Luminant

Mike Blevins
Executive Vice President
& Chief Nuclear Officer
Mike.Blevins@Luminant.com

Luminant Power
P O Box 1002
6322 North FM 56
Glen Rose, TX 76043

T 254 897 5209
C 817 559 9085
F 254 897 6652

CP-200800265
Log # TXX-08033

Ref. # GL 2004-02

February 29, 2008

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

SUBJECT: COMANCHE PEAK STEAM ELECTRIC STATION
DOCKET NOS. 50-445 AND 50-446
SUPPLEMENT TO RESPONSE TO NRC GENERIC LETTER (GL) 2004-02, "POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS AT PRESSURIZED-WATER REACTORS"

REFERENCE:

1. Letter Logged TXX-05047 from M. Blevins to the NRC dated March 7, 2005, providing a 90-day response to NRC Generic Letter 2004-02, "POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS AT PRESSURIZED-WATER REACTORS"
2. Letter Logged TXX-05162 from M. Blevins to the NRC dated September 1, 2005, providing a response to requested information part 2 of NRC Generic Letter 2004-02, "POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS AT PRESSURIZED-WATER REACTORS"
3. Letter Logged TXX-03130 from C. L. Terry to the NRC dated August 8, 2003, providing a response to NRC BULLETIN 2003-01, "POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY SUMP RECIRCULATION AT PRESSURIZED-WATER-REACTORS"
4. Letter Logged TXX-07164 from M. Blevins to the NRC dated December 3, 2007 providing an NRC Generic Letter 2004-02 extension request

Dear Sir or Madam:

Luminant Power provided responses to NRC Bulletin 2003-01 and NRC Generic Letter (GL 2004-02) in References 1, 2, and 3. Subsequently, Luminant Power requested an extension from the NRC for completion of actions with regards to GL 2004-02 per Reference 4.

Comanche Peak testing for chemical effects via the Performance Contracting, Inc. (PCI) Sure Flow Strainer User's Group (SFSUG) at Alden Research Laboratory, Inc. is scheduled to start Monday March 3, 2008. Comanche Peak has updated the debris generation and debris transport analyses based on the design modifications to the plant and other refinements in the analysis. Multiple break location and transport cases were calculated to determine a bounding debris load and debris characterization that is consistent with the test methodology. During preparation for chemical effects testing, issues in contractor calculations and analysis for debris generation were found. These issues are being resolved to support the testing schedule. The schedule for completion of all downstream effects analysis has been impacted by the issues.

A116
NRR

Comanche Peak has the following plant-specific technical/experimental plan with milestones and schedule to address outstanding technical issues with enough margin to account for uncertainties:

- Completion of downstream effects analyses is scheduled for May 2008.
- Additional plant-specific tests that support assumptions and corresponding conclusions contained in the GL 2004-02 evaluations for Comanche Peak are planned to begin on March 3, 2008.
- Following receipt of the final test report from the vendor, numerous additional actions are also required to complete formal verification of design inputs, assumptions and conclusions of calculations and evaluations conducted in response to issues identified in GL 2004-02.

Furthermore, the mitigative measures described in Reference 4 remain in place.

Enclosed, please find Luminant Power's update to the modifications and maintenance actions for resolution of GL 2004-02. As a result of analyses, testing, and design evaluations not being fully completed, an update will be provided at the completion of the final analysis by the end of June, 2008.

This letter contains the following revised licensing commitments regarding Comanche Peak Units 1 and 2.

27370 (revised)	As a result of analyses, testing, and design evaluations not being fully completed, an update to this portion of the response (modifications and maintenance actions) will be provided no later than June 30, 2008.

Should you have any questions, please contact Mr. J. D. Seawright at (254) 897-0140.

I state under penalty of perjury that the foregoing is true and correct.

Executed on February 29, 2008.

Sincerely,

Luminant Generation Company LLC

Mike Blevins

By: Fred W. Madden
Fred W. Madden
Director, Oversight & Regulatory Affairs

Enclosure: ER-ESP-001, Generic Letter 2004-02 Supplemental Resonse (Luminant Power's Update to the Modifications and Maintenance Actions for Resolution of GL 2004-02)

c - E. E. Collins, Region IV
B. K. Singal, NRR
Resident Inspectors, Comanche Peak

Comanche Peak Nuclear Power Plant

ENGINEERING REPORT

Generic Letter 2004-02 Supplemental Response

ER-ESP-001

REVISION 0

SMARTFORM ENR#: ENR-2007-002743-20-00

Table of Contents

Executive Summary

In response to Generic Letter 2004-02, CPNPP is performing an analysis of the susceptibility of the ECCS and CSS recirculation functions for CPNPP Units 1 and 2. This work provides plant specific evaluations of debris generation, water and debris transport to the ECCS and CSS recirculation sump screens, the head loss associated with debris accumulation, and its associated effect on available net positive suction head. The structural capability of the sump strainers under debris loadings was also evaluated. The downstream effects of debris that passes through the screens on components in the ECCS flow path such as pumps, valves, orifices, spray nozzles, and core components are also being evaluated.

Both Unit 1 and Unit 2 of CPNPP have installed new sump strainers to increase the available (i.e., submerged) screen area from the original approximately 200 ft^2 per sump to an area of approximately 4000 ft^2 per sump.

Activities are substantially complete to ensure that the Emergency Core Cooling System (ECCS) and Containment Spray System (CSS) recirculation functions under debris loading conditions at Comanche Peak Nuclear Power Plant (CPNPP) Units 1 and 2 will be in full compliance with the regulatory requirements listed in the Applicable Regulatory Requirements section of Generic Letter 2004-02 [Ref. 1.A] by June 30, 2008.

Full compliance will be achieved through analysis, testing, modifications to increase the available sump screen area, other changes to the plant to reduce the potential debris loading on the installed containment recirculation sump strainers, and programmatic and process changes to ensure continued compliance. The analysis methods being utilized for demonstrating this compliance are based on the methods described in NEI 04-07 as evaluated by the NRC in the Safety Evaluation Report for NEI 04-07.

Section 1.0 Overall Compliance

In response to Generic Letter 2004-02, CPNPP is performing an analysis of the susceptibility of the ECCS and CSS recirculation functions for CPNPP Units 1 and 2. This work provides plant specific evaluations of debris generation, water and debris transport to the ECCS and CSS recirculation sump screens, the head loss associated with debris accumulation, and its associated effect on available net positive suction head. The structural capability of the sump strainers under debris loadings was also evaluated. The downstream effects of debris that passes through the screens on components in the ECCS flow path such as pumps, valves, orifices, spray nozzles, and core components are also being evaluated.

The NRC has approved the methodology for meeting Generic Letter 2004-02 using the guidance of Nuclear Energy Institute (NEI) document titled *"Pressurized-Water Reactor (PWR) Sump Performance Methodology,"* dated May 28, 2004 as approved and supplemented by the NRC in an SER dated December 6, 2004. The sump performance methodology and the associated NRC SER have been issued collectively as NEI Report NEI 04-07, "Pressurized Water Reactor Sump Performance Evaluation Methodology," Revision 0, dated December 2004. [REF. 4.A]

The guidance of Regulatory Guide 1.82, Revision 3, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident" [REF. 9.F] is also being considered.

The methodology employs plant specific refinements, as allowed by the NRC SER.

Additional data and methodology from ongoing research on specific issues such as downstream effects, chemical effects, and coatings are also being used to the extent possible.

The methodology is being supplemented with plant specific design and licensing basis information and contractor specific proprietary information and data as appropriate with the current state of knowledge.

The Current Licensing Basis for CPNPP, as well as plant-specific features, resulted in exceptions and/or interpretations being taken to the guidance given in RG 1.82 and NEI 04-07 as modified by the SER. Exceptions are described in the applicable section of this report. If any additional exceptions are identified during the completion of the analyses, they will be included in a future revision.

The testing and analyses when completed will provide the basis to show compliance with the applicable regulatory requirements including 10 CFR 50.46, and 10 CFR 50 Appendix A, General Design Criteria 35 and 38.

The final analysis report is scheduled to be completed in time to support the June 30, 2008 completion date.

Section 2.0 General Description of and Schedule for Corrective Action

2.1 General Description

Activities are substantially complete to ensure that the Emergency Core Cooling System (ECCS) and Containment Spray System (CSS) recirculation functions under debris loading conditions at Comanche Peak Nuclear Power Plant (CPNPP) Units 1 and 2 will be in full compliance with the regulatory requirements listed in the Applicable Regulatory Requirements section of Generic Letter 2004-02 [Ref. 1.A] by June 30, 2008 in accordance with REF. 1.B.

Full compliance will be achieved through analysis, testing, modifications to increase the available sump screen area, other changes to the plant to reduce the potential debris loading on the installed containment recirculation sump strainers, and programmatic and process changes to ensure continued compliance. The analysis methods being utilized for demonstrating this compliance are based on the methods described in NEI 04-07 as evaluated by the NRC in the Safety Evaluation Report for NEI 04-07 [Ref. 4.A]. Further information regarding this approach is provided in subsequent sections of this report.

2.1.1 Modifications

Both Unit 1 and Unit 2 of CPNPP have installed new sump strainers to increase the available (i.e., submerged) screen area from the original approximately 200 ft^2 per sump to an area of approximately 4000 ft^2 per sump. The previous sump screens were 75 inches tall (partially submerged) whereas the new strainers are approximately 45 inches tall (fully submerged). In support of the new strainer design, Refueling Water Storage Tank (RWST) switchover setpoints were revised to ensure the new strainers are fully submerged at the completion of switchover from RWST injection to sump recirculation. The replacement strainer size was based on the best available knowledge at the time for the proposed installation areas, potential debris generation and transport, and potential head loss across the screen. The new strainers were installed in the existing locations within containment. The strainers were installed inside the structure of the previous screens outside the secondary shield wall.

In additional to the strainer modification, other interrelated modifications have been completed. These include:

- Revised RWST switchover setpoints and motor operated valve modification
- Installation of debris screens and strainers for drains in the refueling cavity
- Drains holes added to the reactor vessel head stand shield wall
- Modifications to minimize water holdup on floors and miscellaneous items

- Installation of debris interceptors
- Installation of water control features to optimize sump performance

2.1.2 Qualification of the Strainer System

To establish the qualification of the new strainer system, numerous additional activities have been completed. A number of activities are still in progress. These activities have been performed, except where noted, pursuant to the guidance given in NEI 04-07 Volume 1, Pressurized Water Reactor Sump Performance Evaluation Methodology (GR), and NEI 04-07 Volume 2, Safety Evaluation by the Office of Nuclear Reactor Regulation Related to NRC Generic Letter 2004-02, Revision 0, December 6, 2004 (SER). [Ref. 4.A] These activities are:

- Containment Condition Assessments – A series of walkdowns have been completed. Containment walk downs were completed for CPNPP Unit 1 during the Spring 2004, 1RF10 outage. Containment walk downs for CPNPP Unit 2 were completed during the Spring 2005, 2RF08 outage. The walk downs were performed using guidance provided in NEI 02-01, "Condition Assessment Guidelines, Debris Sources inside Containment," Revision 1 [Ref. 5]. In addition, the Unit 2 walkdown included extensive sampling for latent debris (dust and lint) considering guidance in NEI 04-07 Volume 2 (i.e., the NRC SER). Supplementary walkdowns to assess containment conditions at power were performed in September 2004, May 2005 and June 2005. See Section 3.d for details.

- Replacement of Radiation Protection Locked High Radiation Doors to the Steam Generator Compartments – These doors, consisting of wire mesh, were replaced with doors with bars with six inch wide openings. This was done to prevent upstream blockage and hold up of water and debris during the blow down and wash down phase of LOCA. Delayed release of debris after pool fill is considered adverse to emergency sump performance. This will optimize the transport of debris to the inactive sump under the reactor vessel as well as low flow areas of the containment floor. See Section 3.j for additional details.

- Redesign of the Drain Path to the Inactive Sump – The locked high radiation door to the incore instrumentation guide tube room, consisting of wire mesh, was replaced with a door with bars with six inch wide openings. The floor hole personnel safety barrier around the guide tubes was redesigned to be raised with vertical bars with six inch openings. This was done to prevent blockage and hold up of water and debris during the blow down and wash down phase of LOCA. The path to the inactive sump is at Elevation

808'-0" whereas there is an effective curb around the emergency sumps that is at elevation 808'-3-7/8". During pool fill, flow and debris will be preferentially directed to the inactive sump. This will optimize the transport of debris to the inactive sump under the reactor vessel as well as low flow areas of the containment floor. See Section 3.e for additional details.

- Removal of Radiation Protection Barriers and a Tool Room Enclosure – Cages consisting of wire mesh which are no longer required were removed. This will prevent blockage by debris which could affect flow to the emergency sumps. See Section 3.j for additional details.

- Implementation of Compensatory Actions – Compensatory actions in response to NRC Bulletin 2003-01 have been implemented as permanent changes in procedures [Ref. 8.D]. The modifications to the locked high radiation doors described above were also completed as compensatory actions These improved doors will be retained pursuant to GL 2004-02.

- Containment Coatings Assessments – The previous Licensing Basis for CPNPP coatings in the containment, as approved by the NRC, was that 100% failure is acceptable for sump performance. A reassessment of CPNPP containment building protective coatings was conducted in support of the response to GL 2004-02. See Section 3.h for additional details.

- Evaluation of the Plant Labeling Program – The plant labeling program is being evaluated to determine suitable material and program changes in support of the response to GL 2004-02. [Ref. 8.F]

- Upstream Effects Evaluation – The upstream effects evaluation [REF. 7.C.1] is complete. As part of the review performed for resolution of GL 2004-02, a potential plugging point was identified. This potential plugging point is the refueling cavity drains. These drains return a portion of the upper containment spray flow back to the lower volume of containment to support the water level analysis. CPNPP installed debris screens and strainers over the drains to prevent blockage of the drain paths in both units. Additional water holdup volumes were identified, and modifications were made. See Section 3.j for details.

- Event Characterization – The event characterization [REF. 7.A.1] evaluates the licensing and design basis to establish the design basis events which require emergency sump recirculation. Additionally, based on plant design inputs, the event characterization establishes the sump flow rates, recirculation pool water level and recirculation pump minimum Net Positive Suction Head margins. This report is complete based on the completed modifications to the plant design and is in the client review process.

- Debris Generation Evaluation – Bounding (Unit 1 and Unit 2) debris generation analyses [REF. 7.A.2] are being performed in support of analysis for the new design. Refinements for the new plant design and configuration are included. This report is complete based on the completed modifications to the plant design and is in the client review process.

- Debris Transport Evaluation – Bounding (Unit 1 and Unit 2) debris transport analyses [REF. 7.A.3] are being performed in support of refined analysis for the new design. This report is complete based on the completed modifications to the plant design and is in the client review process.

- Debris Load Evaluation – Bounding (Unit 1 and Unit 2) debris analyses [REF. 7.A.5] are being performed in support of the analysis and testing for the new design. This report is complete based on the completed modifications to the plant design and is in the client review process.

- Downstream Effects Evaluations – In accordance with NEI 04-07, the ECCS and CSS are evaluated for blockage and wear concerns. The following evaluations are being performed:
  - Blockage (except for reactor vessel)
  - Equipment Wear
  - Valve Wear
  - Reactor Vessel Blockage
  - Fuel Blockage
  - Evaluation of Long Term Cooling

- Calculation of Required and Available NPSH – The available NPSH margin has been calculated in support of strainer modifications performed for resolution of this issue. These analyses were revised to determine the headloss across the clean strainer. These head loss margins will be validated by testing which will demonstrate the margins in the new strainer design.

In addition to the strainer modification and other interrelated modifications, ECCS and CSS pump suction pressure monitoring instrumentation is being upgraded to meet Regulatory Guide

1.97.

Also, actions are in progress to remove unqualified labels, tags, and tape from containment to the extent practical.

2.1.3 Potential or Planned Design/Operational/Procedural Changes

CPNPP is performing evaluations of existing engineering design specifications, engineering design standards, engineering programs, modification and maintenance processes and procedures, and station operation processes and procedures. These will ensure the inputs and assumptions that support the current analysis effort are incorporated into the applicable documents to maintain the necessary attributes for future compliance with these requirements.

Planned changes include:

- Revision to design control procedures to explicitly address emergency sump performance impacts (Complete)
- Revision to Design Basis Documents and Engineering Specifications to ensure necessary control of existing and future materials that could affect sump performance
- Revision to the Coatings Program (Complete)
- Revision to the Station Labeling Program to ensure control of label materials and locations in containment
- Revision to the Containment foreign material control procedures and programs to monitor and control latent debris

2.2 Schedule

	Corrective Action Description	Status	ECD
1.	Containment condition assessment	Complete	
2.	Replacement of Radiation Protection Locked High Rad Doors to the Steam Generator Compartments	Complete	
3.	Redesign of the Drain Path to the Inactive Sump	Complete	
4.	Removal of Radiation Protection Barriers and a Tool Room enclosure	Complete	
5.	Implementation of Compensatory Actions	Complete	
6.	Reassessment of Containment Coatings to provide current assessment of unqualified coatings.	Complete	
7.	Evaluation of the Plant Labeling Program	Complete	

	Corrective Action Description	Status	ECD
8.	Upstream Effects Evaluation	Complete	
9.	Event Characterization	In review	3/30/08
10.	Debris Generation Evaluation	In review	4/30/08
	Confirmation that Debris Generation bounds Units 1 and 2	Complete	
	Testing to support the selection of a 4D ZOI for qualified coatings destruction pressure.	Complete	
	Testing to determine unqualified coating debris source terms	Complete	
	As-built configuration of Radiant Energy Shields	Complete	
	Confirmation that vapor barrier materials were not used in the fiberglass insulation applications	Complete	
	Identification of flexible tubing material used for RCP lube oil collection system	Complete	
	Revision of analysis for the above and minor open items	Complete	
11.	Debris Transport Evaluation	In review	3/30/08
	Refinements based on new sump strainers and related design modifications	Complete	
12.	Summary of Debris Generation and Transport Evaluation	In review	4/30/08
13.	Downstream Effects Evaluation, Blockage	In process	5/30/08
	Determination of RHR Pump Seal Cooler Tube ID	Complete	
14.	Downstream Effects Evaluation, Equipment Wear	In process	5/30/08
15.	Downstream Effects Evaluation, Valve Wear	In process	5/30/08
16.	Downstream Effects Evaluation, Reactor Vessel	In process	5/30/08
17.	Downstream Effects Evaluations, Fuel	In process	5/30/08
18.	Downstream Effects Evaluation, Long Term Cooling	In process	5/30/08
19.	Calculation of Required and Available NPSH	In process	5/30/08
	Chemical effects testing.	In process	5/30/08
	Head loss and bypass testing on the replacement strainer utilizing the results of the site-specific debris generation and debris transportation evaluations.	In process	5/30/08
20.	Strainer Replacements (and interrelated modifications)	Complete*	
	* Except for pump suction pressure instrumentation	In process	6/30/08
21.	Strainer Structural Analysis	Complete	
22.	Potential or Planned Design/Operational/Procedural Changes	In process	6/30/08
	Revision to design control procedures	Complete	
	Revision to Design Basis Documents and engineering	In process	4/30/08

	Corrective Action Description	Status	ECD
	specifications		
	Revision to the Coatings Program	Complete	
	Revision to the Station Labeling Program	In process	5/30/08
	Revision to the Containment material control procedures and programs	In process	5/30/08

Section 3.0 Specific Information Regarding Methodology for Demonstrating Compliance

Section 3.a Break Selection

The objective of the break selection process is to identify the break size and location that present the greatest challenge to post-accident sump performance.

Break selection is documented in ALION-CAL-TXU-2803-03, Comanche Peak Recirculation Sump Debris Generation Calculation [REF. 7.A.2] which is under review by CPNPP Engineering [REF. 7.F.7]. This report will be updated after reviews and approvals are complete.

RAIs 33, 34, 35, 36, 37

Section 3.b Debris Generation/Zone of Influence (ZOI) (excluding coatings)

The objective of the debris generation/ZOI process is to determine, for each postulated break location:
(1) the zone within which the break jet forces would be sufficient to damage materials and create debris; and
(2) the amount of debris generated by the break jet forces.

Debris generation is documented in ALION-CAL-TXU-2803-03, Comanche Peak Recirculation Sump Debris Generation Calculation [REF. 7.A.2] which is under review by CPNPP Engineering [REF. 7.F.7]. This report will be updated after reviews and approvals are complete.

Section 3.c Debris Characteristics

The objective of the debris characteristics determination process is to establish a conservative debris characteristics profile for use in determining the transportability of debris and its contribution to head loss.

Debris characteristics are documented in ALION-CAL-TXU-2803-03, Comanche Peak Recirculation Sump Debris Generation Calculation [REF. 7.A.2] which is under review by CPNPP Engineering [REF. 7.F.7]. This report will be updated after reviews and approvals are complete.

Section 3.d Latent Debris

The objective of the latent debris evaluation process is to provide a reasonable approximation of the amount and types of latent debris existing within the containment and its potential impact on sump screen head loss.

Containment Condition Assessments – A series of walkdowns have been completed as described in REF. 2.A. Containment walk downs were completed for Unit 1 during the Spring 2004 1RF010 outage. Containment walk downs for Unit 2 were completed during the Spring 2005, 2RF08 outage. These containment condition assessments are documented in SMF-2001-002201-00 [Ref. 3.A]. Supplementary walkdowns to assess containment conditions at power were performed in September 2004, May 2005 and June 2005.

3.d.1 Methodology used to estimate quantity and composition of latent debris.

The walk downs were performed using guidance provided in NEI 02-01, "Condition Assessment Guidelines, Debris Sources inside Containment," Revision 1 [REF. 4.B]. In addition, the Unit 2 walkdown included extensive sampling for latent debris (dust and lint) considering guidance in NEI 04-07 Volume 2 (i.e., the NRC SER) [REF. 4.A].

Exception(s) Taken to GR and SER for Latent Debris
The methodology provided in the SER (Section 3.5) [REF. 4.A] for collection of the debris samples was not explicitly followed for CPNPP.

Latent Debris Sampling – Although CPNPP Unit 1 and 2 are predominantly reflective metallic insulation (RMI) plants, the statistical sample mass collections (i.e., three samples from each category of surface) was not used. The loadings of latent debris have been observed to be both light and uniform in both units. Many areas and surfaces could not be reached for sampling without scaffolding or adding special provisions for fall protection devices. CPNPP used an alternative approach to minimize personnel risk. Representative samples were taken from accessible surfaces. Visual observations of these sample locations were compared to visual observations of other surfaces and conservative estimates of bounding debris loadings made. The data from Unit 1 and the data from Unit 2 was used to derive a common latent debris source term for both units.

3.d.2 Basis for assumptions used in the evaluation.

The assumption was made that any significant variation in debris density could be distinguished by visible observation which was substantiated by the correlation of the visual characterization to the sample data. This assumption is appropriate because of the large margin and conservatism in the latent debris assumptions.

3.d.3 Results of the latent debris evaluation, including amount of latent debris types and physical data for latent debris.

Based on those walkdowns, a calculation was performed to quantify the latent debris that could exist in CPNPP Unit 2. This calculation conservatively determined the debris loading to be just less than 91 lbm. [Ref. 5.B]

The Unit 2 estimate of latent debris bounded the Unit 1 estimate [REF. 5.C]. The Unit 1 estimate included sampling of vertical steel and concrete surfaces which showed the contribution is not significant.

Apart from the debris collection that was performed, it was also identified that there were unqualified labels in containment. Labels are included in the scope of Sections 3.b, 3.c, 3.e, and 3.f.

CPNPP elected to use a bounding value of 200 lbm for the latent debris source term in containment. Conservative values were assumed for the composition in accordance with NEI 04-07, Section 3.5.2.3 [REF. 4.A]. The latent debris characteristics used for debris generation is in the scope of Section 3.c.

CONSERVATISM: Note that the assumptions for latent debris result in a significant conservatism in the quantity and characteristics of latent fiber.

3.d.4 Sacrificial strainer surface area allotted to miscellaneous latent debris.

Two hundred square feet of sacrificial surface area per strainer was specified to account for miscellaneous debris, including unqualified paper labels.[REF. 8.A.1]

RAIs 38, 43

Section 3.e Debris Transport

The objective of the debris transport evaluation process is to estimate the fraction of debris that would be transported from debris sources within containment to the sump suction strainers.

Debris transport is documented in ALION-CAL-TXU-2803-04, Comanche Peak Reactor Building GSI-191 Debris Transport Calculation [REF. 7.A.3] which is under review by CPNPP Engineering [REF. 7.F.8]. This report will be updated after reviews and approvals are complete.

RAIs 39, 41, 42

Section 3.f Head Loss and Vortexing

The objectives of the head loss and vortexing evaluations are to calculate head loss across the sump strainer and to evaluate the susceptibility of the strainer to vortex formation.

Head loss and vortex formation are being evaluated by a combination of testing and analysis which are in progress. This report will be updated after all analysis and testing reports are complete, reviewed and approved.

Section 3.g Net Positive Suction Head (NPSH)

The objective of the NPSH section is to calculate the NPSH margin for the ECCS and CSS pumps that would exist during a loss-of-coolant accident (LOCA) considering a spectrum of break sizes.

- Applicable pump flow rates, the total recirculation sump flow rate, sump temperature(s), and minimum containment water level:

	ECCS	CSS	TOTAL
One Train (gpm)	4,900	7,520 (2 x 3760)	12,420
Two Train (gpm)	9,000	15,040 (2 x 7520)	24,040
REF. 7.A.1			

Each train has its own sump and strainer. ECCS suction is one RHR pump per sump with the two trains operating in parallel. CSS suction is two pumps per sump with each train operating independently.

Peak sump temperature at the initiation of recirculation is approximately 250°F. Peak sump temperature prior to initiation of recirculation is approximately 260°F. Specific peak sump temperatures depend on the event being analyzed and the initial assumptions. Determination of the minimum flood level is based on a sump temperature of 200°F.

Minimum containment water level for the design basis LBLOCA was determined to be 811.12 ft (3.12 ft above floor level) at the initiation of ECCS recirculation and 813.21 ft (5.21 ft above floor level) at the initiation of spray recirculation. A variety of cases were analyzed in addition to LBLOCA, and these included SBLOCA with and without accumulator injection, MSLB, and several other cases of interest.

- Assumptions used in the calculations for the above parameters and the sources/bases of the assumptions:

The ECCS recirculation flow rate is the design basis ECCS recirculation rate used in the plant design. Spray recirculation flow rate is determined directly using the system resistance and tested spray pump performance.

The sump temperature data is taken from the accident analysis which includes a maximum sump temperature analysis. The sump temperature used to calculate the containment flood level was taken as 200°F as this yielded a specific volume lower than the expected sump temperatures at the initiation of recirculation. Sensitivity analysis performed in the flooding analysis for long term scenarios confirmed decreasing the sump temperature to ambient (120°F) in the long term would have no significant negative impact.

Details related to the determination of containment flood levels are provided below.

- Provide the basis for the required NPSH values, e.g., three percent head drop or other criterion.

NPSH requirements were taken from the vendor supplied pump performance data.

- Friction and other flow losses.

Friction losses for the protective cage around the sump strainers, the sump strainers clean head loss, the entrances into the suction piping and the pipe and fitting friction from the sumps to the inlets of each pump are included as losses in the determination of NPSHa. Note that design clean strainer head loss at full flow is applied for the ECCS pumps although at the initiation of ECCS recirculation only ECCS flow will be drawn through the strainers. The scenario used for determination of friction losses in the suction paths to the ECCS and Spray pumps was the LBLOCA scenario. SBLOCA scenarios have lower system flowrates and hence small strainer losses.

Friction losses are based on the design system flowrates and no single failures of pumps or systems that would have the effect of decreasing the frictional losses to either the Spray pumps or the ECCS pumps. The redundant ECCS pump suction paths and Spray pump suction paths were each analyzed to identify the individual flow path that had the highest line losses and hence the smallest NPSH margins. The NPSH margins identified below are based on the limiting case suction line losses for each pump group.

- System response scenarios for LBLOCA and SBLOCAs.

For a LBLOCA the scenario develops as follows. The RCS inventory is released to the containment and the accumulators inject their inventory into the RCS.

The line breaks, and SI is actuated by RPS instrumentation and begins ECCS injection. At this point containment atmosphere is heating up and the containment pressure is increasing. The SI signal starts the spray pumps, and they start and operate in minimum flow recirculation mode until the containment HI pressure permissive is achieved and the spray system begins to actuate and refill the RCS to the elevation of the break.

The sprays and released RCS inventory start collecting in the various locations throughout containment where they can be held up. It is assumed that all the holdups fill before flooding starts to occur to minimize the containment flood level at the initiation of ECCS recirculation. Once all of the holdups are filled, the water is assumed to drain to the containment floor and the flood level starts to rise. Once the RWST reaches low-low level, ECCS recirculation is initiated and the suction of the ECCS pumps is switched to the sumps. The sprays are still taking suction from the RWST.

Flood level in the containment continues to rise, and when the setpoint for the initiation of Spray recirculation is reached the suction of the Spray pumps is manually switched to the sumps.

For a SBLOCA the scenario develops in a similar manner although the accumulators may not inject if pressure doesn't drop sufficiently, and the sprays may not actuate for a longer period of time as the containment pressure response will be significantly less. Switchover of the ECCS pump suction paths will occur at the same setpoint, and when the Spray switchover setpoint is reached (if spray has been initiated) the Spray pumps suctions will be switched over to the sumps. As described below, the containment minimum flood level for a SBLOCA includes no credit for RCS inventory adding to the sump flooding.

