U. S. NUCLEAR REGULATORY COMMISSION

REGION III

Reports No. 50-254/87028(DRS); 50-265/87028(DRS)

Docket Nos. 50-254; 50-265 Licenses No. DPR-29; DPR-30

Licensee: Commonwealth Edison Company
P. O. Box 767
Chicago, Illinois 60690

Facility Name: Quad Cities Station, Units 1 and 2

Inspection At: Quad Cities Station, Cordova, Illinois
Sargent and Lundy Office, Chicago, Illinois
Impell Corporation Office, Lincolnshire, Illinois
U. S. NRC, Headquarters, Bethesda, Maryland
U. S. NRC, Region III, Glen Ellyn, Illinois

Inspection Conducted: September 14, 1987, at NRC Headquarters
October 8-9 and November 4-5, 1987, at Quad Cities
December 9, 1987 and January 26-28, 1988, at Sargent and Lundy
January 11 and January 28, 1988, at Impell
February 11, 1988, at Region III

Inspector: J. A. Gavula — March 18, 1988 — Date

Approved By: D. H. Danielson, Chief, Materials and Processes Section — 3/18/88 — Date

Inspection Summary

Inspection from September 14, 1987 through March 4, 1988 (Report No. 50-254/87028(DRS); No. 50-265/87028(DRS))

Areas Inspected: Special safety inspection of snubber surveillance and functional testing (70370), non-licensed training (41400) and licensee action on previously identified items (92700).

Results: Two apparent violations were identified (failure to accomplish activities in accordance with documented drawings - Paragraphs 2.a and 2.c; inadequate design control - Paragraph 2.b and 2.c.

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DETAILS

1. Persons Contacted

Commonwealth Edison Company (CECo)

*R. L. Bax, Station Manager, Quad Cities
°*R. Robey, Services Superintendent
°*J. Kopacz, Technical Staff Supervisor
*D. Hoogheem, Regulatory Assurance Engineering Assistant
*D. Kunzman, Quality Assurance Inspector
#S. Javidan, BWR Engineering
°#I. Johnson, Nuclear Licensing Administrator
°#R. Mirochna, Supervising Engineer
#E. Zebus, Superintendent, Dresden/Quad Cities
°G. Knapp, Snubber Coordinator, Quad Cities

Sargent and Lundy Engineers (S&L)

T. G. Longlais, Head, Structural Engineering Division
R. L. Krawczyk, Project Engineer
G. L. Jurkin, Mechanical Project Engineer
J. M. Nosko, Mechanical Project Engineer
R. H. Jason, Project Manager
#B. Erler, Assistant Manager, Structural Department
#D. Gullaksen, Assistant Head, Structural Engineering Division
#P. Gazda, Senior Structural Project Engineer

Impell Corporation (Impell)

#T. Wittig, Division Manager, E. D.
#A. Ho, Section Manager, E. D.
D. Bailey, Lead Senior Engineer

Nuclear Reactor Regulation (NRR)

#P. T. Kuo, Section Chief, EMEB

Brookhaven National Laboratory (BNL)

#W. Grossman, Structural Analysis Engineer
#K. Bandyopadhyay, Analysis Engineer

*Denotes those attending the interim exit meeting on November 5, 1987, at Quad Cities.

#Denotes those attending the interim exit meeting on January 28, 1988, at S&L.

°Denotes those participating in the final telephone exit interview on March 4, 1988.

2. Action on Licensee Event Reports (LERS)

a. (Closed) LER 254/87024-00: Primary containment structural steel connections did not meet design requirements due to original installation errors.

As a result of the structural steel deficiencies discovered at CECo's Dresden Station (Reference: LER 237/87-003, LER 249/87-005 and NRC Inspection Reports No. 50-237/87006; 50-249/87011), investigative walkdowns were initiated at Quad Cities. The walkdowns were performed to identify and quantify any similar structural steel deficiencies at Quad Cities. These walkdowns disclosed that 10 structural connections and three structural beams contained deficiencies that resulted in stresses exceeding the FSAR limit. Further evaluation concluded that although the stresses exceed FSAR limits, all stresses were within the range where the structural components were considered operable. Additionally, 14 other deficiencies were noted and although the stresses were within the FSAR limits, prudent engineering practice indicated they should be corrected. All of the identified FSAR deficiencies and as many of the other identified deficiencies as possible were corrected prior to restart of the unit. Engineering Change Notices No. QC-87S-24, QC-87S-25 and QC-87S-27 were issued to implement the above modifications.

The above described deficiencies are an example of a violation of 10 CFR 50, Appendix B, Criterion V, in that the structural steel connections were not installed in accordance with the applicable design drawings. (254/87028-01A)

Similar walkdowns were previously performed on Unit 2 but no violations of FSAR stress allowables were found. However, these walkdowns addressed only the cheek plate connections and as such, verified only a portion of the connections in question. Pending the completion of the comprehensive walkdown verifying all the necessary connections, this is considered an Open Item. (265/87028-01)

b. (Closed) LER (254/87-011-00): Original construction errors caused an embedment plate for three pipe supports to exceed FSAR design stresses.

As a result of the design deficiencies discovered at CECo's Dresden Station (Reference: LER 237/87-010, LER 237/87-017, and NRC Inspection Reports No. 50-237/87006; 50-249/87011), a comprehensive Embedment Plate Assessment Program was implemented at both the Dresden and Quad Cities sites. A summary report for this program was issued October 16, 1987, and transmitted in a letter from I. M. Johnson (CECo) to A. B. Davis (NRC) on October 19, 1987.

