welding between the support bracket and the duct angle flanges is of poor quality (See SEWS in Appendix B). An inspection was subsequently performed by the Duquesne Light Materials and Codes supervisor to accurately evaluate the condition of this weld. His response is included in Appendix C, which concludes that the appearance of these welds are aesthetically not pleasing, however, these welds are structurally sound.

(9) The 1.5X Bounding Spectrum (B.S.) of Reference 1 is exceeded by the 5% damped in-structure response spectrum (IRS) at El. 730' of the Intake Structure (INTS) in the frequency range of 2.5 to 5 Hz. In order to show that the Capacity of these dampers and their controls (i.e., 1.5 X B.S. per Appendix A) is greater than the Demand (i.e., INTS 730', 5%, IRS per Appendix D and Reference 8), an in-situ measurement of the response frequency of the duct housing and damper actuators was performed (see Appendix E). It was shown that the lowest modal response frequency is well above 5Hz. Therefore, the outlier with respect to the Capacity-Demand issue for the dampers and their controls in

the INTS is resolved as the 5% IRS for the INTS at El. 730 is bounded by the 1.5 X B.S. over all frequency ranges above 5Hz (see Appendix D).

5.0 CONCLUSIONS

The seismic experience database was expanded to include examples of dampers that have gone through major earthquakes and caveats were developed to preclude vulnerabilities that might lead to damage in a seismic event. The dampers included in the Beaver Valley's SSEL were compared to the caveats developed in the damper database and were shown to satisfy these caveats. Also this calculation resolved any additional outliers that were identified as a result of walkdown of these dampers. In conclusion , it can be stated that the dampers included in the Beaver Valley's SSEL are seismically adequate.

26 pages (including this page)

APPENDIX A

DAMPERS - SUMMARY OF SEISMIC ADEQUACY

DAMPERS

SUMMARY OF SEISMIC ADEQUACY

Dampers are sheet metal fabricated devices that consist of a system of parallel vanes or louvers to either permit or prevent air flow. The actuators controlling the position of these louvers can be operated manually, electrically or pneumatically.

A.1 DEFINITION OF EQUIPMENT CLASS

Dampers are part of any heating, ventilating and air conditioning (HVAC) system, and are found at nearly all industrial sites. The principal functions of this equipment are control of air flow and isolation of HVAC systems. Some dampers at nuclear plants are used in safety related applications and must function under extreme conditions of violent weather, radiation, temperature, seismic shock, and high pressure transients (due to loss of coolant accident or tornado transient). Dampers are self-supporting structures that do not require additional integral supports or bracing. These devices are typically used in the following applications:

- Inlet or outlet side of an air handler
- In-line in HVAC ducting
- Mounted in walls to allow or prevent air flow between rooms

Dampers may be operated passively, manually, or actively. The louvers of dampers are tied together by a common linkage which is externally controlled by an electric, pneumatic or manual actuator. Typical components mounted on an air operated actuator are air tubing, flexible conduit, solenoid operated valves and pressure gages. Air receiver tanks that supply air to the solenoid valves require separate evaluation.

EQUIPMENT ANCHORAGE

Dampers are an integral part of the fans, air handlers and HVAC ducting and as such are characterized as in-line components. Dampers in fans or airhandlers are part of the equipment and are evaluated with the "Rule of The Box". Some dampers such as fire dampers are mounted in walls or ceilings and therefore are not considered as in-line components. These devices are normally attached to the supporting equipment, ducting, or penetrations in walls and ceilings by bolts, rivets, or welding along their perimeter. Heavy motor-operated or pneumatic dampers typically have their own supporting system.

EQUIPMENT APPLICATIONS

Dampers are typically operated pneumatically, electrically or manually. In the case of the pneumatically controlled and motor-operated dampers, such as flow/pressure control and isolation/shutoff dampers, a pneumatic or electrical signal is sent to the actuator to either open, close or modulate the louver position. Some dampers ,such as pressure relief and tornado protection dampers, are self actuated when quick differential pressure changes are detected and use counterweights or counterbalances to return to normal position. Some fire dampers have fuseable link, that either melt or electronically actuate in a fire and the damper closes by gravity.

APPLICATION IN NUCLEAR PLANTS

Dampers are used in all nuclear plants for control of air flow and isolation of HVAC systems. Dampers are utilized in the HVAC systems to perform one or more of the following functions:

- Flow and Pressure Control - Used to control a given flow rate or pressure within a system. Actuators may be electrical, pneumatic or manual.
- Balancing - Used to establish a flow and pressure relationship within a system. Actuation is through a manual adjustment hand-quadrant that is left at a pre-set level.
- Isolation/Shutoff Control - Used to isolate or seal off a portion of the system from selected flows. This type of damper is used only in an open/close application. Actuators could be electric, pneumatic or manual.
- Backdraft Control - Utilized where reverse flow of air is undesirable or could cause system inefficiencies. Actuation is by counterweight or counterbalance.
- Pressure Relief - Used to protect the system from excess pressure or damaging surges. The dampers are closed under normal conditions and open very quickly when positive pressures are detected. Actuation is by counterweight or counterbalance.
- Tornado Protection - Used at the intake or exhaust openings of the HVAC system. During tornado conditions this damper closes automatically. Actuation is by counterweight or counterbalance.
- Isolation Shutoff - Used to prohibit any leakage passing through the damper and downstream. Actuators are typically either pneumatic or manual.
- Fire Dampers - Mounted in walls or ceilings and is used for isolation of two separate but adjacent areas in case of fire.

A.2 DATABASE REPRESENTATION FOR DAMPERS

Figures A-1 through A-3 show typical components of dampers.

Figures A-4 through A-18 present examples of dampers within the database. The database inventory of dampers includes at least 175 examples, representing 20 sites and 14 earthquakes studied. Of this inventory, there are no instances of seismic damage.

Figure A-19 presents a bar chart that illustrates the inventory of dampers at various database sites as a function of estimated PGA. It should be noted that much attention has recently focused on the existence and verification of ground motion records at sites within the SQUG Seismic Experience Database. Although the PGA level has been used traditionally within the A-46 program to rate the level of the earthquakes at database facilities, concerns have been expressed by the Nuclear Regulatory Commission regarding use of this single parameter to measure earthquake damage. The NRC's position is that a better measure is the ground response spectrum developed from the ground motion recorded at or near a facility. At this date only a limited number of the SQUG database sites meet this requirement. A list of those sites is included in Appendix G of this calculation. Of the database dampers presented in this calculation 47 are located at six of those sites that meet the ground motion requirement and have been accepted by the NRC (Reference 5). They are also presented in Appendix G. On this basis of representation, it is considered acceptable to use the SQUG Reference Spectrum as a basis for comparison of the air handler database equipment. Additional examples within the inventory in Figure A-19 at sites that presently do not meet the ground motion requirements cited by the NRC are also presented to demonstrate that additional dampers are known to have been subjected to significant earthquake motion with no damage, underscoring the inherent ruggedness of the equipment class. It should be noted that activities are currently under way to document the ground motion at currently unapproved sites, thus allowing a greater number of database sites to meet the NRC's requirements in the future.

The database represents a wide variety of damper configurations. Pneumatic, motor driven and manual dampers are well represented. Some dampers in the database are housed in steel boxes which are anchored to the ground or to the building's structural steel. Heavy pneumatically operated dampers in the database have their own independent supporting system, and their usually long actuators attach to the side of the duct for louver control within the duct.

BASIS FOR THE GENERIC BOUNDING SPECTRUM

The seismic experience database includes a vast amount of data on the performance of dampers of various configurations and installations which experienced many different seismic excitation levels. The Generic Bounding Spectrum developed by SSRAP (2) to represent the motion at typical data sites was based on the average horizontal free field motion from each of the four reference database sites: Sylmar Converter Station (1971

San Fernando), El Centro Steam Plant (1979 Imperial Valley), Pleasant Valley Pumping Plant (1983 Coalinga), and Llolleo Pumping Plant (1985 Chile). The average of the four ground motion spectra is referred to as the Reference Spectrum. This spectrum is a conservative representation of the ground motion level to which the earthquake experience data demonstrate seismic ruggedness. In other words, the Reference Spectrum is used as a measure of the equipment capacity which has been demonstrated by experience. This capacity, coupled with caveats on equipment attributes and installation, is then compared to the demand represented by the respective floor spectrum within a nuclear power plant. The Generic Bounding Spectrum is obtained by dividing this Reference Spectrum by 1.5. This 1.5 factor is to account for the possibility that floor spectra within about 40 feet above garde in the nuclear power plant might be amplified over the ground spectra more than occurred in the database plants. Thus, the resultant Bounding Spectrum is directly applicable for comparison with Ground Spectra.

El Centro Steam Plant experienced a peak ground acceleration of 0.42g during the 1979 Imperial Valley Earthquake. Strong motion at the site lasted about 15 seconds. The site ground motion is based on measurements from an instrument located within 1/2 mile of the plant.

This plant includes many pneumatic and manual controlled dampers. The positioners for these dampers are enclosed in steel boxes which are then anchored to the ground or the building structural steel. There were no instances of damage to the dampers or their operators in the earthquake.

The Sylmar Converter Station located near the fault rupture of the 1971 San Fernando Earthquake, is estimated to have experienced at least 0.50g peak ground acceleration, with about 10 seconds of strong motion.

Eight instances of dampers are included in the database at this facility. None of the dampers experienced any seismic effects.

The Shell Water Treatment Plant is located about two miles north of the Main Oil Plant. The peak ground acceleration experienced at this site during the 1983 Coalinga Earthquake is conservatively estimated at 0.60g.

At this site only one documented case of a butterfly damper exists in the database. This damper remained undamaged as a result of the earthquake.

The IBM/Santa Teresa Computer Facility experienced a PGA of 0.37g, with strong motion occurring for about eight seconds during the 1984 Morgan Hill Earthquake. This facility included several motion monitors, one located in the free field 100 yards from the main building.

The database includes one pneumatic operated damper at this facility. This damper was not damaged in the earthquake.

Valley Steam Plant experienced ground shaking during both the 1971 San Fernando earthquake and the 1994 Northridge earthquake. The peak ground acceleration at the site due to each of these earthquakes was approximately 0.40g. The plant, which includes four units with a total generating capacity of 513 MW, is located about 10 miles from the epicenter and three miles from the fault of the San Fernando Earthquake.

Twenty four of the pneumatically operated dampers at this plant are represented in the seismic experience database. None of these dampers sustained any damage due to the above earthquakes.

Burbank Power Plant, located in the Burbank/Glendale area of the San Fernando Valley, is estimated to have experienced a peak ground acceleration of 0.30g, with about 10 seconds of strong motion, during the 1971 San Fernando Earthquake. This plant also experienced the 1994 Northridge earthquake with an estimated peak free field acceleration of 0.30g. This plant consists of five steam generating units and two gas turbine units.

A total of 35 pneumatically operated dampers at this site are represented in the database. No damage was reported to these dampers as a result of the above earthquakes.

Pasadena Power Plant has the unique distinction of being the only site included in the seismic experience database that has been shaken at comparable levels of intensity by four earthquakes, each producing a level of moderate ground motion comparable to a design basis event for a nuclear plant in the eastern United States. The Pasadena Plant experienced the magnitude 6.6 San Fernando earthquake in 1971, the magnitude 5.9 Whittier earthquake in 1987, the magnitude 5.8 Sierra Madre earthquake in 1991, and finally the magnitude 6.7 Northrige earthquake in 1994. The peak ground acceleration experienced by this site during these shakings is estimated to be about 0.20g.

The database includes a total of 24 pneumatically operated dampers at this facility. These dampers functioned properly during and after the above mentioned earthquakes with no damage.

AES Placerita Cogeneration Plant experienced a peak ground acceleration of at least 0.60g during the 1994 Northridge Earthquake (3). The estimated site ground motion is based on measurements from several instruments located a few kilometers from the plant.

Twenty small motor operated fire dampers for Halon system isolation are included in the database for this plant. No damage, as a result of the Northridge earthquake, was reported for these dampers.

A.3 INSTANCES OF SEISMIC EFFECTS AND DAMAGE

The experience database contains no instances of seismic effects to dampers. The database contains no evidence of the malfunction of dampers during or immediately after an earthquake. In addition no instances of seismically induced damage to dampers were found in an extensive literature search. In general dampers can be classified as inherently rugged equipment.

A.4 SOURCES OF SEISMIC DAMAGE

The seismic experience database indicates that dampers possess characteristics that generally preclude damage in earthquakes. The experience database contains no instances of damage or significant seismic effects to dampers or their actuators.

A.5 BIBLIOGRAPHY

1. Quality Air Design, "Design of Nuclear Dampers," Division of ACDC Inc..
2. Senior Seismic Review Advisory Panel (SSRAP), "Use of Seismic Experience and Test Date to Show Ruggedness of Equipment in Nuclear Power Plants, "Sandia Report SAND92-0140, Part 1, 1992.
3. Electric Power Research Institute, "The January 17, 1994, Northridge Earthquake: Effects on Selected Industrial Facilities and Lifelines," Prepared by EQE International, July, 1995.
4. Electric Power Research Institute, "The October 1, 1987, Whittier Earthquake: Effects on Selected Power, Industrial, and Commercial Facilities," EPRI NP-7126, Prepared by EQE Engineering Inc., December, 1990.
5 "Review of Seismic Qualification Utility Group's Report on the Use of the Generic Implementation Procedure for New and Replacement Equipment and Parts, " letter dated August 18, 1998, from Elinor G. Adensam, NRC, to Neil Smith, SQUG.