- Operational status for each ECCS and CSS pump before and after the initiation of recirculation.

All ECCS and CSS pumps start automatically and continue to run through switchover from injection to recirculation. The ECCS system is designed for the pumps to run continuously during switchover from cold leg recirculation to hot leg recirculation and back.

For the purposes of determining the minimum containment flood level and NPSHa all of the ECCS pumps and Spray pumps are assumed to be operating. This was done to maximize the water holdups throughout the containment which acts to minimize the containment flood level. It was also done to maximize the strainer and suction line friction losses to minimize the determination of NPSHa.

- Single failure assumptions relevant to pump operation and sump performance.

The sumps were evaluated for one and two train operation bounding any single active failure.

In general, no single failures of pumps were postulated when calculating the containment minimum flood levels as full two train operation maximized flowrates and maximized holdups which corresponded to minimum flood levels. Full flowrates were also postulated for NPSHa calculations as this maximized the line, strainer and fitting losses in each pump suction line. No assumptions in the NPSHa analysis were made to minimize strainer flow to minimize strainer head losses such as taking suction for spray pumps from one sump and ECCS pumps from the other.

Single failures were applied to values taken from the accident analysis such as containment temperatures used to calculate steam holdup in the atmosphere. A single train accident calculation yielded higher atmospheric temperatures which yielded higher steam holdups.

- Determination of containment sump water level.

The minimum sump water level is determined by calculation.

The minimum containment flood level is determined by first the minimum amount of water available for flooding. This initial water inventory is based on the minimum RWST volumes and the accident scenario under analysis. Once the amount of water available for flooding is determined, the amount of water captured in various holdup scenarios is determined, and that value is subtracted from the initial inventory of water for flooding. The holdup scenarios include steam in the atmosphere, droplet transit time in the atmosphere, various geometric holdups in supports, equipment, etc., rooms below the sump elevation in the containment, volumes to fill dry piping, and a variety of plant specific holdups. The volume of the containment is then determined as a function of elevation. The containment minimum flood level is then determined by taking the net available flood water and dividing by the sump cross sectional area.

- Assumptions that are included in the analysis to ensure a minimum (conservative) water level is used in determining NPSH margin.

The major assumptions made to ensure a minimum flood level in the containment are as follows:

- Minimum RWST injection volumes are used with negative impact from instrumentation errors.
- Minimum net RCS or SG inventory values are used for the scenario under consideration.
- The volume of the Chemical Addition Tank is neglected and not assumed to contribute to the water inventory.

The floor drain system and the hydrogen mixing vents in all of the intermediate slab elevations in the containment are assumed not to provide a drainage path for water held up on these slabs. The only drainage from these slabs is assumed to be through opening in the slab perimeter. Analysis performed for other reasons has shown that the hydrogen mixing vents provide a substantial drainage path through each slab, and due to their number and widespread locations they will not all be clogged with debris regardless of the accident or its location. However, no credit was taken for these paths.

All identified holdup penalties are assumed to fill prior to any accumulation of flood level in the containment including the incore instrument room below the reactor which is the single largest holdup penalty identified. An analysis was performed to estimate the time required to fill the areas below the reactor and that analysis indicated the subject volume would not be filled prior to the initiation of ECCS recirculation. However, to minimize flood level at this point, it was assumed that all holdups filled prior to any increase in containment flood level.

Spray droplet size assumed for atmospheric holdup is the minimum size which has the slowest fall speed and maximizes atmospheric droplet holdup.

Holdups on the major sprayed slabs in the containment are based on two train spray operation as this maximizes the holdups on the slabs.

The containment atmosphere is assumed to be at 0% Relative Humidity prior to the accident for the purpose of determining the steam holdup in the containment atmosphere. Bounding values of the atmospheric temperature at the initiation of ECCS recirculation (for LOCAs) or Spray recirculation (for MSLBs) are assumed. The atmospheric holdup is not reduced for any of the analyzed scenarios except for the long term case with RCS and atmospheric cooldown.

No credit is taken for the containment volume displaced by piping, supports, equipment, etc within the flood pool. The volume of the flood pool is only reduced by the volumes of the physical concrete structure and the reactor vessel.

- Describe whether and how the following volumes have been accounted for in pool level calculations: empty spray pipe, water droplets, condensation and holdup on horizontal and vertical surfaces. If any are not accounted for, explain why.

The minimum amount of water available for flooding in the minimum containment flood level analysis is reduced by the amount of water required to fill the dry portions of both spray headers and all four sump suction lines up to the normally closed sump isolation valve. A holdup penalty is determined for the time required for spray droplets to fall to the various surfaces and another penalty is determined for the amount of water that is draining from higher elevations to lower elevations by gravity flow. A holdup penalty is determined due to the steady state holdups on the major sprayed horizontal elevations that have drainage perimeters. To address surface condensation and other unquantifiable potential holdups an arbitrary holdup penalty was taken. This penalty was equivalent to a quantity of water equal to a 2" depth across the entire free cross sectional area of the containment.

- Assumptions (and their bases) as to what equipment will displace water resulting in higher pool level.

The flooding analysis determined the cross sectional area of the containment at each elevation where the cross sectional area changed to determine the pool flood level. In the flooding analysis, structural concrete components, columns, walls, curbs and the reactor vessel, were credited as reducing the floor area of the pool area. Miscellaneous equipment, support steel, piping, etc. was not credited as displacing any water or raising the calculated pool water level.

- Assumptions (and their bases) as to what water sources provide pool volume and how much volume is from each source.

  The potential sources of water that contribute to the pool volume that were considered in the determination of the minimum flood level are as follows:

  A. Minimum injection volume from the RWST before the initiation of ECCS recirculation was 300,000 gallons.
  B. Minimum injection volume from the RWST before the initiation of ECCS recirculation was 440,300 gallons.
  C. The analysis that determined the minimum available RWST volume was based on determining a design minimum amount of available water. Actual water availability will be greater than or equal to the specified amounts. For details see calculation ME(B)-389 [REF. 7.F.18].
  D. For LBLOCA the RCS volumes contributing were 210,000 lbm from the Accumulators and the minimum net contribution from the spectrum of breaks analyzed was 212,000 lbm from RCS system.
  E. For SBLOCA the RCS volumes contributing were either zero or 210,000 lbm depending on whether the accumulators injected. Both were analyzed.
  F. The determination of RCS volumes available for flooding was taken from the mass and energy balances developed and used in the determination of RCS blowdowns for the containment accident analysis. The value use was the case that contributed the minimum net RCS inventory to the pool volume.
  G. For MSLB an initial SG inventory of 105,000 lbm was used. It was assumed that there was no contribution from connecting piping or feedwater flow prior to feedwater isolation.
  H. The SG inventory was taken from the NSSS vendor SG design information for the power level that had the lowest SG inventory over the range of the plant operation. Again this was done to minimize the contribution to the pool volume.

- Credit taken for containment accident pressure in determining available NPSH, description of the calculation of containment accident pressure used in determining the available NPSH.

Credit is not taken for containment accident pressure when determining NPSHa. It was assumed that the vapor pressure of the sump fluid was equal to the containment accident pressure.

- Assumptions made which minimize the containment accident pressure and maximize the sump water temperature.

  As stated above, no credit is taken for containment accident pressure when determining NPSHa

- Containment accident pressure set at the vapor pressure corresponding to the sump liquid temperature.

  For purposes of determining NPSHa, it was assumed that the vapor pressure of the sump fluid was equal to the containment accident pressure.

- NPSH margin results for pumps taking suction from the sump in recirculation mode.

  The RHR pump margin assuming clean strainer head loss is 7.38 ft at the initiation of ECCS recirculation and 9.38 ft once spray recirculation is initiated.

  The Spray pump margin assuming clean strainer head loss is 5.32 ft at the initiation of Spray recirculation.

  Both of the margins reported above are based on the minimum flood levels specified in the Sump Strainer Specification. Actual margins are slightly higher as the elevations in the Strainer Specification are more conservative (lower) than the minimum flood levels determined.

RAIs 25, 26, 30

Section 3.h Coatings Evaluation

The coatings evaluations performed have determined the plant-specific ZOI and debris characteristics for coatings for use in determining the contribution of coatings to overall head loss at the sump screen as well as bypass effects on downstream components.

3.h.1 Summary of types of coating systems used in CPNPP containment

The primary field-applied "Acceptable" coatings systems in containment for Comanche Peak are CZ-11 for high heat applications, CZ-11/Phenoline 305 for steel and Nutec 11S/Nutec 11/Nutec 1201 for concrete. 191 was used as touch-up for CZ-11.

While these are the primary coating systems for containment, other similar systems were used in limited applications. For example, the following "Acceptable" coatings systems have been used for steel maintenance coating work: Carboline 801, Carboline 890, and Amerlock 400. Also, the following "Acceptable" coatings system has been used for concrete maintenance work: Starglaze 2011S /Starglaze 2011/Carboline 890.

DBA-unqualified coatings systems include inorganic zinc, epoxy, silicones and alkyds.

3.h.2 Bases for assumptions made in post-LOCA paint debris generation and transport analysis

The post-DBA debris evaluations of all coatings were based on NEI-04-07 [REF. 4.A] and/or appropriate testing as discussed below.

Because Comanche Peak protective coatings were declassified during construction of the plant as described in the response to NRC Generic Letter 98-04 [see REF. 2.K], 100% DBA-unqualified coatings were initially assumed to exist for GSI-191 analyses consistent with the licensing basis assumed 100% failure. However, all of the coatings were applied under either the Comanche Peak 10CFR50, Appendix B QA program or the Comanche Peak Non-Appendix B QA program. [See REF.s 2.K, 2.L, and 2.M]

Containment coatings are generally subject to applicable portions of 10CFR50, Appendix B because their failure has the potential to be detrimental to Safety Related Structures, Systems, and Components. The CPNPP quality assurance program for such items is covered by the Comanche Peak Non-Appendix B QA program (Appendix D of the QA Manual).

As described in TXX-05162 [REF. 2.A], a reevaluation of all declassified coatings inside containment was performed. This assessment and its goals included the following key elements:

- Revising the Current Licensing Basis to upgrade containment building protective coatings from "declassified" to "acceptable" status (per ASTM D-5144 [REF. 12.B]).
    - A suitability for application review of applied protective coatings was performed per ASTM D-5144 – using EPRI "Guideline on Nuclear Safety-Related Coatings" TR-1003102 (formerly TR-109937) for guidance.
    - The protective coatings program was assessed and revised using updated industry standards (i.e., ASTM vs. obsolete ANSI standards).
    - The protective coatings program was assessed and revised using recommendations of EPRI TR-1003102.
- Revising the coatings program to restore a coatings quality assurance program consistent with the latest industry standards for Service Level I coatings endorsed by the NRC in Reg. Guide 1.54, Revision1 [REF. 9.J] and to restore qualification for containment coatings.

The reevaluation of all declassified coatings inside containment was performed under SMF-2004-002882-00 [REF. 3.E]. The suitability for application review of applied protective coatings was performed by ER-ME-124, "Evaluation of CPSES Protective Coatings" [REF. 5.E].

The program procedure for protective coatings, STA-692 [REF. 14.A], was revised. There are three classifications: Qualified, Acceptable, and Unqualified in accordance with the guidance in EPRI TR-1003102 [REF. 4.C] and ASTM D-5144 [REF. 12.B]. Qualified and Acceptable coatings are referred to as "qualified". Unqualified coatings, which includes indeterminate coatings, are included on the Coatings Exempt Log (CEL) for each unit. The CEL for each unit was revised to include coatings which require additional testing or analysis to classify as Qualified or Acceptable.

The change to the licensing basis was completed under SMF-2004-002882-00 [REF. 3.E]. The CPNPP FSAR is being updated in accordance with 10CFR50.71(e). [REF. 9.C]

CONSERVATISM: Note that "unqualified" coatings are all actually "indeterminate" coatings. As shown in various tests [e.g. REF. 4.D, they may or may not fail completely during a design basis accident. They are conservatively assumed to fail if classified as Unqualified. This is a significant conservatism in the evaluation of emergency sump performance.

Zone of Influence

The debris generation assumption made for "Qualified" and "Acceptable" coatings in the zone of influence of the LOCA is based on testing performed on representative coating systems. A spherical ZOI of 4D for "Acceptable" epoxy was selected based on two separate tests.

WCAP-16568-P, "Jet Impingement Testing to Determine the Zone of Influence (ZOI) for DBA Qualified/Acceptable Coatings", Revision 0 dated June 2006. [REF. 7.E.6] concluded that a spherical ZOI of 4D is conservative for the "Acceptable" epoxy coatings comparable to those used by CPNPP.

In addition, a ZOI evaluation of the specific "Acceptable" containment coatings at CPNPP was performed using the results of the Coatings Performance Tests conducted by FPL and Areva NP (JOGAR Testing). This evaluation concluded that a spherical ZOI of 4D is conservative for "Acceptable" epoxy coatings such as those used by CPNPP. [REF. 7.B.1]

Based on the assessment of coatings under REF. 3.E, only minor quantities of concrete coatings are unqualified whereas there are large quantities of unqualified steel coatings. Therefore:

- All concrete coatings within a 10D ZOI are considered "Acceptable" . Therefore, a 4D ZOI has been justified and was assumed for debris generation.
- All steel coatings within a 10D ZOI were conservatively assumed to be DBA-unqualified. Therefore, a 10D ZOI was assumed for debris generation.

Coatings under intact insulation were not assumed to fail. However, the coatings under destroyed insulation were assumed to fail within a 10D ZOI.

For debris generation and transport analysis, 10 micron particles were assumed for "Acceptable" epoxy coatings within the 4D ZOI. "Acceptable" coatings outside the 4D ZOI were not assumed to fail.

For debris generation and transport analysis, 10 micron particles were assumed for DBA-unqualified coatings within a 10D ZOI.

DBA-unqualified Coatings

In addition to the coatings within the ZOI, 100% of the DBA-unqualified and degraded coatings outside the ZOI were assumed to fail as 10 micron particles except where based on testing and plant specific conditions as described below.

Testing was performed for Comanche Peak by Keeler & Long PPG [REF.7.D.1] and transmitted to the NRC for information. [REF. 2.F]

Keeler and Long Report No. 06-0413, Design Basis Accident Testing of Coating Samples from Unit 1 Containment, TXU Comanche Peak SES [REF.7.D.1] , has been reviewed and found applicable to the degraded DBA-qualified epoxy and inorganic zinc coatings applied at CPNPP. In the test, epoxy topcoat / inorganic zinc primer coating system chips, taken from the Comanche Peak Unit 1 containment after 15 years of nuclear service, were subjected to DBA testing in accordance with ASTM D 3911-03. [REF. 12.A] In addition to the standard test protocol contained in ASTM D 3911-03, 10 μm filters were installed in the autoclave recirculation piping to capture small, transportable particulate coating debris generated during the test.

The data in this report shows that inorganic zinc predominantly fails in a size range from 9 to 89 microns with the majority being between 14 and 40 microns. Therefore, a conservative size of 10 microns was assumed for transport analysis and head loss testing of inorganic zinc.

The data in this report also showed that DBA-qualified epoxy that has failed as chips by delamination tend to remain chips in a LOCA environment. The data showed that almost all of the chips remained in the test trays which had holes 1/32 inch in diameter.

Subsequent to the Keeler & Long test, a paint chip characterization on the chips that were generated from the test was performed by Alion Science and Technology [REF. 7.A.11] and provided to the NRC for information. [REF. 2.G]

The scope of the characterization was to perform a size distribution analysis of paint chips (as best possible). This involved a combination of visual, optical magnification and/or Scanning Electron Microscopy (SEM) of the smaller sizes or coating thickness. Size distribution analysis in this case was quantifying a size distribution to fit the NUREG/CR-6916 [REF. 9.I] distribution, which is comprised of the following categories:

- Small (1/64th to 1/32nd inch),
- Medium (1/8th to 1/4th inch),
- Large (1-2 inch) flat
- Large (1-2 inch) curled.

The characterization also binned the paint chips into a distribution that was more distinct than that noted above. Chips that were in length ½" to 1" and from ¼" to ½" were also included in a size distribution as medium large and medium small.

The conservatively determined results of the characterization used in debris generation [REF. 7.A.2] were as follows:

Size Range of Coating	Mass Percentage
1"-2" (50% curled)	32.0%
1/2"-1" (50% curled)	9.04%
1/4"-1/2"	4.41%
1/8" –1/4"	5.02%
< 1/8"	49.5% as follows 37.1% - 15.6 mils (1/64" chips) and 12.4% - 6 mil chips
Total	100%

Therefore, a chip diameter of greater than or equal to 1/64 inch may be used for transport for 87.6% of Phenoline 305 epoxy coatings shown to fail as chips by delamination. The balance that is assumed to be 6 mil chips is a very conservative estimate of the size distribution. The above size distribution based on testing is used in lieu of the default size of 10 microns or the default area equivalent to the area of the sump-screen openings for coatings size. This is further discussed under testing below.

Carboline Phenoline 305, according to manufacturer's published data sheets and MSDS's, is conservatively representative of the other DBA-qualified/Acceptable epoxy coatings found in US nuclear power plants, including Mobil 78, Mobil 89, Amercoat 66, Keeler & Long 6548/7107 and Keeler & Long D-1 and E-1. [REF. 7.G.1]

The Coatings Exempt Logs (CELs) provide minimum and maximum estimates of coating quantities based on the range of applied coating thickness and density information. The estimates for maximum thickness in the CEL were grouped according to inorganic zinc, epoxy, and alkyd enamel and used to calculate volume and mass for each generic coating material. These values were used to calculate a volume average density. The range of average thicknesses for degraded DBA-qualified epoxy on the CELs is 3 to 22.5 mils. The Unit 1 CEL is bounding for unqualified coatings. To determine the mass of epoxy on the Unit 1 CEL, a distribution of epoxy coatings was determined based on the following range of thicknesses: 4% (3 to 7 mil), 71% (7 to 10 mil), and 26% (10 to 23 mil). A thickness distribution of IOZ coatings was determined based on the following range of thicknesses: 3% (0.5 to 2.5 mil) and 97% (>2.5 to 4.3 mil). Therefore, the coatings on the CEL were assumed to fail with this distribution.

OEM Coatings

For OEM coatings, Design Basis Accident Testing of Pressurized Water Reactor Unqualified Original Equipment Manufacturer Coatings, EPRI 1011753 [REF. 4.D], was used to determine that 10 microns is a very conservative assumption for particle sizes. None of the OEM coatings failed as chips. Therefore, 10 micron particle sizes were used for transport and head loss analyses.

This report also showed that, on average, much less than half of OEM coatings detached and failed during testing. Based on the EPRI test results and the conservative assumption of 10 micron particle size, 100% failure of all OEM coatings is overly conservative. CPNPP has determined based on the review of the EPRI Report No 1011753 for Original Equipment Manufacturers (OEM) unqualified coatings that CPNPP could not reduce the failure percentage across the board for all non qualified OEM coatings. It has been determined, based on the review of the EPRI report and plant specific coating types, that a reduction in the failure percentage for the epoxy could be justified if enough information were known. The failure percentage for specific epoxy types could be less than 50% which bounds the worst performing sample for this type in the test data. However, because the amount of epoxy on OEM equipment is small and detailed information on the OEM coatings are not readily available, 100% failure of all OEM coatings was assumed.

Therefore, the following conservative failure percentages were assumed for OEM coatings.
Epoxy – 100%
Inorganic Zinc – 100%
Alkyds – 100%
Urethane – 100%
Other – 100%

No debris was included in transport and head loss analysis for unqualified coatings outside the ZOI that are a) within an inactive sump, b) covered by intact insulation, or c) otherwise isolated from spray and transport to the sump.

CONSERVATISM: Note that the assumed quantity of unqualified coatings is very conservative. Additional evaluations and/or testing may be performed at some time in the future to identify and quantify margins in the assumed coating debris.

3.h.4 Head Loss Testing

For head loss testing, representative surrogates with similar density, size, and shape characteristics to the debris generation and transport assumptions above were selected.

For coating debris from epoxy, phenolics, silicones, enamel and alkyds specified as powder, #325 walnut shell flour which has similar density, size, and shape characteristics to these coatings has been utilized. This surrogate is conservative when used for OEM coatings and all epoxy coatings within the ZOI.

For coating debris from inorganic zinc, the surrogate used was tin powder with a particle size range of ~10 to 44 microns. Tin powder has similar density, size, and shape characteristics as inorganic zinc. The particle size selected for all DBA-unqualified inorganic zinc coatings was based on the Keeler and Long Report No. 06-0413 as discussed above. This size is also consistent with the size assumption for inorganic zinc within the ZOI. This surrogate is conservatively used for all inorganic zinc coatings.

Because CPNPP is a low fiber plant, the possibility of head loss caused by chips was investigated. For epoxy and phenolic coating debris specified as chips, the surrogate used in the original prototype testing with no fiber was formed from the dry film of Carboline® Carboguard® 890 broken into pieces forming a spectrum of sizes. No head loss was recorded at design conditions. [REF. 8.D.2]

Creating surrogate chips with exactly the size of the holes in the strainer (0.095 inch) is not practical. The transport velocity at the perimeter of the strainers is less than 0.2 fps which then decreases as the flow approaches the strainer surface. This indicates that chips greater than 1/64 inch (0.0156 inch) will sink readily as they approach the strainer based on NUREG/CR-6916, Hydraulic Transport of Coating Debris, December 2006. [REF. 9.I]

Since the testing discussed above dispels any concern about chips blocking holes in the strainer, no further testing with chips alone (fiberless testing) is planned. The size distribution determined conservative for debris generation and transport is considered to be conservative for head loss testing.

For epoxy and phenolic coating debris specified as chips, the supplementary testing planned will use epoxy and/or Mylar chips similar in size and distribution to that in the debris generation and transport analysis.

3.h.4 Ongoing Containment Coating Condition Assessment Program

The acceptability of visual inspection as the first step in monitoring of Containment Building coatings is validated by EPRI Report No. 1014883, "Plant Support Engineering: Adhesion Testing of Nuclear Coating Service Level 1 Coatings," August 2007. [REF. 4.E]

Monitoring of Containment Building coatings is conducted at a minimum, once each fuel cycle in accordance with CPNPP procedure EP-5.01 [REF. 14.B] based on ASTM D 5163-05a, "Standard Guide for Establishing Procedures to Monitor the Performance of Coating Service Level I Coating Systems in an Operating Nuclear Power Plant." [REF. 12.C] Monitoring involves conducting a general visual examination of all assessable coated surfaces within the Containment Building, followed by additional nondestructive and destructive examinations of degraded coating areas as directed by the plant Protective Coatings Specialist. Examinations and evaluations of degraded coating areas are conducted by qualified personnel as defined in CPNPP procedures as recommended by ASTM D 5163-05a. Detailed instructions on conducting coating examinations, including deficiency reporting criteria and documentation requirements are delineated in CPNPP procedures.

Section 3.i Debris Source Term

The objective of the debris source term section is to identify any significant design and operational measures taken to control or reduce the plant debris source term to prevent potential adverse effects on the ECCS and CSS recirculation functions.

The evaluations of and changes to plant programs and procedures are in process. This section will be updated when these changes are complete.

RAIs 32, 40

Section 3.j Screen Modification Package

Plant hardware modifications, developed in response to issues identified in GL 2004-02 (as described in REF. 2.A), are installed in CPNPP and are actively supporting compliance with the regulatory requirements for long term cooling following a design basis loss of coolant accident.

Hardware modifications include the following.

- ECCS sumps screens were replaced with new strainers increasing the effective surface area from 200 square feet to almost 4000 square feet per emergency sump. The new strainers are contained within a one foot tall solid debris interceptor which will significantly reduce the quantity of debris which could reach the strainers. Unit 1 was completed during 1RF12 in the spring of 2007. Unit 2 was completed during 2RF09 in the Fall of 2006. Modifications which divert significant water and debris from entering the recirculation pool near the strainers were completed in December of 2007. The design approach is to maximize the capability of the strainer while minimizing the debris load to the extent practical.

- The Refueling Water Storage Tank (RWST) Low-low set point and the RWST switchover procedure were revised to support the strainer modification. The Refueling Water Storage Tank to Containment Spray Isolation valves were replaced to reduce closing time for switchover from injection to recirculation. Control board instruments, controls and alarm were modified to support the setpoint change and enhance the operator interface for ECCS and spray switchover.

- Various modifications were made to reduce recirculation water holdup volumes and to assure that blockage would not occur in critical areas such as the refueling cavity. These modifications are described in Section 3.l, Upstream Effects.

These modifications increase the minimum post accident flood levels for Large Break LOCA from 4 feet to over 5 feet resulting in a corresponding increase in net positive suction head (NPSH) margin.

3.j.1 Major Features of the Original Sump Screen Design

The original sump screens were part of a structure over 6 feet - 3 inches tall and would not have been submerged at the previous minimum LOCA water levels. The previous minimum water level for Large Break LOCA was 4 feet [Elevation 812'-0"]. The effective (wetted) surface at that depth are was approximately 200 square feet. The screens consisted of a fine screen, a coarse screen and a trash rack.

Picture P-3.j.1-1 (Attachment A) is an external view of an original sump screen showing the structure.

The containment floor is located at el. 808'-0". The centerlines of the two ESF Recirculation Sump pits are located approximately 45° apart in the annular region between the secondary shield wall and the containment wall. Each ESF train has a dedicated recirculation sump pit whose arc matches that of the containment walls. Dimensions of each pit are approximately 14' long (centerline of arc) X 5 '-5" wide X 6'-0" deep. The 16" ESF recirculation suction pipes are located in the pits in a slightly sloped orientation, terminating with a 24" suction cone opening. The centerline of the recirculation suction piping is at el. 804'-4 15/16" (approximately 3.5 ft. below containment floor elevation). A vortex suppressor, located within the sump, is provided for each suction pipe.

Picture P-3.j.1-2 (Attachment A) is a plan view of the sumps and suction piping. There are two sumps - One for train A ECCS and Containment Spray. One for train B ECCS and Containment Spray.

Picture P-3.j.1-3 (Attachment A) is an elevation view of the sumps and suction piping.

Picture P-3.j.1-4 (Attachment A) is an internal view of an original sump screen.

Picture P-3.j.1-5 (Attachment A) is a view of a sump, a vortex suppressor and suction piping.

Picture P-3.j.1-6 (Attachment A) is a close up view of an original screen. The fine screen openings were a maximum of 0.115 inches.

Pictures P-3.j.1-1 through P-3.l.1-6 (Attachment A) show the original sump screens.

The design of the original sump screens and vortex suppressors, in accordance with Regulatory

Guide 1.82 Revision 0 [REF. 9.F], was proven by full scale testing.

3.j.2 Major Features of the Sump Strainer Design Modification.

In anticipation of GSI-191 analysis showing that the original strainers would be inadequate, CPNPP teamed with the Strategic Teaming and Resource Sharing (STARS) participants; Callaway, Comanche Peak, Diablo Canyon, Palo Verde, STP and Wolf Creek to request proposals for new strainers from qualified vendors.

In collaboration with the STARS team, CPNPP engineering evaluated six proposed strainer designs based on the following criteria:

1) adaptability of the design to specific plants,
2) constructability and maintainability,
3) flexibility (ability to increase or decrease sump screen area),
4) potential to minimize risk due to regulatory uncetainty and
5) cost

CPNPP contracted with Performance Contracting, Inc. (PCI) to provide a qualified Sure-Flow® Suction Strainer specifically designed for CPNPP in order to address and resolve the NRC GSI-191 ECCS sump performance issue.

A passive strainer design was selected over an active strainer design because of concerns for constructability and maintainability as well as for downstream effects. Active approaches such as backflushing, screen cleaners, backup strainer banks which could be valved in if needed, were considered but not pursued due to the required Generic Letter 2004-02 schedule for the design and installation of new strainers.

The new strainers were specified to maximize the surface area employing a robust, modular design installed withing the existing screen structure. The specification requires the strainers to be designed for a minimum of 2 feet of water at the start of ECCS switchover and a minimum of 4.4 feet of water at the initiation of containment spray switchover.

Two sump suction strainers per unit, each with nominal surface area of 3947 ft^2 were design to meet the specified requirements. [REF. 8.A.1]

Each module contains 7 stacked disks 42 inches tall and has a surface area of over 100 ft^2. Four banks of nine modules each are connected to a plenum box which sits on a cover over the sump pit which also supports two of the banks of strainer modules.

Picture P-3.j.2-1 (Attachment A) shows a shop assembly of one strainer. Each strainer was fully assembled in the shop prior to shipment and again upon receipt at the plant before installation.

The existing screens and trash racks were scrapped and the new strainers were installed interior to the original structure.

Pictures P-3.j.2-2, P-3.j.2-3, and P-3.j.2-4 (Attachment A) are plant views of new strainers post installation.

The nominal hole size of 0.095 inches was specified for the perforated plate which is smaller than the 0.115 inches for the original screens. [REF. 8.A.1]

The top of the strainer disks is 45 inches above the floor. To ensures the strainers are fully submerged during full recirculation for all design basis accident scenarios, the RWST setpoints and RWST switchover procedures were changed. The RWST to CSS Isolation Motor Operated Valves were changed from slow closing gate valves to fast closing butterfly valves. See P-3.j.3-1 for the MOV Modification.

These changes are described in detail in License Amendment 129 [REF. 2.C.1].