The deficiency discovered at Dresden and subsequently found at Quad Cities was a misinterpretation of the design drawings which caused the anchor strap spacing to be 18 inches, instead of 9 inches. This spacing increase reduced the overall load carrying capacity of the embedment plates and consequently affected the piping supports attached to these plates.

The assessment program at Quad Cities reviewed over 2000 pipe supports attached to approximately 1200 embedment plates. The results showed that only three supports attached to one embedment plate exceeded the revised embedment plate load capacity. This embedment plate was modified under Engineering Change Notice (ECN) QC-87S-10 by drilling expansion anchors through the plate and into the concrete.

Although a total 19 supports were inaccessible during the implementation of the program, based on the lack of significant problems as well as the justifications provided in CECo's summary report, no further work is required to close this issue.

The deficiency discussed above is an example of a violation of 10 CFR 50, Appendix B, Criterion III, in that the design requirements for the embedment plates were not correctly translated into the fabrication drawings. (254/87028-02A; 265/87028-2A).

c. (Closed) LER (254/87-026-00; 254/87-026-01): Pipe support for core spray discharge line was not constructed in accordance with the design drawing.

As a result of design deficiencies discovered at CECo's Dresden Station, (Reference: LER 237/87-010-00 and NRC Inspection Report No. 50-237/87006; 50-249/87011), the Piping Configuration Verification Program was implemented at both the Dresden and Quad Cities sites. This program is currently ongoing and is scheduled for completion later in 1988. The intent of the program is to verify the existence and location of pipe supports, confirm pipe sizes and pipe schedules, determine branch connection details and general configuration for comparison with the as analyzed condition.

While implementing this program, support M-1610-18 was found with clearances which exceeded the specified installation tolerance. The subsequent evaluation concluded that the associated piping system would exceed the FSAR stress allowables but was within the operability limit. The excessive clearance causing the discrepancy was corrected under work request NWR Q62124 by adding additional shims.

In addition to the above discrepancy, at least five other problems were identified in the same piping model, Q1.10.2. Two supports which should have been demolished were not removed, one demolished support was still in the model as a spring hanger, one support was mislocated by 2'-7" and the wrong pipe schedule was used in the analysis.

The discrepancies discussed above are the result of design deficiencies as well as construction deficiencies. For the above situations where the work was not performed in accordance with the specified design drawings, this as another example of a violation of 10 CFR 50, Appendix B, Criterion V. (254/87028-01B; 265/87028-03)

For the above situations where the piping configuration was not correctly analyzed or modelled, this is another example of a violation of 10 CFR 50, Appendix B, Criterion III. (254/87028-02B; 265/87028-02B)

d. (Open) LER (254/87-008-00): Anchor bolts for a residual heat removal piping support were found sheared off. An operability analysis was eventually performed assuming the support did not carry any weight. This analysis indicated that the piping was within the operability limit, but had exceeded the FSAR stress allowables.

The Impell operability analysis, Calculation No. 0590-206-001, "Operability of Q1-RHRS-02C," Revision 0, May 7, 1987, was reviewed by the NRC inspector. No adverse comments were made.

At the time of the inspection, two issues were raised by the NRC inspector. First, the root cause of the event has not been ultimately determined. Pending the conclusion of the ongoing root cause evaluation, this item will remain open.

The second issue concerns the manner in which this event was handled. The noted discrepancy was originally identified by the licensee on March 9, 1987. At that time, a work request was initiated to repair the problem. As part of the work request approval, the operating engineer determined that the damage to the hanger did not make the RHR system inoperable. It was unclear to the NRC inspector how the operating engineer, without contacting engineering, was able to determine that the system was still operable with a broken support. It was also unclear to the NRC inspector why this potentially significant deficiency existed for almost two months before any addition review or other work was performed on it.

Pending further review by the NRC into the basis for considering the system operable with an inoperable support and the procedures that control this type of situation, this will be considered an Unresolved Item. (254/87028-03)

e. (Closed) LER (265/87-019-00; 265/87-019-01): Design errors relating to pipe supports caused portions of the resident heat removal and high pressure coolant injection systems to exceed FSAR stress allowables.

The above discrepancies were discovered during the implementation of the ongoing Piping Configuration Verification Program. (Refer to LER 254/87-026 in Paragraph 2.c for addition details.) All of the above discrepancies were within the previously establish operability limits. Additional deficiencies as well as subsequent corrective actions will be tracked under the previously discussed violations in Item 2.c.

3. Snubber Visual Inspection and Functional Testing

a. Background

Quad Cities Unit 1 has approximately 122 safety-related mechanical snubbers. The visual inspection and functional testing requirements are specified in Technical Specification (Tech Spec) Section 4.6.I. The functional test sample size is limited to an initial sample of 10% with an additional 10% for each functional test failure.

b. Procedure and Documentation Review

The NRC inspector reviewed relevant portions of the following procedures to determine whether they complied with NRC requirements and licensee commitments.

(1) CECo Procedure QTS 180-2, "Mechanical Snubber Visual Inspection," Revision 3, July 1987.

Paragraph E.1 discusses actions required if a snubber is believed to be inoperable. It states that a functional test may be required. The note associated with this paragraph states that the functional test shall include verification of proper break away force and running drag force. However, there is no mention that the functional test shall include verification of activation parameters. Although there was no instance found where the functional test excluded the activation parameters, this is a potential source of confusion. After discussing this aspect with the licensee, it was agreed that this clarification would be added to the procedure at its next revision.