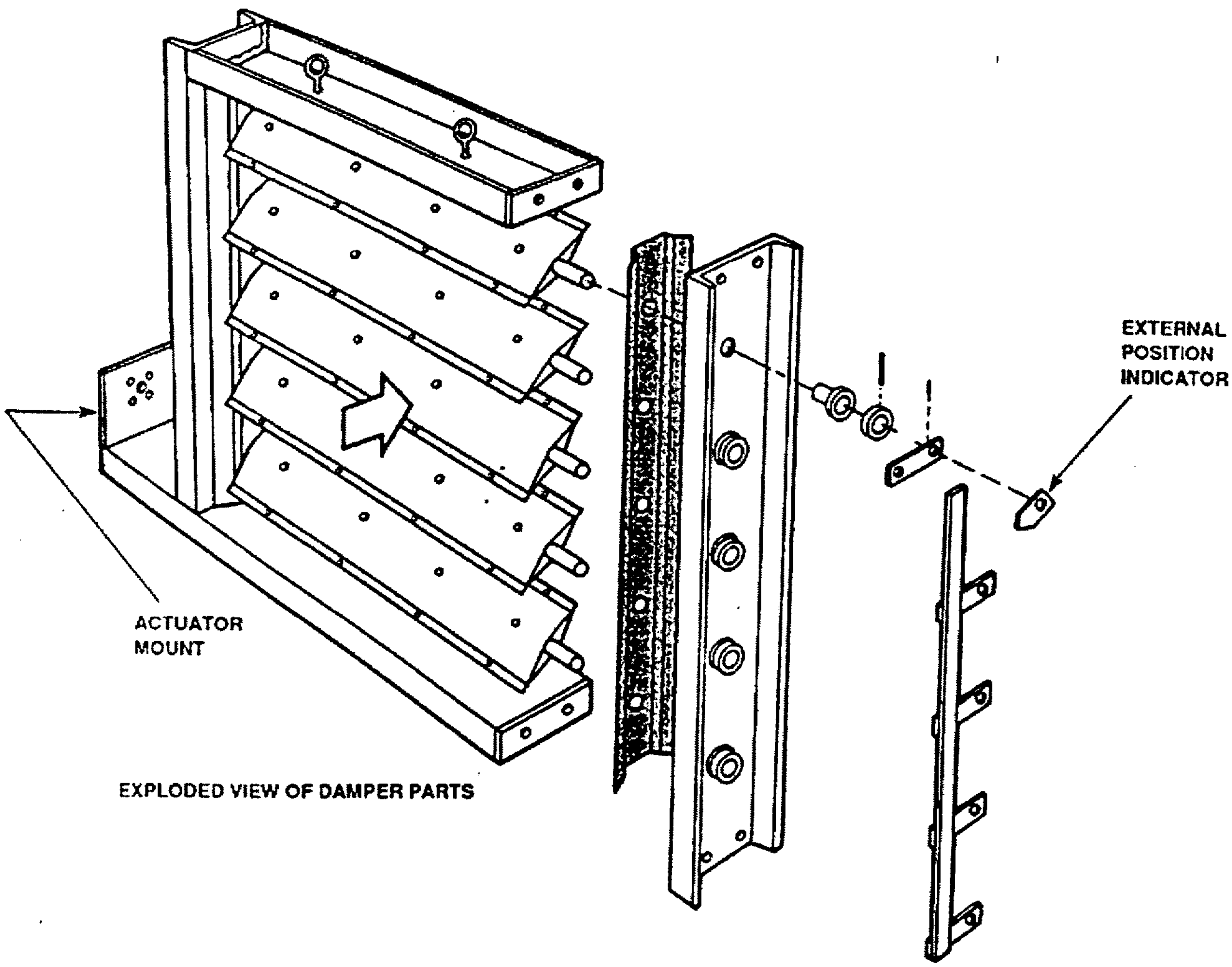


Figure A-1: Exploded View of A Typical Damper

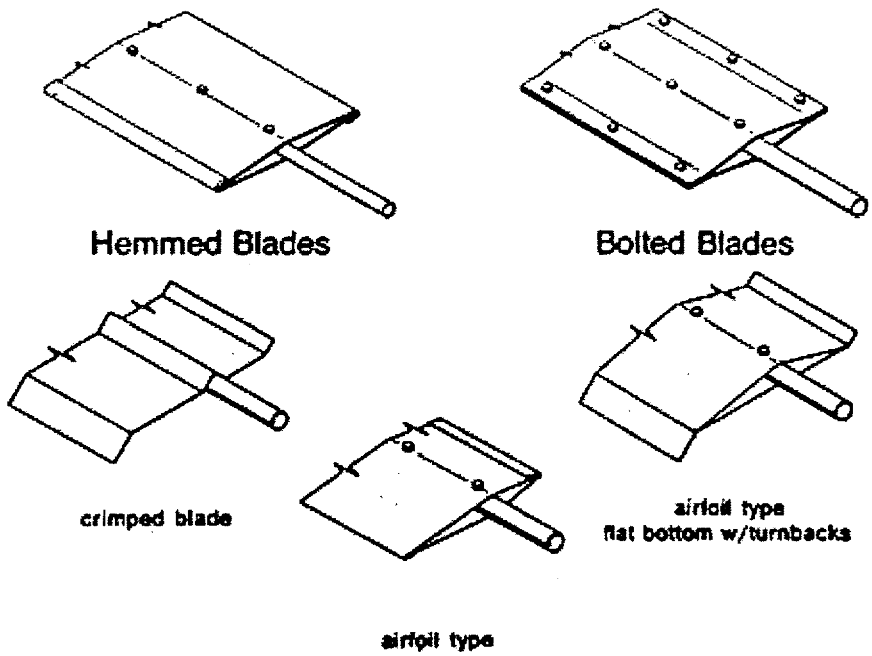


Figure A-2: Typical Damper Blades or Louvers

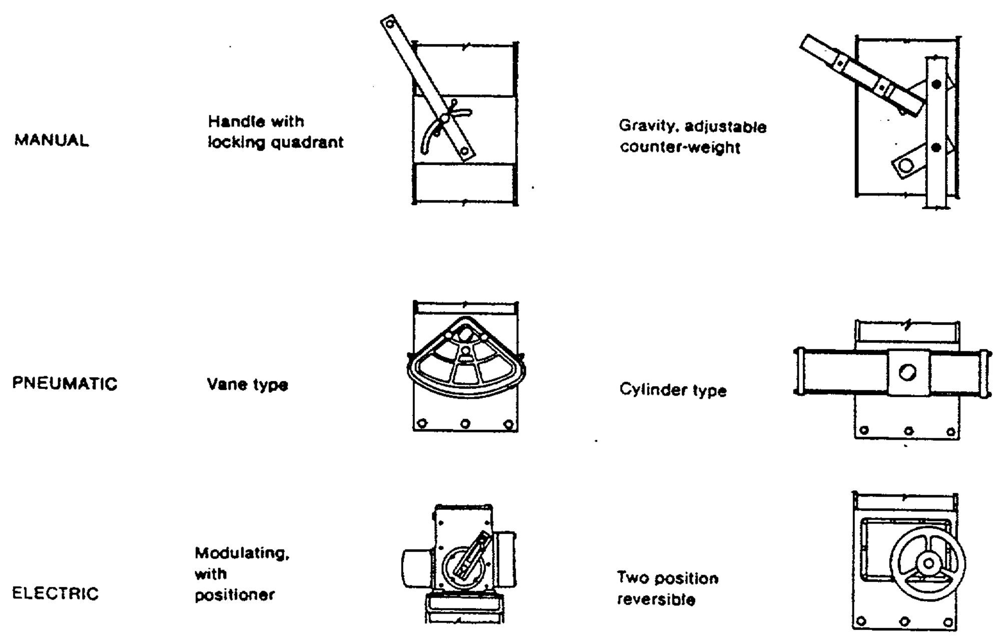


Figure A-3: Typical Damper Actuators

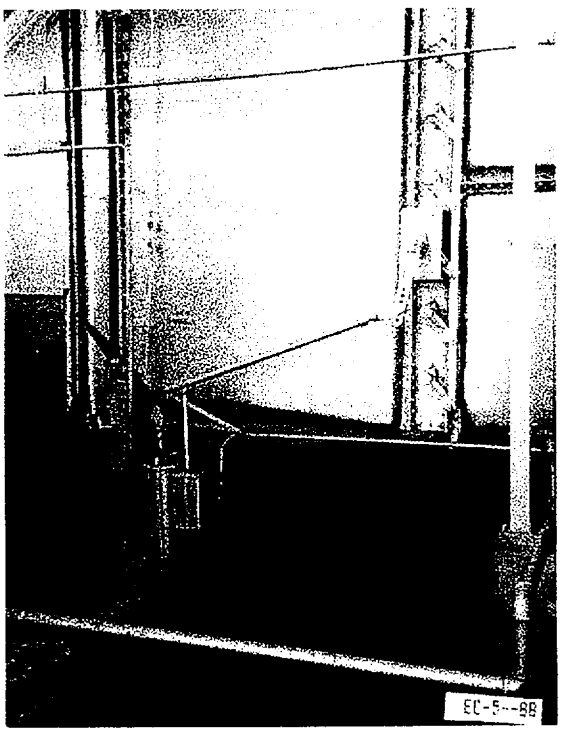


FIGURE A-4: PNEUMATIC DAMPER AT EL CENTRO STEAM PLANT SUBJECTED TO THE 1979 IMPERIAL VALLEY EARTHQUAKE (0.42G).

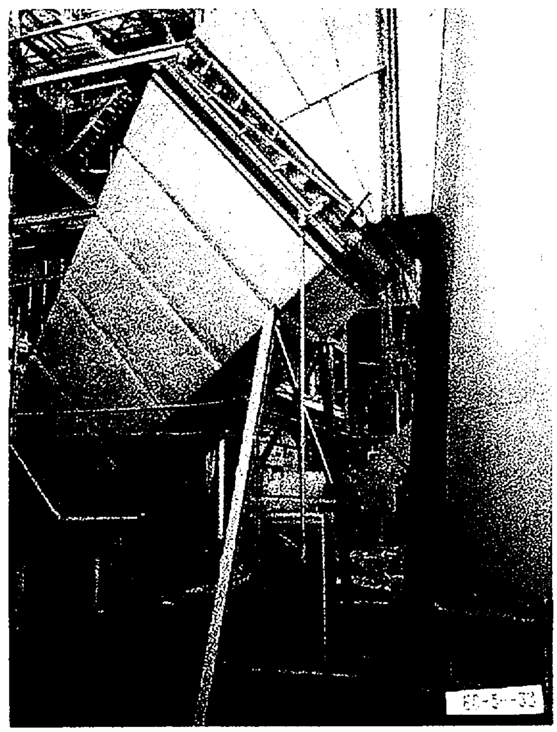


FIGURE A-5: LOUVER STYLE DAMPER ON THE BOILER STRUCTURE AT THE EL CENTRO STEAM PLANT WHICH EXPERIENCED THE 1979 IMPERIAL VALLEY EARTHQUAKE (0.42G).

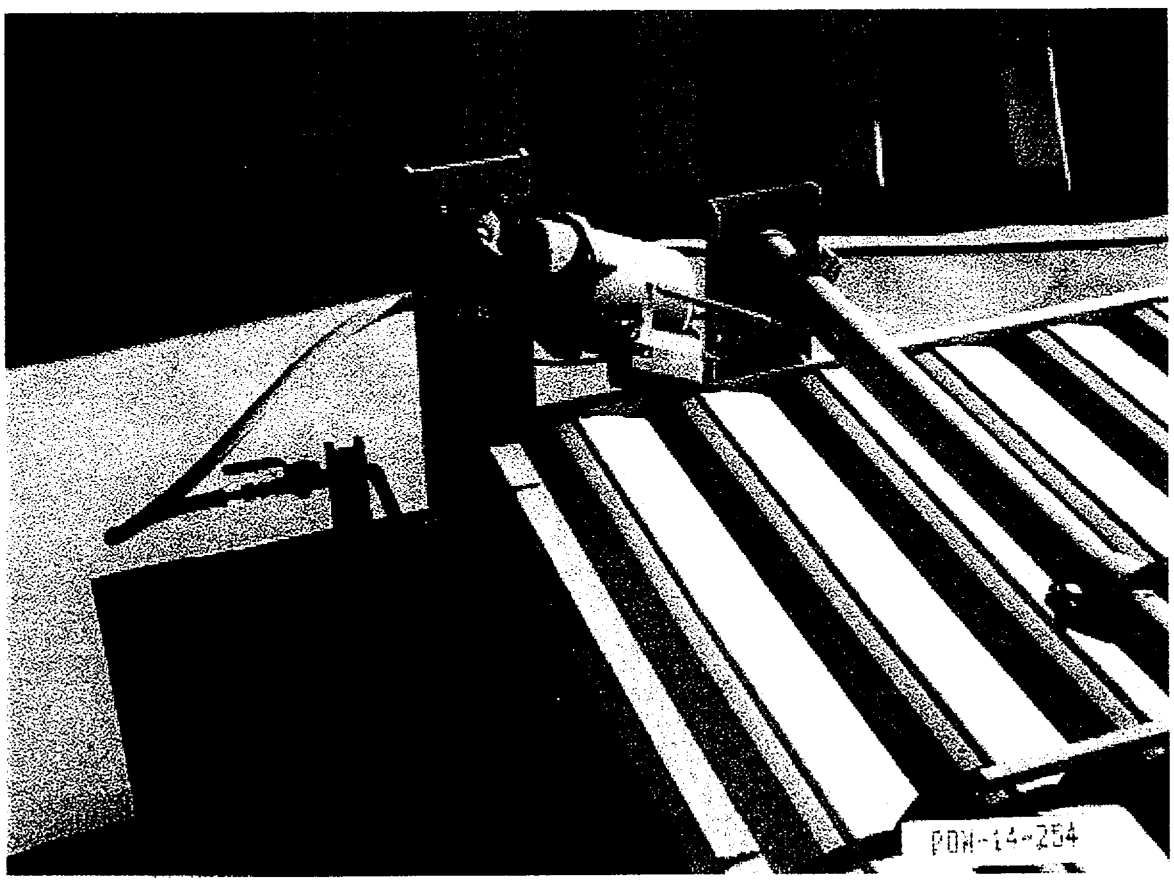


FIGURE A-6: PNEUMATIC ACTUATOR AT THE PUENTE HILLS LANDFILL GAS AND ENERGY RECOVERY PLANT.