The containment flooding analysis has been revised to reflect all of the plant modifications. At the completion of switchover from injection from the RWST to recirculation from the sump for ECCS and CSS, the minimum water level is:

- > 4.5 ft. for small break LOCA
- > 5.0 ft. for large break LOCA
- > 4.6 ft.for MSLB

[REF. 7.F.17 and 7.A.1]

The key and unique design feature of the Performance Contracting, Inc. (PCI) Sure-Flow® Suction Strainer is the flow control design of the core tube which assures that the flow through each strainer module is essentially equal. The top of the core tube is less than 2 ft. above the floor. The minimum flood level at the initiating of ECCS switchover is greater than 2.0 ft. above the floor [REF. 7.F.17]. Switchover is complete within 25 minutes. Testing was performed to show that the strainer head loss and vortexing would be acceptable during the flood-up transient.

Trash racks are not required for this design; however, trash racks with 6 inch by 6 inch bars were provided on two sides to protect the strainers from damage during outages. A solid panel was provided on the outboard ends to divert high velocity water from direct impingement on the strainer array. The side towards the containment liner is open.

3.k Sump Structural Analysis

The objective of the sump structural analysis is to verify the structural adequacy of the sump strainer including seismic loads and loads due to differential pressure, missiles, and jet forces. The CPNPP structural analyses are based on the technical requirements and design input in Specification CPES-M-2044 ([REF. 8.A.1] "Emergency Sump Suction Strainers"). The structural analyses for the sump strainers and results are provided by PCI ([REF. 8.C.1] "Structural Evaluation of the Emergency Sump Suction Strainers").

3.k.1 Design Requirements

Classification

The new strainers are designed and analyzed as Seismic Category I equipment as described in FSAR Chapter 3.7B.3.

Codes and Standards

The strainers are not pressure retaining components. The design methods of AISC (3.k.4.a) were used for the design of structural components. Since the AISC does not address designs with stainless steel, supplemental input was obtained from N690-1994 (3.k.4.b).

For the perforated plates, the AISC does not provide any design guidelines for plates with our-of-plane pressure loads and closely spaced holes. Therefore, the equations provided by ASME (3.k.4.c) were used to calculate the stresses in the perforated sheet metal.

The strainer also has several components made from thin gage sheet and cold formed stainless steel. ASCE (3.k.4.d) is used for certain components where rules specific to thin gage and cold form stainless steel are applicable. The rules for Allowable Stress Design (ASD) as described herein were used. This is further supplemented by the AISI (3.k.4.e) where the ASCE Specification does not provide specific guidance. Finally, guidance is also taken from AWS (3.k.4.f) as it relates to the qualification of stainless steel welds.

Design Input

<u>Seismic Input</u>

The response spectra used are for the containment building basement at EL 808'-0". Being passive equipment that is primarily a bolted assembly, the damping used was 4% and 7% for OBE and SSE analyses, respectively. The seismic acceleration response spectra are summarized in Table 3.k-1.

Process Fluid Input

The design input for the process fluid used in the design and qualification of the new sump strainers is provided in Table 3.k-2.

Material Input

All steel plates and shapes are fabricated from Type 304 stainless. The materials were provided in accordance with a number of ASTM Specifications such as A-240, A-312 and A-493. The lower bound material properties associated with the ASTM A-240 were used in the design and qualification. The material properties at the maximum process fluid temperature were obtained from the ASME B&PV Code (3.k.4.h), and are provided in Table 3.k-3.

The tension rods are fabricated from ASTM A-276, Type 304, Grade B material. The material properties for the accident condition were computed using the same reductions as applied for Condition A materials, and are provided in Table 3.k-3.

Other material property input used in the design and qualification analyses are provided in Table 3.k-4.

All welding was performed with ER308 or ER308L electrodes with a minimum tensile strength of 75 ksi (3.k.4.f).

Design Loads

The following loads were considered in the design of the strainers.

Dead Weight (WT)

This includes the weight of all elements of the sump strainer in a dry condition. The sump strainers do not provide structural support to any other plant components.

Live Load (LL)

This is the possible additional load acting on the sump strainer during refueling outages only. The Live Load includes rigging reactions at lifting points or a smeared load of 100 psf.

Weight of Debris (WD)

This is the amount of mixed debris (i.e., fibers, coatings, etc.) based on the plant specific debris loading that could be theoretically transported to and deposited on the sump components. The amount of mixed debris that would settle on a given strainer module was based on bounding test data. The weight of debris was included with the vertical dead weight when computing the vertical seismic responses. The maximum amount of mixed debris on a given strainer module will not exceed 55 lbs. In addition to the theoretical debris that could act on the strainer modules, excess debris that is not captured by the modules would settle in the area immediately beneath and adjacent to the modules. The theoretical debris weight that would bear on the cover plate due to debris settlement will not exceed 827.1 lbs, or 10.43 lbs/ft^2.

During normal operating conditions there will be no debris on the sump strainers.

Differential Pressure (DP)

This is a static pressure load across the perforated plate during accident conditions when the strainers are covered with debris. This is conservatively based on the maximum allowable head loss (i.e., pressure drop) across the debris covered strainers and the cover plate plus the maximum hydrostatic pressure due to the depth of the water. The differential pressure used in the design qualification was 14 feet of water (8.83 ft pool depth plus 5 ft of allowable head loss rounded up).

Note that the Comanche Peak new sump strainer does not include any capability to back flush the strainers. Thus, the differential pressures will always be acting inwards on the strainer modules and downwards on the sump pit cover plates.

During normal operations, including periods of containment integrity pressure testing, the fully vented sump strainer design precludes any differential pressure stresses from occurring.

Seismic Loads

A response spectra analysis was performed to analyze the seismic inertia loads. The seismic loads included both the seismic inertia loads associated with the strainer metal mass and the hydrodynamic effect.

The hydrodynamic effect includes both sloshing and inertial effects of water with a full debris loading associated with the strainer modules being submerged in the post-accident pool. An analysis of the seismic induced sloshing loads for the Prairie Island strainers was used as the basis for not explicitly analyzing it for Comanche Peak. The Prairie Island analysis concluded that the seismically induced sloshing loads were negligible (5 lbs per module). The critical parameters for the comparison analysis of the two PWR plants were the size of the containment, the magnitude of the ground motions, and the size of the modules. Although there are slight differences between the values of the parameters used in the Prairie Island analysis compared to the corresponding values associated with Comanche Peak, these differences would not result in a different conclusion (i.e., sloshing loads are insignificant in comparison to other seismic loads). The conclusion of the comparison with Prairie Island was that the results were applicable to Comanche Peak. Furthermore, the conservatism in the hydrodynamic mass determination more than offsets any loads resulting from a sloshing of the water inside containment.

The strainers are subjected to seismic accelerations in the submerged condition. As such, there will be a hydrodynamic mass effect that must be considered. In addition to the steel mass of the strainer being subjected to seismic accelerations, the mass of the water enclosed by the strainer and some portion of the mass of the water surrounding the strainer will also be accelerated. Reference (3.k.4.g) provided the formulas to determine the hydrodynamic mass, or added mass, for various cross sections of the sump strainer design. The hydrodynamic mass is different in each direction of seismic motion because the profile of the strainer is different in each direction. The results of the analysis determined that the following water weights were required to be added to each strainer module.

$Mass_X$ = 1,596 lbs (axial direction)

$Mass_Y$ = 736 lbs (vertical direction)

$Mass_Z$ = 882 lbs (lateral direction)

The seismic analysis of the strainers was performed with the mass of the steel elements adjusted to include the weight of debris and the added hydrodynamic mass.

Temperature - Accident (T_A)

There are no significant stresses due to the restraint of thermal expansion. The individual strainer modules are basically free to expand without restraint due to the designed gaps built in to every connection. The floor mounting angles and sump cover plates have insignificant loads due to restrained thermal growth due to the use of slotted bolt holes with expansion gaps in the design. For the impact on material properties, the design accident temperature was assumed to be the maximum process fluid temperature of 269° F even though the required maximum temperature was 265° F.

Pipe Break (Y_m, Y_r, Y_j)

Loads associated with pipe whip, jet impingement and missile impacts associated with LOCA and secondary high-energy line breaks are not credible for the new sump strainers. The strainers are located outside of the loop rooms where they will not be exposed to any dynamic effects of LOCA pipe breaks. Furthermore, the new sump strainers were installed under the protective structural steel cover that formed the roof of the old sump design. A large opening steel rod mesh was provided to further protect the strainers from accidental physical damage during refueling outages and from buoyant debris following a postulated pipe break.

Design Load Combinations

The following loading combinations were considered in the design and qualification of the new sump strainers.

LOADING CONDITION	COMBINATION	ALLOWABLE
(1a) Normal Operating	WT	1.0 S
(1b) Normal Operating (outage)	WT + LL	1.0 S
(2) Operating Basis Earthquake	WT + DP + WD + OBE	1.0 S
(3) Safe Shutdown Earthquake	WT + DP + WD + SSE	1.6 S

By inspection, load combination equation number 2 will bound the results from load combination equation 1.a. Load combination 1.b provides localized stresses through load paths that are not used when installed, such as lifting lugs, and is therefore uniquely bounding for a few components.

The allowable, S, is the AISC allowable unless supplemented by another source. The Load Combination 3 AISC based allowable stress of 1.6 S is limited to 90-percent of yield for both normal and shear stresses.

The perforated plates are evaluated by the equations of Article A-8000 (3.k.4.c). Note that Article A-8000 refers to Subsection NB for allowable stresses which are defined in terms of stress intensity limits, S_m. NB-3220 provides stress limits, S, for the primary membrane, and primary membrane plus bending. Based on Table NC-3321.1 (3.k.4.l) and Article A-8000 (3.k.4.c), the allowable stresses for the perforated plate are provided below.

LOAD CONDITION	STRESS TYPE	ALLOWABLE STRESS
Normal/Upset	Primary Membrane	1.0 S
	Primary Membrane + Bending	1.5 S
Emergency/Faulted	Primary Membrane	min(1.2 S or 1.0 S_y)
	Primary Membrane + Bending	min(1.8 S or 1.5 S_y)

3.k.2 Structural Analysis

The analysis of the strainer modules was performed with the aid of two computer programs, GTSTRUDL and ANSYS. Both GTSTRUDL and ANSYS are general purpose finite element programs.

The structural analysis of the strainer modules was performed with GTSTRUDL, and took advantage of the similarity between modules. The modules are essentially identical with the only difference being the hole sizes in the core tube. Therefore, only one strainer module pair (side-by-side on the same angle track) was required to be analyzed. Each module pair is independently supported and can therefore be analyzed as individual units. The modules are connected with thin gauge stainless steel sleeves that are used to prevent debris from entering the system between adjacent in-line modules. This connection permits relative motion in the axial direction as the core tube can slide relative to the stainless steel sleeves. The sleeves can transfer shear loads but not moments, therefore, the analysis considers the scenario when adjacent in-line module pairs are in phase with one another (student body motion in axial direction with all modules moving in the same direction) and when adjacent module pairs are 180^{O} degrees out of phase (adjacent units moving in opposite axial directions). Both phase conditions were evaluated to ensure that the bounding solution was analyzed. The worst case module pair is the end module pair because these modules have the highest hydrodynamic mass and also have the largest holes in the core tubes.

Four different GTSTRUDL seismic models are used to evaluate the strainer modules. All four models include a pair of strainer modules, but use different support configurations to represent the differences in the way the modules respond to dynamic loads. The first model is for the modules over the sump pit which are anchored at the end with Belleville springs. The flexibility of the sump pit cover plate is considered in this model using a combined section as the two modules respond as a pair to dynamic loads. The second model is identical to the first, except that at the ends the angles are connected to clip angle supports which are welded to the embedded angle and adjacent baseplates. The third model is for the modules that are over the concrete. In this model, the strainer modules themselves are identical to the first two models, however in this model the angle iron tracks are supported by eight expansion anchor bolts with the anchor points modeled into the angles. Also in this model, the two strainer modules are supported independently and do not act together dynamically. The three previous models conservatively used the hydrodynamic forces of an end module. The fourth model is the end module strainer which is supported over the sump pit on one side, and anchored to the embedded angle at the lip of the sump pit on the other. This end module controls over the end module supported over concrete because of the flexible cover plate on one side. This end model has an additional force not required in the previous three models to account for the differential pressure across the end cover of the core tube.

Most of the member properties used in the four structural models are defined using standard shapes available in GTSTRUDL. Those that could not be represented by the standard shapes, such as the core tube and edge channels were represented by equivalent member sections. Appropriate member end releases were used in order to simulate the anticipated behavior of connections.

The stresses in the perforated plate face disks for seismic loadings were computed using the ANSYS finite element program. Two cases were evaluated by ANSYS.

Case 1 reflects the scenario where the perforated plate bends inwards into the internal wire stiffeners. In this case, the perforated plate is supported at the four outer tension rods and around the core tube by the gap disk. Along the edges of the disk, the edge channels are modeled in as flexible supports.

Case 2 reflects the scenario where the disk face bends outward and pulls away from the internal wire stiffeners. In this case, the disk face is supported at the four outer tension rods and around the core tube by the seven inner tension rods. Along the edges of the disks, the edge channels are modeled in as flexible supports. In addition to the edge channels, the external radial stiffeners are modeled in as flexible supports.

The stresses in the inner gap were also determined using the ANSYS finite element program to take advantage of the added strength associated with the curvature of the inner gap. The analysis was initially performed for another plant whose configuration is not identical to those for Comanche Peak. The model was developed for a gap diameter of 18.48-inches and a thickness of 0.0478-inches (18 ga.). The Comanche Peak gap diameter is 17.875-inches and a thickness of 0.0959-inches (16 ga.). In addition, the Comanche Peak inner gap uses seven tension rods used for support versus just four used in the analysis. The use of the existing analysis was judged to be conservative in that a smaller gap diameter with additional support points will result in lower stresses.

The inner gap model includes the full 360-degrees of the gap plate. The cross section is just a thin flat plate, modeled as an equivalent plate to account for the perforations. The model is supported at four discrete points along the circumference at the inner rod locations. One way supports are used such that they only restrain the plate from displacing inward, but offer no resistance if the plate wants to pull away from the rods. Three cases of unit load pressure (1 psi) were applied. Case 1 is for all the pressure in the vertical direction. Case 2 is similar, but with the pressure acting in the lateral direction.

Case 3 is for the differential pressure that is acting radially inward. A fourth combined case was run with the initial guesses for the actual pressures in each direction. The ANSYS results were then scaled up by the worst case increase from any of the three load cases.

In addition to bending stresses calculated by ANSYS, buckling of the inner gap ring was also evaluated. The buckling evaluation was performed based on Section 7.3 through 7.6 of Timoshenko's book on elastic stability (3.k.4.m).

Since the inner gap ring will be supported at the tension rods and periodically between each tension rod by tabs off of the strainer disks, the buckling mode of the gap disk will reflect the higher modes of buckling for the circular ring discussed in Section 7.3. Due to symmetry, the equations for the circular arch under uniform pressure discussed in Section 7.6 will have the same results as the circular ring from Section 7.3. Since the buckling of this arch depends on the inextensional deformation of the arch, the buckling mode resembles that of the second mode of buckling of a column, with an inflection point in the center. The critical buckling pressure required to case the inner gap ring to buckle for the maximum support spacing was computed by equation 7-21 of Reference 93.k.3.m) and determined to be 15.51 psi. The critical buckling pressure was then reduced by the AISC factor of safety of (23/12) used for column buckling from Section 2.4 of Reference (3.k.4.a).

3.k.3 Summary of Results

The new sump strainers were conservatively evaluated for the postulated loads associated with OBE, SSE, and accident conditions including flooding with debris and suction head losses. The structural elements were evaluated for the combined postulated loads and compared to acceptance criteria that maintained the stresses within the elastic region. The perforated plate was evaluated by methods consistent with the ASME Boiler & Pressure Vessel Code for tube sheets.

The results of the qualification analyses for the new sump strainers are summarized in Table 3.k-5. The table provides the critical attribute actual (i.e., force, stress, etc), the corresponding allowable, and the interaction ratio (IR). The interaction ratio is the actual divided by the allowable. Thus, any interaction ratio less than or equal to 1.00 indicates conformance with the design requirements.

The conclusion of the structural analyses is that the new sump strainers are qualified as Seismic Category I, Nuclear Safety Related equipment, and that they are structurally capable of performing their intended design function.

3.k.4 References

a. American Institute of Steel Construction (AISC), "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings", February 1969, with Supplements 1, 2 and 3.

b. American National Standard ANSI/AISC N690-1994, "Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities."

c. American Society of Mechanical Engineers (ASME) Boiler & Pressure Vessel Code, Section III, Division 1, Appendices, Article A-8000, "Stresses in Perforated Flat Plates," 1989 Edition, No Addenda.

d. American Society of Civil Engineers (ASCE) Standard SEI/ASCE 8-02, "Specification for the Design of Cold-Formed Stainless Steel Structural Members."

e. American Iron and Steel Institute (AISI), "Specification for the Design of Cold-Formed Steel Structural Members," 1996 edition.

f. American National Standard ANSI/AWS D1.6:1999, "Structural Welding Code - Stainless Steel."

g. Blevins, Robert D., "Formulas for Natural Frequency and Mode Shape," Van Nostrand Reinhold, 1979.

h. American Society of Mechanical Engineers (ASME) Boiler & Pressure Vessel Code, Section II, Part D, Material Properties, 1998 Edition, through 1999 Addenda.

i. Avallone, and Baumeister, "Mark's Standard Handbook for Mechanical Engineers," 9th Edition, McGraw-Hill.

j. Robertson, John A. and Clayton T. Crowe, "Engineering Fluid Mechanics," 2nd Edition, Rudolf Steiner Press, Library of Congress Catalog Number 79-87855.

k. Moran and Shapiro, "Fundamentals of Engineering Thermodynamics," 4th Edition, John Wiley & Sons.

l. American Society of Mechanical Engineers (ASME) Boiler & Pressure Vessel Code, Section III, Division 1, Subsection NC, 1989 Edition.

m. Timoshenko, Stephen P. and James M. Gere, "Theory of Elastic Stability," 2nd Edition, McGraw-Hill.

3.k.5 Tables

Table 3.k-1: Seismic Spectra Input Summary

EVENT	DAMPING (%)	DIRECTION	PEAK OF SPECTRA (g)	ZPA (g @ 39.5 Hz)
OBE	4	North-South	0.527	0.115
OBE	4	Vertical	1.141	0.183
OBE	4	East-West	0.536	0.112
SSE	7	North-South	0.668	0.210
SSE	7	Vertical	1.413	0.327
SSE	7	East-West	0.660	0.205

Table 3.k-2: Process Fluid Conditions

PROCESS FLUID CONDITION	NORMAL	ACCIDENT
Working Fluid	Air	Borated Water
Max Sump Water Level	N/A	EL 816.83 ft (8.83 ft above basement floor elevation.)
Fluid Temperature	60°F to 120°F	265°F (max)
Max Head Loss Allowed	N/A	3.0 feet (RHR @ T = 0 minutes) 5.0 feet (CSS @ T = 25 minutes)

Table 3.k-3: Material Properties

ASTM A-240 Type 304	@ 70°F	@ 269° F*
Modulus of Elasticity	E = 28,300 ksi	E = 27,200 ksi
Yield Strength	Sy = 30.0 ksi	Sy = 23.1 ksi
Ultimate Strength	Su = 75.0 ksi	Su = 67.7 ksi
Allowable Stress	S = 20.0 ksi	S = 19.2 ksi

ASTM A-276 TYPE 304 Gr. B		
Yield Strength	Sy = 100.0 ksi	Sy = 77.0 ksi
Ultimate Strength	Su = 125.0 ksi	Su = 112.8 ksi

* Note the reduced material properties at 269°F were used instead of the required 265°F. The difference in the material properties due to the 4° F variance is trivial and in the conservative direction (i.e., reduced values).

Table 3.k-4: Other Material Properties

PROPERTY	VALUE USED	REFERENCE
Density of Stainless Steel	501 lbs/ft^3	(3.k.4.i)
Poisson's Ratio	0.305	(3.k.4.i)
Density of water @ 20°C	62.4 lbs/ft^3	(3.k.4.j)
Density of water @ 269°F**	58.3 lbs/ft^3	(3.k.4.k)
Mean Coefficient of Thermal Expansion of Stainless Steel (70°F to 269°F)	9.14E-06 in/in/°F	(3.k.4.h)

** Note the decreased density of water at 269° F compared to 265° F has negligible increase to the water masses calculated.

Table 3.k-5: Summary of Analysis Results

	LOAD CASE	ALLOWABLE STRESS OR LOAD	MAXIMUM STRESS OF LOAD	IR
Perforated Plate	OBE	28.8 ksi	25.1 ksi	0.87
	SSE	34.56 ksi	29.73 ksi	0.86
Wire Stiffener (*OBE allowable of 1.0 S was used)	SSE	17.32 ksi*	16.90 ksi	0.98
Weld of Radial Stiffener to Core Tube	OBE	0.58 k/in	0.55 k/in	0.95
	SSE	0.72 k/in	0.65 k/in	0.91
Weld of Seismic Sleeve to Debris Stop	OBE	1.73 k/in	1.57 k/in	0.91
	SSE	2.17 k/in	1.97 k/in	0.91
Module-to-Module Latch Connection	OBE	219 lbs	199.5 lbs	0.91
	SSE	328 lbs	290.5 lbs	0.89
Angle Iron Tracks on Concrete	OBE	F_A= 13.86 ksi F_V= 9.24 ksi	f_N= 13.47 ksi f_V= 1.43 ksi	0.97
	SSE	F_A=20.79 ksi F_V= 11.55 ksi	f_N= 18.45 ksi f_V= 2.24 ksi	0.89
End Module Angle Iron Tracks on Concrete	OBE	F_A=13.86 ksi F_V= 9.24 ksi	f_N=13.28 ksi f_V= 3.67 ksi	0.96
	SSE	F_A=20.79 ksi F_V= 11.55 ksi	f_N=15.85 ksi f_V= 4.38 ksi	0.76
Expansion Anchors to Floor	OBE	T_A =1698 lbs V_A =3986 lbs	T=1113 lbs V=316 lbs	0.51
	SSE	T_A =1698 lbs V_A =3986 lbs	T=1583 lbs V=423 lbs	0.91
Sump Pit Cover Plate	OBE	17.3 ksi	15.83 ksi	0.92
	SSE	20.79 ksi	16.54 ksi	0.80
Weld of Tee to Sump Pit Cover Plate	OBE	1.73 k/in	1.68 k/in	0.98
	SSE	2.17 k/in	1.71 k/in	0.80
Inner Gap Ring Buckling	DP	8.09 psi	6.07 psi	0.75

Section 3.1 Upstream Effects

The objective of the upstream effects assessment was to evaluate the flowpaths upstream of the containment sump for holdup of inventory which could reduce flow to and possibly starve the sump.

The reactor cavity is an inactive sump below the elevation of the emergency sumps. It is addressed in Section 3.e.

The evaluation was performed under SMF-2001-002201 [REF. 3.A]. Modifications were performed under SMF-2002-001952 [REF. 3.B] and SMF-2005-003364 [REF. 3.H].

The modifications based on the upstream effects evaluation assure that the water inventory required to ensure adequate ECCS or CSS recirculation would not be held up or diverted by debris blockage at choke-points in containment recirculation sump return flowpaths.

3.1.1 Evaluation of Upstream Effects

The initial evaluation of upstream effects was documented in WES002-PR-02, Evaluation of Containment Recirculation Sump Upstream Effects for the Comanche Peak Steam Electric Station, Rev. 0 dated 8/17/05 [Ref. 7.C.1] as described in Letter Logged TXX-05162 dated September 1, 2005, RESPONSE TO REQUESTED INFORMATION PART 2 OF NRC GENERIC LETTER 2004-02, "POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS AT PRESSURIZED-WATER REACTORS" [REF. 2.A]. The evaluation included review of design documents and verification by walk down for the various flow paths to the containment base slab, which is the location of the ECCS recirculation sumps.

3.1.2 Modifications to the Refueling Cavity Drains

As part of the upstream effects review, the refueling cavity drains were identified as a potential plugging point. These drains return a portion of the upper containment spray flow back to the lower volume of containment.

(1) Upender Area & Refueling Cavity Lower Internals Storage Area 4 Inch Drains:

Drain strainers for the two Refueling Cavity 4 Inch drains were designed and fabricated based on the design of the emergency sump strainers. The SF Drain Strainers were supplied by Performance Contracting Inc. (PCI) under Specification CPES-M-2044 [REF. 8.A.1] as Seismic

Category I equipment. The core tubes of the strainers are installed aligned with the drain cavities with the module assembly sitting on the liner floor. Two (2) guide pins pass through the drain cover plate to maintain orientation. Each strainer is supported by its own weight. Inherent in the design is a capturing mechanism that will not allow the strainer to move horizontally, and its weight will ensure it remains in place during an SSE event.

Drain strainers were selected rather than debris screens since the existing drain covers used during refueling could be subject to blockage by fibrous debris during a DBA. The design uses stacked disks to provide approximately 70 ft^2 of strainer surface area. Each one has a solid steel top to protect them from falling debris. The design is not vulnerable to blockage from large debris such as RMI or a LDFG blanket.

Pictures P-3.1.2-1 and P-3.1.2-3 (Attachment A) show a drain strainer before and after installation.

These strainers are administratively controlled. They are removed during refueling outages in Modes 5 and 6 when the normal drain function is used. They are required to be installed in Modes 1-4 when the 4" drains are also required to be open to containment.

(2) Refueling Cavity Lower Internals Storage Area 6 Inch Drains:

The main refueling cavity has two architectural drains which consists of open six inch pipes connecting the refueling cavity to the main area of containment. These drains are covered by a blind flange during refueling.

Refueling Cavity 6 inch Drain Debris Screens for the 6" dia. architectural drains were designed and fabricated in accordance with Seismic Category I requirements. These screens will prevent blockage by large debris. They will pass debris small enough to pass through the pipe without blockage. This design is not vulnerable to RMI or fibrous debris.

Pictures P-3.1.2-2 and P-3.1.2-3 (Attachment A) show a drain debris screen before and after installation.

These debris screens are administratively controlled. They are removed during refueling outages in Modes 5 and 6 when the drains are covered by a blind flange to enable filling of the refueling cavity. They are required to be installed in Modes 1-4 when the 6" drains are also required to be open to containment.

(3) Removal of pipe reducers at the end of refueling cavity drain pipe

Refueling Cavity 4 Inch drains are required to be open in Modes 1-4. Reducers had been installed to allow connection of hoses to the drains during outages. These reducers would limit outflow of water via this drain path.

The modification made to the existing refueling cavity drain from 4" x 2" reducer to 4" straight pipe with elbow as shown was made to maximize the drain flow. Removable fittings are provided for outages.

Picture P-3.1.2-4 (Attachment A) shows the drain pipe before and after modification.

The removable fittings are administratively controlled. They are removed during Modes 1-4.

3.1.3 Other Measures Taken to Mitigate Potential Choke Points and Water Holdup

Additional pinch points and water holdup volumes were identified which were evaluated and modifications were made to minimize water lost for recirculation.

(1) Wire Mesh Door Modification

Picture P-3.1.3-1 (Attachment A) shows the wire mesh door replaced by the door with six inch spaced bars.

(2) Reactor Vessel (RV) Head Stand Shield Wall Modification:

The shield wall is an NNS structure that has no structural function. The only function of the RV head stand shield wall is to provide a radiation barrier during the storage and cleaning of the head during a refueling outage. It has a floor drain interior to the wall. To assure that fibrous debris does not block drainage and hold up water, twelve (12) - 2 inch diameter holes were core drilled in the shield wall.

Each pair of 2" dia. holes is designed to be located behind the corresponding pedestal and the centerline of the holes are 3" above the floor surface. The configuration provides sufficient shielding during outages while the hole height location minimize the amount of contaminated water that could exit to the open area when outage personnel decon the area. This is consistent with ALARA.

Picture P-3.1.3-2 (Attachment A) shows the head stand shield wall modification.

(3) Toe Plate Modifications

Equipment hatches located at Elevations 905 and 860 were identified as major drain paths for containment spray on those elevations. These hatches are protected by handrails with toe plates. The toe plates were modified to be raised during Modes 1-4 to allow free drainage through the hatches.

Picture P-3.1.3-3 (Attachment A) shows a toe plate modification.

The toe plates are administratively controlled. They are raised during Modes 1-4.

(4) Roll Away Missile Shield Plat form Modification

The Roll Away Missile Shield (RAMS) Platforms were identified as possible water holdup due to solid floor and toe plates. The Unit 1 RAMS was removed by an unrelated modification in 1RF12. The checkered plate floors of the Unit 2 RAMS platforms were drilled with 1-1/4" holes to enable drainage of spray water.

Picture P-3.1.3-4 (Attachment A) shows the RAMS platform modification.

(5) Ventilation Exhaust Modification

The CRDM Cooling Fans were identified as possible water holdup due to vertical exhausts. The Unit 1 fans were removed by an unrelated modification in 1RF12. The Unit 2 fans were retrofitted with hoods to prevent ingestion of spray water.

Picture P-3.1.3-5 (Attachment A) shows the Unit 2 ventilation exhaust modification.

(6) Whip Restraint Modification

A number of pipe whip restraints were oriented such that spray water could be trapped. Flashing was added to divert spray water from accumulating in the restraints.

Picture P-3.1.3-6 (Attachment A) shows a whip restraint before modification. Picture P-3.1.3-7 (Attachment A) shows that whip restraint after the modification.