(2) Paul-Munroe Procedure OSS-QAP 11.1, "Functional Testing of Pacific Scientific Shock Arrestors," February 22, 1985.

It was noted by the NRC inspector, that there was no definitive acceptance criteria specified in this procedure. Instead the procedure states that the acceptance criteria shall be specified by the owner/agent. This is not a poor practice as long as the licensee adequately defines the acceptance criteria.

In this case the acceptance criteria was specified in a letter from the station's Tech Staff supervisor to Paul-Munroe's Regional Sales Manager. In addition, the functional test package for each snubber also contained a copy of the acceptance criteria. There was, however, no reviewed and approved document that gave the functional test acceptance criteria. During the inspection it was established that the existing acceptance criteria had an adequate technical basis.

It was the station's position that since each snubber test package contained a copy of the acceptance criteria, and a Tech Staff engineer was required to sign this, that this was an adequate review of the acceptance criteria. Although the NRC inspector felt that this was a potential weakness in the program, it was accepted. The licensee agreed to review this matter in the future with the intent of formalizing the functional test procedure and including the acceptance criteria.

The calibration records for the snubber test stand were also reviewed. The Paul-Munroe STADAS Pipe Support Test Machine, Model STM-4120, Serial No. 653 A, due to be calibrated January 27, 1988, was within the calibration schedule at that time. In addition, the Position Measurement Systems, Load Measurement Instrumentation and all of the related load cells were within the calibration time schedule. It was noted that the Position Measurement System STM-1 had to be re-calibrated in October. This was attributed to a severe mechanical jolt received during the trailer transportation from the previous site. Although this is the first time this had occurred, calibration verification may need to be performed after each transfer of the test stand trailer.

As an additional aspect to the normal functional test inspection, the NRC inspector reviewed the specific implementation of CECo's Quality Procedure (QP) No. 3-54 relative to the snubber testing program. This procedure, "Design Control for Operations-Digital Computers and Software," appears to apply to the software that is used to control the snubber test stand. The output from this program is used as the basis for determining operability of individual snubbers.

Based on discussions with plant personnel, this Quality Procedure had not previously been applied to this application. Since the hardware and software for the snubber test facility were purchased from CECo's corporate office, detailed documentation for all aspects of the original system verification were not available at the site. Pending a review of the documentation demonstrating compliance with QP 3-54 verification requirement or adequate justification as to why it is not applicable, this will be considered an Open Item. (254/87028-04; 265/87028-04)

Within the areas inspected, no violations or deviations were identified.

c. Functional Test Results

During functional testing, a total of three snubbers failed to meet the established acceptance criteria. The initial failure occurred when snubber 1-73 failed to move at 25% of its rated load. The snubber was assumed to be locked-up and was analytically evaluated as such. The piping system was reanalyzed assuming a rigid support at that location for the associated thermal load cases. Although piping stresses and support loads increased, all of the results were within FSAR allowable limits. The calculations are documented in S&L File No. EMD-045229, Appendix A. The autopsy performed on the snubber indicated that there was some abnormal internal wear; however, there was no indication of an excessive or unanticipated load.

It was noted by the NRC inspector that the engineer performing the operability evaluation was not aware of the autopsy results until they were presented during this inspection. The autopsy had been performed 23 days prior the this date. Without the autopsy results, operability determination could not be made since unanticipated loads may have occurred in the system. In this case there were no adverse consequences but it appears that a better coordination between the field efforts and the engineering organization is needed.

Two additional snubbers, 1-46 and 1-93, failed the functional test criteria. Both snubbers were analyzed for the deficient condition and were both found to be operable. The nature of the failures did not dictate extensive re-analysis or root cause evaluations.

During the additional functional testing, required to meet Tech Spec action statements, the validity of the existing acceptance criteria was questioned by CECo. As a result of CECo's review, the criteria used at Quad Cities will be revised to bring it in line with the criteria currently being used at other CECo plants.

Within the areas inspected, no violations or deviation were identified.

d. Visual Inspections

As required by the Tech Spec, all safety related snubbers were visually inspected during the outage. Two snubbers were noted as having potentially significant indications during the visual inspections. The cold setting for Snubber 1-61 was within 0.875 inches from bottoming out. The design documents for this snubber called for a minimum cold setting of 1.29 inches. The other snubber, 1-65, was observed as having an interference with the adjacent grating. This interference could potentially restrict the thermal movement of the snubber.

The above two indications were dispositional by S&L. For snubber 1-61, a reinspection of the snubber setting indicated that the snubber was within an acceptable cold setting range if the recommended safety factor was subtracted from the minimum cold setting position. On this basis, there is no analytical problem associated with the snubber condition. However, S&L made a recommendation to adjust the associated pipe clamp to a position where the snubber's cold setting is back to within the recommended range.

For snubber 1-65, S&L evaluated the possibility of reversing the snubber orientation to eliminate the observed interference. It was concluded that this would be acceptable and the necessary changes were made. Due to some miscommunication, S&L was not aware that they also needed to evaluate the consequence of the snubber interference. A contributing factor to the miscommunication was the fact that the visual inspection sheet with the exact interference configuration was never given to S&L. After this issue was raised by the NRC inspector, it was determined that the thermal movements would be away from the observed interference and as such did not present an analytical concern. Due to the lack of significance associated with this issue no further action is necessary. However, it appears that better coordination between the field efforts and engineering organizations is needed.

Within the areas inspected, no violations or deviations were identified.