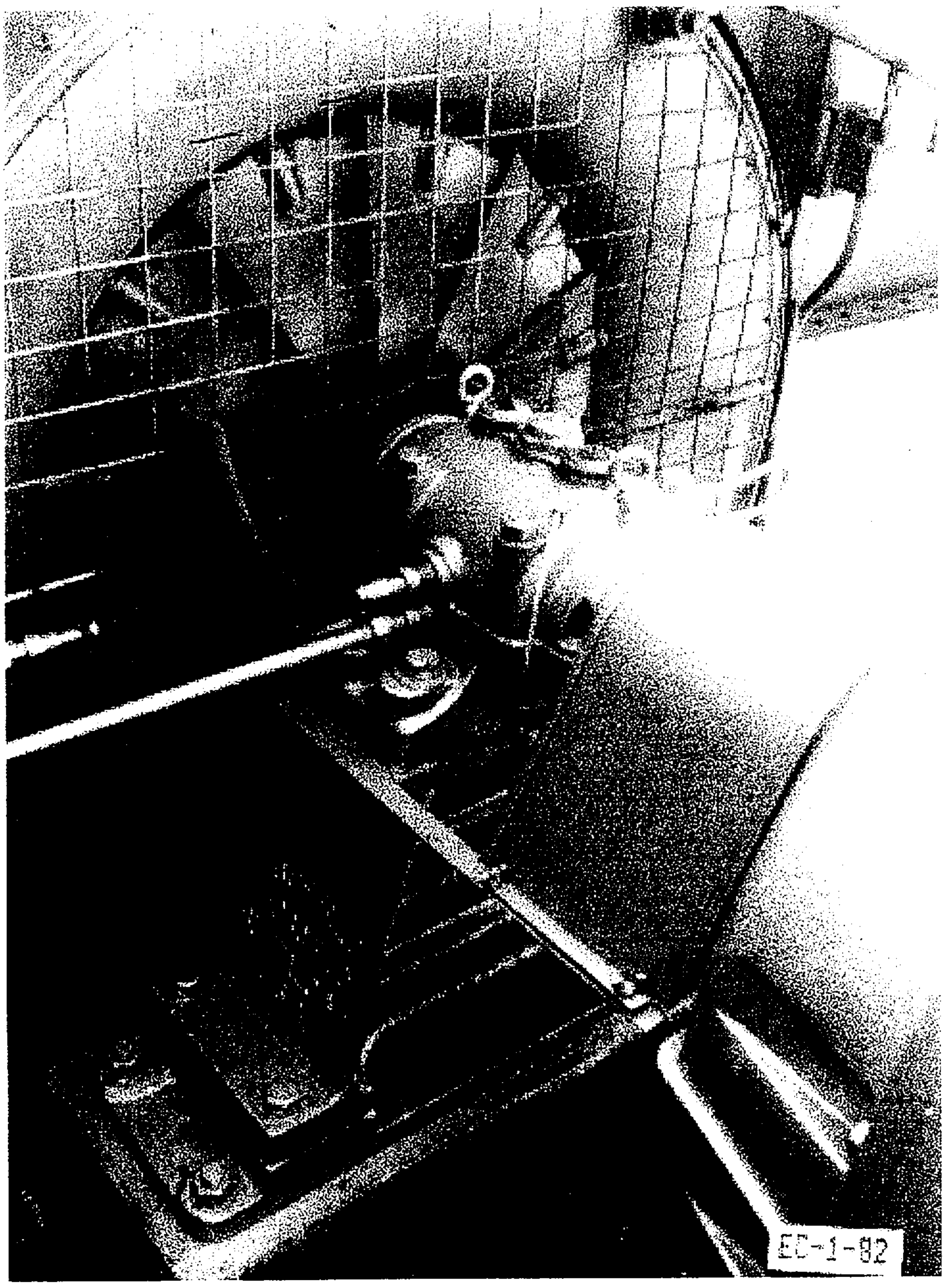


FIGURE A-7: RADIAL TYPE DAMPER AT THE EL CENTRO STEAM PLANT WHICH WAS SUBJECTED TO THE 1979 IMPERIAL VALLEY (0.42G) AND 1987 SUPERSTITION HILLS (0.25G) EARTHQUAKES.

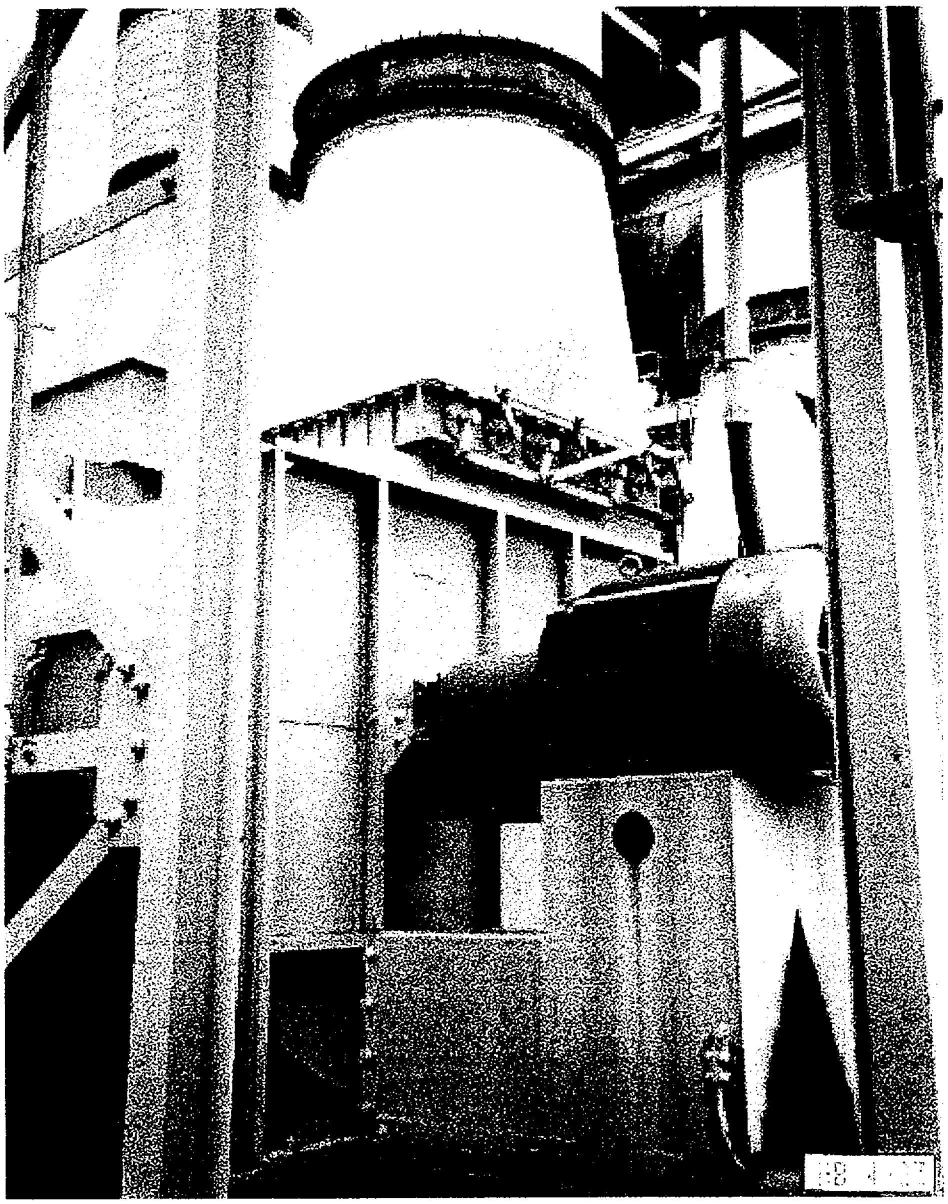


FIGURE A-8: LOUVER TYPE DAMPER AT HUMBOLDT BAY POWER PLANT (0.30G).

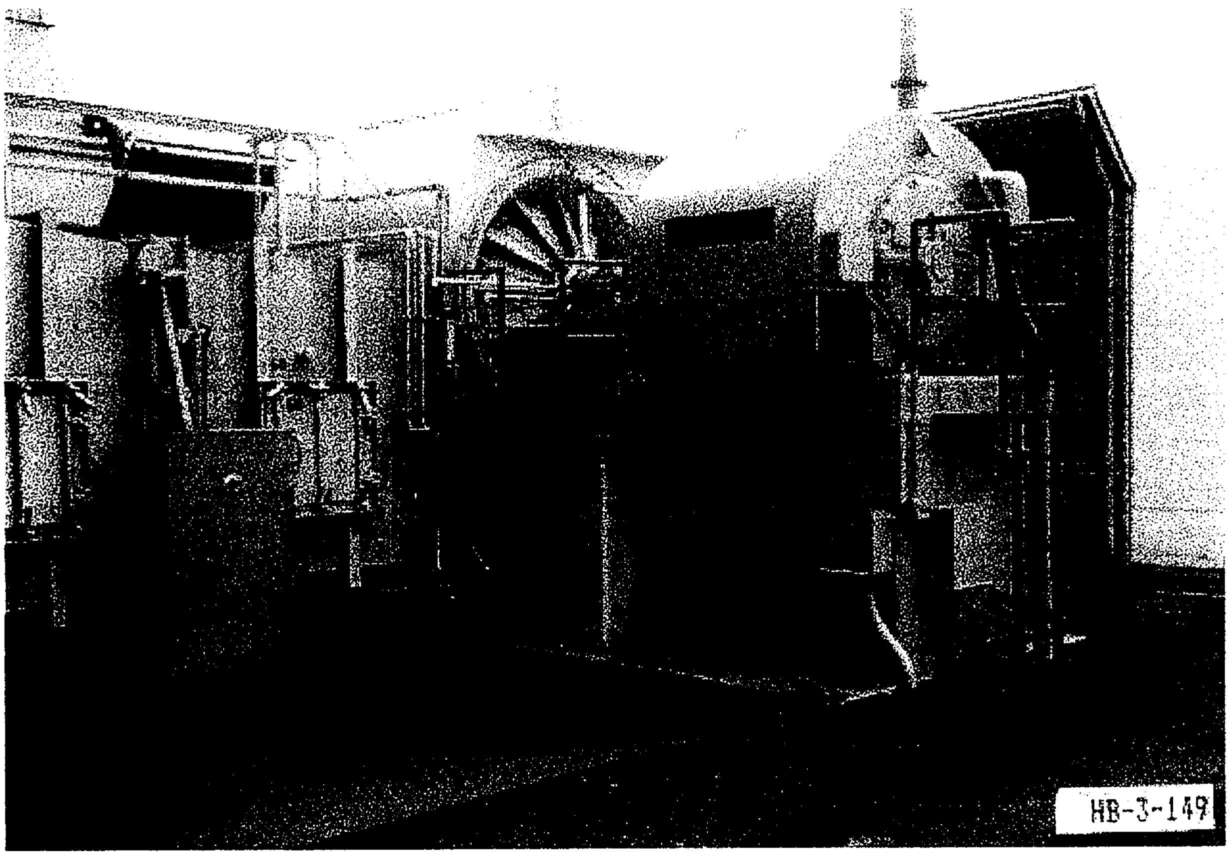


FIGURE A-9: RADIAL AND LOUVER TYPE DAMPERS AT HUMBOLDT BAY POWER PLANT WHICH EXPERIENCED THE 1975 FERNDALE EARTHQUAKE (0.50G).

FIGURE A-10: MOTOR-OPERATED DAMPER AT ADAK NAVAL STATION, WHICH EXPERIENCED THE 1986 ADAK ALASKA EARTHQUAKE (0.25G).