(7) Tube Steel Newell Caps

A number of vertical tube steel beams were identified which had not been covered by Newell caps in accordance with specifications.

Picture P-3.1.3-8 (Attachment A) shows four tube steel columns before modification. Picture P-3.1.3-9 (Attachment A) shows four columns after the modification.

3.1.4 Summary of Upstream Effects

The calculation of containment flood levels [REF. 7.F.17] was revised in support of the above modifications to address the issues identified in the WES002-PR-02, Evaluation of Containment Recirculation Sump Upstream Effects for the Comanche Peak Steam Electric Station, Rev. 0 dated 8/17/05 [Ref. 7.C.1]. Modifications and analysis of upstream effects are complete. [REF. 7.F.2]

Section 3.m Downstream effects - Components and Systems

The objective of the downstream effects, components and systems section is to evaluate the effects of debris carried downstream of the containment sump screen on the function of the ECCS and CSS in terms of potential wear of components and blockage of flow streams.

RAI 31 Testing and analysis of downstream effects are in progress in accordance with WCAP-16406-P, Evaluation of Downstream Sump Debris Effects in Support of GSI-191, Revision 1 dated August 2007 [REF. 6.A] and the NRC Safety Evaluation [REF. 1.E].

The information requested in GL 04-02 Requested Information Item 2(d)(v) and 2(d)(vi) regarding blockage, plugging, and wear at restrictions and close tolerance locations in the ECCS and CSS downstream of the sump will be provided in a future revision of this report.

Section 3.n Downstream Effects - Fuel and Vessel

The objective of the downstream effects analyses for the fuel and vessel is to evaluate the effects that debris carried downstream of the containment sump screen and into the reactor vessel has on core cooling.

RAI 31 Testing and analysis of downstream effects is in progress in accordance with WCAP-16406-P, Evaluation of Downstream Sump Debris Effects in Support of GSI-191, Revision 1 dated August 2007 [REF. 6.A] and the NRC Safety Evaluation [REF. 1.E].

Analysis of the in-vessel downstream effects are in progress in accordance with WCAP-16793-NP, Evaluation of Long-Term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculating Fluid, Revision 0, May 2007.

NRC Letter dated February 4, 2008 to Anthony Pietrangelo, NEI, DRAFT CONDITIONS AND LIMITATIONS FOR USE OF WESTINGHOUSE TOPICAL REPORT WCAP-16793-NP, REVISION 0, "EVALUATION OF LONG-TERM COOLING CONSIDERING PARTICULATE, FIBROUS AND CHEMICAL DEBRIS IN THE RECIRCULATING FLUID" is being considered in the analysis.

The information requested in GL 04-02 Requested Information regarding in-vessel effects will be provided in a future revision of this report.

RAIs 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 19

Section 3.o Chemical Effects

The objective of the chemical effects section is to evaluate the effect that chemical precipitates have on head loss and core cooling.

Analysis and testing for the impact of chemical effects on sump performance are in progress in accordance with WCAP-16530-NP, "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191", Revision 0, February 2006. [REF. 6.B] and NRC Safety Evaluation [REF. 1.G].

The information requested in GL 04-02 regarding chemical effects will be provided in a future revision of this report.

Section 3.p Licensing Basis

The objective of the licensing basis section is to provide information regarding any changes to the plant licensing basis due to the sump evaluation or plant modifications.

3.p.1 Changes to the Technical Specifications

License Amendment 129 approved LDCR-TS-2005-003 [REF. 2.C.1]

- Revise TS 3.3.2 RWST Setpoint Allowable Value,
- Revise description of sump screens to strainers in SR 3.5.2.8

Requested changes to the current Comanche Peak Steam Electric Station Technical Specifications, Amendments 138, July 24, 2007 [REF. 2.C]

- LDCR-TS-2007-005, Revision to Technical Specification 3.6.7, "Spray Additive System" [EVAL-2007-002743-01] [LAR- 2007-008, REF. 2.J]

3.p.2 Changes to the Licensing Basis in the FSAR

Changes to the licensing basis for the completed plant modifications have been made.

The FSAR updates will be performed in accordance with the requirements of 10CFR50.71(e).

Completed changes to the licensing basis in Comanche Peak Steam Electric Station Final Safety Analysis Report (FSAR), Amendment 101, February 1, 2007. [REF. 2.B]]

- LDCR-SA-2005-024, Update for the change to the radiation protection doors and barriers modified by MCA-2002-001952-03. Correct FSAR Appendix 1A(B) and Section 6.2.2.3.3 for descriptions of the emergency sump and RG 1.82. [REF. 2.B.1]

- LDCR-SA-2006-001, Update for removal of the personnel barriers beneath the fuel transfer tube inside containment by FDA-2005-003364-07 and -17. [REF. 2.B.2]

- LDCR-SA-2006-010, Update for LA129 and GSI-191 mods:
    - FDA-2005-003364-02 and 12 - Replace RWST/CT Isolation Valves HV-4758/4759
    - FDA-2005-003364-03 and 13 - Replace Sump Screens/Trash Racks with Sump Strainers/Debris Interceptors

- FDA-2005-003364-04 and 14 - Add Drain Strainers and Debris Screens in Refueling Cavity Drains
- FDA-2005-003364-05 and 15 - Reduce spray water holdup
- FDA-2005-003364-09 and 19 - RWST Setpoint Mod
- Tech Spec LA 129 to TS Table 3.3.2-1 (RWST Low-Low Allowable value) and SR 3.5.2.8 (sump surveillance).

[REF. 2.B.3]

- LDCR-SA-2007-019, clarify the type of insulation used inside containment [REF. 2.B.6]

- LDCR-SA-2007-022, Update the Protective Coatings Program description in the FSAR [2.B.7]

In process change to the licensing basis in Comanche Peak Steam Electric Station Final Safety Analysis Report (FSAR), Amendment 101, February 1, 2007. [REF. 2.B]

- LDCR-SA-2005-029, Addition of narrow range suction pressure instrumentation for RHR and CSS pumps, RG 1.97 R2 Type 2D accident monitoring by FDA-2005-003364-08 and -18 [REF. 2.B.5]

3.p.3 Change to the Licinsing Basis for Emergency Sump Performance

In process change to the licensing basis in Comanche Peak Steam Electric Station Final Safety Analysis Report (FSAR), Amendment 101, February 1, 2007. [REF. 2.B]

- LDCR-SA-2006-36, Update for the changes to the emergency sump licensing basis [REF. 2.B.8]

The CPNPP licensing basis will be updated to reflect the results of the analysis and modifications performed to demonstrate compliance with the regulatory requirements. These updates will be performed in accordance with the requirements of 10CFR50.71(e).

In general, the FSAR will be revised as follows:
- Section 1A(B) to update the discussion of Regulatory Guide 1.82
- Section 6.1B to update for materials, including coatings, and chemical effects
- Section 6.2.2 to update for upstream and downstream design features
- Section 6.2.2.2.1 to reflect the new design and licensing basis for the emergency sumps
- Section 6.2.2.3.1 to reflect the new sump strainer qualification
- Section 6.2.3.3 to reflect the new design and licensing basis for sump performance

- Section 6.2.3.3.4 to reflect the new design and licensing basis for NPSH
- Section 6.3.2.2.10 to reflect the new design and licensing basis for NPSH
- Section 6.3.2.5.2 to address potential changes due to downstream wear

Section 4.0 References

References used in this report (e.g. "REF. #.α") are grouped and listed below . Additional references are provided in Section 3.k.

4.1 NRC Correspondence

1.A NRC Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," dated September 13, 2004.

1.B NRC Letter dated December 27, 2007, "APPROVAL OF EXTENSION REQUEST FOR CORRECTIVE ACTIONS RE: GENERIC LETTER 2004-02, "POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS AT PRESSURIZED WATER REACTORS" (TAC NOS. MD4676 AND MD4677) [CP-200800066]

1.C NRC Letter dated February 9, 2006, REQUEST FOR ADDITIONAL INFORMATION REGARDING RESPONSE TO GENERIC LETTER 04-002 POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN-BASIS ACCIDENTS AT PRESSURIZED-WATER REACTORS" (TAC NOS. MC4776 AND MC4777)

1.D NRC Letter dated November 30, 2007 to Anthony Pietrangelo, NEI, SUPPLEMENTAL LICENSEE RESPONSES TO GENERIC LETTER 2004-02, "POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS AT PRESSURIZED-WATER REACTORS"

1.E SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION TOPICAL REPORT (TR) WCAP-16406-P, REVISION 1, "EVALUATION OF DOWNSTREAM SUMP DEBRIS EFFECTS IN SUPPORT OF GSI-191" PRESSURIZED WATER REACTOR OWNERS GROUP PROJECT NO. 694, December 20, 2007.

1.F NRC Letter dated February 4, 2008 to Anthony Pietrangelo, NEI, DRAFT CONDITIONS AND LIMITATIONS FOR USE OF WESTINGHOUSE TOPICAL REPORT WCAP-16793-NP, REVISION 0, "EVALUATION OF LONG-

TERM COOLING CONSIDERING PARTICULATE, FIBROUS AND CHEMICAL DEBRIS IN THE RECIRCULATING FLUID"

1.G FINAL SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION TOPICAL REPORT WCAP-16530-NP "EVALUATION OF POST-ACCIDENT CHEMICAL EFFECTS IN CONTAINMENT SUMP FLUIDS TO SUPPORT GSI-191" PRESSURIZED WATER REACTOR OWNERS GROUP PROJECT NO. 694, Decemebr 21, 2007.

1.H NRC Letter from William H. Ruland to Anthony Pietrangelo, NEI, REVISED CONTENT GUIDE FOR GENERIC LETTER 2004-02 SUPPLEMENTAL RESPONSES, dated November 21, 2007.

4.2 Comanche Peak Correspondence and Other Docketed Documents

2.A Letter Logged TXX-05162 dated September 1, 2005, RESPONSE TO REQUESTED INFORMATION PART 2 OF NRC GENERIC LETTER 2004-02, "POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS AT PRESSURIZED-WATER REACTORS".[CPSES-200501776]

2.B Comanche Peak Steam Electric Station Final Safety Analysis Report (FSAR), Amendment 101, February 1, 2007.

2.B.1 LDCR-SA-2005-024, Update for the change to the radiation protection doors and barriers modified by MCA-2002-001952-03. Correct FSAR Appendix 1A(B) and Section 6.2.2.3.3 for descriptions of the emergency sump and RG 1.82. [EVAL-2002-001952-03]

2.B.2 LDCR-SA-2006-001, Update for removal of the personnel barriers beneath the fuel transfer tube inside containment by FDA-2005-003364-07 and -17. [EVAL-2005-003364-01]

2.B.3 LDCR-SA-2006-010, Update for LA129 and GSI-191 mods:

- FDA-2005-003364-02 and 12 - Replace RWST/CT Isolation Valves HV-4758/4759
- FDA-2005-003364-03 and 13 - Replace Sump Screens/Trash Racks with Sump Strainers/Debris Interceptors
- FDA-2005-003364-04 and 14 - Add Drain Strainers and Debris

Screens in Refueling Cavity Drains
- FDA-2005-003364-05 and 15 - Reduce spray water holdup
- FDA-2005-003364-09 and 19 - RWST Setpoint Mod
- Tech Spec LA 129 to TS Table 3.3.2-1 (RWST Low-Low Allowable value) and SR 3.5.2.8 (sump surveillance).

[EVAL-2005-003364-03]

2.B.5 LDCR-SA-2005-029, Addition of narrow range suction pressure instrumentation for RHR and CSS pumps, RG 1.97 R2 Type 2D accident monitoring by FDA-2005-003364-08 and -18 [EVAL-2005-003364-07]

2.B.6 LDCR-SA-2007-019, clarify the type of insulation used inside containment [EVAL-2001-002201-21]

2.B.7 LDCR-SA-2007-022, Update the Protective Coatings Program description in the FSAR [EVAL-004-002882-07]

2.B.8 LDCR-SA-2006-36, Update for the changes to the emergency sump licensing basis [EVAL-2005-003364-19]

2.C Comanche Peak Steam Electric Station Technical Specifications, Amendments 138, July 24, 2007.

2.C.1 License Amendment 129: LDCR-TS-2005-003, Revise TS 3.3.2 RWST Setpoint Allowable Value, revise description of sump screens to strainers in SR 3.5.2.8, and change from NaOH to TSP in TS 3.6.7 [EVAL-2005-001869-01-00]

2.C.2 LDCR-TS-2007-005, Revision to Technical Specification 3.6.7, "Spray Additive System" [EVAL-2007-002743-01] [LAR- 2007-008, REF. 2.J]

2.D Letter Logged TXX-05047 dated March 7, 2005, 90-DAY RESPONSE TO NRC GENERIC LETTER 2004-02, POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS AT PRESSURIZED-WATER REACTORS. [CPSES-200500464]

2.E Letter Logged TXX-06062 dated March 31, 2006, UPDATED RESPONSE TO REQUESTED INFORMATION PART 2 OF NRC GENERIC LETTER 2004-02, "POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY

RECIRCULATION DURING DESIGN BASIS ACCID ENTS AT PRESSURIZED-WATER REACTORS". [CPSES-200600627]

2.F Letter Logged TXX-06180 dated October 20, 2006, TRANSMITTAL OF REPORT ON TXU POWER SPONSORED COATINGS PERFORMANCE TEST. [CPSES-200602162]

2.G Letter Logged TXX-07156 dated November 8, 2007, SUPPLEMENTAL INFORMATION TO REPORT ON LUMINANT POWER SPONSORED COATINGS PERFORMANCE TEST. [CPSES-200700051]

2.H Letter Logged TXX-03130 dated August 8, 2003, RESPONSE TO NRC BULLETIN 2003-01, "POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY SUMP RECIRCULATION AT PRESSURIZED-WATER-REACTORS". [CPSES-200301604]

2.I Letter Logged TXX-05118 dated June 27, 2005, REQUEST FOR ADDITIONAL INFORMATION REGARDING RESPONSE TO NRC BULLETIN 2003-01. [CPSES-200501323]

2.J Letter Logged TXX-07149 dated November 29, 2007, LICENSE AMENDMENT REQUEST (LAR) 2007-008, REVISION TO TECHNICAL SPECIFICATION 3.6.7, "SPRAY ADDITIVE SYSTEM". [CPSES-200700022]

2.K Letter Logged TXX-98249 dated November 11, 1998, RESPONSE TO GENERIC LETTER 98-0 4, "POTENTIAL FOR DEGRADATION O F TH E EMERGENCY CO RE COOLING SYSTEM AND T HE CONTAINMENT SPR AY SYSTEM AFT E R A LOSS-OF-COOLANT ACCIDENT BECAUSE OF CONSTRUCT ION AND PROTECTIVE COATING DEFICIENCIES AND FOREIGN MATE RIAL IN CONTAINMENT

2.L NUREG-0797, Safety Evaluation Report Related to the Operation of Comanche Peak Steam Electric Station, Units 1 and 2.

- Supplement 9, March 1985
- Supplement 11, May 1985

2.M Gibbs & Hill Report, "Evaluation of Paint and Insulation Debris Effects on Containment Emergency Sump Performance," June 1984

2.N Letter Logged TXX-07164 dated December 3, 2007, SUPPLEMENT TO RESPONSE TO NRC GENERIC LETTER (GL) 2004-02, "POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS AT PRESSURIZED-WATER REACTORS". [CPSES-200700090]

4.3. Comanche Peak SmartForms (Corrective Action Program Documents)

3.A. SMF-2001-002201-00: Track activities associated with NRC Generic Safety Issue (GSI)-191, "Assessment of Debris Accumulation on PWR Sump Performance"

3.B. SMF-2002-001952-00: Doors to the Steam Generator Compartments could adversely effect the containment and ECCS design functions if closed in MODES 1-4

3.C. SMF-2002-003029-00: Removal of El. 808 Transfer Tube Area Cages

3.D. SMF-2003-002008-01: Response to "NRC Bulletin 2003-01: Potential impact of debris blockage on emergency sump recirculation at pressurized-water reactors"

3.E. SMF-2004-002882-00: Errors in screen size in the FSAR, the 1984 paint study and other calculations.

3.F SMF-2004-003972-00: Labeling Program deficiencies - Specification inappropriately voided. Vendor documentation is incomplete. Procedure contains adverse allowances for label materials.

3.G SMF-2005-001869-00: Process SmartForm for GSI-191 Sump Related License Amendments.

3.H SMF-2005-003364-00: Process SmartForm for GSI-191 Sump Related Modifications.

3.I SMF-2007-001267-00: Commodities containing unlogged quantities of aluminum were found in Unit 1 containment.

3.J SMF-2007-002743-00: Close-out activities associated with NRC Generic Safety Issue (GSI)-191, "Assessment of Debris Accumulation on PWR Sump Performance"

4.4 Nuclear Energy Institute (NEI) and Electric Power Research Institute (EPRI) Reports and Correspondence

4.A Nuclear Energy Institute report NEI 04-07, "Pressurized Water Reactor Sump Performance Methodology," dated December 2004.

4.B Nuclear Energy Institute report NEI 02-01, "Condition Assessment Guidelines: Debris Sources Inside PWR Containments," Revision 1, September 2002.

4.C EPRI 1003102, "Guideline on Nuclear Safety-Related Coatings", Revision 1 (Formerly TR-109937) Final Report, November 2001.

4.D EPRI 1011753, "Design Basis Accident Testing of Pressurized Water Reactor Unqualified Original Equipment Manufacturer Coatings", Final Report, September 2005.

4.E EPRI 1014883, Plant Support Engineering: Adhesion Testing of Nuclear Coating Service Level I Coatings Final Report, August 2007.

4.F EPRI 1014884, Plant Support Engineering: Degradation Research for Nuclear Service Level I Coatings Final Report, September 2007.

4.5 Comanche Peak Nuclear Power Plant Condition Assessments and Scoping

5.A ER-ME-118, "Debris Source Inventory Confirmatory Walkdown Report for Comanche Peak Steam Electric Station - Unit 1", Revision 0.

5.B ER-ME-119, "Report on Comanche Peak Steam Electric Station Unit 2 GSI-191 Debris Source Term Confirmatory Walkdown", Revision 0.

5.C. ER-ME-122, "Latent Debris and Supplementary Condition Assessment", Revision 1.

5.D ER-ME-123, "GSI-191 Scoping Study", Revision 0, December 20, 2004.

5.E ER-ME-124, "Evaluation of CPSES Protective Coatings", Revision 0, November 28, 2007.

4.6 PWR Owner's Group Topical Reports and Correspondence

6.A WCAP-16406-P, Evaluation of Downstream Sump Debris Effects in Support of GSI-191, Revision 1 dated August 2007.

6.B WCAP-16530-NP, "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191", Revision 0, February 2006.

6.C WCAP-16785-NP, "Evaluation of Additional Inputs to the WCAP-16530-NP Chemical Model", Revision 0 dated May 2007.

6.D WCAP-16596-NP, "Evaluation of Alternate Emergency Core Cooling System Buffering Agents ", Revision 0 dated July 2006.

6.E WCAP-16727-NP, "Evaluation of Jet Impingement and High Temperature Soak Tests of Lead Blankets For Use Inside Containment of Westinghouse Pressurized Water Reactors", Revision 0, November 2007.

6.F WCAP-16793-NP, Evaluation of Long-Term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculating Fluid, Revision 0 dated May 2007

4.7 Comanche Peak GSI-191 Analyses and Testing

7.A Alion Science and Technology

7.A.1 ALION-REP-CPSES-2803-002, Comanche Peak: Characterization of Events That May Lead to ECCS Sump Recirculation, Revision 1 dated December , 2007. [VDRT-3448927]

7.A.2 ALION-CAL-TXU-2803-03, Comanche Peak Recirculation Sump Debris Generation Calculation, Revision 1 dated December, 2007. [VDRT-3448906]

7.A.3 ALION-CAL-TXU-2803-04, Comanche Peak Reactor Building GSI-191 Debris Transport Calculation, Revision 1 dated December, 2007. [VDRT-3448917]

7.A.4 ALION-CAL-TXU-2803-05, Comanche Peak GL 2004-02 Recirculation

Sump Head Loss Analysis, Revision 0 dated August 30, 2005. [VL-05-002197]

7.A.5 ALION-CAL-TXU-2803-06, "SUMMARY OF DEBRIS GENERATION AND DEBRIS TRANSPORT RESULTS", Revision 0 [VDRT-3448922]

7.A.6 ALION-REP-LAB-2532-95, "Debris Settling Velocity Testing Report", Rev. 1 [VL-07-001293]

7.A.7 ALION-REP-LAB-2532-96, "Debris Tumbling Velocity Testing Report", Rev. 1 [VL-07-001296]

7.A.8 ALION-REP-LAB-2532-97, "Debris Interceptor Testing Report", Rev. 1 [VL-07-001297]

7.A.9 ALION-REP-TXU-2803-21, "Debris Transport and Interceptor Testing Report", Rev. 1 [VL-07-001298]

7.A.10 ALION-REP-TXU-2803-22: "TXU MinK Material Characterization Report (SEM)", Revision 0 [VL-07-001299]

7.A.11 ALION-LAB-REP-TXU-4464-02, TXU Paint Chip Characterization, Revision 0 [VL-07-001897]

7.A.12 ALION-REP-TXU-4464-03, "Comanche Peak Low Density Fiberglass Debris Erosion Testing Report", Revision 0 [VDRT-3457167]

7.A.13 ALION-REP-LAB-2352-77, "Erosion Testing of Low Density Fiberglass Insulation", Revision 1, May 25, 2007. [VDRT-3457160]

7.B AREVA NP

7.B.1 AREVA NP, Engineering Information Record, Document Identifier 51-9037978-001, ZONE OF INFLUENCE EVALUATION FOR DBA QUALIFIED COATINGS AT COMANCHE PEAK NUCLEAR POWER PLANT, Revision 1, January 19, 2007.

7.C ENERCON

7.C.1 WES002-PR-02, Evaluation of Containment Recirculation Sump Upstream Effects for the Comanche Peak Steam Electric Station, Rev. 0 dated 8/17/05.

7.C.2 WES002-PR-01, Evaluation of Containment Recirculation Sump Downstream Effects for the Comanche Peak Steam Electric Station, Rev. 0 dated 8/17/05.

7.D Keeler & Long PPG

7.D.1 Report 06-0413, Design Basis Accident Testing of Coating Samples from Unit 1 Containment, TXU Comanche Peak SES".

7.E Westinghouse

7.E.1 CN-SEE-05-100, Comanche Peak Sump Debris Downstream Effects Evaluation for ECCS Equipment, Rev. 0 [Westinghouse Proprietary Class 2]

7.E.2 CN-SEE-05-87, Comanche Peak Sump Debris Downstream Erosion Effects Evaluation for ECCS Valves, Rev. 0 [Westinghouse Proprietary Class 2]

7.E.3 CN-CSA-05-19, Comanche Peak Steam Electric Station Units 1 and 2 GSI-191 Downstream Effects – Vessel Blockage Evaluation, Rev. 0. [Westinghouse Proprietary Class 2]

7.E.4 CN-CSA-05-70, Comanche Peak Units 1 and 2 GSI-191 Downstream Effects – Reactor Fuel Blockage Evaluation, Rev.0 [Westinghouse Proprietary Class 2]

7.E.5 CN-CSA-05-65, Comanche Peak Units 1 and 2 GSI-191 Downstream Effects Debris Ingestion Evaluation, Rev. 0. [Westinghouse Proprietary Class 2]

7.E.6 WCAP-16568-P, "Jet Impingement Testing to Determine the Zone of Influence (ZOI) for DBA Qualified/Acceptable Coatings", Revision 0, June 2006. [This work performed under Utilities Service Alliance, Inc. Project Service Agreement No. 2005-11-00]

7.F Comanche Peak Engineering Evaluations and Calculations

7.F.1 EVAL-2001-002201-04-01, Comanche Peak Comparison to ICET

7.F.2 EVAL-2001-002201-05-01, Upstream Effects

7.F.3 EVAL-2001-002201-06-01, Downstream Effects, Blockage

7.F.4 EVAL-2001-002201-07-01, Downstream Effects, Wear

7.F.5 EVAL-2001-002201-08-01, Downstream Effects, Vessel Blockage

7.F.6 EVAL-2001-002201-09-01, Downstream Effects, Fuel

7.F.7 EVAL-2001-002201-10-01, Debris Generation

7.F.8 EVAL-2001-002201-11-01, Debris Transport

7.F.9 EVAL-2001-002201-12-01, Head Loss

7.F.10 EVAL-2001-002201-14-01, Event Characterization

7.F.11 EVAL-2001-002201-15-00, Evaluate deviations from RG 1.82

7.F.12 EVAL-2001-002201-16-00, Changes to Engineering Specifications and Procedures

7.F.13 EVAL-2001-002201-17-00, Changes to Containment Inspection and Surveillance Procedures

7.F.14 EVAL-2001-002201-18-00, Capturing the information that was used as design input for analyses, modifications, or other aspects of this effort to ensure that the necessary configuration can and will be maintained.

7.F.15 EVAL-2001-002201-19-00, Evaluate antisweat insulation specifications and materials for debris characteristics

7.F.16 EVAL-2001-002201-20-00, Evaluate mechanical seals on ECCS and CT Pumps for Leakage requirements and for the effect of failure of the seal and disaster bushing.

7.F.17 ME-CA-0000-5066, Calculation of Minimum Flood Level in the Containment Following a Large Break LOCA, Small Break LOCA and MSLB, Revision 3.

7.F.18 ME(B)-389, RWST Setpoints, Volume Requirements, and time depletion analysis, Revision 11

7.F.19 ME(B)-325, Head Losses between Containment Sumps and RHR Pumps During Recirculation and NPSHa, Revision 3

7.F.20 ME-CA-0232-5416, Evaluation of GSI-191 Impacts on the Containment Spray System Performance,.Revision 0

7.F.21 ME-CA-0232-4006, NPSHa for Containment Spray Impellers Using Nominal Test Data, Revision 2

7.G Corrosion Control Consultants and Labs Inc.

7.G.1 Letter from Jon Cavallo, Vice President, Corrosion Control Consultants and Labs Inc. to Charles Feist, CPNPP, dated September 20, 2007

4.8. Comanche Peak Strainer Specification, Design, and Testing Documents

8.A Specification

8.A.1 CPES-M-2044, Emergency Sump Suction Strainers, Revision 5

8.B PCI Hydraulic Calculations

8.B.1 TDI-6004-00, Sure-Flow" Suction Strainer Qualification Report, Rev. 2

8.B.2 TDI-6004-01, SFS Surface Area, Flow and Volume Calculation, Revision 1, dated 9/25/2006

8.B.3 TDI-6004-02, Debris Allocations Design Inputs for Test Plan, Revision 3, dated 9/26/2006

8.B.4 TDI-6004-03, Core Tube Design Comanche Peak Steam Electric Station, Revision 0, dated 7/27/2006

8.B.5 TDI-6004-04, Debris Weights on Modules, Revision 1, dated 4/24/2007

8.B.6 TDI-6004-05, Clean Head Loss Comanche Peak Steam Electric Station, Revision 2, dated 9/27/2006

8.B.7 TDI-6004-06, Total Head Loss Comanche Peak Steam Electric Station, Revision 1, dated 5/07/2007

8.B.8 TDI-6004-07, Vortex, Air Ingestion & Void Fraction - Comanche Peak Steam Electric Station, Revision 0, dated 5/10/2007

8.B.9 TDI-6004-08, Floor Drain Design and Qualification Report, Revision 1, dated 9/26/06

8.C AES Calculations - Structural

8.C.1 AES Document No. PCI-5472-S01, Structural Evaluation of Emergency Sump Suction Strainers, Revision 3, dated 3/23/2007

8.C.2 AES Document No. PCI-5472-S02, Structural Evaluation of the Reactor

Cavity Floor Drain Strainers, Revision 0, dated 9/27/2006

8.D AREVA NP Reports - Testing

8.D.1 AREVA NP, Engineering Information Record, Document Identifier 519009544-002, Test Plan for Comanche Peak 1 & 2 Strainer Performance Testing, dated March 2006

8.D.2 AREVA NP, Engineering Information Record, Document Identifier 519024342-001, Comanche Peak 1 & 2 Strainer Performance Test Report, dated August 2006

8.D.3 AREVA NP, Engineering Information Record, Document Identifier 519022445-000, Comanche Peak Debris Bypass Percentages, dated September 2006

4.9 NRC Regulations, Regulatory Guidance, and Reports

9.A 10CFR50.46, Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors.

9.B 10CFR50.59, Changes, tests and experiments.

9.C 10CFR50.71, Maintenance of records, making of reports.

9.D 10CFR50, Appendix A, General Design Criteria for Nuclear Power Plants
Criterion 4 - Environmental and Dynamic Effects Design Bases
Criterion 35 - Emergency Core Cooling
Criterion 38 - Containment Heat Removal

9.E 10CFR100, Reactor Site Criteria

9.F Regulatory Guide 1.82, "SUMPS FOR EMERGENCY CORE COOLING AND CONTAINMENT SPRAY SYSTEMS", Revision 0, June 1, 1974.

9.G Regulatory Guide 1.82, "WATER SOURCES FOR LONG-TERM RECIRCULATION COOLING FOLLOWING A LOSS-OF-COOLANT ACCIDENT, Revision 3, November 2003.