4. Flued Head Anchors

Background

On September 2, 1987, the NRC inspector was contacted by CECo concerning an operability question for the ongoing embedded plate program. (See NRC Inspection Reports No. 50-237/87006; 50-249/87011, Paragraph 3.c.1 for background information on the program.) A followup inspection was conducted the next day to review the details of the operability analysis for a portion of flued head anchor X116A at Dresden Unit 2. It was disclosed that, based on an Impell evaluation, the embedded plate portion of the X116A penetration could be considered operable only if increased damping specified in Regulatory Guide 1.61 and increased allowables based on yield strain criteria from ANSI/AISC N690-84 could be utilized. Neither of these criteria were part of the licensing basis for Dresden. Also, CECo stated that the flued head anchor structures at both Dresden and Quad Cities were not included under the IE Bulletin (IEB) No. 79-14 scope of work. For this reason, none of these anchor structures were ever as-built verified.

At the request of the NRC inspector, CECo contacted NRR personnel to discuss the above situation, and to receive concurrence for the use of the above operability criteria. Based on these discussions, CECo was asked to clarify several technical issues concerning the operability analysis. Subsequently, CECo was requested to make a presentation giving the justification for use of the above criteria as well as the basis for exclusion of the flued head anchor structures from the IEB 79-14 program.

A meeting was held on September 14, 1987, in Bethesda, Maryland to discuss the above topics. Presentation material discussed during the meeting is included as Enclosure 3. During the meeting CECo presented the original design basis loads and analytical methodologies for the flued head anchor structures in question. It was concluded by CECo that the first operability analysis done by Impell had used a more conservative design assumption than the original analyses. Furthermore, by using the original methodologies, the operability question for the X116A embedment plate was completely resolved since all components could be shown to meet the FSAR stress criteria. On this basis, CECo withdrew their request for using Regulatory Guide 1.61 damping and AISC N690 strain criteria.

Concerning the IEB 79-14 issue, CECo's position was that the flued head anchor structures are structural anchors for the containment penetrations and as such did not require as-built verification under the subject program.

The conclusions drawn by the NRC at the end of the meeting were as follows:

- The CECo presentation did not appear to be sufficient for the staff to agree or disagree without further study.
- The staff was concerned that the original design basis may not have been properly implemented is some respects such as the application of loads on the structure and assumptions in the frame analysis.
- The staff would have to examine the FSAR's for Quad Cities and Dresden before coming to a final conclusion.
- Further efforts by the NRC would include an audit of the design calculations and an inspection of the anchor structures.

Inspection Activities

The Regional NRC inspector field verified the as-built configuration of 11 flued head anchor structures at Quad Cities and 10 anchor structures at Dresden. The inspections showed that the overall structures were basically in accordance with the design drawings relative to member sizes and configuration; however, some differences were noted. At both sites the structure's legs were not precisely indicated. In some cases the legs were more than 20 inches shorter than specified on the drawings. This gave a general indication of a lack of correlation between the design versus the as-built details for the structures. In several instances there were missing welds between beam connections. At Dresden, the anchorage details were unavailable and therefore could not be compared to the installed configuration. Several anchor structures were noted as being redesigned during the course of recent modification work. Some cross bracing details and attachments to base plates were slightly different from the design drawings. The original analytical assumption of pinned connections was considered to be invalid by the NRC inspector.

Additional inspections of design calculations were later conducted by Regional as well as Headquarters and contractor personnel at the engineering offices of S&L and Impell. The evaluation report from the contractor assisting in this inspection is contained in Enclosure 4.

Conclusions

The overall conclusions reached during this portion of the inspection is as follows:

a. CECo's decision to exclude the flued head anchor structures from the IEB 79-14 program appeared to be an inappropriate decision.

b. Based on recent walkdowns performed by CECo, a number of anchor structure baseplates at Quad Cities utilized concrete expansion anchors which were never reassessed as required by IE Bulletin 79-02.

c. During the above walkdowns CECo identified a number of discrepancies between the design drawings and as-built configuration. These discrepancies could not be dispositioned using engineering judgement and will require additional reassessment.

d. Impell did not use the original design bases for the requalification and modification of the flued head anchor structures that were altered as part of the Recirculation Pipe Replacement (RPR) Project. Pipe break loads were never considered during the redesign effort, contrary to FSAR requirements.

e. The original design methodology assuming pinned connections was not accurate but not necessarily inappropriate. The structural members designed using this approach should be adequate. However, this approach potentially underestimates concrete attachment loads to a significant degree. Anchor bolts should be reevaluated using appropriate loads with appropriate design capacities and safety factors. Base plates should be reassessed for both tension and compression loads.

f. It was not obvious that the original load combinations provided bounding loads for all cases. This should be reviewed to confirm conservatism.

Based on the above concerns, CECo committed to implement a comprehensive program to demonstrate the adequacy of the flued head anchor structures at Quad Cities and Dresden.

On February 11, 1988, a meeting was held in the NRC Regional office to discuss the details of the above program. Information presented at the meeting is contained in Enclosure 5. The adequacy of the proposed program is currently under review by NRR.

The overall flued head anchor issue has not been resolved and will continue to be considered an Unresolved Item. (254/87028-05; 265/87028-05)

5. Open Items

Open items are matters which have been discussed with the licensee, which will be reviewed further by the inspector, and which involves some action on the part of the NRC or licensee or both. Open items disclosed during this inspection are discussed in Paragraphs 2.a and 3.b.