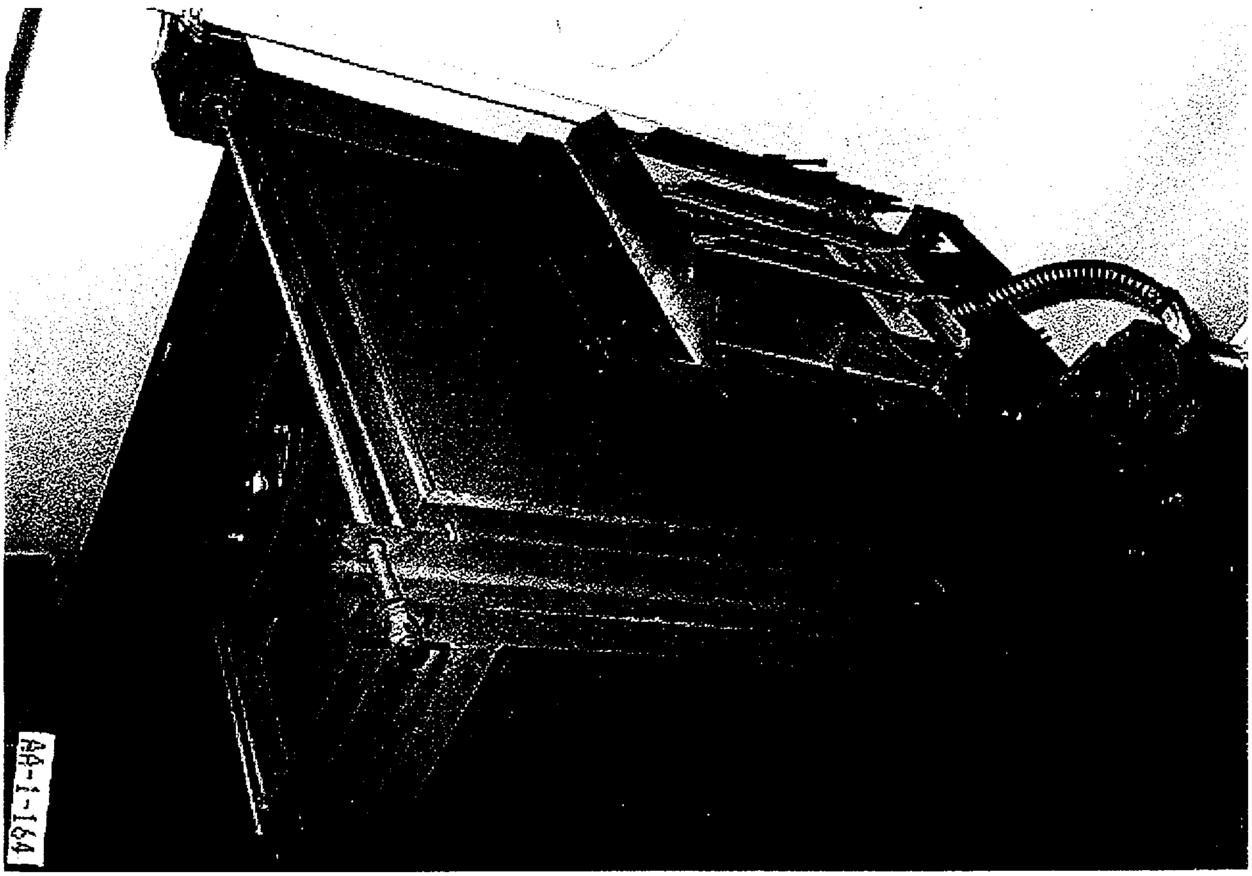


FIGURE A-11: DAMPER AT ADAK NAVAL STATION (0.25G).

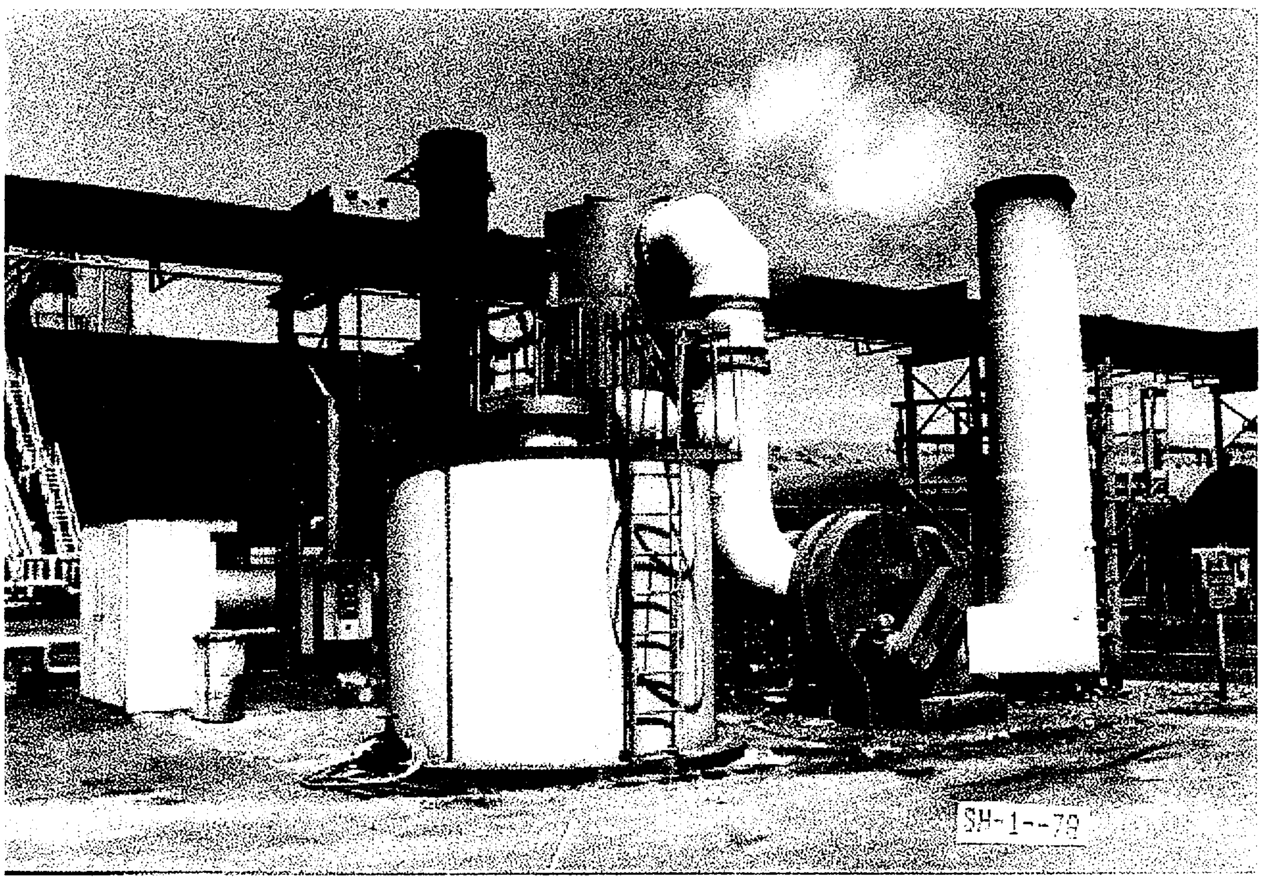


FIGURE A-12: PNEUMATICALLY CONTROLLED DAMPER AT UC SANTA CRUZ APPLIED SCIENCE BUILDING SUBJECTED TO 1989 LOMA PRIETA EARTHQUAKE (0.46G).

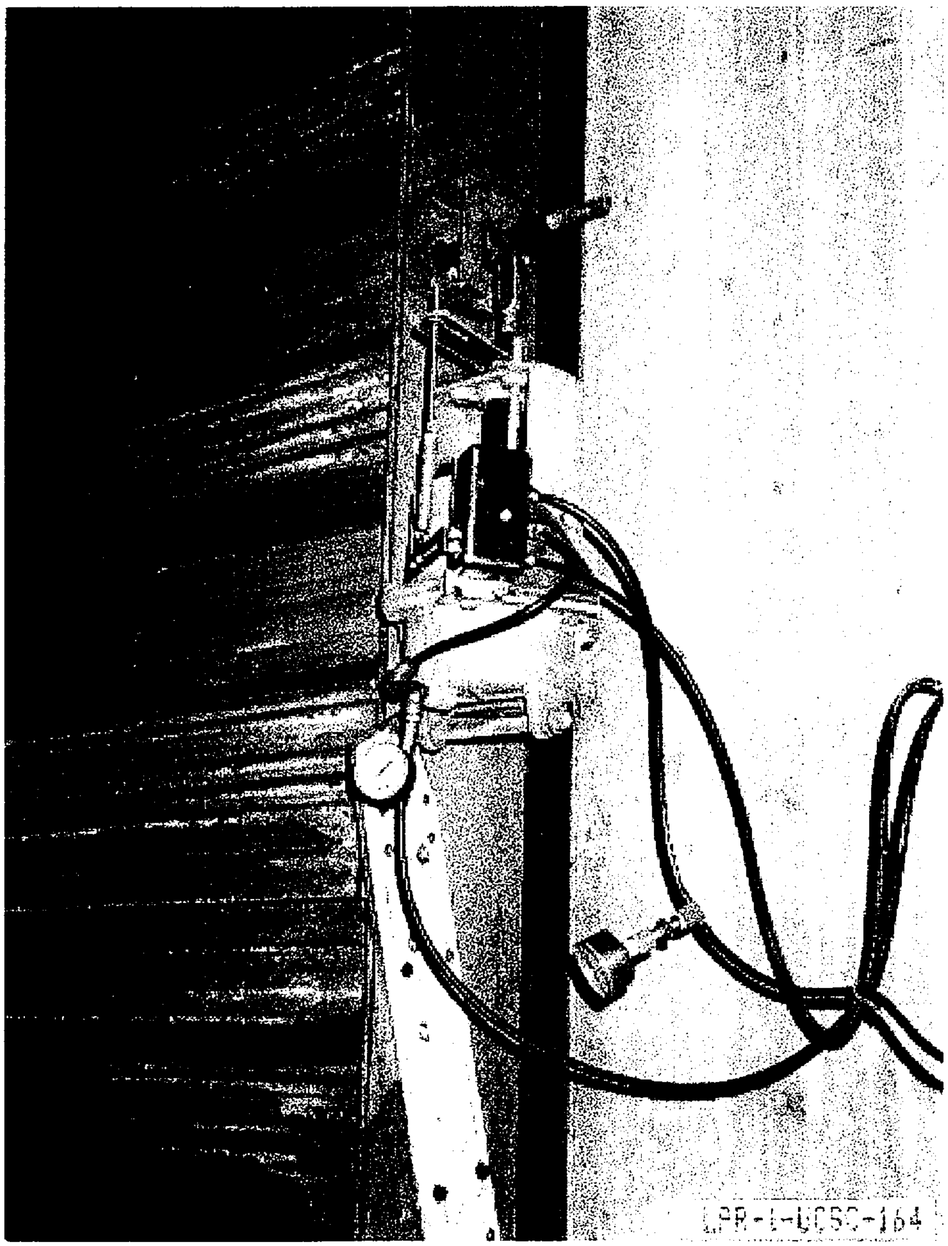


FIGURE A-13: ELECTRIC MOTOR FOR A FIRE DAMPER AT AES PLACERITA COGENERATION PLANT EXPERIENCED THE 1994 NORTHRIDGE EARTHQUAKE (0.60G).

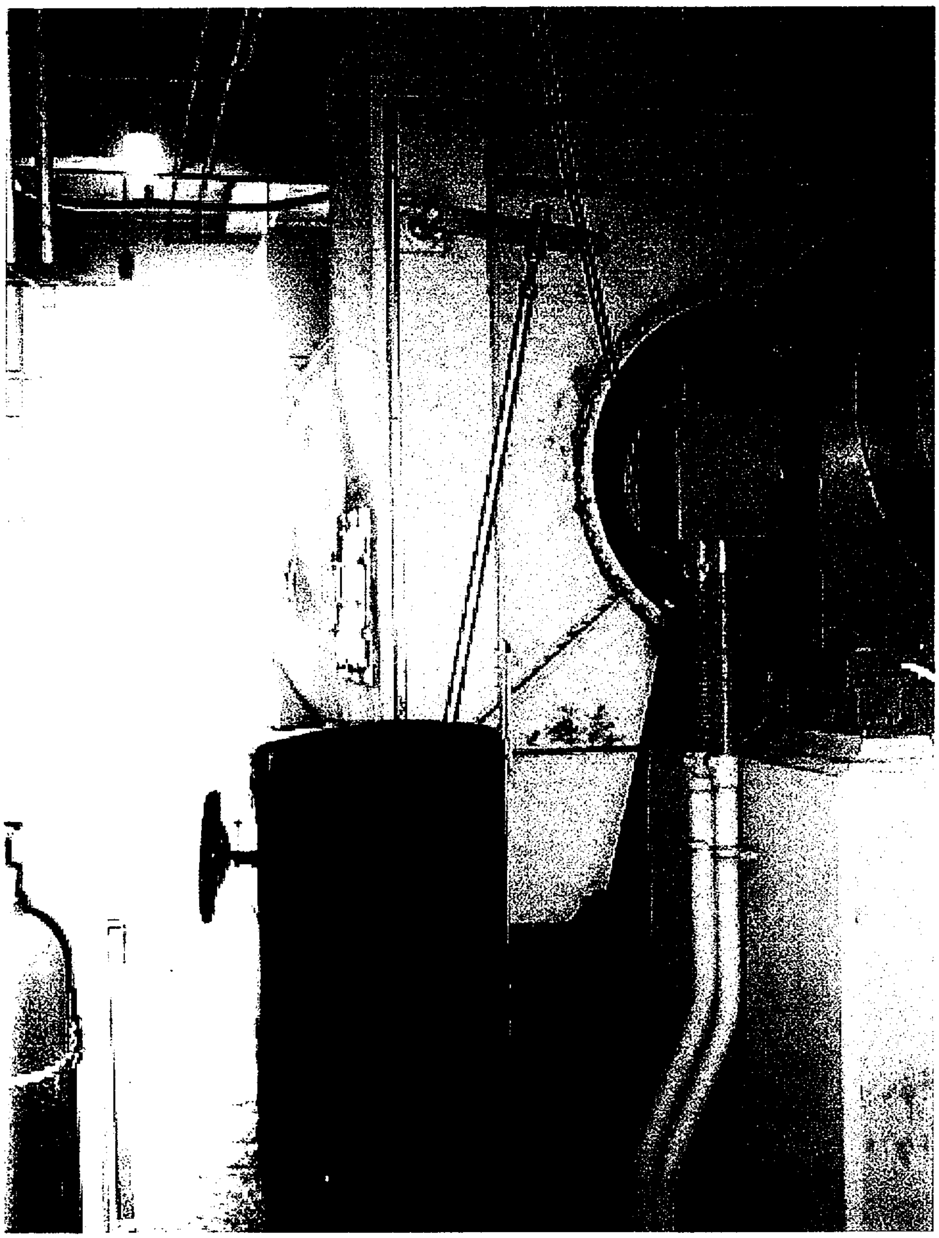


FIGURE A-14: PNEUMATIC DAMPER WITH LONG ACTUATOR AT VALLEY STEAM PLANT WHICH EXPERIENCED THE 1971 SAN FERNANDO (0.40G) AND THE 1994 NORTHRIDGE EARTHQUAKES (0.40G).