9.H Acceptance Criteria of NRC Standard Review Plan, Section 3.6.2, Determination of Break Locations and Dynamic Effects Associated with the Postulated Rupture of Piping. Also Branch Technical Position MEB 3-1, Postulated Breaks and Leakage Locations in Fluid System Piping Outside Containment.

9.I NUREG/CR-6916, Hydraulic Transport of Coating Debris, December 2006.

9.J RG 1.54, Service Level I, I, And III Protective Coatings Applied to Nuclear Power Plants, Revision 1, July 2000.

9.K D.V. Rao, et al., "Drywell Debris Transport Study: Experimental Work", NUREG/CR-6369, Volume 2, September 1999.

4.10 Los Alamos National lab

10.A LA-UR-05-0124, Integrated Chemical Effects Test Project: Test #1 Data Report, June 2005.

10.B LA-UR-05-6146, Integrated Chemical Effects Test Project: Test #2 Data Report, dated September 2005

10.X LA-UR-04-5416, "Screen Penetration Test Report," dated November 2004.

4.11 General Electric BWR Owners' Group

11.A Report NEDO-32686, Rev. 0, "Utility Resolution Guidance for ECCS Suction Strainer Blockage".

4.12 Industry Codes and Standards

12.A ASTM D 3911-03, Standard Test Method for Evaluating Coatings Used in Light-Water Nuclear Power Plants at Simulated Design Basis Accident (DBA) Conditions..

12.B ASTM D 5144-00, Standard Guide for Use of Protective Coating Standards in Nuclear Power Plants.

12.C ASTM D 5163-05a, Standard Guide for Establishing Procedures to Monitor the

Performance of Coating Service Level I Coating Systems in an Operating Nuclear Power Plant.

4.13 Comanche Peak Specifications

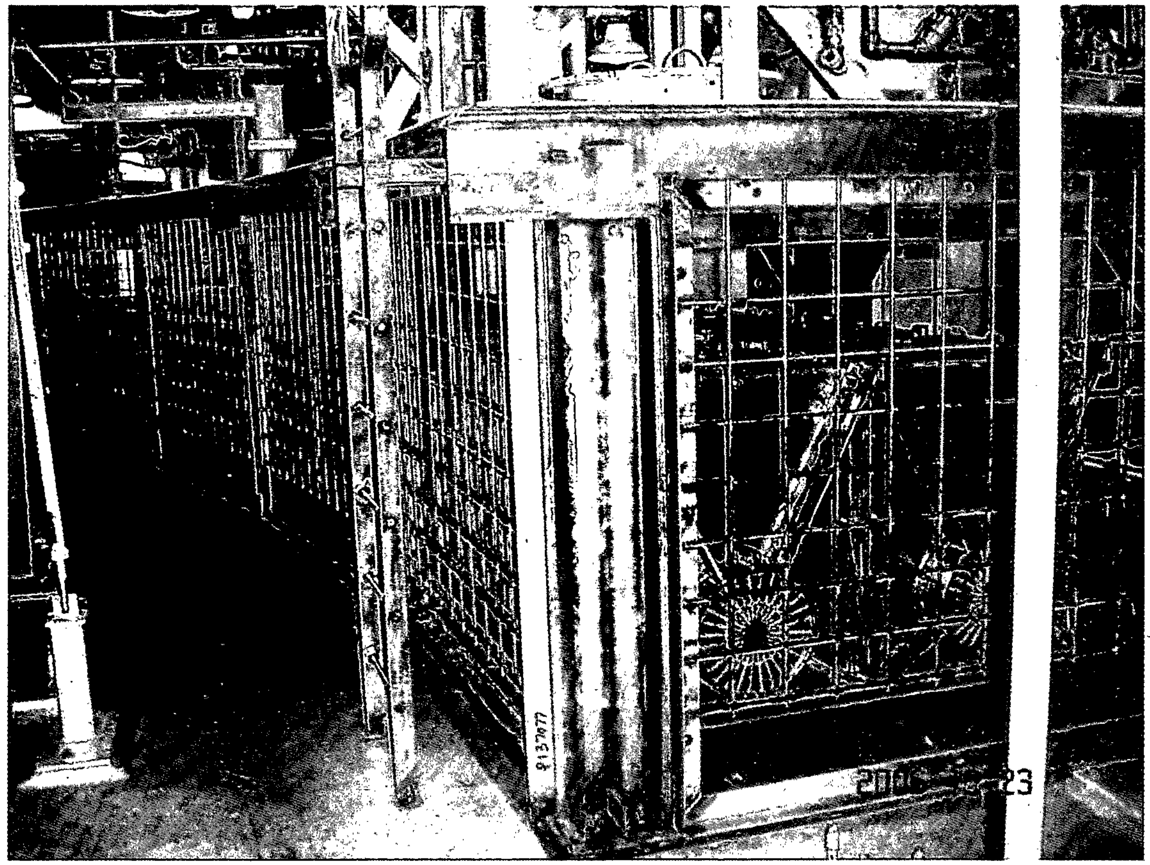
[Later]

4.14 Comanche Peak Procedures

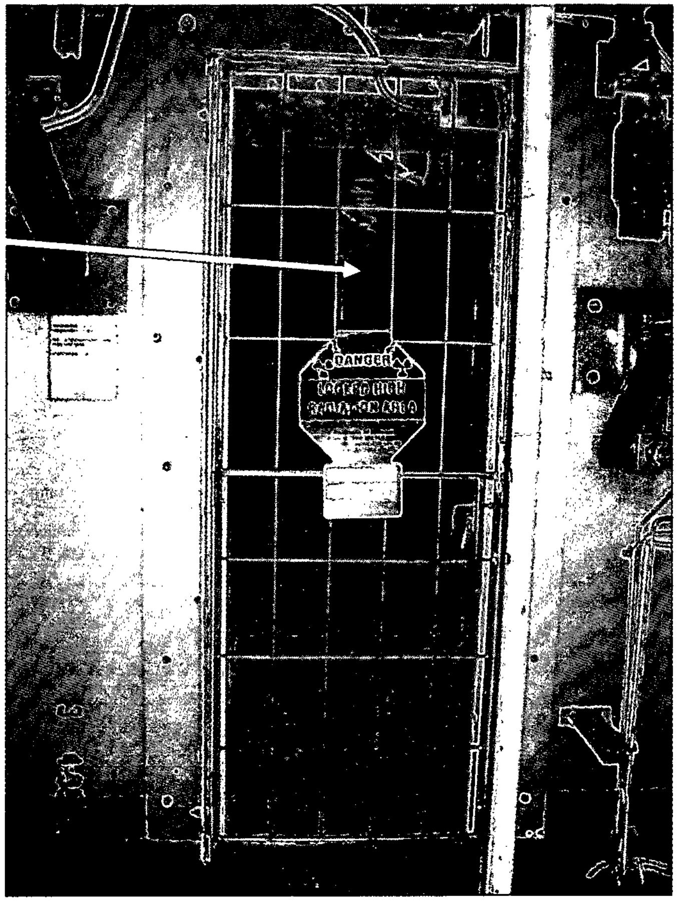
14.A STA-692, MAINTENANCE COATINGS PROGRAM, Revision 4.