6. Unresolved Items

An unresolved item is a matter about which more information is required in order to ascertain whetner it is an acceptable item, an open item, a deviation, or a violation. Unresolved items disclosed during this inspection are discussed in Paragraphs 2.d and 4.

7. Exit Interview

The Region III inspector met with the licensee representatives (denoted in Paragraph 1) at the conclusion of the inspection. The inspector summarized the purpose and findings of the inspection. The licensee representatives acknowledged this information. The inspector also discussed the likely informational content of the inspection report with regard to documents or processes reviewed during the inspection. The licensee representatives did not identify any such documents/processes as proprietary.

ENCLOSURE 3

COMMONWEALTH EDISON COMPANY

CONTAINMENT PENETRATIONS

SEPTEMBER 14, 1987

AGENDA

I.	INTRODUCTION	I.M. JOHNSON, CECO
II.	ORIGINAL DESIGN FOR DRESDEN & QUAD CITIES	B.A. ERLER, S & L
III.	JUSTIFICATION FOR TREATMENT OF CONTAINMENT PENETRATIONS	T.T. WITTIG, IMPELL
IV.	CONCLUSIONS FOR DRESDEN	B.A. ERLER, S & L
V.	OTHER CECO PLANTS	I.M. JOHNSON, CECO

II. ORIGINAL DESIGN FOR DRESDEN AND QUAD CITIES

- DESCRIPTION
  - GENERAL CONFIGURATION
  - TYPICAL CONTAINMENT PENETRATION
  - TYPICAL FRAME
  - QUANTITIES OF CONTAINMENT PENETRATION ANCHORS
  - SYSTEM DESCRIPTION
- DESIGN DETAILS
  - DESIGN LOAD CASES
  - ANALYTICAL MODELS AND ASSUMPTIONS
  - ACCEPTANCE CRITERIA
  - TYPICAL MARGINS
  - FSAR COMMITMENTS
  - SUMMARY

QUANTITIES OF CONTAINMENT PENETRATION ANCHORS AND STRUCTURES

STATION	UNIT	NO. OF CONTAINMENT PENETRATIONS WITH BELLOWS	NO. OF SUPPORT FRAMES
DRESDEN	2	22	16 (1)
	3	22	16 (1)
	TOTAL	44	32
QUAD CITIES	1	20	12 (2)
	2	20	12 (2)
	TOTAL	40	24
BOTH STATIONS	TOTAL	84	56

NOTES

1) MAIN STEAM - REACTOR FEED STRUCTURE SUPPORTS 7 LINES

2) MAIN STEAM - REACTOR FEED STRUCTURE SUPPORTS 9 LINES

SYSTEM DESCRIPTIONS

LINE NAME IN THE PENETRATION	PENETRATION NUMBER			
	DRESDEN		QUAD CITIES	
	2	3	1	2
MAIN STEAM	105A-D	105A-D	7A-D	7A-D
MAIN STEAM DRAIN	106	106	8	8
REACTOR FEED WATER	107A&B	107A&B	9A&B	9A&B
ISO CONDENSER SUPPLY	108A	108A	-	-
ISO CONDENSER RETURN	109A	109A	-	-
RCIC STEAM SUPPLY	-	-	10	10
HPCI STEAM SUPPLY	115A	128	11	11
SHUTDOWN SUPPLY	111A&B	111A&B	-	-
RHRS SUPPLY	-	-	12	12
LPCI PUMP DISCHARGE	116A&B	116A&B	13A&B	13A&B
CLEAN-UP SUPPLY	113	113	14	14
CORE SPRAY	149A&B	149A&B	16A&B	16A&B
REACTOR VESSEL HEAD SPRAY	147	147	17	17
CLOSED COOLING WATER SUPPLY	123	123	23	23
CLOSED COOLING WATER RETURN	124	124	24	24
CRD RETURN	144	109B	36	36
STANDBY LIQUID CONTROL	130	130	47	47

DESIGN BASIS LOADING

CASE I:

BLOWDOWN FORCE FOR THE LINE UNDER INVESTIGATION

CASE II & III:

FORCE REQUIRED TO BRING THE PIPE INTO CONTACT WITH THE SPACER, GUARD PIPE OR SLEEVE. THE MOMENT IS LIMITED TO THE PLASTIC CAPACITY OF THE PIPE.

CASE IV:

WORST LOADING, BASED UPON ACTUAL PIPING CONFIGURATION, FOR OUT-OF-PLANE CONFIGURATION WHICH PRODUCES REACTIONS WITH BENDING AND TORSION. LOADING IS BASED UPON FORCE REQUIRED TO BRING THE PIPE INTO CONTACT WITH THE SPACER, GUARD PIPE OR SLEEVE.