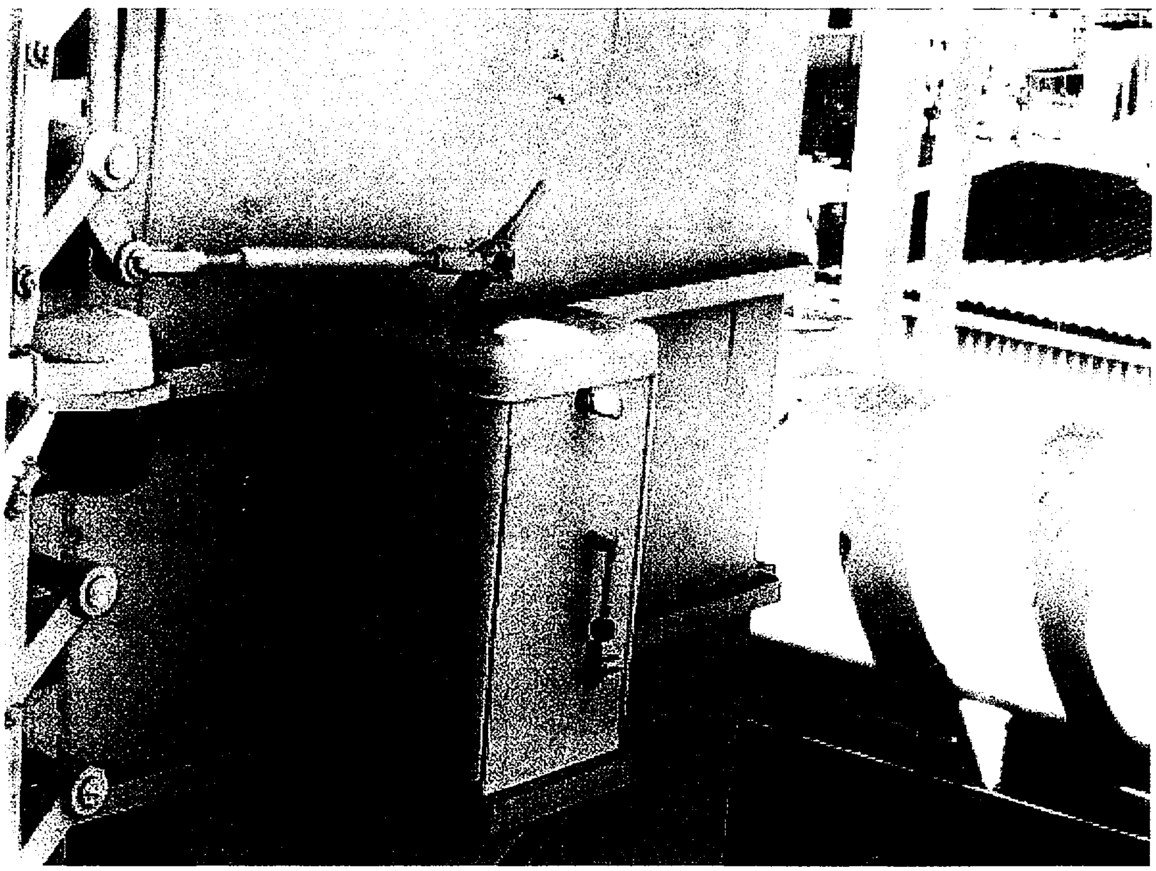


FIGURE A-15: PNEUMATIC LOUVER CONTROL DAMPER AT PASADENA POWER PLANT WHICH EXPERIENCED SEVERAL DATABASE EARTHQUAKES WITH PGA'S OF 0.20G.

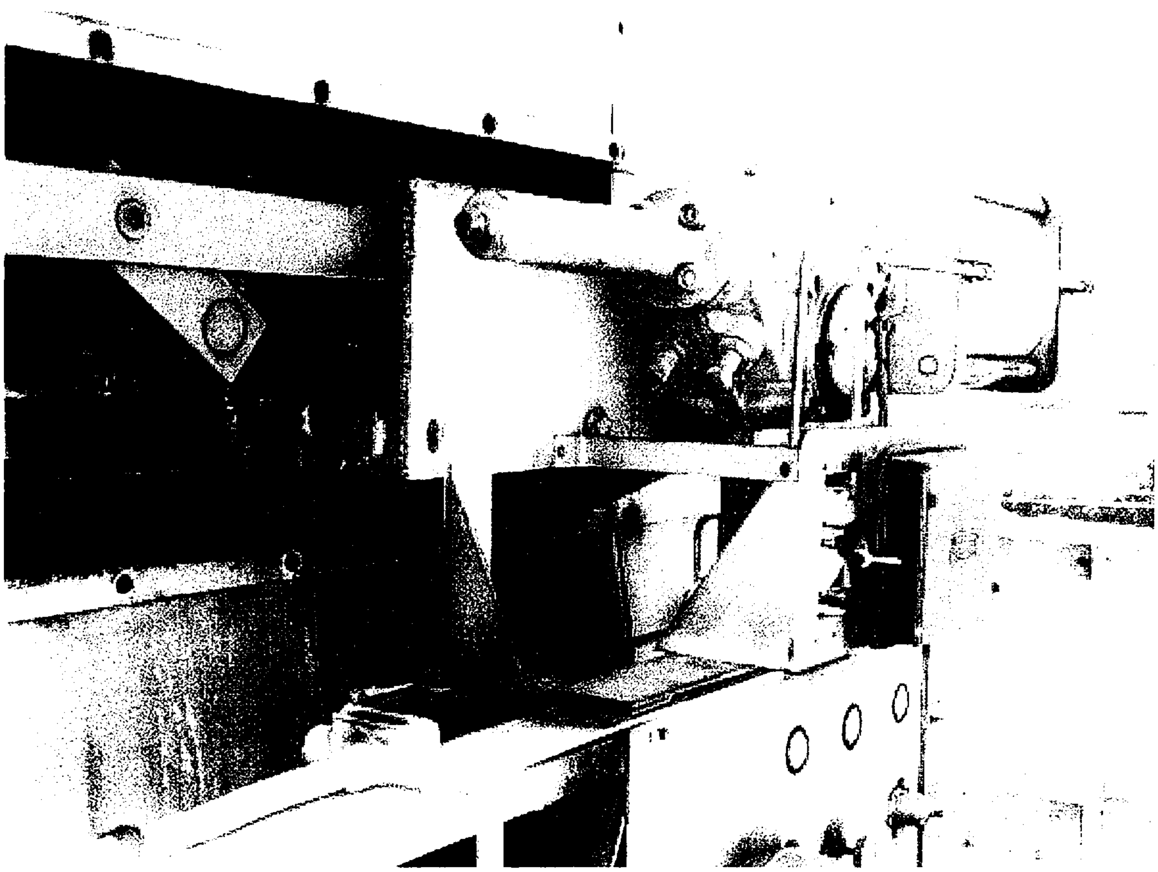


FIGURE A-16: HEAVY PNEUMATIC CONTROLLER, WITH INDEPENDENT SUPPORT, FOR A LARGE DAMPER AT PASADENA POWER PLANT LOCATED VERY HIGH IN THE BOILER STRUCTURE.

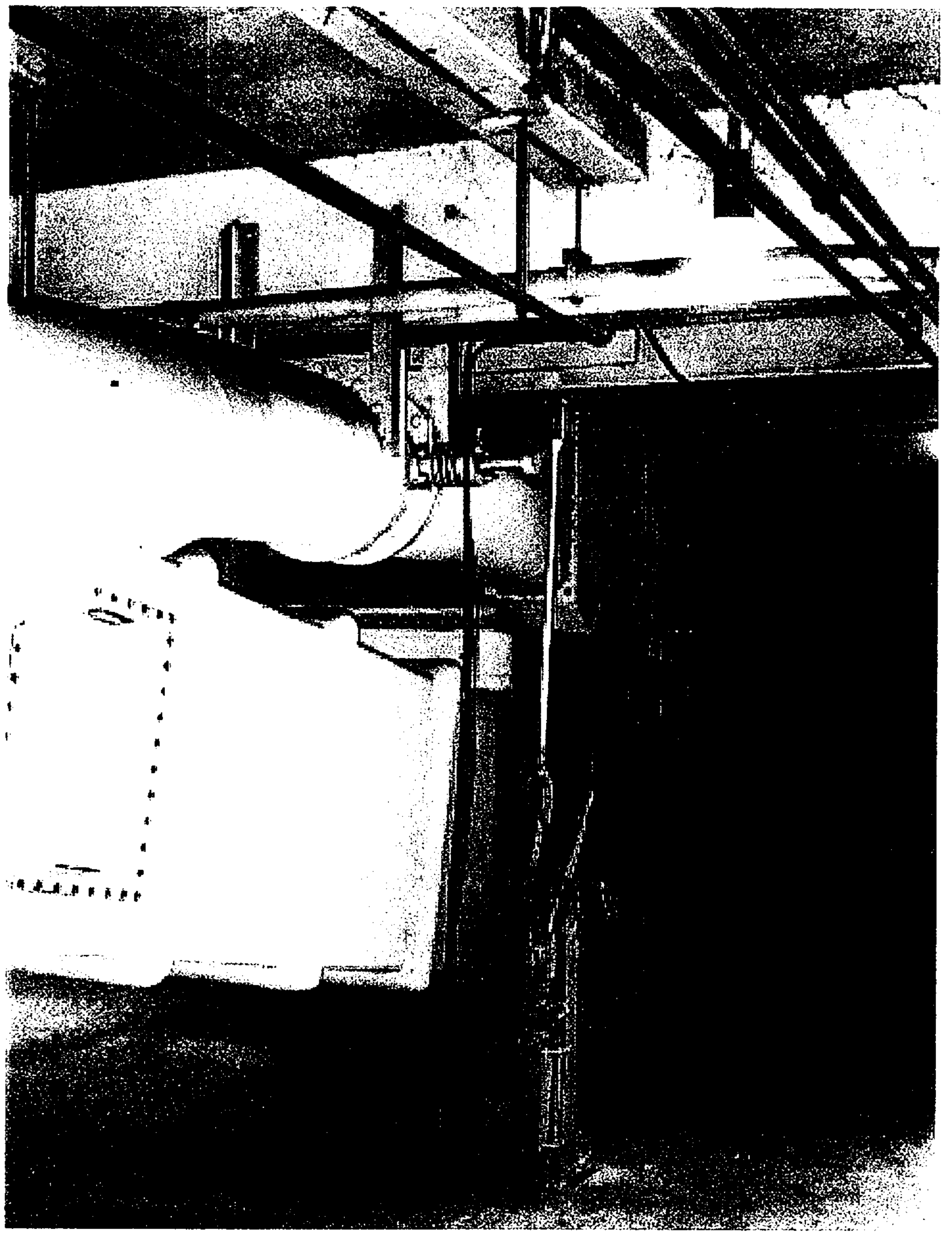


FIGURE A-17: FLOOR-MOUNTED AIR-OPERATED DAMPER WITH REMOTE ACTUATOR AT BURBANK POWER PLANT EXPERIENCED THE 1971 SAN FERNANDO AND THE 1994 NORTHRIDGE EARTHQUAKES (PGA=0.30G).

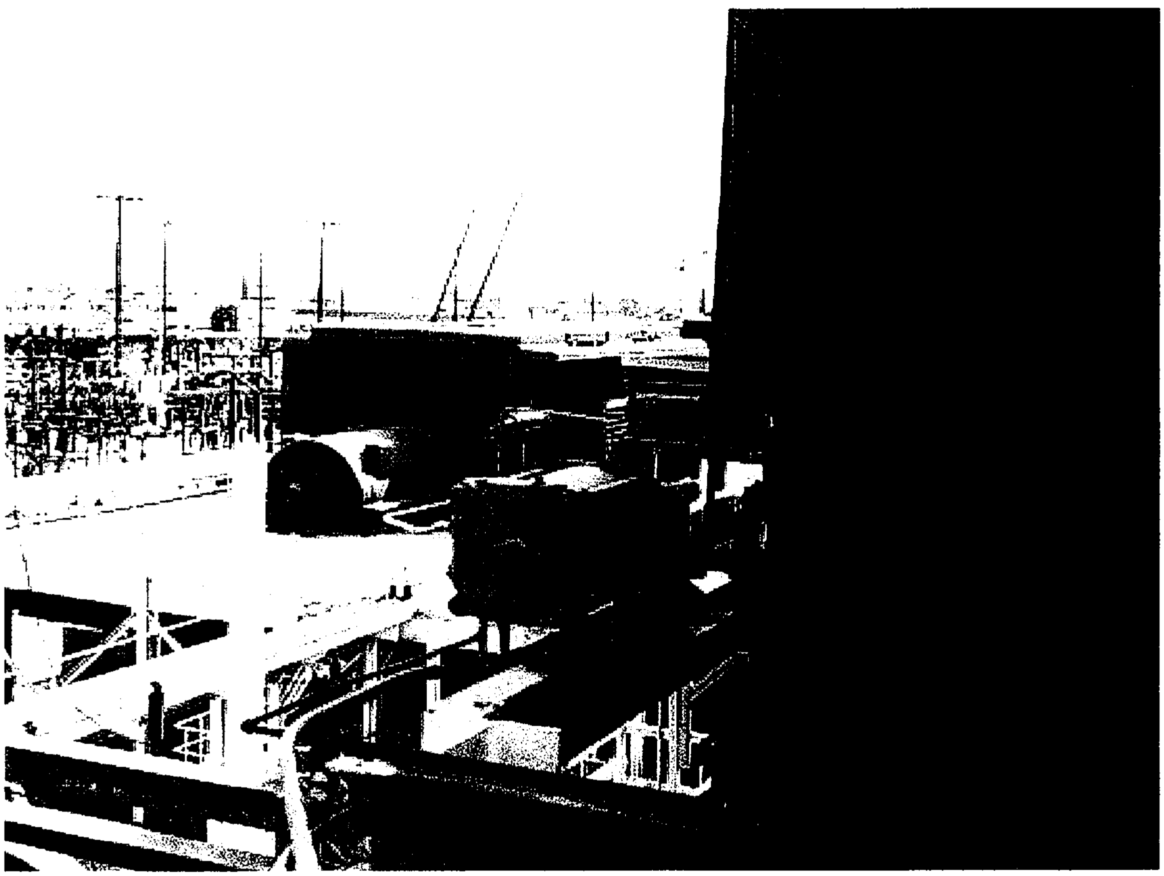


FIGURE A-18: LARGE INDEPENDENTLY SUPPORTED DAMPER CONTROLLER AT THE BURBANK POWER PLANT (PGA=0.30G).