14.2 EPG-5.01, ENGINEERING SUPPORT - PROTECTIVE COATINGS PROGRAM, Revision 1.

Containment Emergency Sump Modifications



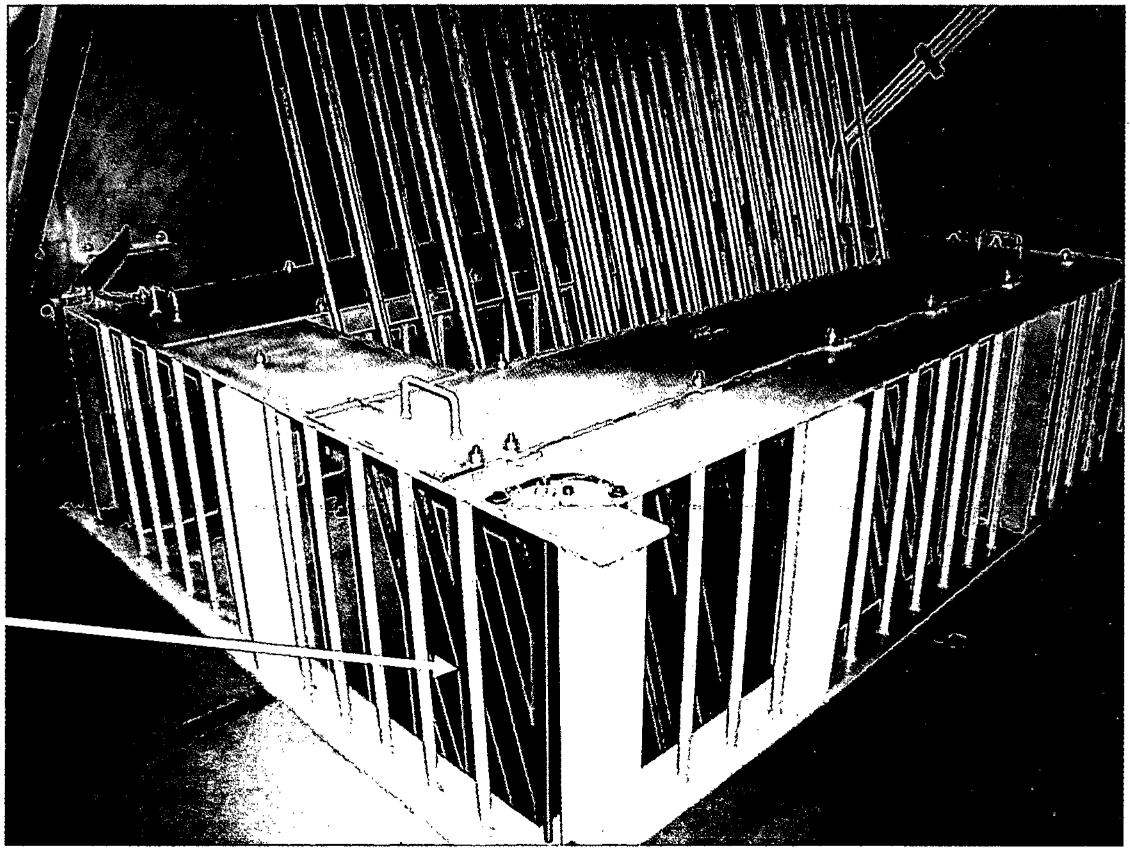
Incore Instrumentation Guide Tube Room



P-3.e.1-1 Door to Inactive Sump

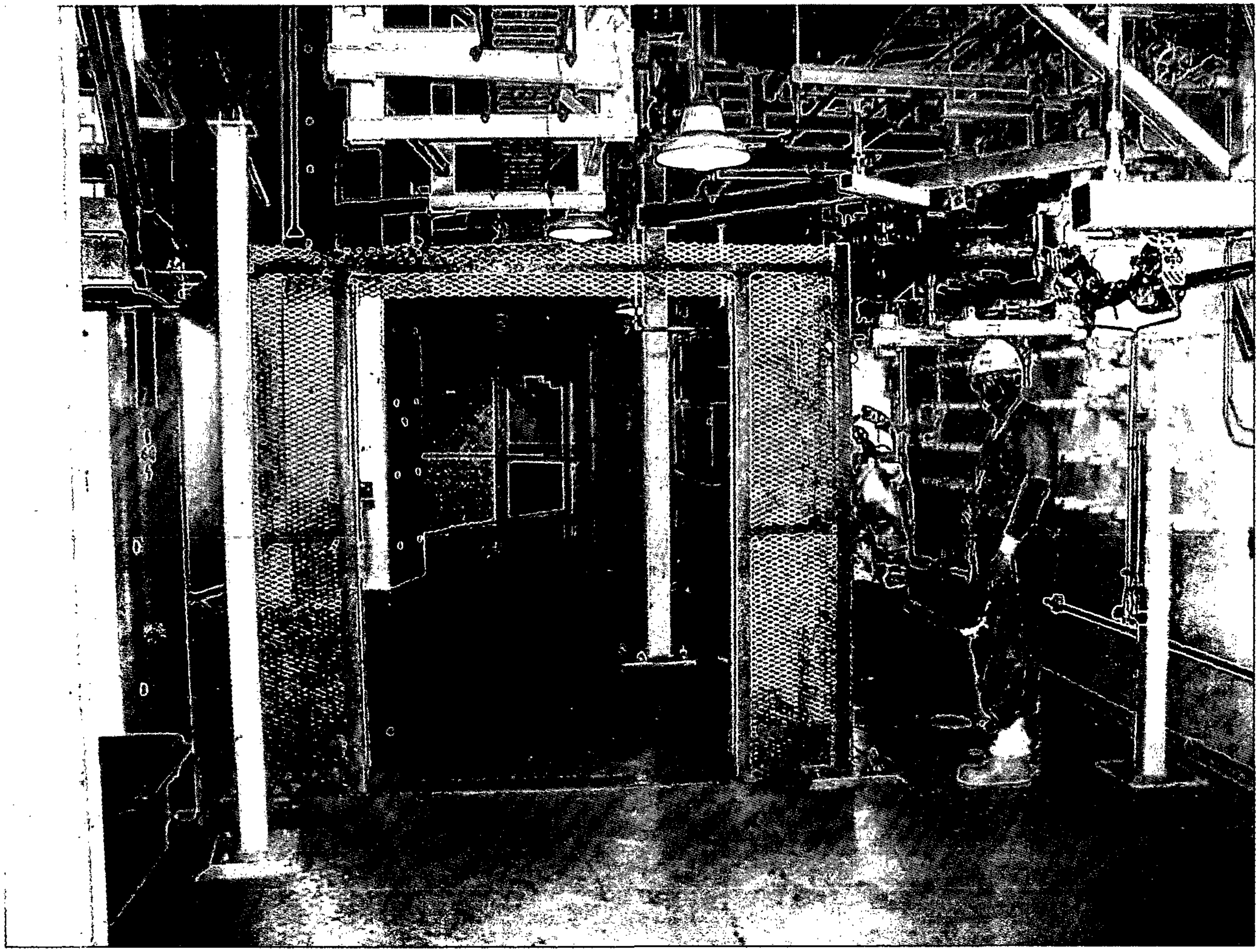
P-3.e.1-2 Drain to Inactive Sump

Modified

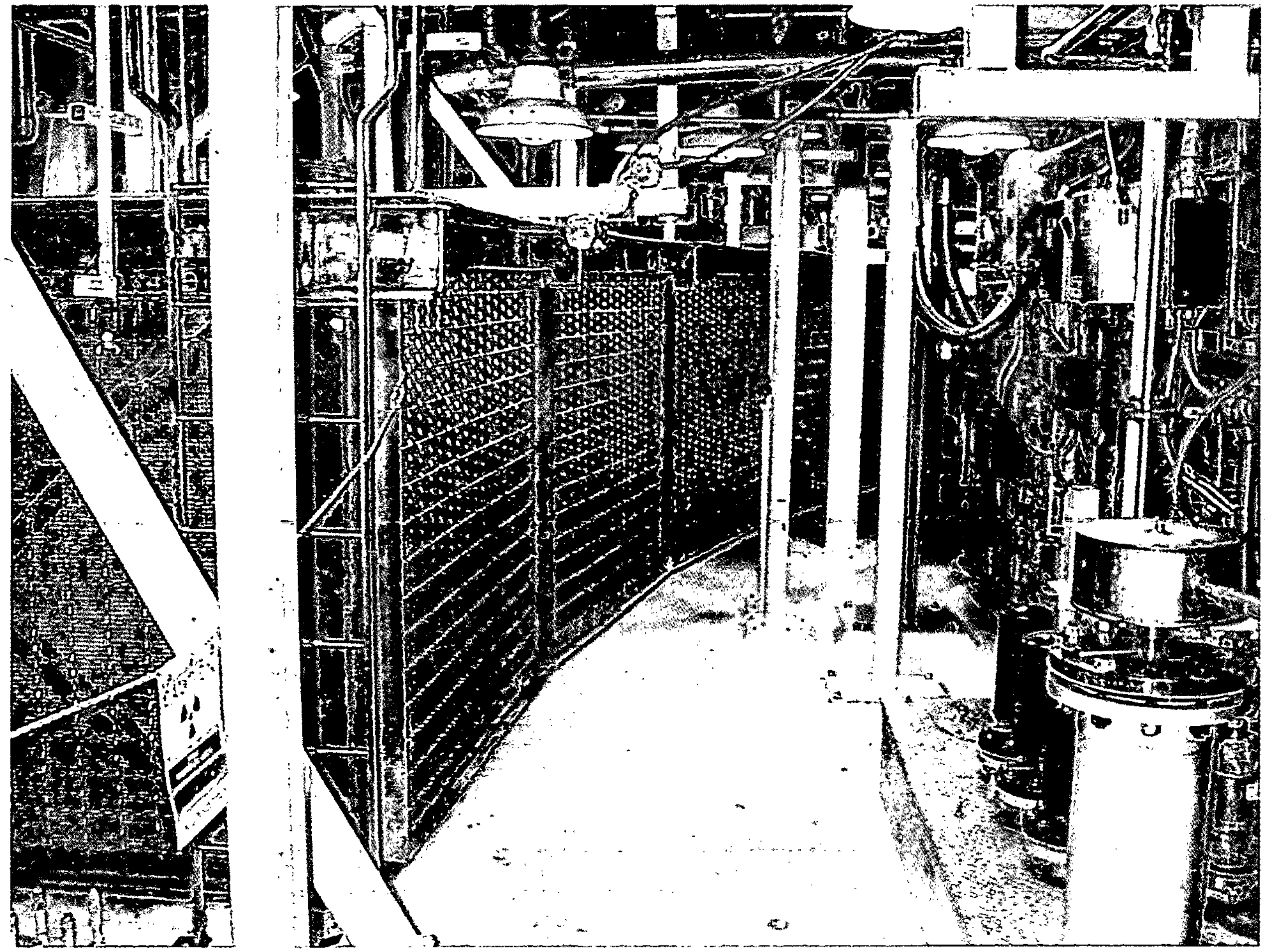


P-3.e.1-3 Drain to Inactive Sump

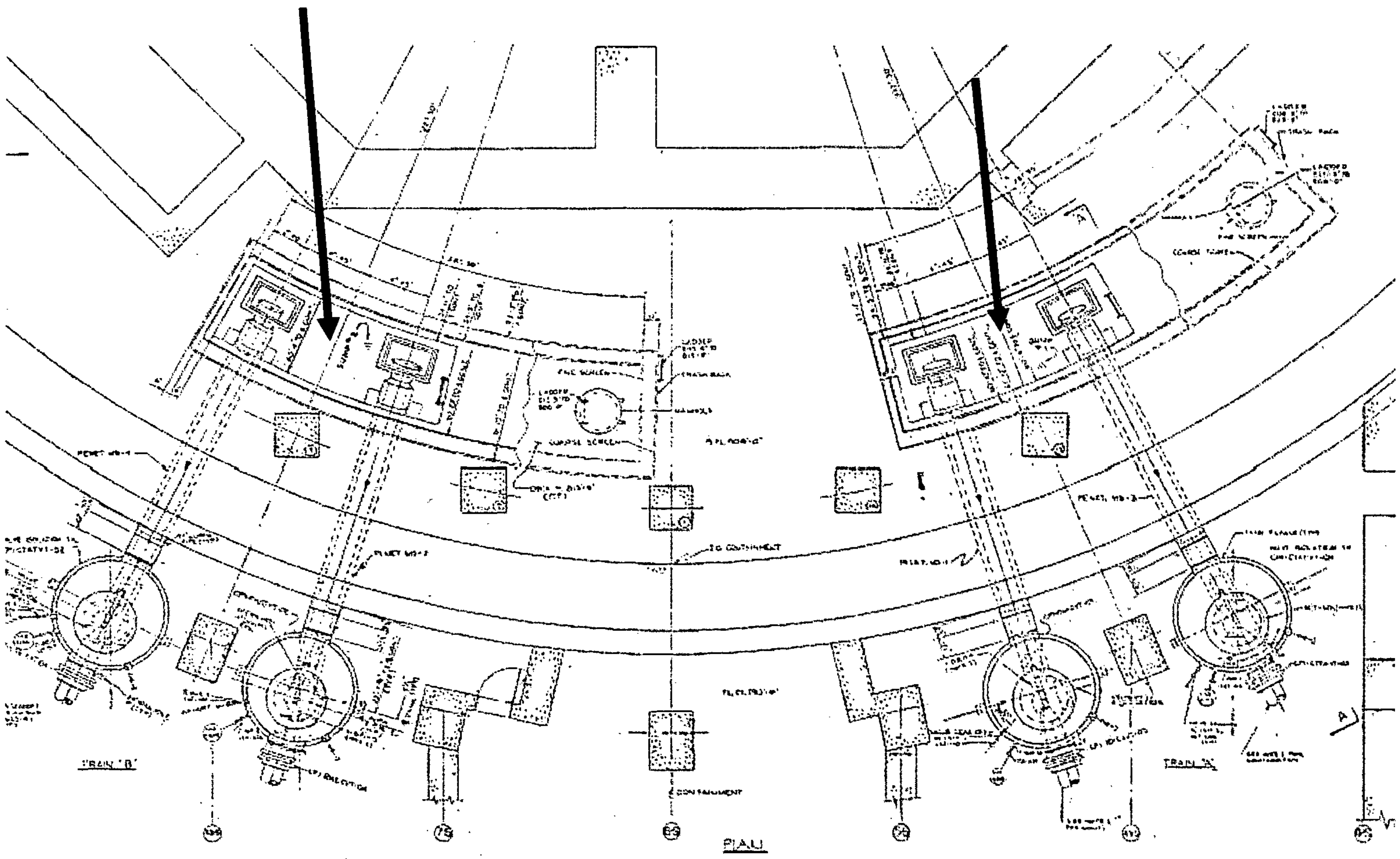
P-3.e.1-4 Wire Mesh Cage



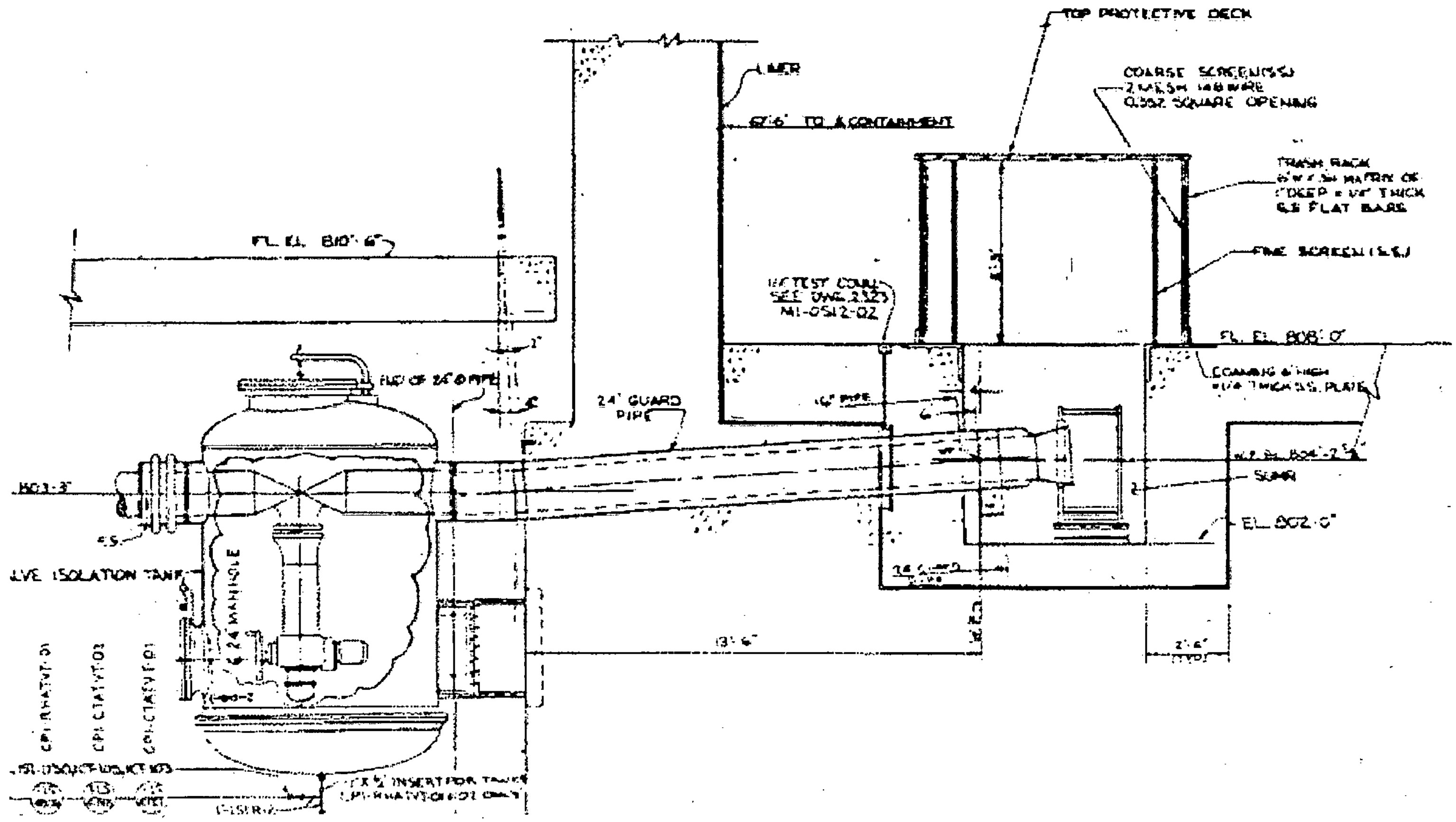
P-3.e.1-5 Unit 2 Tool Room



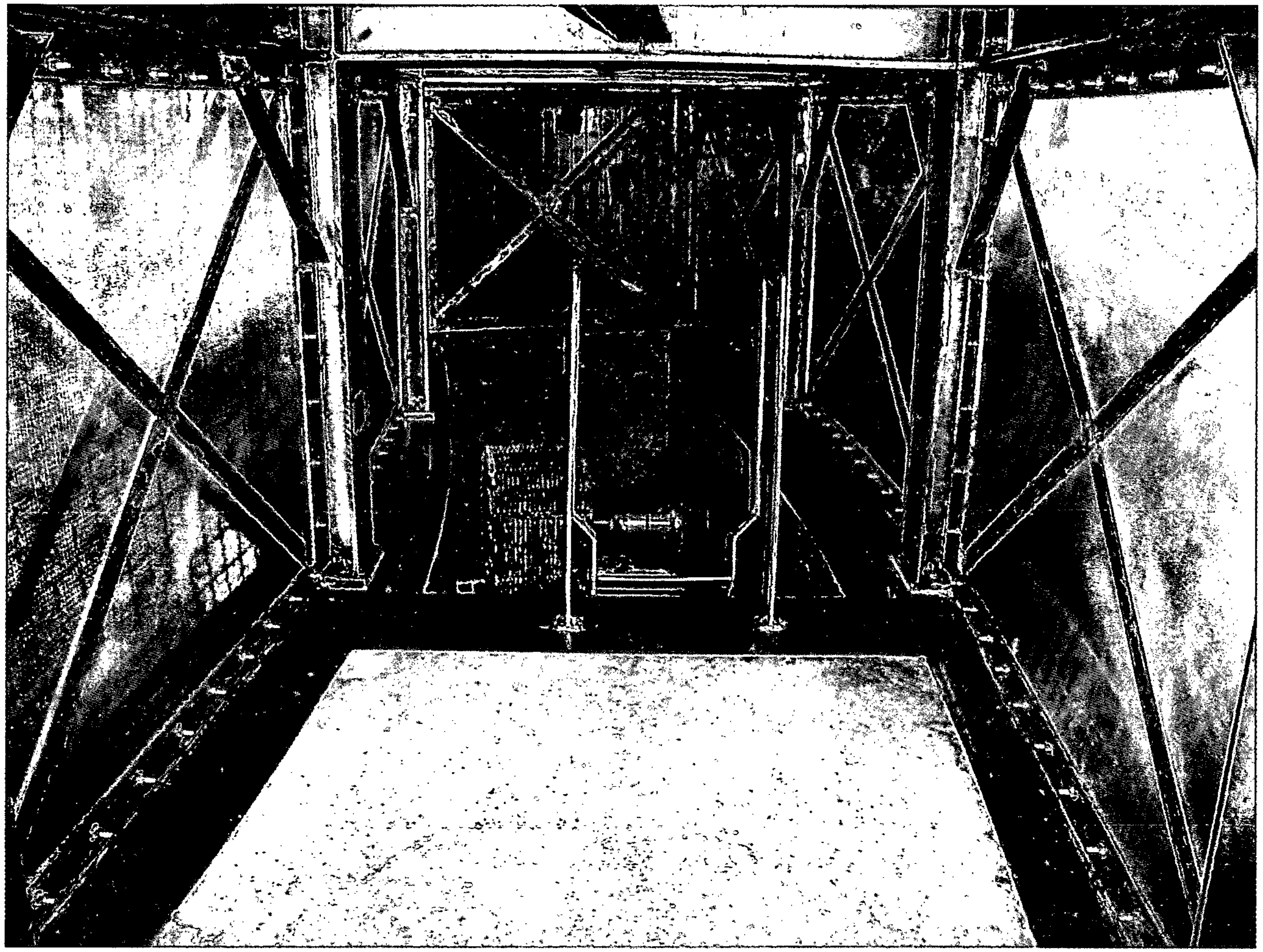
P-3.j.1-1 Original Sump Screens



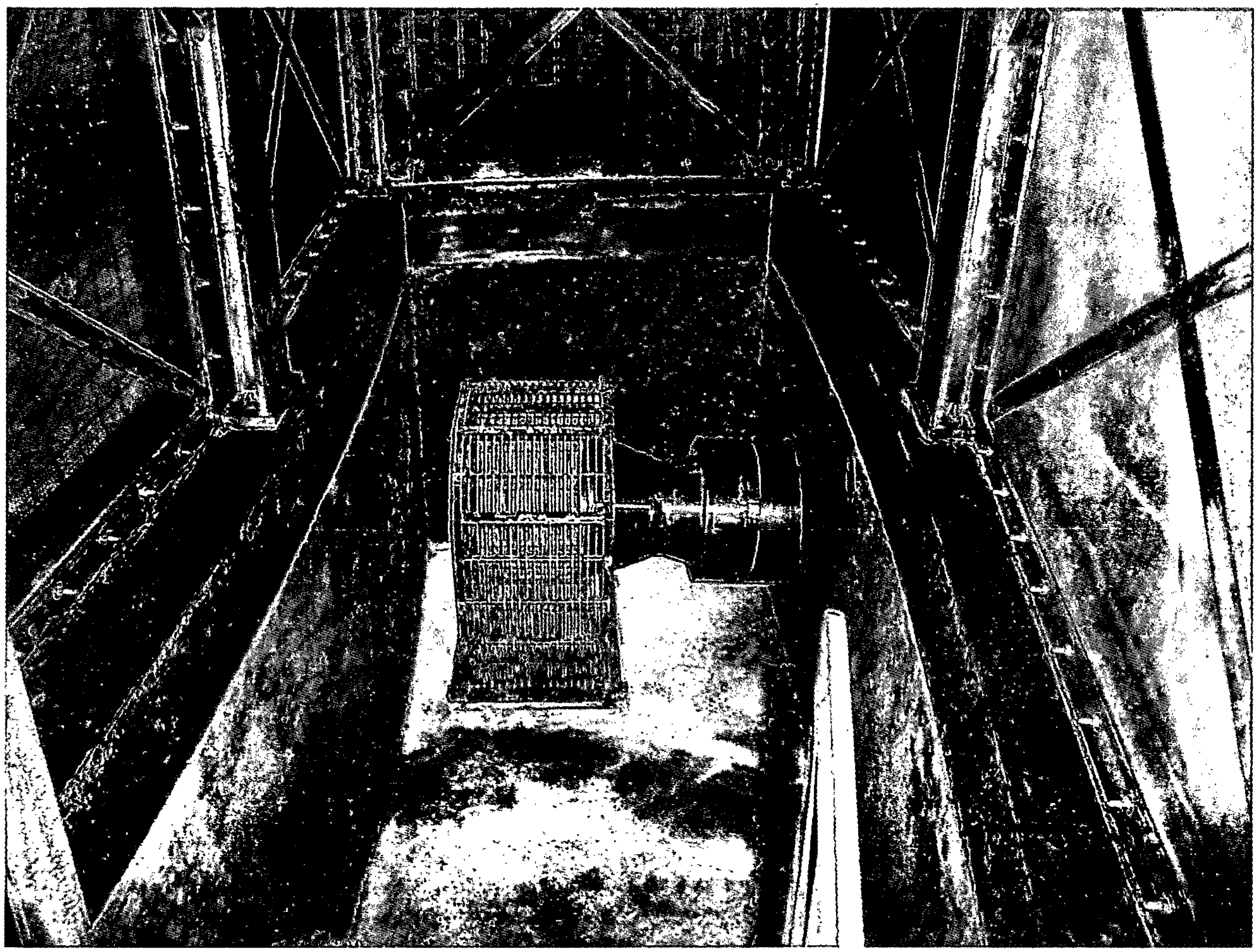
P-3.j.1-2 Emergency Sump Arrangement



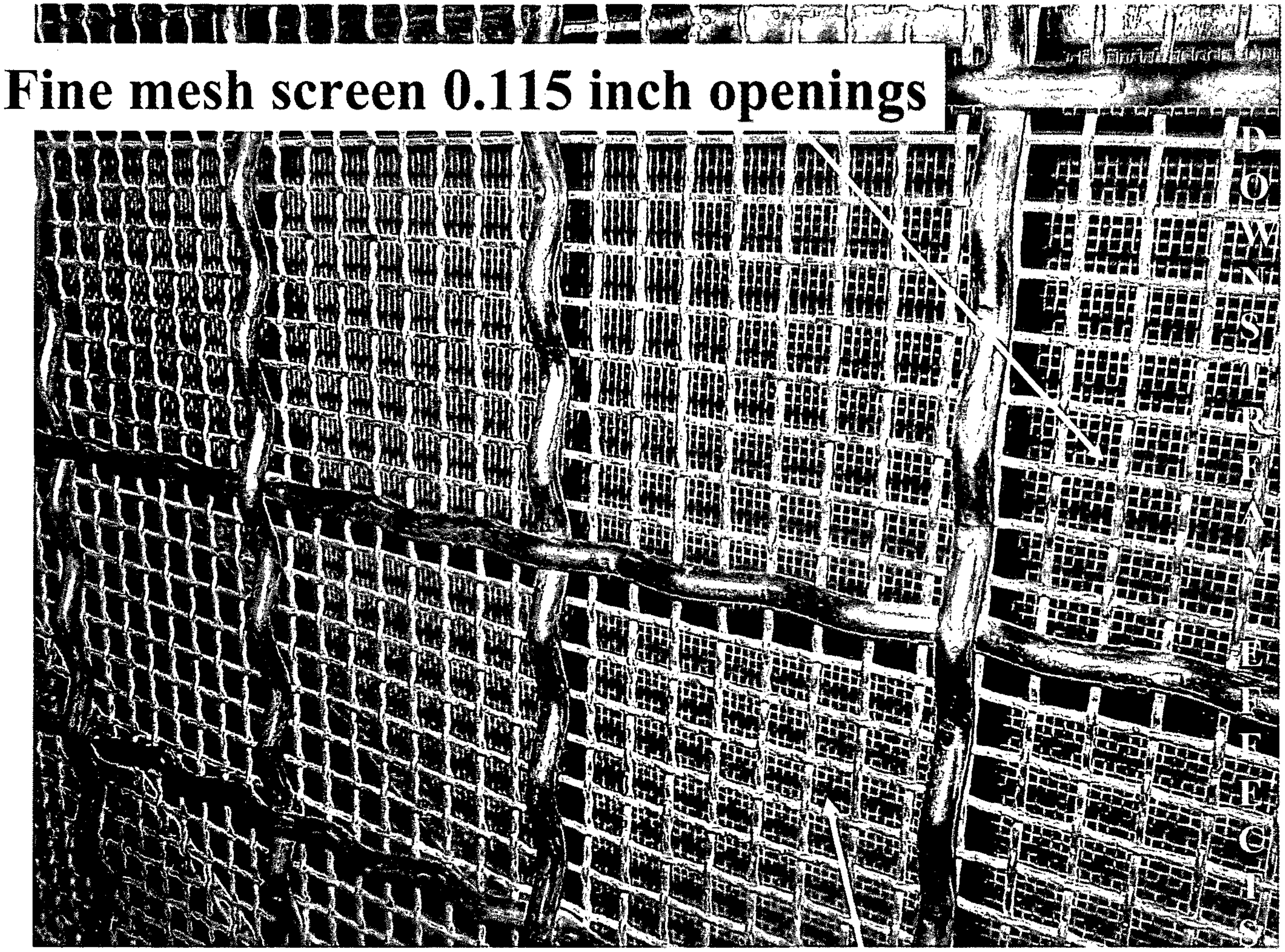
P-3.j.1-3 Emergency Sump Arrangement



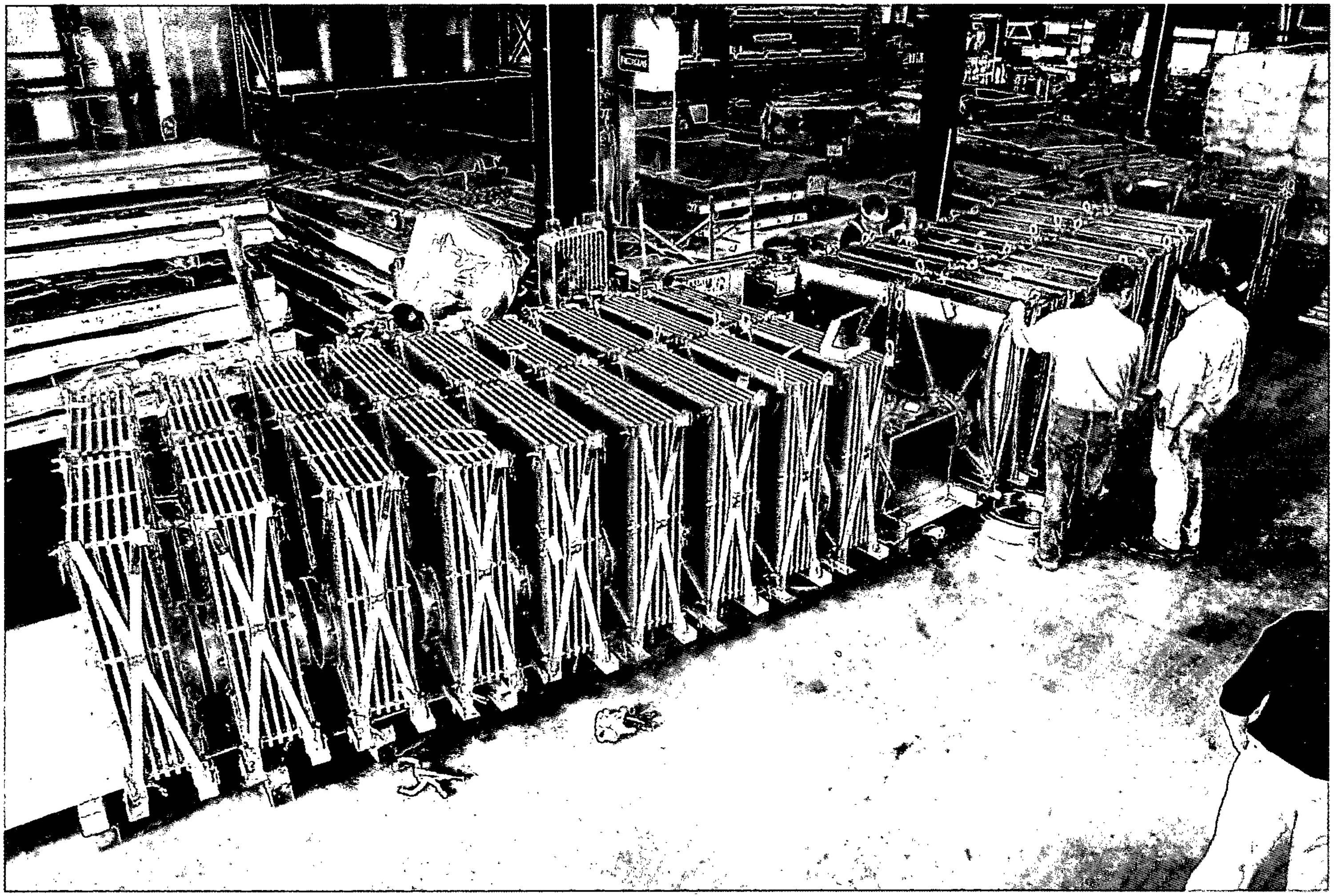
P-3.j.1-4 Inside Sump Screens