LOAD CASES FOR ORIGINAL DESIGN

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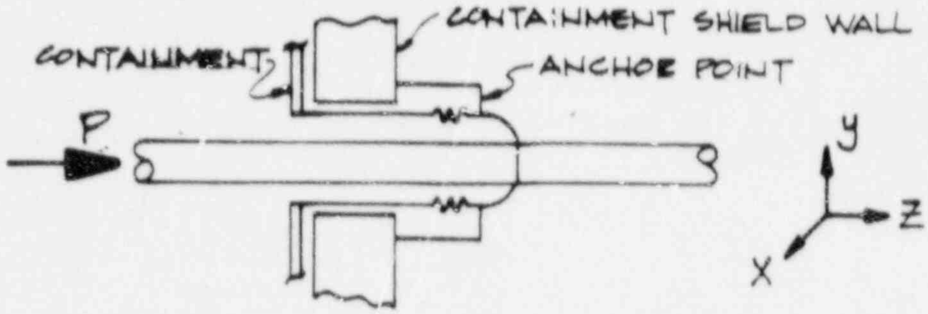
<tr><td>I</td><td>
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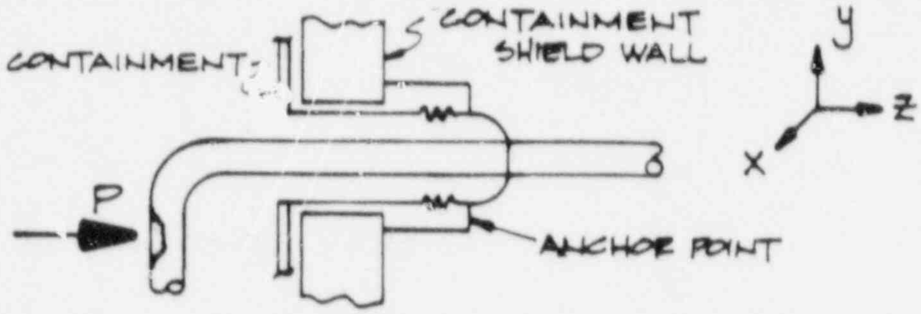
<tr><td>II</td><td>
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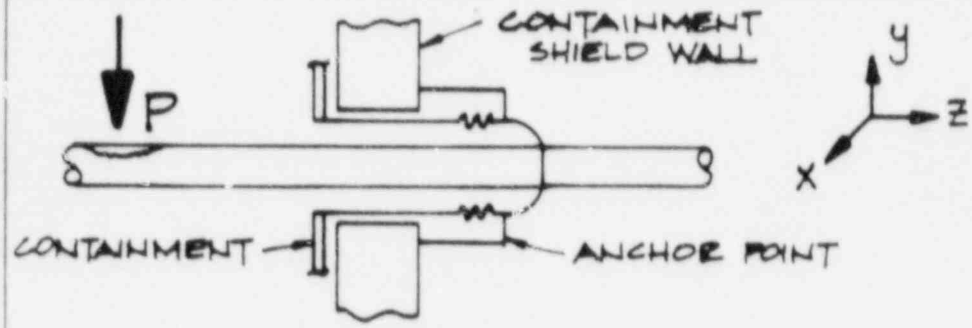
<tr><td>III</td><td>
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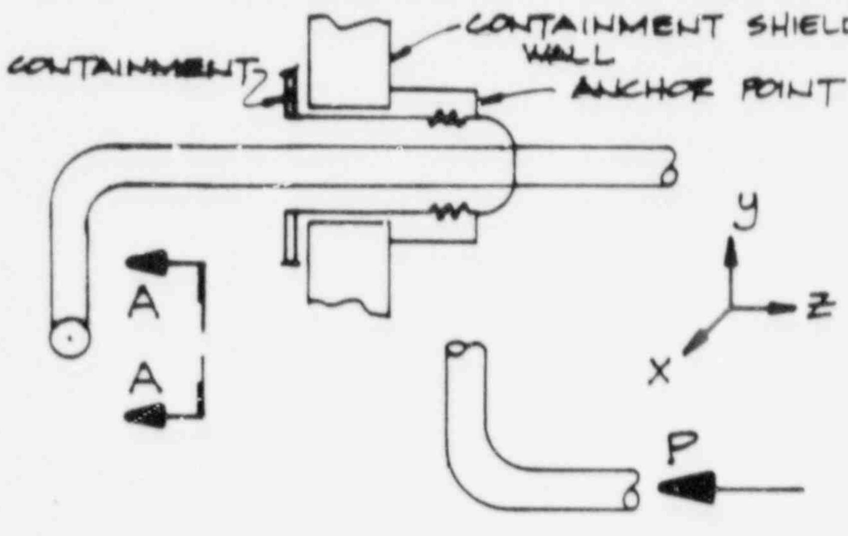
<tr><td>IV</td><td>