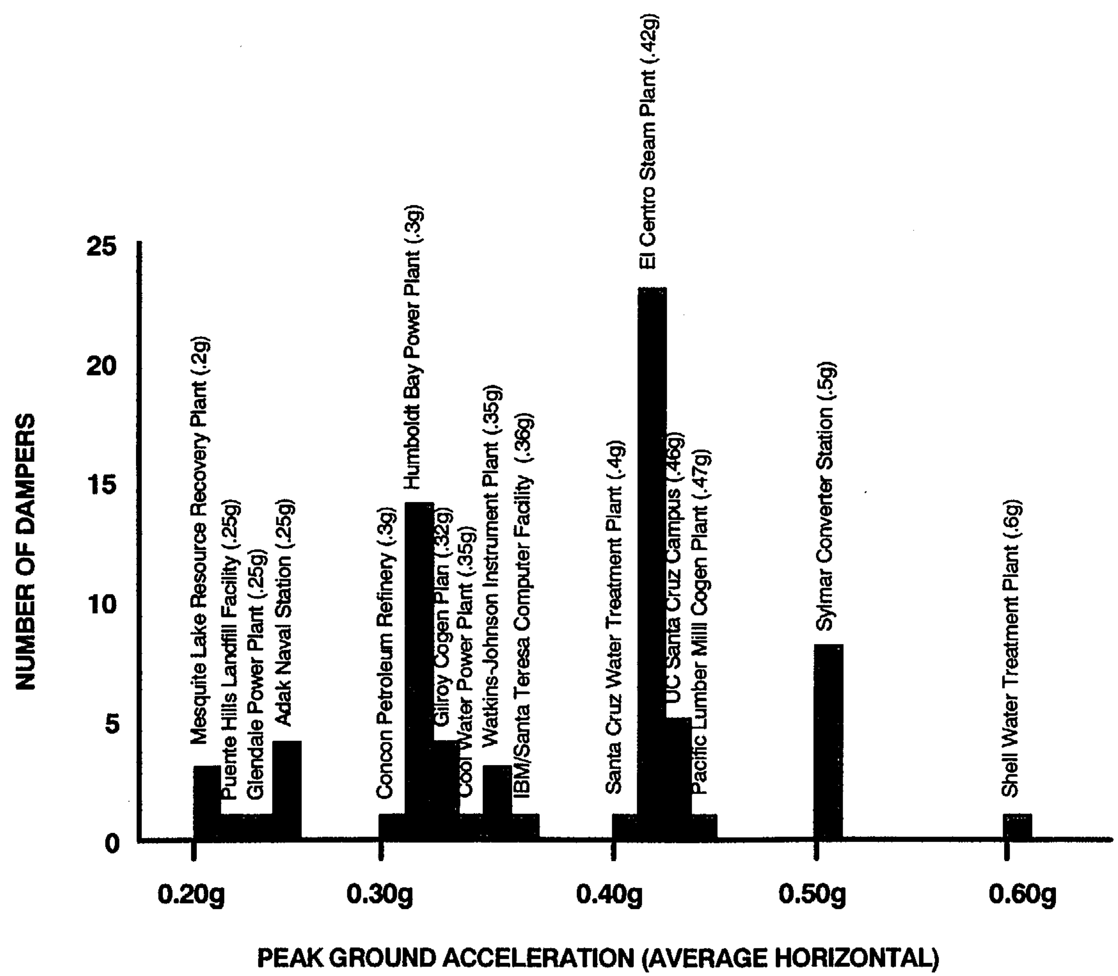


FIGURE A-19: INVENTORY OF DAMPERS WITHIN EXPERIENCE DATABASE

SUGGESTED GIP CAVEATS FOR DAMPERS

The equipment class of Dampers described below has been determined to be seismically rugged based on earthquake experience data, provided the intent of each of the caveats listed below is met. This equipment class includes all components of dampers installed in HVAC systems (or other types of duct systems). Fire dampers which are installed in walls or ceilings are also within this equipment class. Damper components are louver blades, actuators (pneumatic, electrical, and manual, as well as automatic counterweight and counterbalance actuators), attached air tubing and rigid or flexible electrical conduit, solenoid valves and pressure gages.

Dampers are sheet metal fabricated devices that consist of parallel flaps to either permit or prevent air flow. Dampers are an integral part of fans, air handlers and HVAC ducting and in case of fire dampers they are installed in walls or ceilings. The flaps or louvers of dampers are tied together by a common linkage which is externally controlled by an electric, pneumatic or manual actuator. Automatic dampers are operated by a pre-set counterweight or counterbalance.

Attachment of dampers to the HVAC ducting or equipment is through bolting, riveting or welding provided around the perimeter of the damper housing. The pneumatic or electric motors that control the actuation are typically attached to the damper housing; however, they also could be mounted on a nearby wall or floor with rack and pinion connection provided for the actuator. Dampers with heavy motor-operated actuators (typically greater than about 200 pounds) that are installed in-line in HVAC ducting are also represented in the database. This type of damper, however, should have its own independent support system.

The Bounding Spectrum represents the seismic capacity (defined as free-field motion at effective grade) of dampers when the damper meets the intent of the following inclusion and exclusion rules. Note, however, that when the specific wording of a caveat is not met, then a reason for concluding that the intent has been met should be provided on the SEWS.

DMPR/BS Caveat 1 - Earthquake Experience Equipment Class. The damper should be similar to and bounded by the DMPR class of equipment described above. The equipment class descriptions are general and the Seismic Capability Engineers should be aware that worst case combination of certain parameters may not be represented in the generic equipment class. These worst case combinations may have reduced seismic capacity and should be carefully evaluated on a case-by-case basis.

DMPR/BS Caveat 2 - Damper Operator/Actuator Not of Cast Iron. The intent of this caveat is to avoid the brittle failure mode of cast iron as evidenced by poor performance

of some cast iron components in the past earthquakes. Note that the database does not contain actuators with cast iron components; therefore, it is not necessary to determine the material of the damper control components unless it appears to the seismic capability engineers to be made of cast iron.

DMPRS/BS Caveat 3 - Sufficient Slack and Flexibility of Attached Lines. Sufficient slack and flexibility should be present in attached lines (e.g., air tubing, electrical conduit) to preclude a line breach due to differential seismic displacement of the equipment and the line's nearest support. Also, for damper positioners with independent supports (i.e., not mounted integrally on the duct) the effect of differential displacement on the actuator (with actuator defined as the rod connected at one end to the positioner and at the other end to the duct louver controls) needs to be considered. The issue here is to identify cases where the actuator is connected to a rigidly mounted positioner at one end and to a rod hung duct system at the other.

DMPRS/BS Caveat 4 - Adequate Anchorage. Damper controls when mounted on the ground or nearby structures should be properly anchored in accordance with the guidelines of GIP section 4.4. When the motor or pneumatic operator is mounted on the duct at the damper location the adequacy of the attachment point to the duct skin or its stiffeners should be ensured.

DMPR/BS Caveat 5 - Duct Distortion. The duct at the damper location should be carefully investigated for any signs of distortion as this could interfere with the damper operation.

DMPR/BS Caveat 6 - Interactions. All credible and significant interactions in the immediate vicinity of the dampers and their controls should be identified and evaluated. Evaluation of Interaction effects should consider detrimental effects on the capability of dampers and their controls to function. In the evaluation of proximity effects and overhead or adjacent equipment failure and interactions, the effects of intervening structures and equipment which would preclude impact should be considered.

Attachment 4

EQE INTERNATIONAL

CALCULATION COVER SHEET

Calculation No. 250540-C-013

Project: BEAVER VALLEY A-46 OUTLIER RESOLUTION

Calculation Title: SEISMIC ADEQUACY OF SWITCHBOARDS AND PANELBOARDS THAT EXCEED TYPICAL PANEL DIMENSIONS SUGGESTED IN THE GIP

References: SEE SECTION 6.0

Appendices: A

Total Number of Pages (Including Cover Sheet): 15

Revision Number	Approval Date	Description of Revision	Originator	Checker	Approver
0	4/8/98	ORIGINAL ISSUE	F.R.BEIGI FBeigi	R.W.CUSHING R. Cushing	R.W.CUSHING R. Cushing

Table of Contents

1.0 INTRODUCTION AND PURPOSE

Several instances were identified during walkdowns of the Beaver Valley Nuclear Power Station of electrical switchboards and distribution panelboards that exceeded the typical cabinet dimensions mentioned in Appendix B of the Generic Implementation Procedure (Reference 1). Section 14 of Appendix B of the GIP, which summarizes the twenty generic categories of equipment, describes floor-mounted switchboards as having typical dimensions of 20 to 40 inches in width and depth, and 90 inches in height. Wall-mounted panelboards are described as typically 20 to 40 inches in height and width, and 6 to 12 inches in depth. These cabinet dimensions are considered as guidelines for bounding cases, and are mentioned in the GIP primarily for the purpose of describing the typical construction of equipment and establishing equipment class representation. Dimensions are not listed for the purpose of presenting rigorous limits on the allowable size of equipment considered seismically adequate in nuclear plants.

However, the GIP requires that nuclear plant equipment generally comply with the construction of equipment represented at the various database sites, upon which the generic seismic performance for each equipment class is based. Electrical cabinets that exceed the typical dimensions presented in the GIP are technically outliers -- equipment that appears to fall beyond the bounds of representation by the seismic experience database. If the particular seismic capability engineers (SCEs) performing the walkdown are not prepared to pass the (apparently oversized) equipment on the basis of judgment, then the equipment items are considered outliers and require further study to demonstrate their seismic adequacy. The purpose of this write-up is to provide such demonstration of seismic adequacy for switchboards and panelboards that appear to exceed typical cabinet dimensions.

2.0 SCOPE

The following cabinets are included in the scope of this calculation:

Equipment ID No.	Building	Elevation	Outlier Description
DC-SWBD-1	SRVB	713	Cabinet exceeds dimensions for the equipment class #14. Height = 98" vs. 90".
DC-SWBD-2	SRVB	713	Cabinet exceeds dimensions for the equipment class #14. Height = 98" vs. 90".
DC-SWBD-3	SRVB	713	Cabinet exceeds dimensions for the equipment class #14. Height = 98" vs. 90".
DC-SWBD-4	SRVB	713	Cabinet exceeds dimensions for the equipment class #14. Height = 98" vs. 90".
PNL-AC-E1	SRVB	713	Cabinet exceeds dimensions for the equipment class #14. Height=50" vs. 40" & Depth=16" vs. 12".
PNL-AC-E2	SRVB	713	Cabinet exceeds dimensions for the equipment class #14. Height=50" vs. 40" & Depth=16" vs. 12".
PNL-AC-E3	SRVB	713	Cabinet exceeds dimensions for the equipment class #14. Height=50" vs. 40" & Depth=16" vs. 12".
PNL-AC-E4	SRVB	713	Cabinet exceeds dimensions for the equipment class #14. Height=50" vs. 40" & Depth=16" vs. 12".
PNL-PR-HTR-A	SFGB	735	Cabinet exceeds dimensions for the equipment class #14. Height=64" vs. 40" & Width=44-1/2" vs. 40".
PNL-PR-HTR-B	SFGB	735	Cabinet exceeds dimensions for the equipment class #14. Height=64" vs. 40" & Width=44-1/2" vs. 40".
PNL-PR-HTR-D	SFGB	735	Cabinet exceeds dimensions for the equipment class #14. Height=64" vs. 40" & Width=44-1/2" vs. 40".
PNL-PR-HTR-E	SFGB	735	Cabinet exceeds dimensions for the equipment class #14. Height=64" vs. 40" & Width=44-1/2" vs. 40".
PNL-VITBUS-1	SFGB	735	Cabinet exceeds dimensions for the equipment class #14. Width=72" vs. 40".
PNL-VITBUS-2	SFGB	735	Cabinet exceeds dimensions for the equipment class #14. Width=72" vs. 40".
PNL-VITBUS-3	SFGB	735	Cabinet exceeds dimensions for the equipment class #14. Width=72" vs. 40".
PNL-VITBUS-4	SFGB	735	Cabinet exceeds dimensions for the equipment class #14. Width=72" vs. 40".