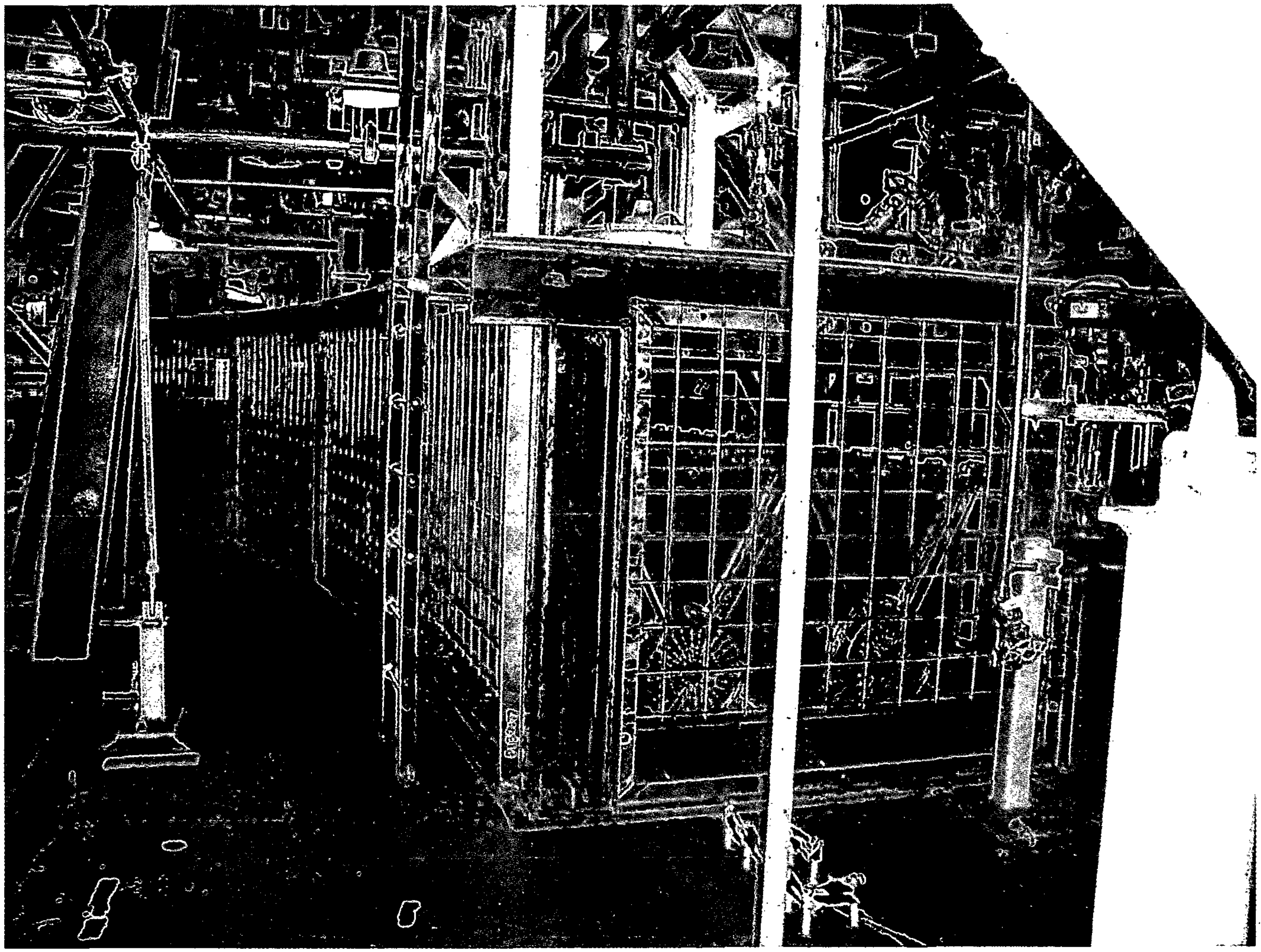
P-3.j.1-5 Vortex Suppressor



P-3.j.1-6 Original Sump Screens

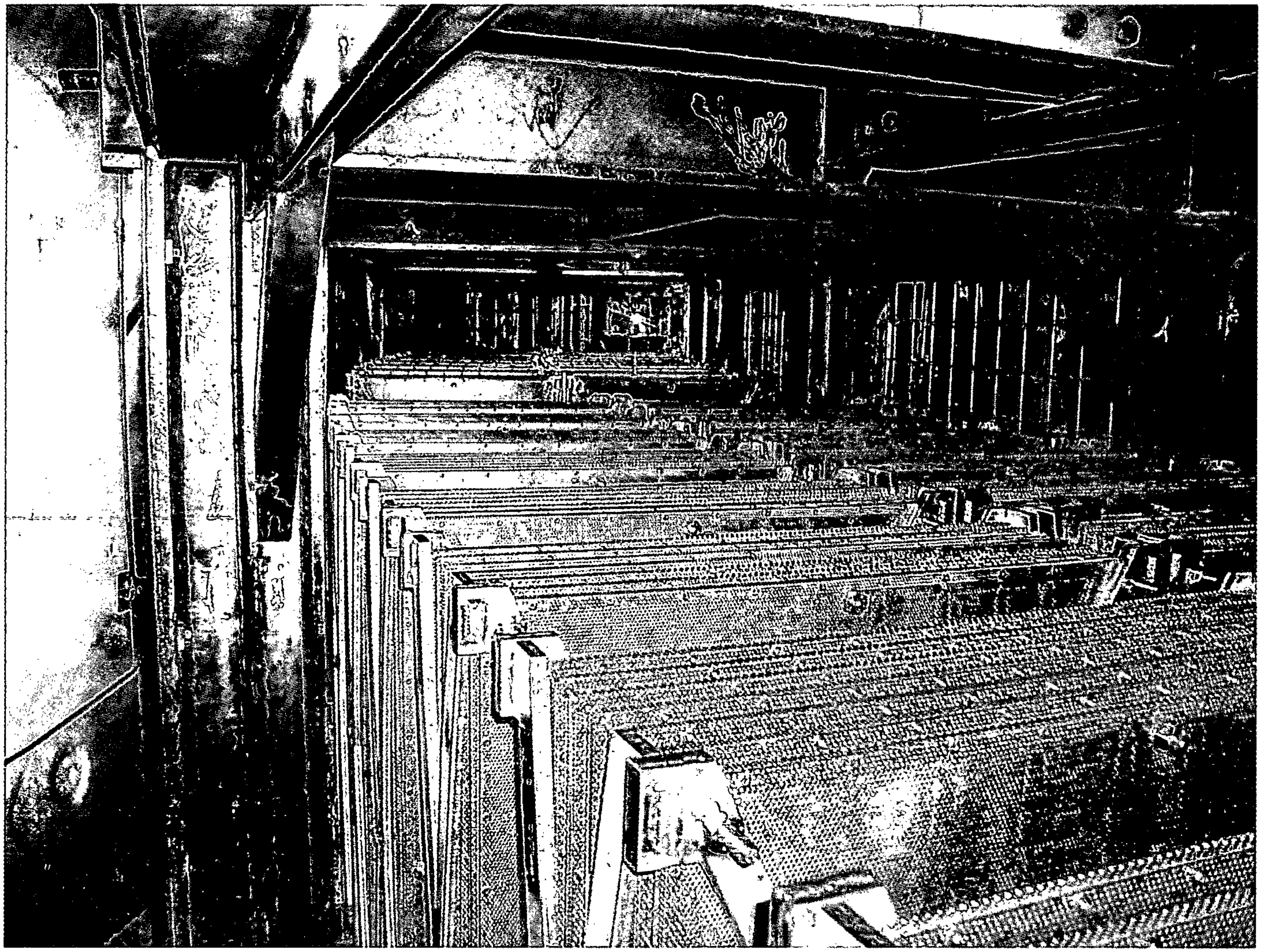


P-3.j.2-1 Shop Assembly

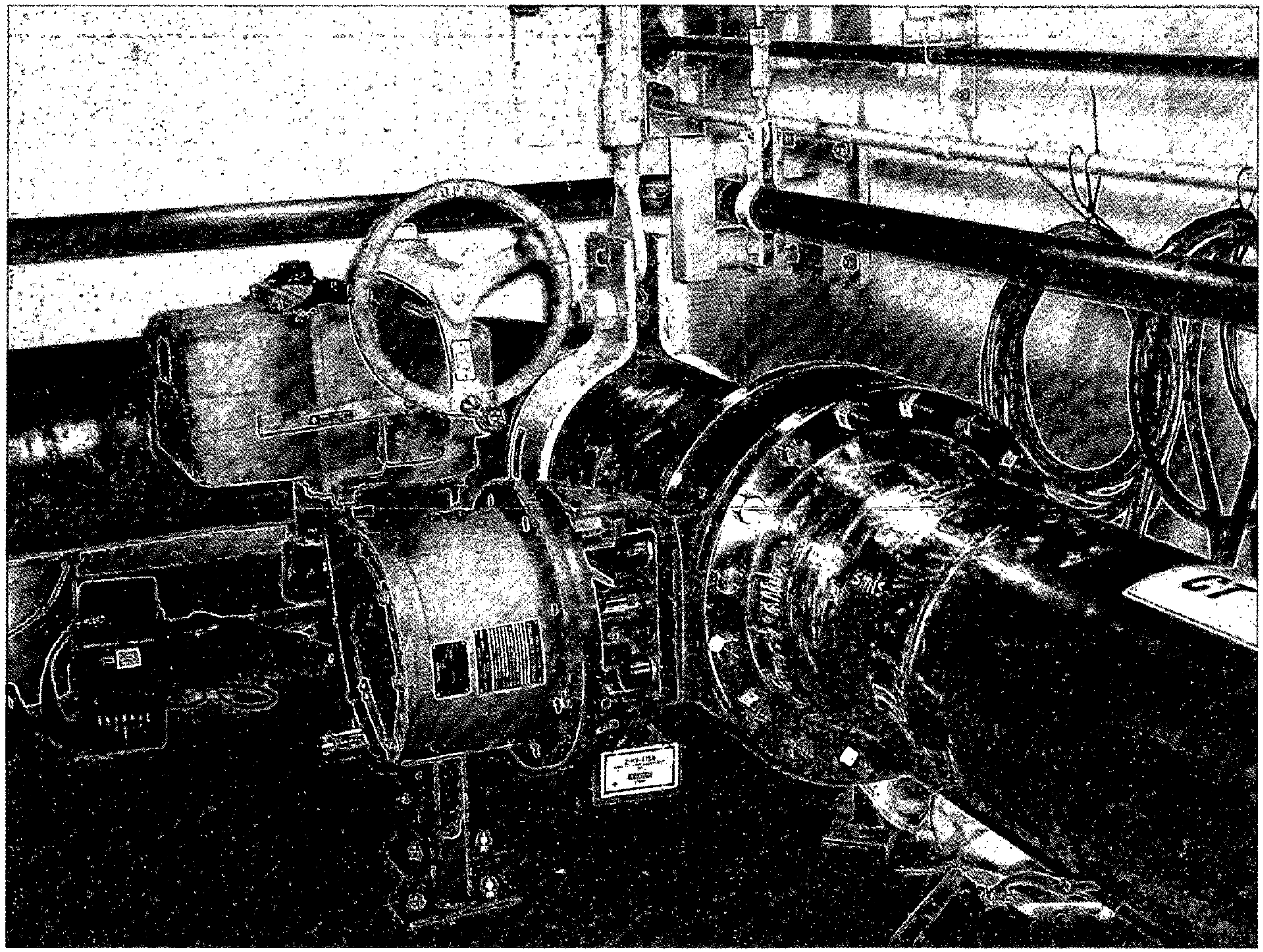


P-3.j.2-2 New Sump Strainer

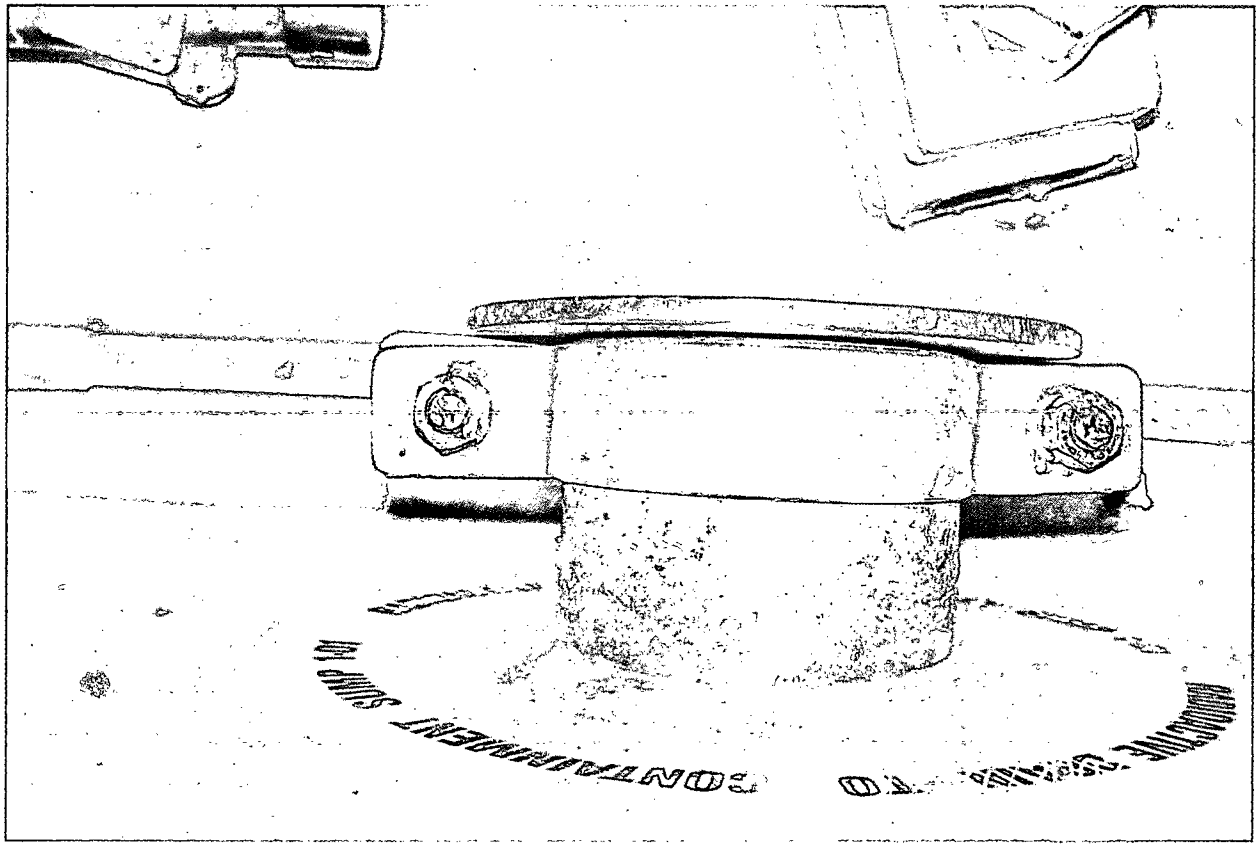
P-3.j.2-3 New Sump Strainer



P-3.j.2-4 New Sump Strainer

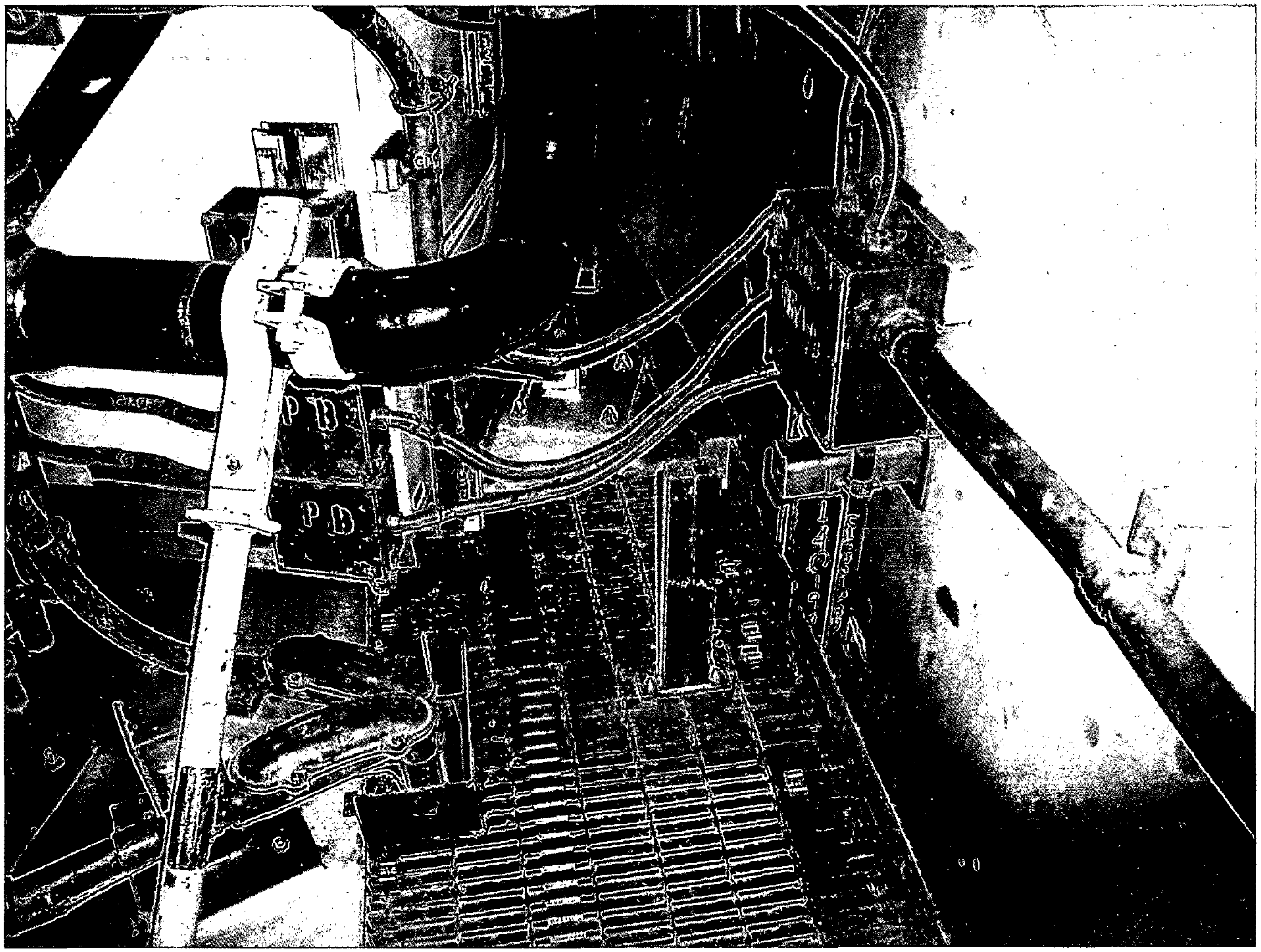


P-3.J.3-1 MOV Modification



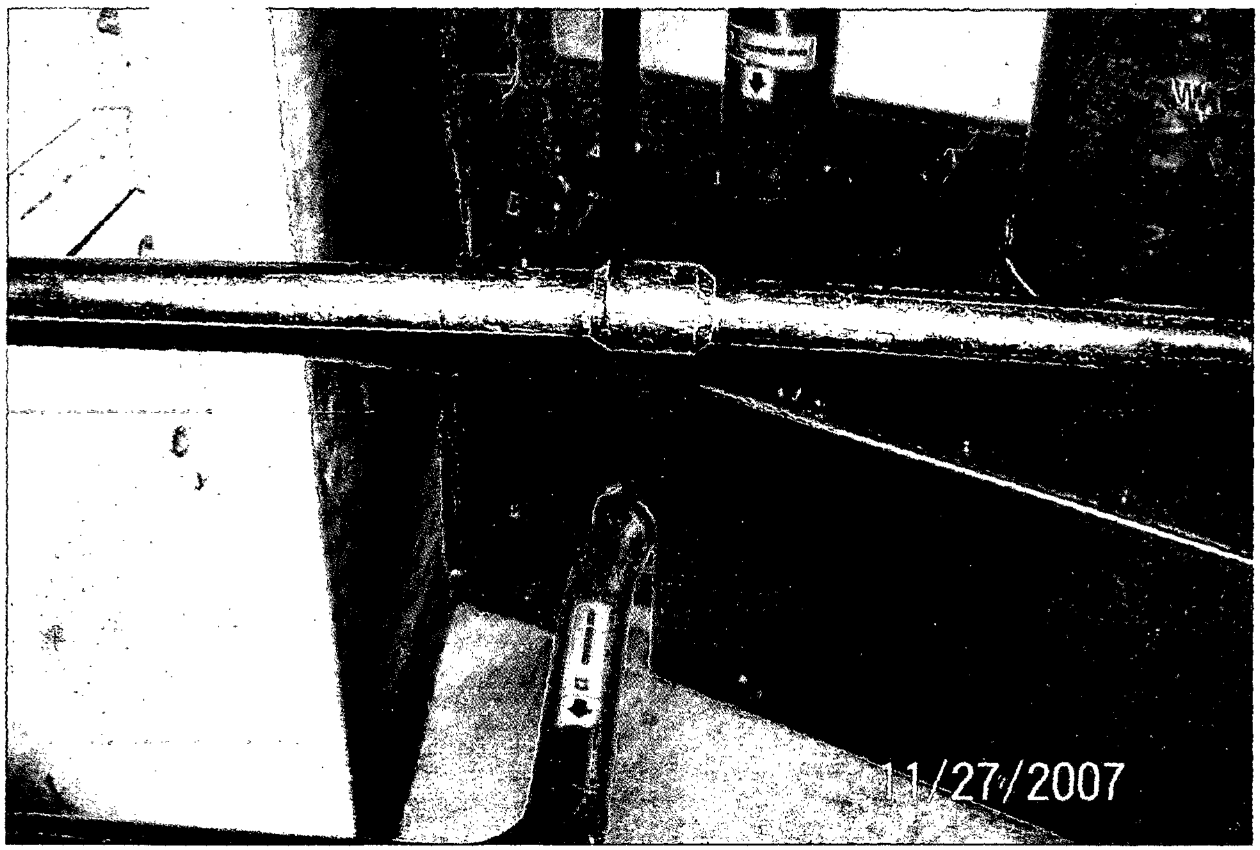
P-3.J.3-2 Equipment Drain Capped

P-3.J.3-3 Normal sump drain cover

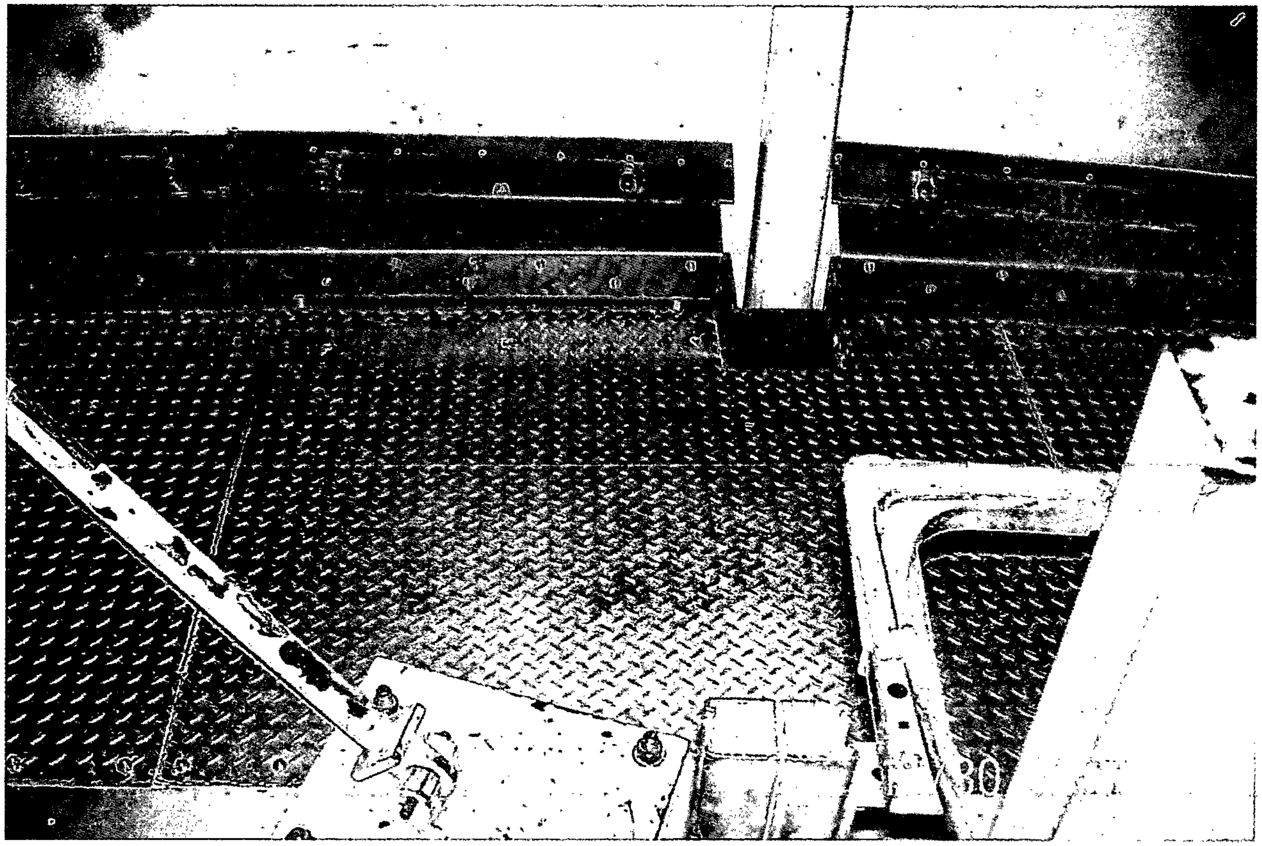


P-3.J.3-4 El. 832 Grating and Gap

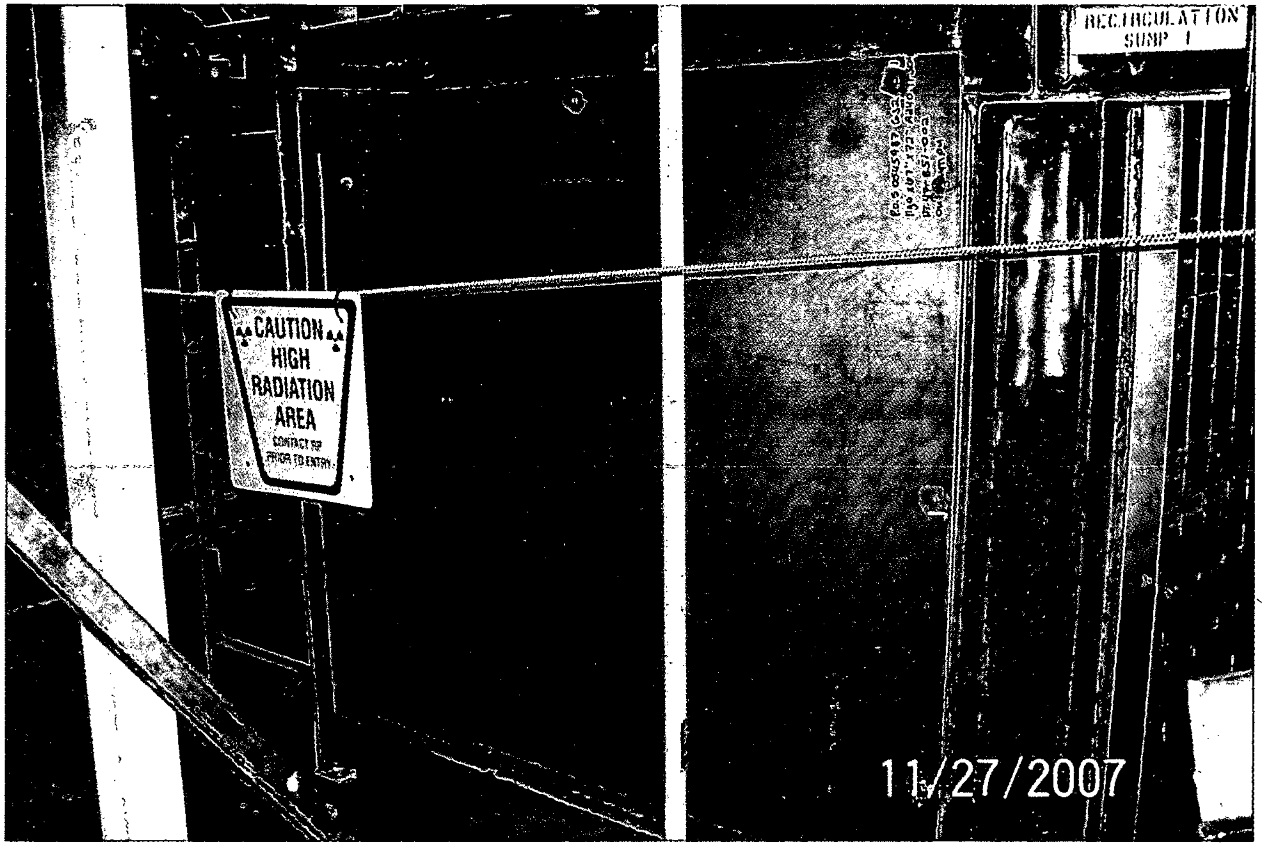
P-3.J.3-5 Flashing Mod



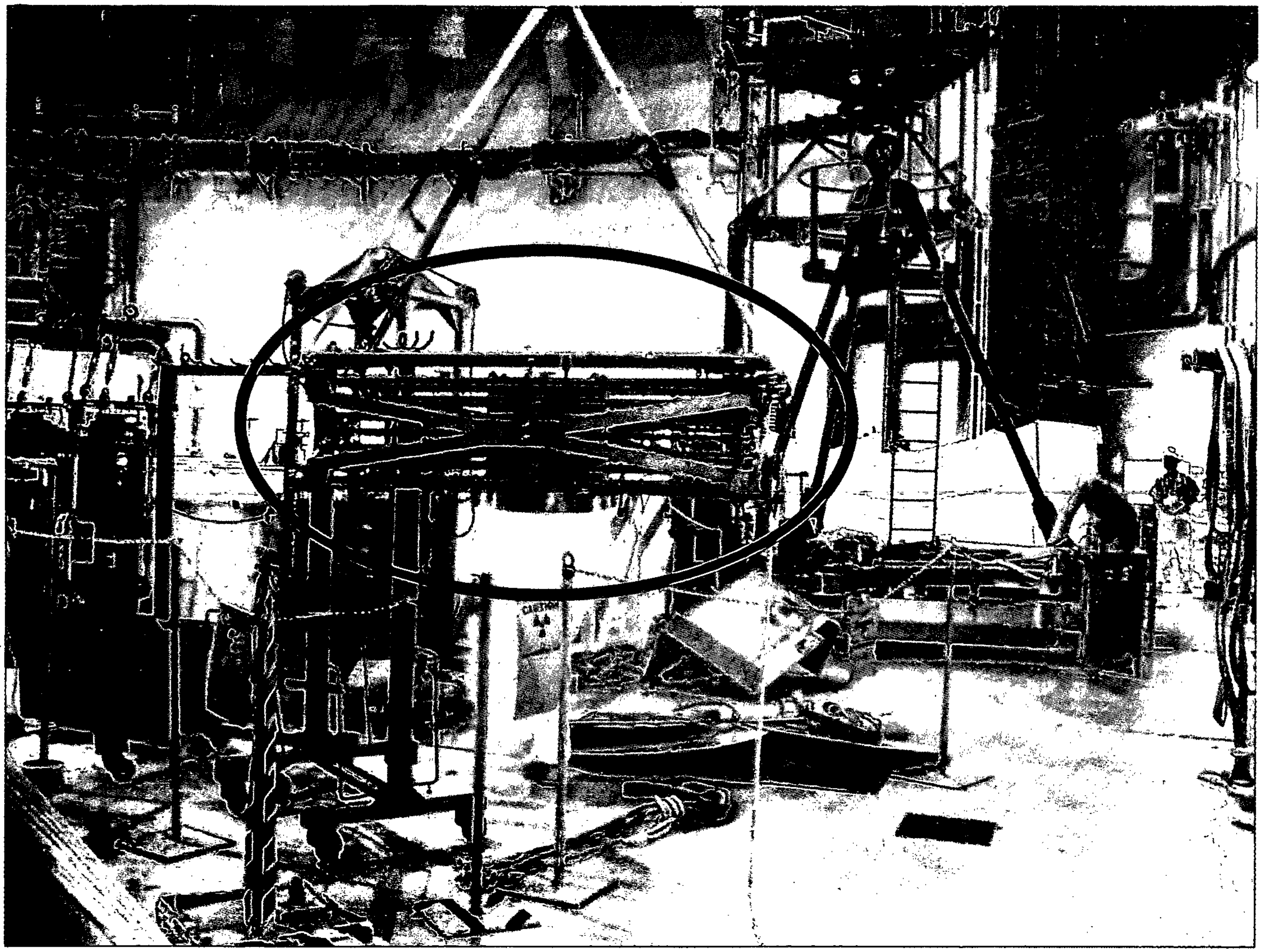
P-3.J.3-6 Flashing Mod



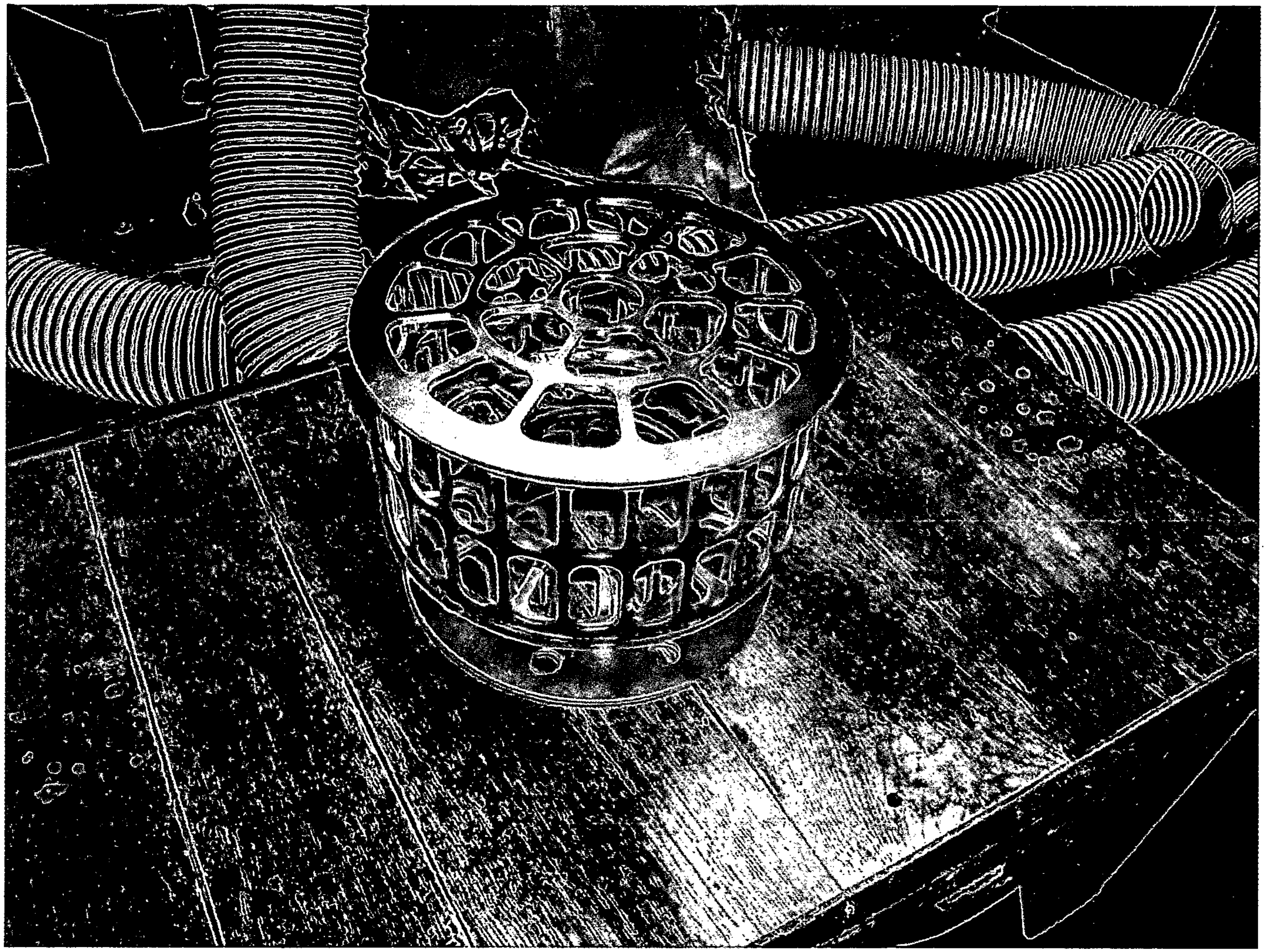
P-3.J.3-7 Flashing Mod



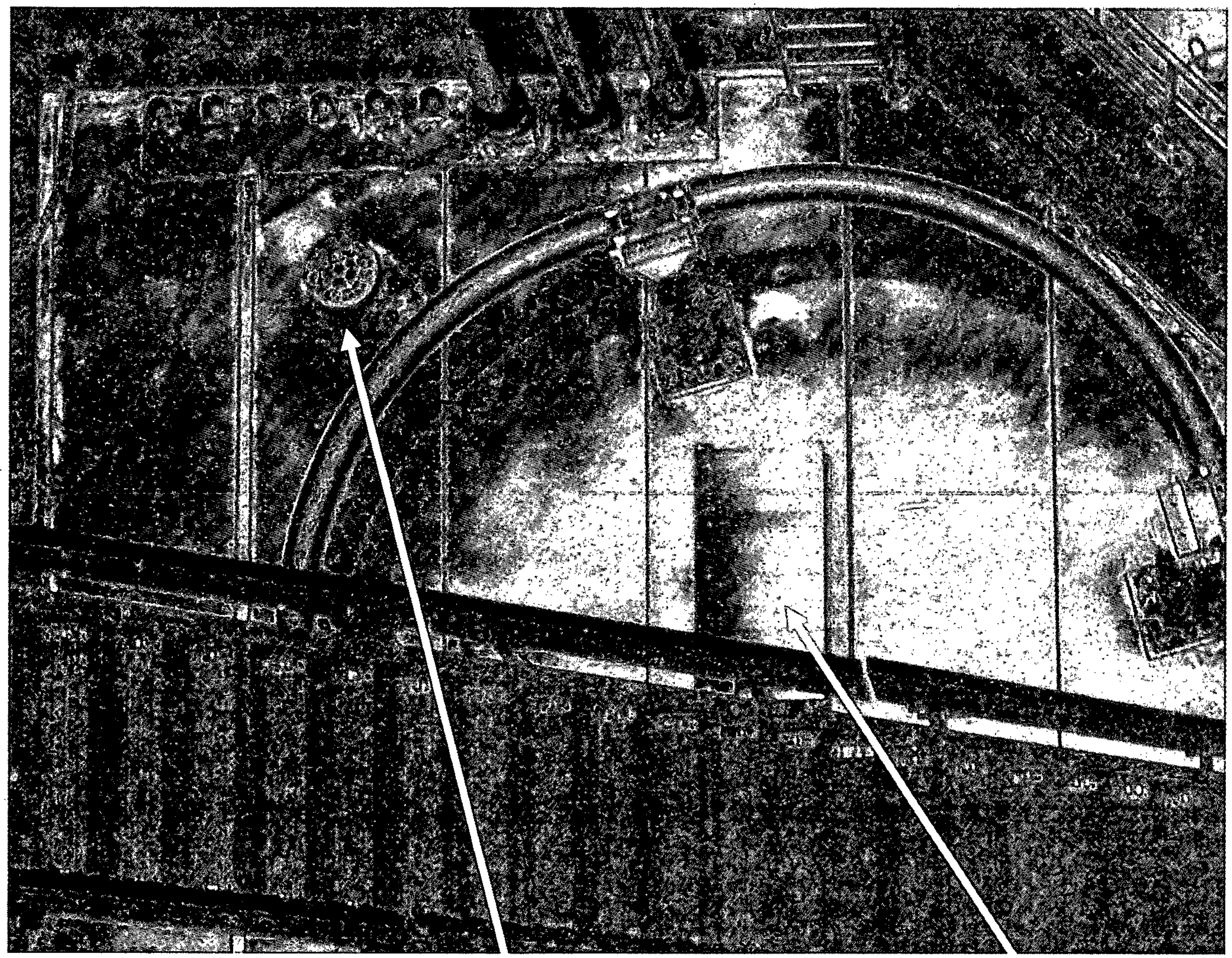
P-3.J.3-8 Diverter Modification