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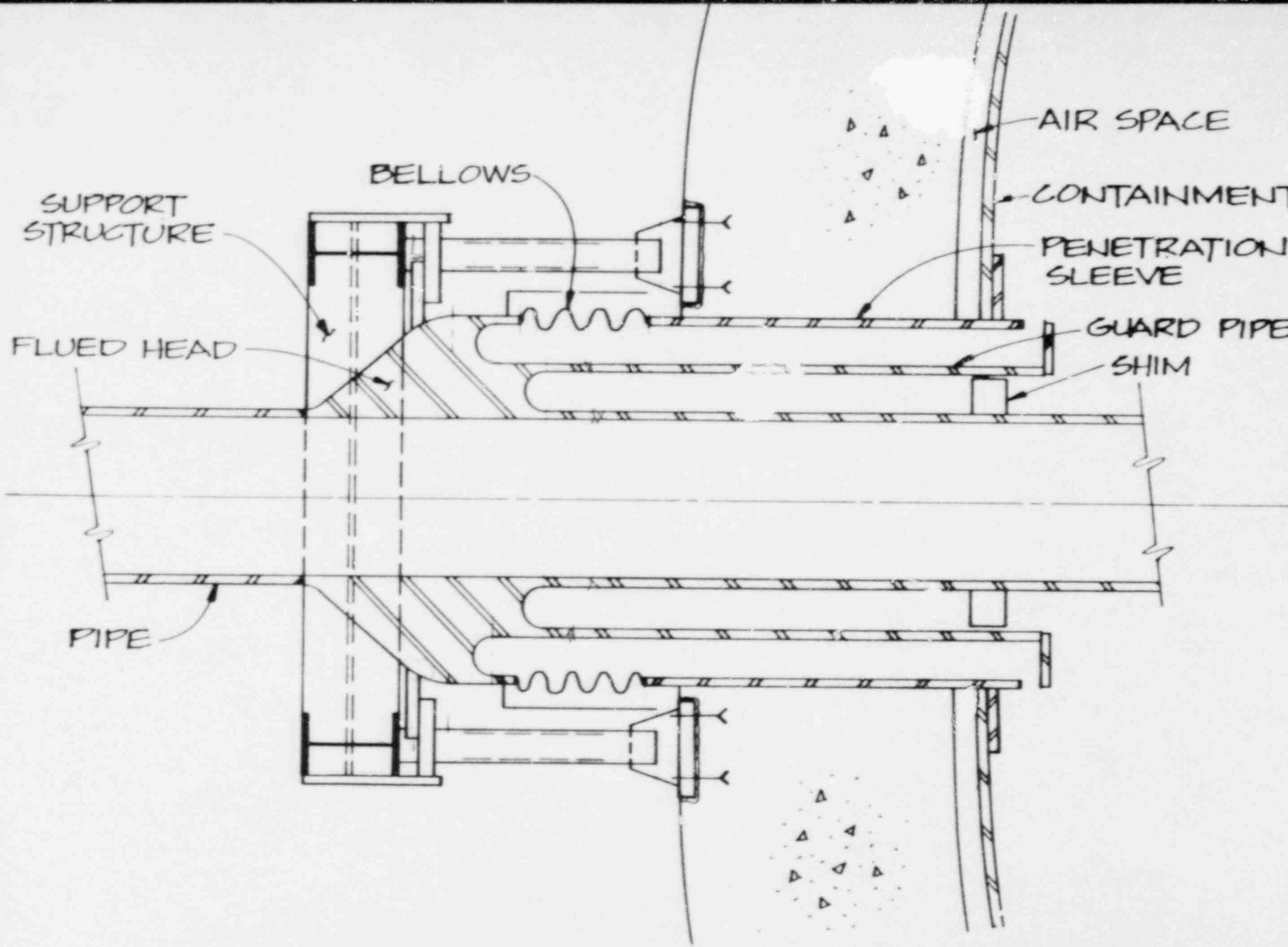
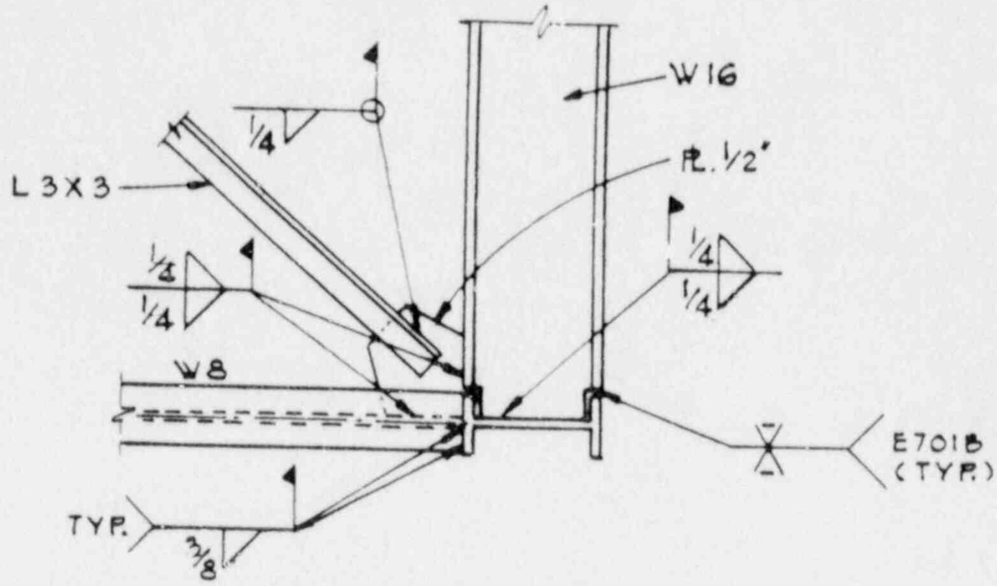
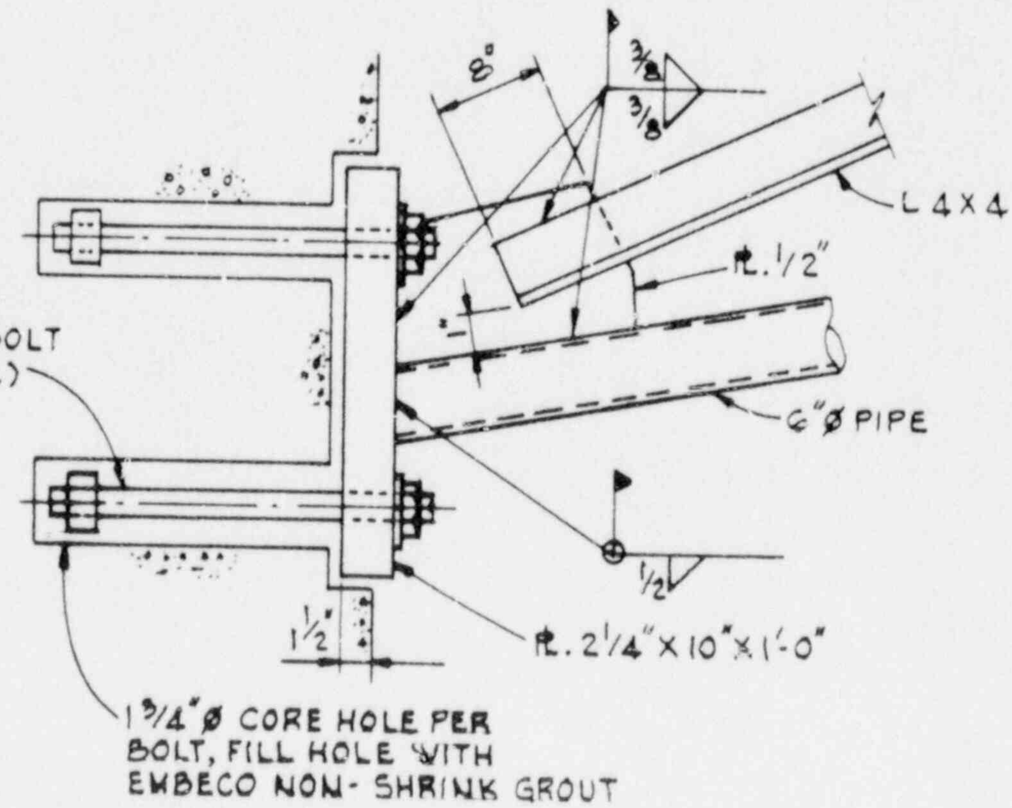