3.0 METHOD

The GIP provides several options for the resolution of outliers as described in its Section 5. Among these is the option of providing more detailed seismic experience data to address the particular issue that creates the outlier. Specifically the GIP states: "The earthquake experience equipment class may be expanded to include the equipment or specific equipment features of interest" (page 5-7). In practice this normally means preparing a short write-up that demonstrates that characteristics of nuclear plant equipment thought to result in outliers are in fact found in the SQUG database, and, more importantly, these characteristics are not linked to sources of seismic failure in past earthquakes. This write-up therefore has two objectives:

1. To demonstrate that the database includes examples of switchboards and panelboards that, like the equipment items at Beaver Valley Station, exceed the nominal bounds of cabinet dimensions.

2. To demonstrate that the general durability of switchboards and panelboards in past earthquakes is not sensitive to cabinet dimensions, i.e., that the few instances of seismic failure for the equipment category are not linked to the specific parameter of cabinet size.

4.0 EVALUATION

4.1 EXCEEDENCE OF STANDARD DIMENSIONS

Floor-mounted switchboards at Beaver Valley were found to have heights as great as 98.5 inches, a minor excedence over the standard cabinet height of 90 inches found in most industrial switchboards and motor control centers. Typically the added height consists of a sheet metal pullbox mounted atop the cabinet to collect cable routed from overhead conduit attachments.

Instances were also found during the Beaver Valley walkdown of wall-mounted panelboards exceeding one of the three nominal limits on cabinet dimensions -- height, width, and depth -- although never all three in a single unit. Specifically, examples were found of panelboards up to

72 inches in height (as opposed to 40 inches), up to 44 inches in width (as opposed to 40 inches), and up to 16 inches in depth (as opposed to 12 inches).

Examples from the SQUG database are presented in Figures 1 - 6, of switchboards and panelboards that represent similar exceedences from a standpoint of the cabinet mass cantilevered from floor or wall anchorage. In all examples of course, the database equipment survived earthquakes with spectra which exceed those at Beaver Valley without effects and remained operable afterward.

4.2 SEISMIC VULNERABILITY

The equipment category of switchboards and panelboards includes about 140 examples from various database sites (Reference 2). Within this inventory there is only one instance of damage, i.e., one instance where a panelboard was found to be inoperable following the earthquake, due to any reason. A wall-mounted panelboard suffered electrical damage at the Caxton Paper Mill during the 1987 New Zealand earthquake. The site experienced a peak ground acceleration in the range of 0.30 - 0.40g, based on estimates from the nearest strong motion records. An electrical ground fault occurred in the panelboard when a loose bus bar contacted the enclosing sheet metal cabinet. Site electricians suspected that the busbar was not completely attached within the bus bar compartment. It appears then that the failure was more of a specific defect in the item of equipment, than a failure due to excessive shaking. The panelboard was one of several that had been recently installed, and it is possible that proper electrical attachments had been overlooked during installation.

There are no instances of seismic damage in free-standing floor-mounted switchboards. However, the equipment category of motor control centers is very similar to floor-mounted switchboards, being of about the same dimensions but of heavier mass due to similar but more extensive internals. Motor control centers have suffered several failures in past earthquakes, due either to overturning from lacking or insufficient anchorage, or due to damage from water spray from fractured overhead piping.

Even including the instances of damage to motor control centers, seismic vulnerabilities of switchboards and panelboards have never been shown to be related to the parameter of cabinet dimensions. The general durability of the equipment is seen to be insensitive to the specific dimensions of the sheet metal enclosure. There is obviously no "abrupt threshold" in cabinet dimensions, above which excessive mass moment arm with respect to anchorage to wall or floor makes the equipment susceptible to seismic failure.

5.0 CONCLUSIONS

This calculation demonstrated that the seismic experience database includes examples of switchboards and panelboards that, like the equipment items at Beaver Valley Station (see section 2.0), exceed the nominal bounds of cabinet dimensions mentioned in the GIP. It is also demonstrated that the general durability of switchboards and panelboards in past earthquakes is not sensitive to cabinet dimensions, i.e., that the few instances of seismic failure for the equipment category are not linked to the specific parameter of cabinet size. Therefore, the panelboards' and switchboards' outliers for dimensional exceedences as compared to the GIP guidelines are resolved. It is also noted that the anchorage of all panels in the scope of this calculation have been evaluated and shown to be seismically adequate (Refs. 3, 4 and 5).

6.0 REFERENCES

1. "Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Plant Equipment", June 1991, Prepared by Winston & Strawn et al, for the Seismic Qualification Utility Group (SQUG).

2. "Summary of the Seismic Adequacy of Twenty Classes of Equipment Required for the Safe Shutdown of Nuclear Plants: A Supplement", Prepared by EQE, inc. for the Seismic Qualification Utility Group, December 1994.

3. EQE Calculation No. 52233-C-013, " Wall Mounted Panels Anchorage Evaluation," Rev. 0.

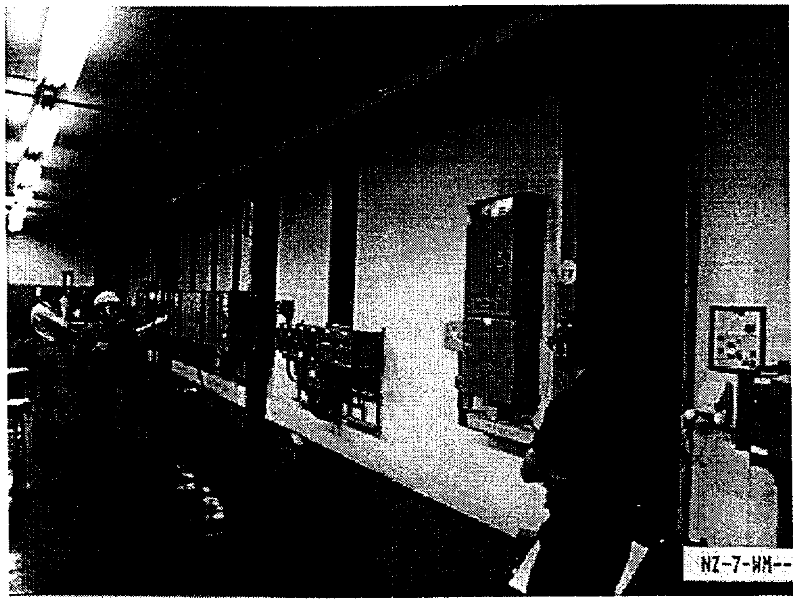
4. EQE Calculation No. 52233-C-014, " Distribution Panels Anchorage Evaluation," Rev. 0.

5. EQE Calculation No. 250540-C-006, " Resolution of Anchorage Outlier for Panel DC-SWBD-2," Rev. 0.

7 pages (including this page)

APPENDIX A

EXAMPLES FROM THE SQUG EXPERIENCE DATABASE OF DISTRIBUTION SWITCHBOARDS AND PANELBOARDS EXCEEDING TYPICAL CABINET DIMENSIONS



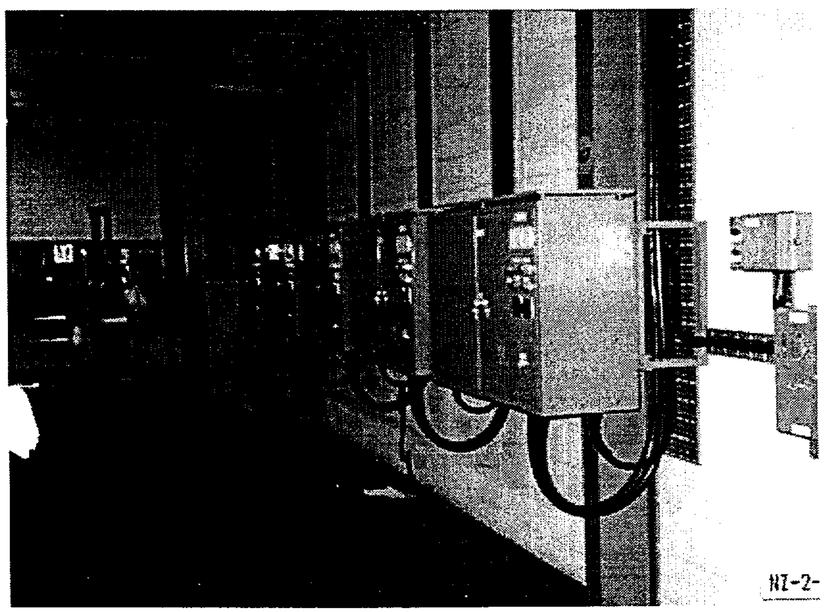


Figure 1: Wall-mounted distribution panelboards exceeding the standard dimensions for depth (dimension normal to the wall) create a question regarding the effect of increased mass moment arm cantilevered from the wall anchorage. Some of the best examples of excessive cantilevered mass in panelboards and similar wall-mounted cabinets are found at sites which withstood the 1987 earthquake in New Zealand. The examples illustrated above are wall-mounted cabinets serving the Whakatane Paper Mill (PGA = 0.3g), where the center of gravity of the cabinets is cantilevered an estimated 18 inches from the bolts anchoring the cabinets to the supporting block wall.

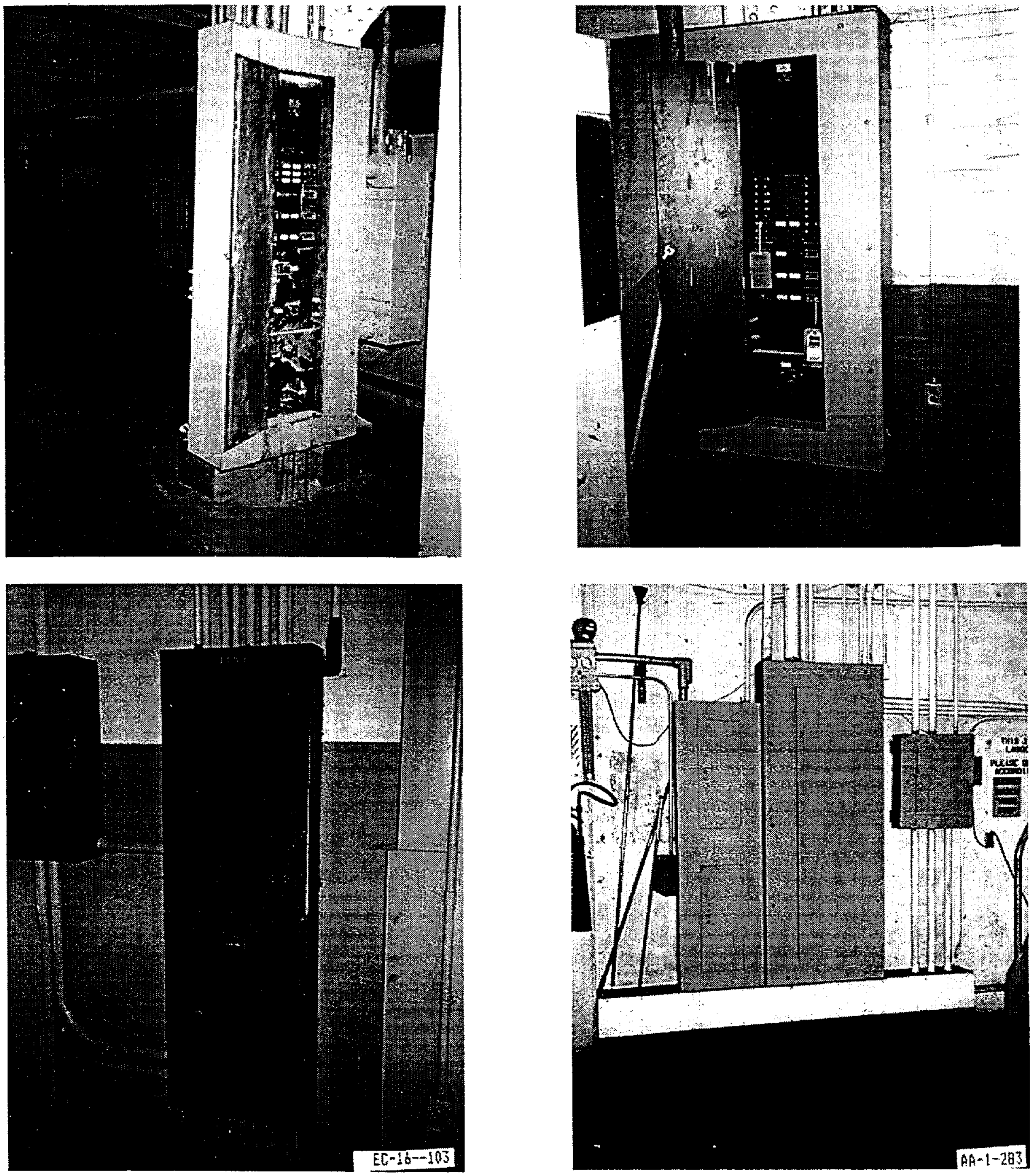
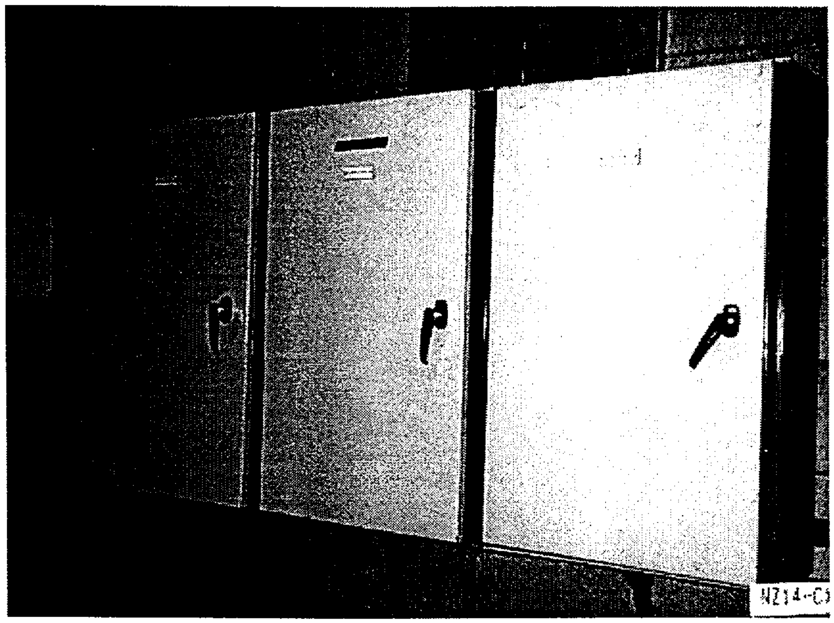


Figure 2: Examples of wall-mounted panelboards ranging from 60 to more than 70 inches in height are found at El Centro Steam Plant (upper and lower left photos, which withstood the earthquakes of 1979 and 1987, with PGA's of 0.42g and 0.25g respectively), and at the Adak Naval Base (lower right photo, which withstood the earthquake of 1986, PGA= 0.25g).