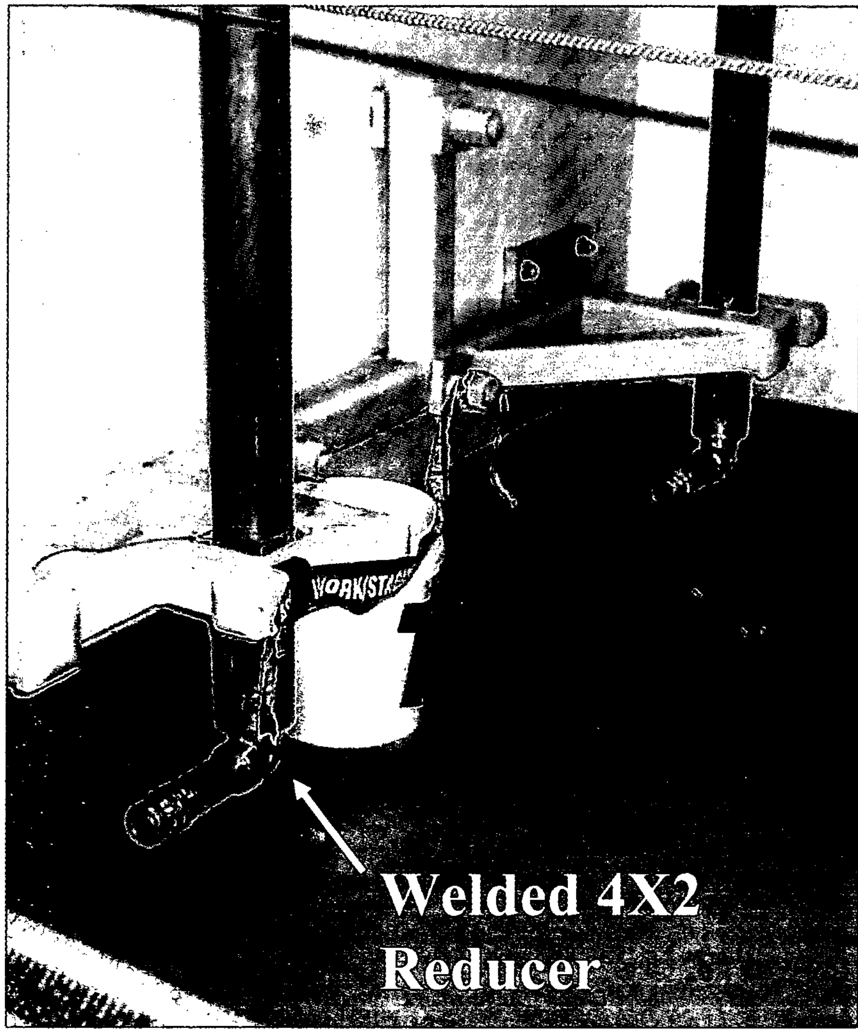
P-3.I.2-1 Drain Strainer

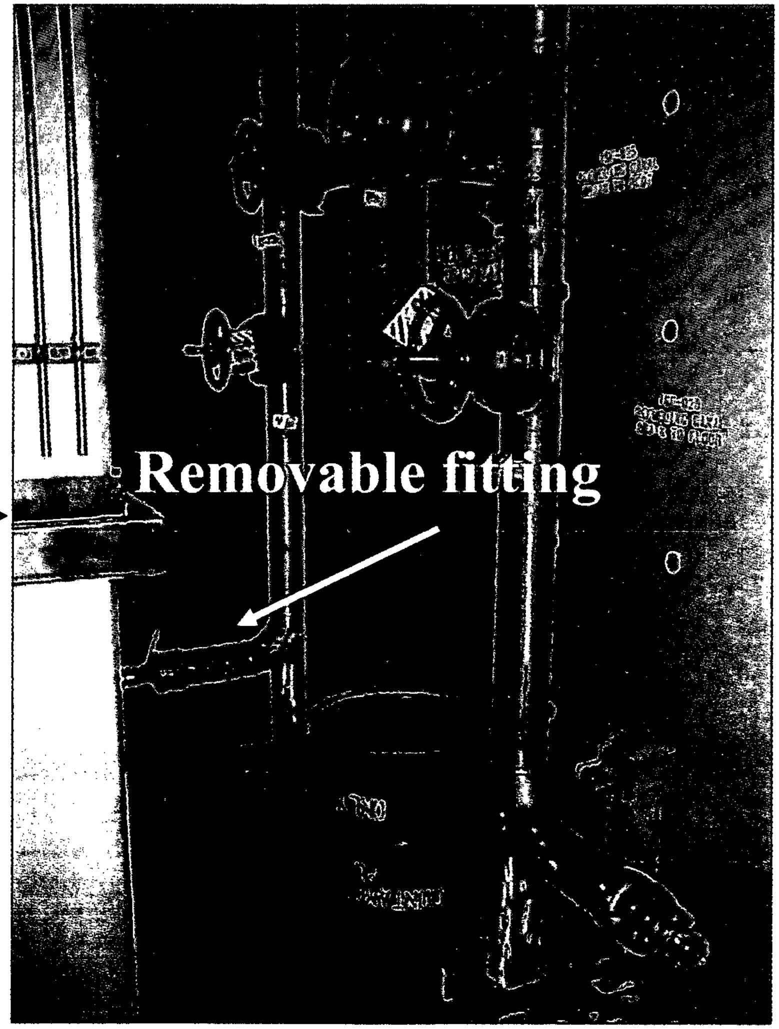


P-3.I.2-2 Six Inch Drain Debris Screen

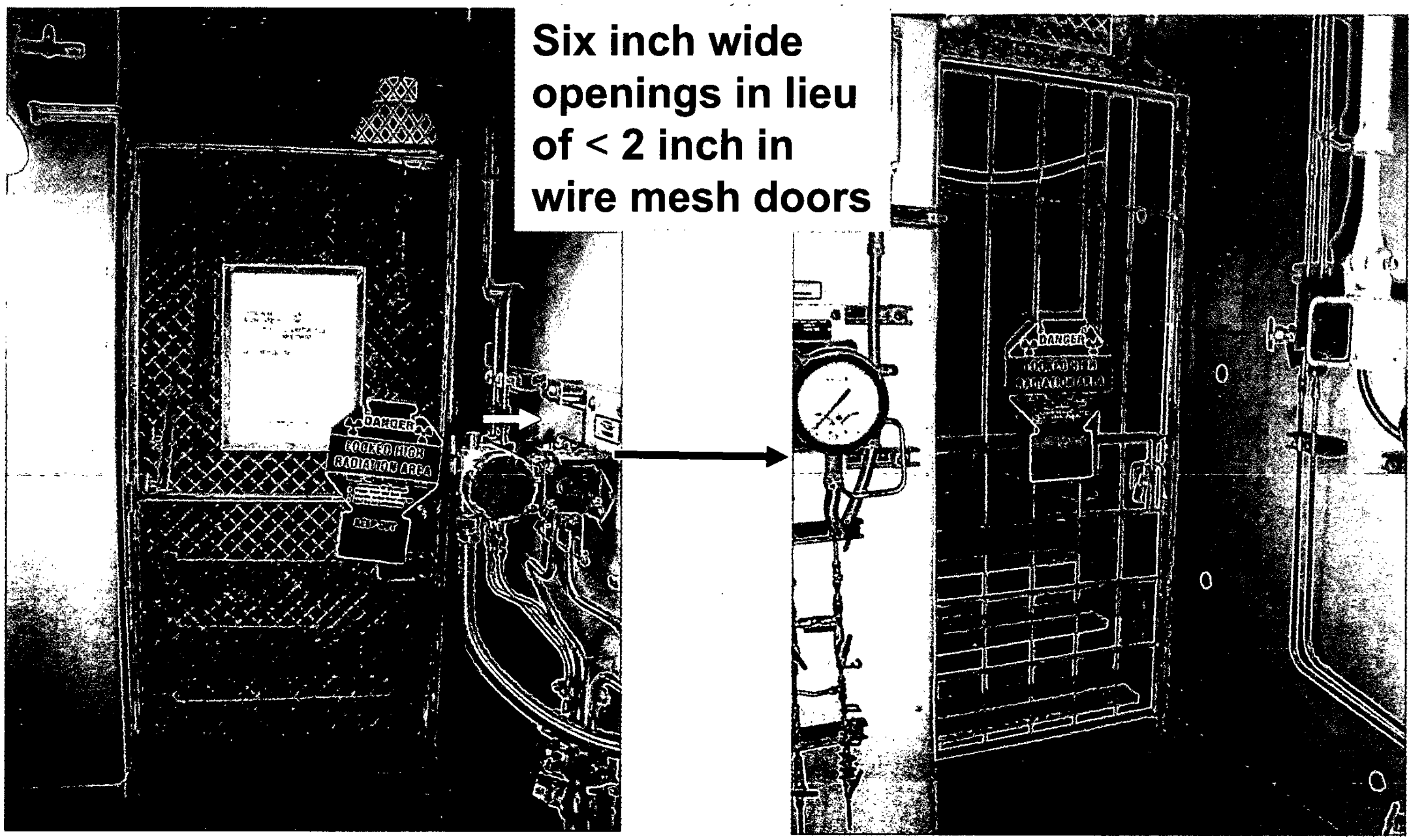


P-3.I.2-3 Debris Screen and Drain Strainer



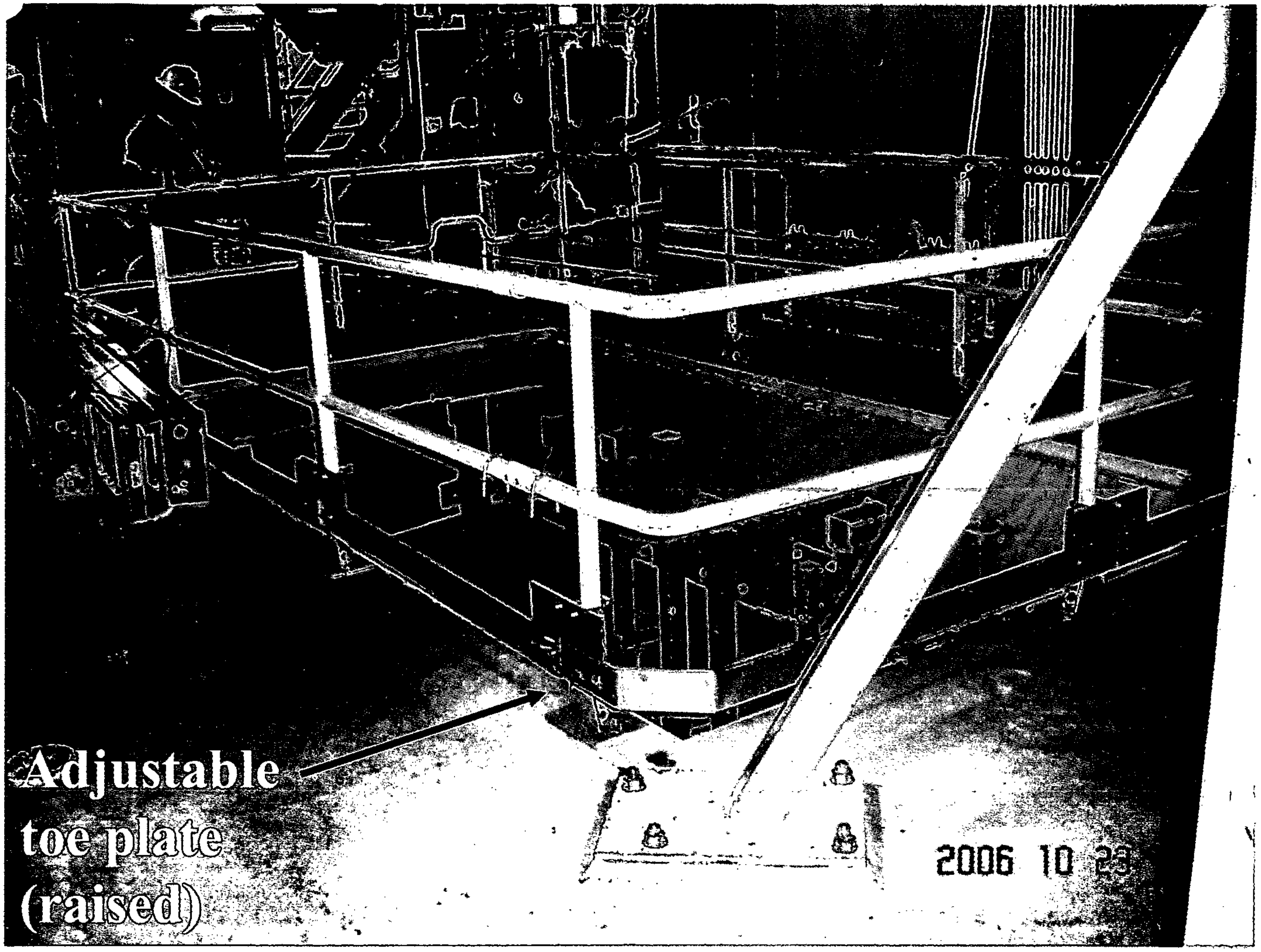


P-3.I.2-4 Drain Modification

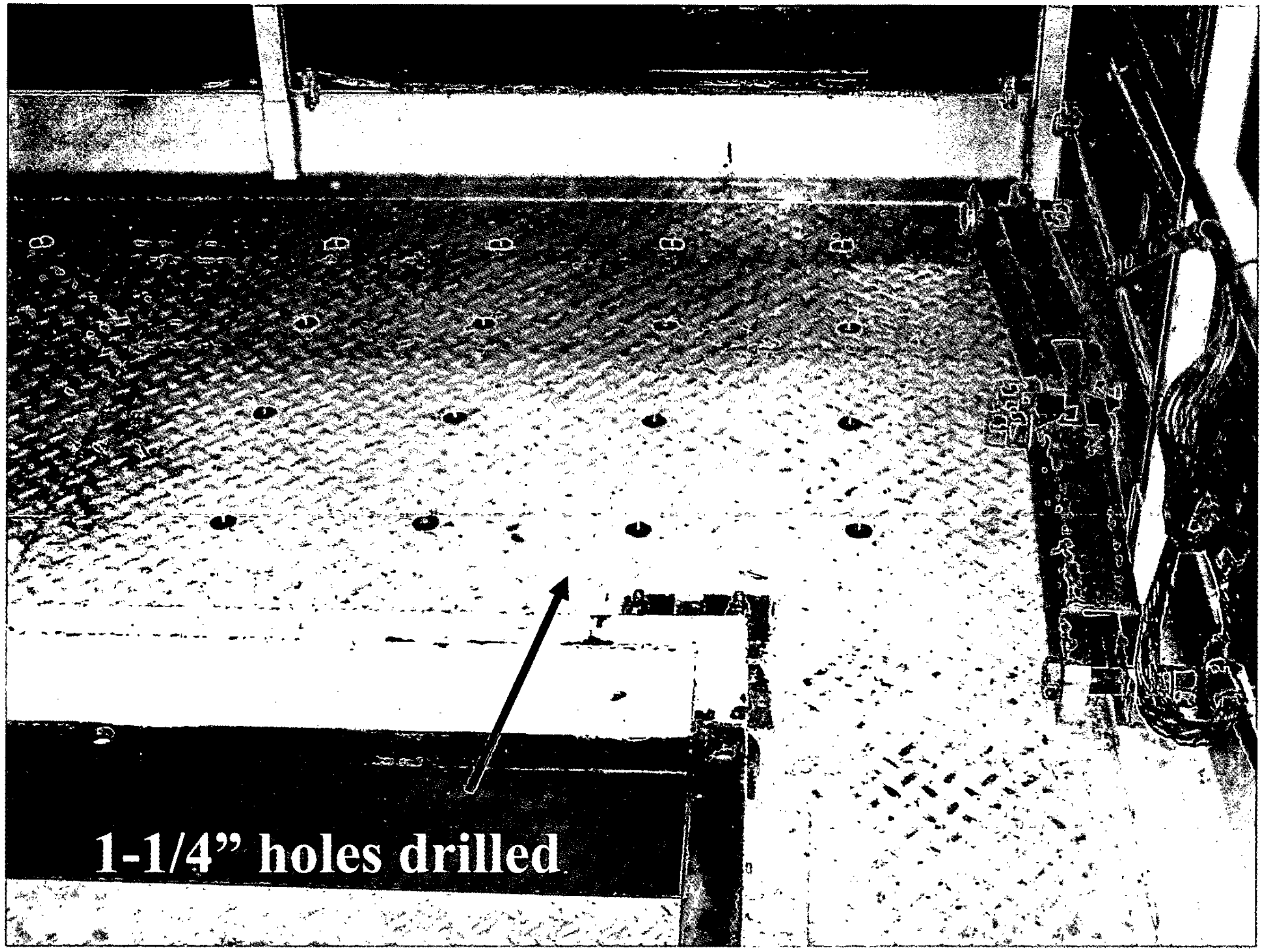


P-3.I.3-1 Wire Mesh Door Mod

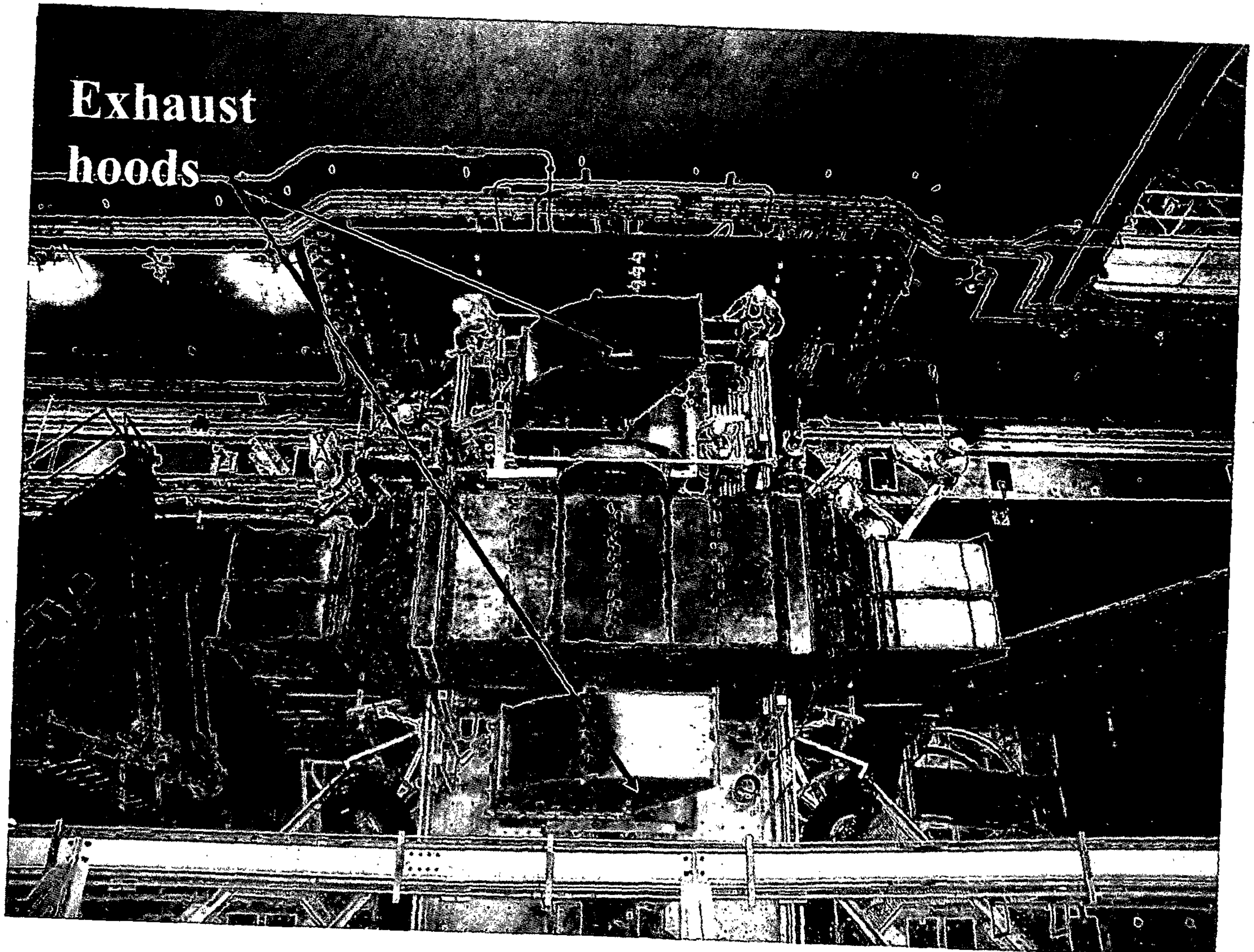
P-3.I.3-2 Shield Wall Modification



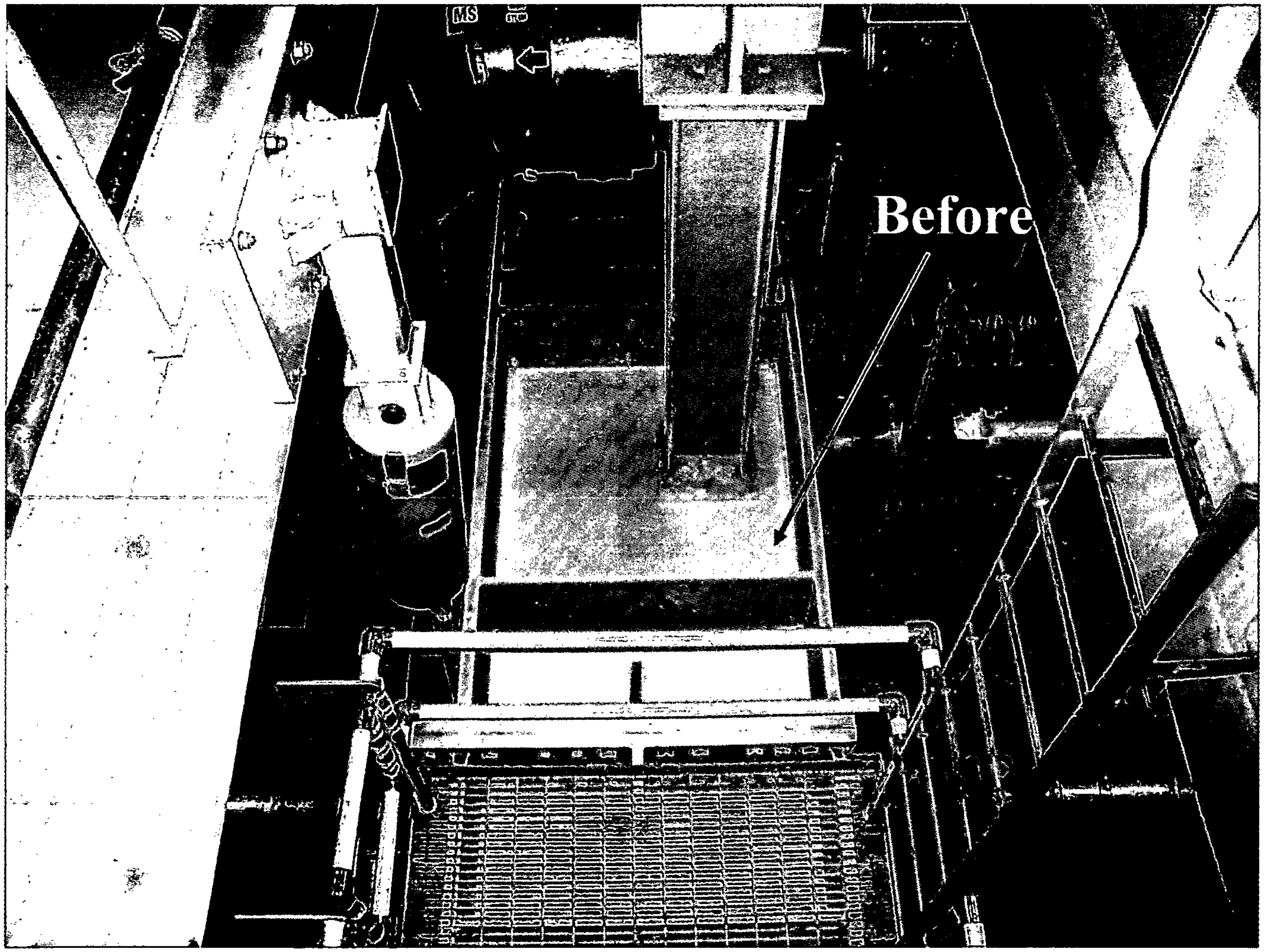
P-3.I.3-3 Toe Plate Modification



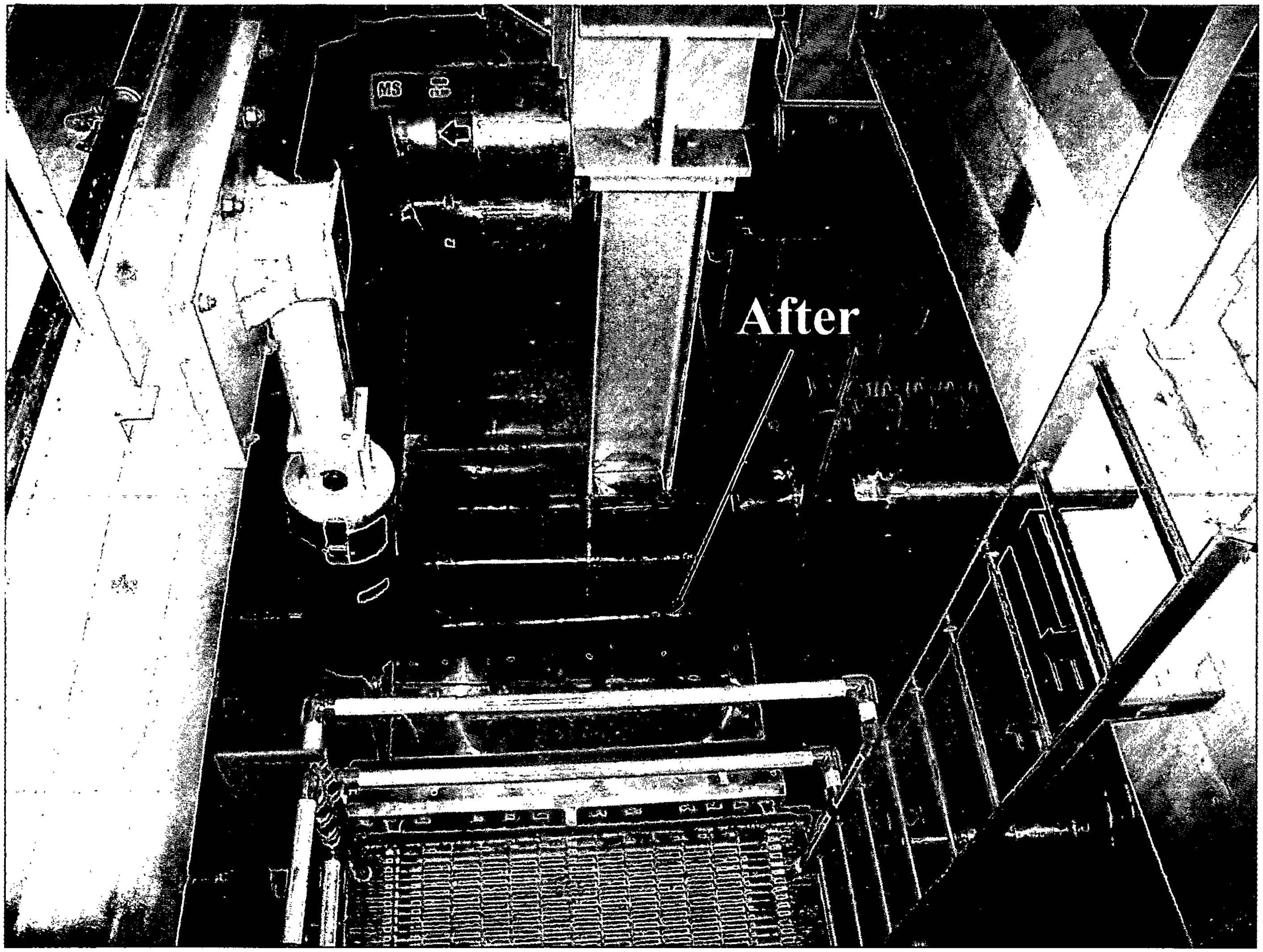
P-3.I.3-4 Platform Modification



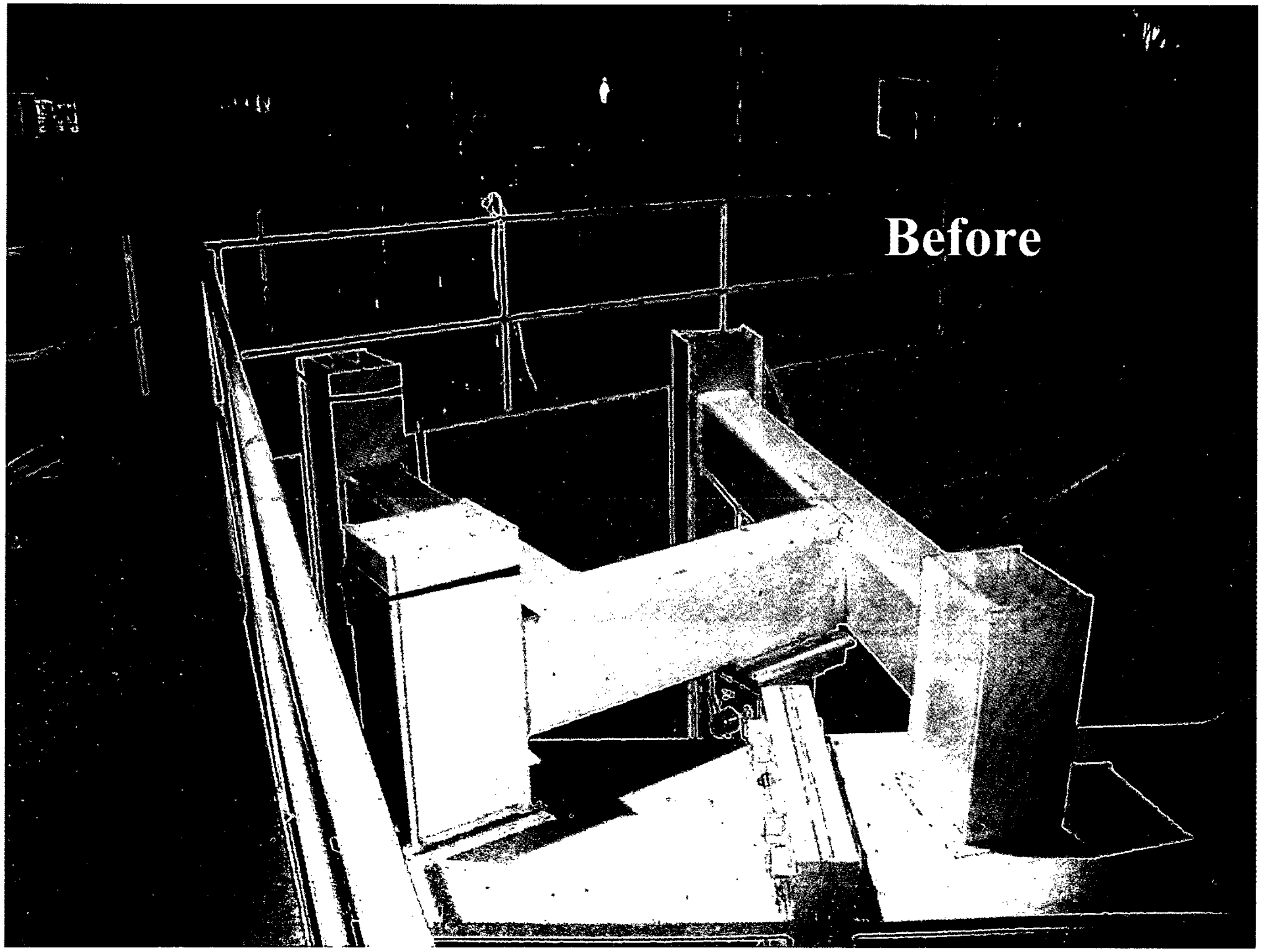
P-3.I.3-5 Ventilation Exhaust Modification



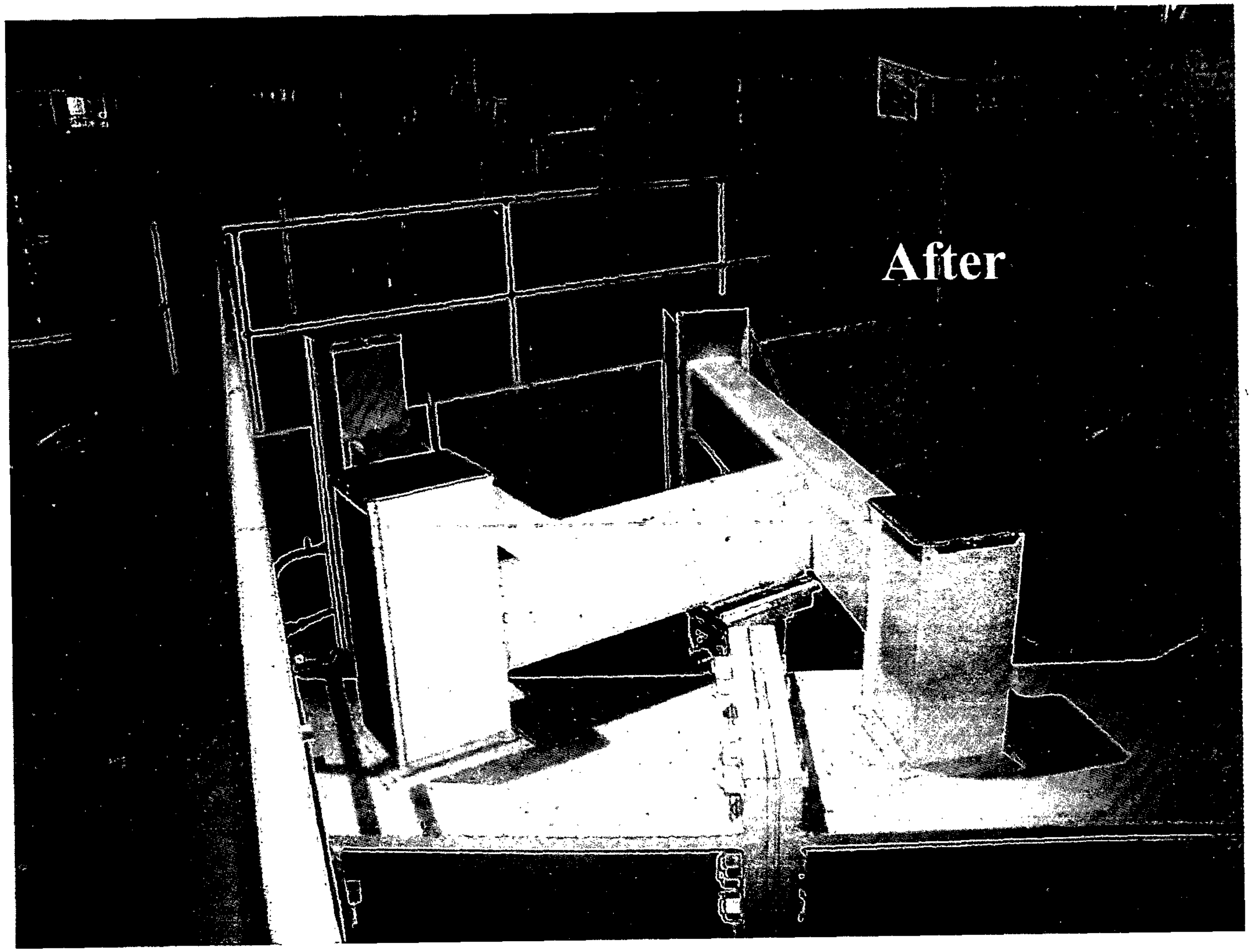
P-3.I.3-6 Whip Restraint



P-3.I.3-7 Whip Restraint Flashing



P-3.I.3-8 Box Beams



P-3.I.3-9 Newel Caps