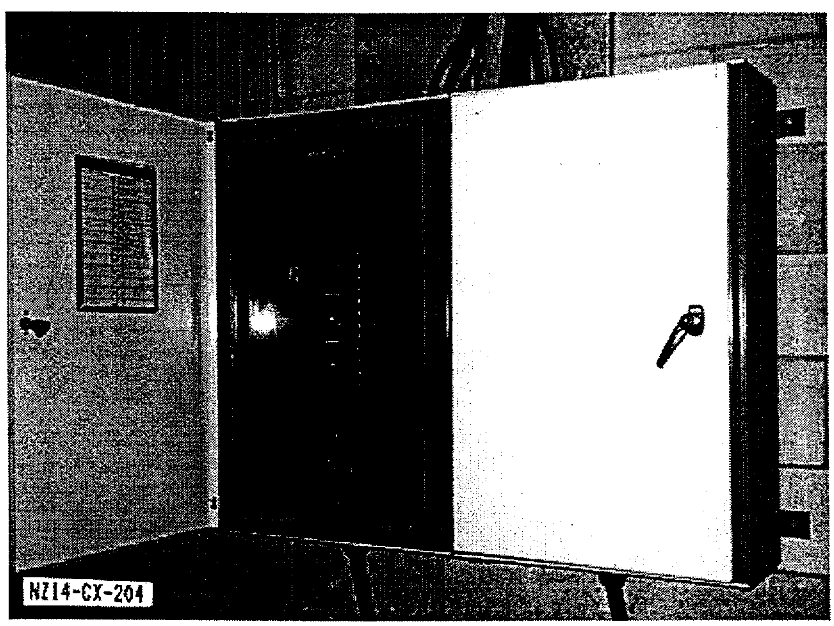


Figure 3: Wall-mounted panelboards exceeding the standard dimensions of width also create a question of excessive mass cantilevered from their supporting wall anchorage. Examples of wall-mounted panelboards exceeding 40 inches in width (~ 72") include double and triple panelboards combined as single wall-mounted cabinets at the Caxton Paper Mill, which withstood by the 1987 earthquake in New Zealand, PGA= 0.40g.

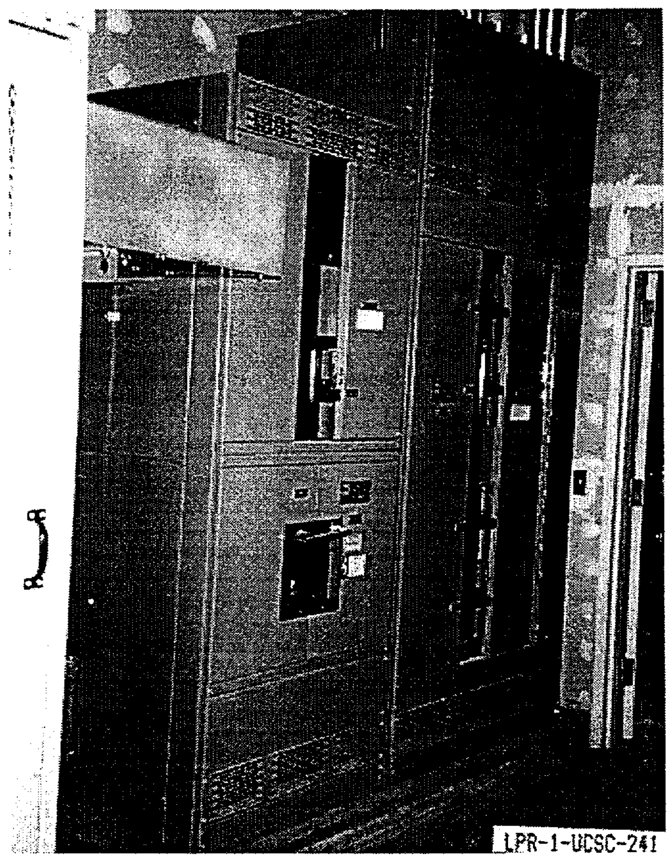


Figure 4: Switchboards exceeding the standard 90 inches in height present a question of excessive mass concentrated at the top of the cabinet, or an excessively high center of gravity. Cabinet height extensions sometimes include cable pullboxes into which overhead conduit connections are made, as in the two examples illustrated in the photos. The switchboards are located in the electrical rooms of the UC Santa Cruz Central Campus, which withstood the 1989 Loma Prieta earthquake (PGA= 0.4g).

EQE INTERNATIONAL

						SHEET NO.	A6 of 7
JOB NO.	250540	JOB	BEAVER VALLEY A-46 OUTLIER RESOLUTION	BY	7Beg	DATE	2-2-98
CALC. NO.	C-013	SUBJECT	SEISMIC ADEQUACY OF SWITCHBOARDS AND PANELBOARDS	CHK	RC	DATE	4-8-98

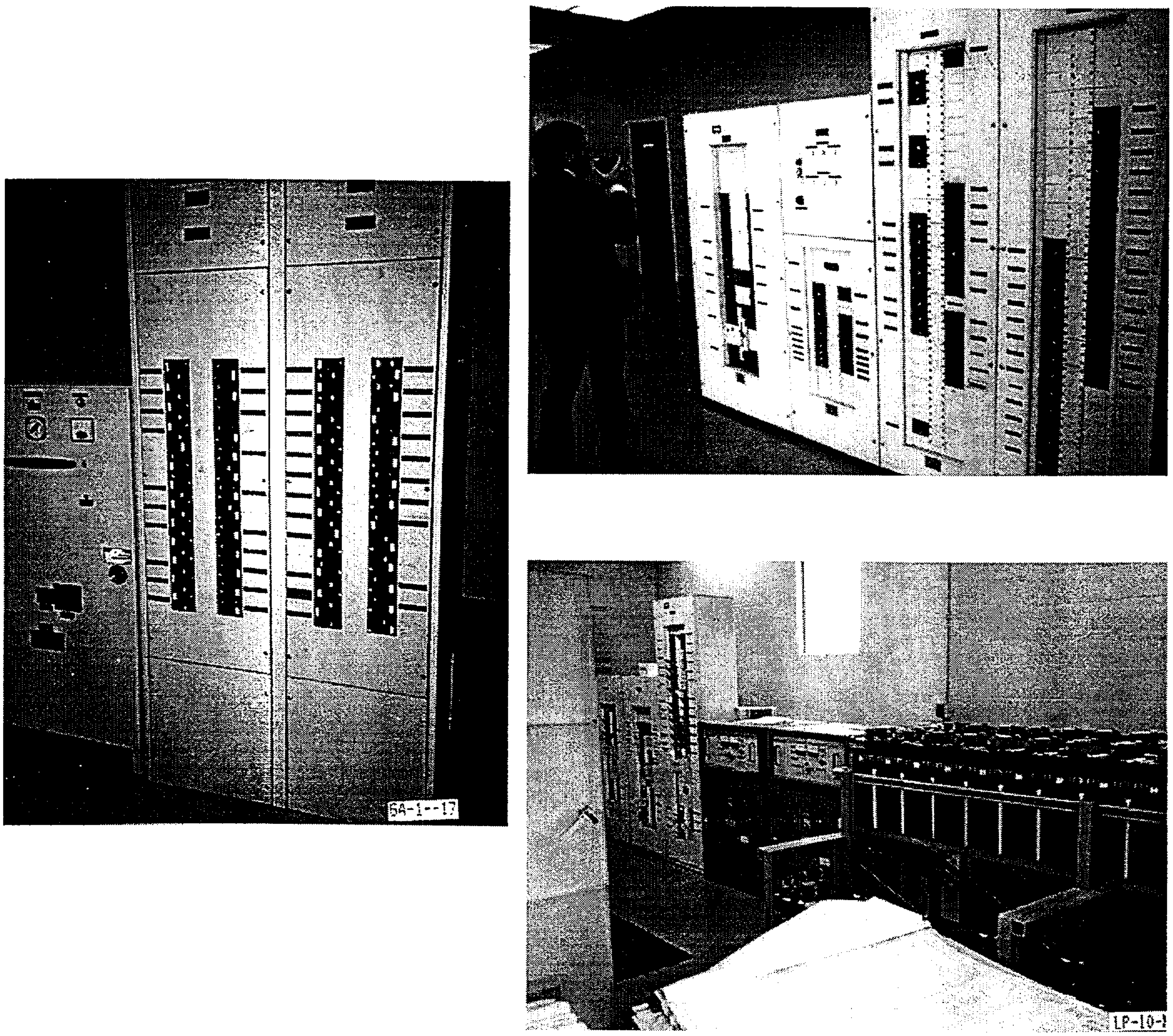
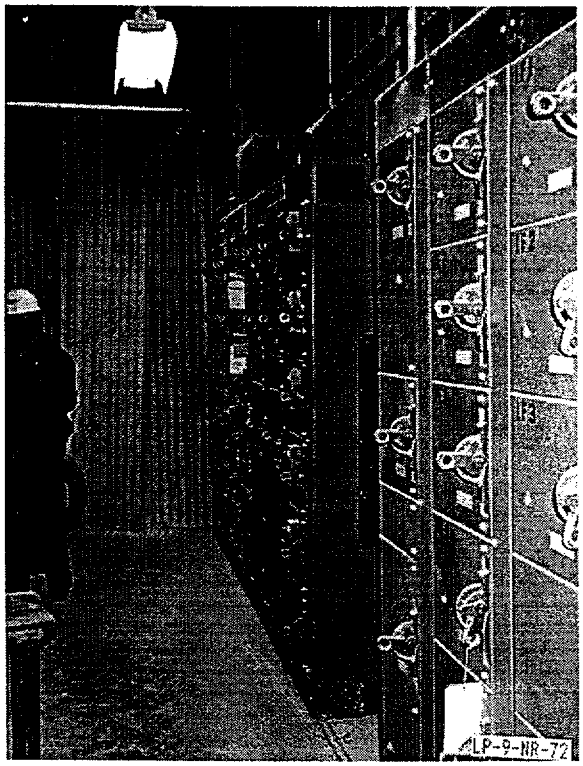


Figure 5: Switchboards with heights estimated from 94 to 98 inches are found at certain electrical substations. Examples of excessively tall switchboards are found at the Gates Substation (left photo, 1983 Coalinga earthquake, PGA= 0.25g), at Metcalf Substation (upper right, 1984 Morgan Hill, PGA= 0.40g, and 1989 Loma Prieta, PGA= 0.30g, earthquakes), and at Moss Landing Substation (lower right, 1989 Loma Prieta earthquake, PGA= 0.30g).



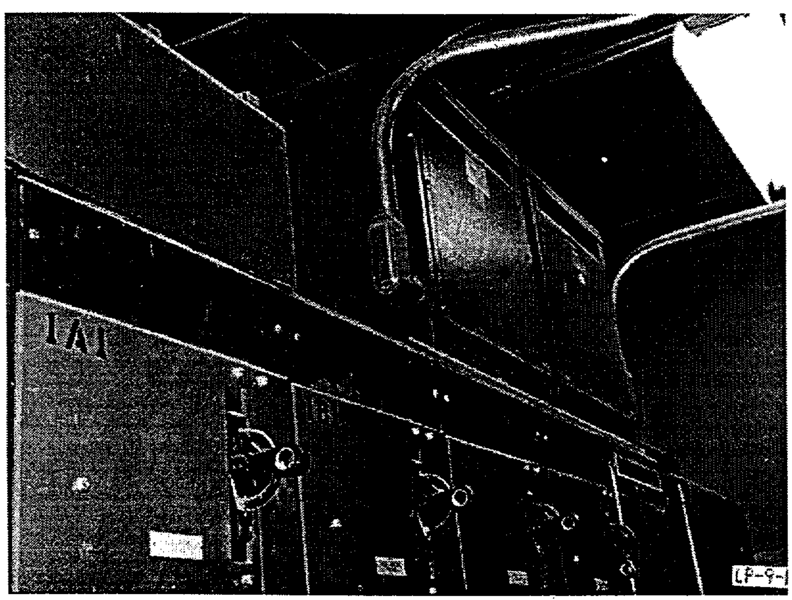


Figure 6: Examples of excessive mass concentrated above the standard cabinet height of 90 inches are best illustrated by the heavy distribution transformers mounted atop motor control centers (with characteristics similar to those of a switchboard) at the National Refractory, which withstood the 1989 Loma Prieta earthquake, PGA= 0.30g. The two transformers, which comprise concentrated masses of about 100 pounds each, did not overstress the floor anchorage of the MCCs or otherwise damage the cabinets or the switching components housed within.