TYPICAL FLUED HEAD ANCHOR AND SUPPORT

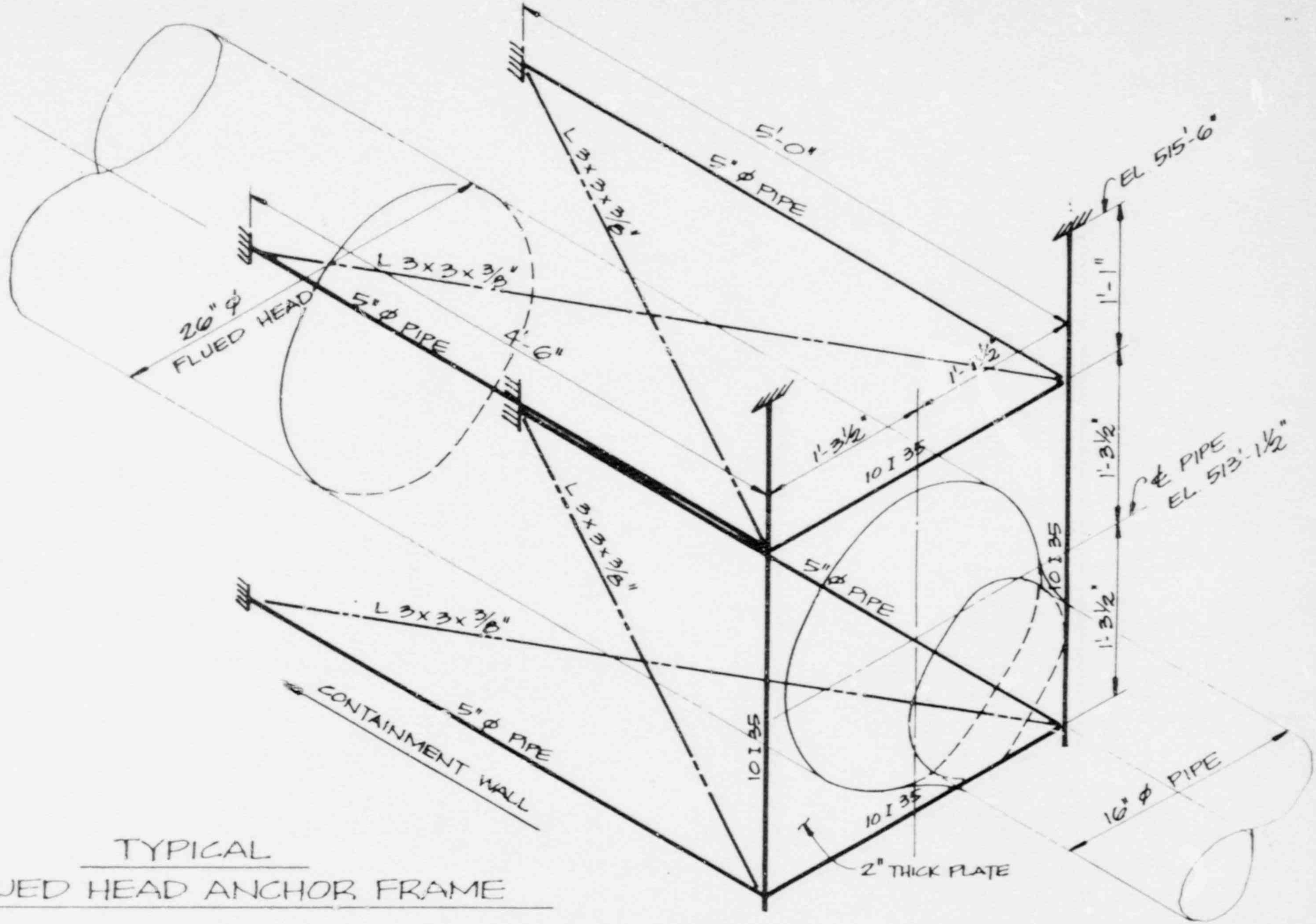
8



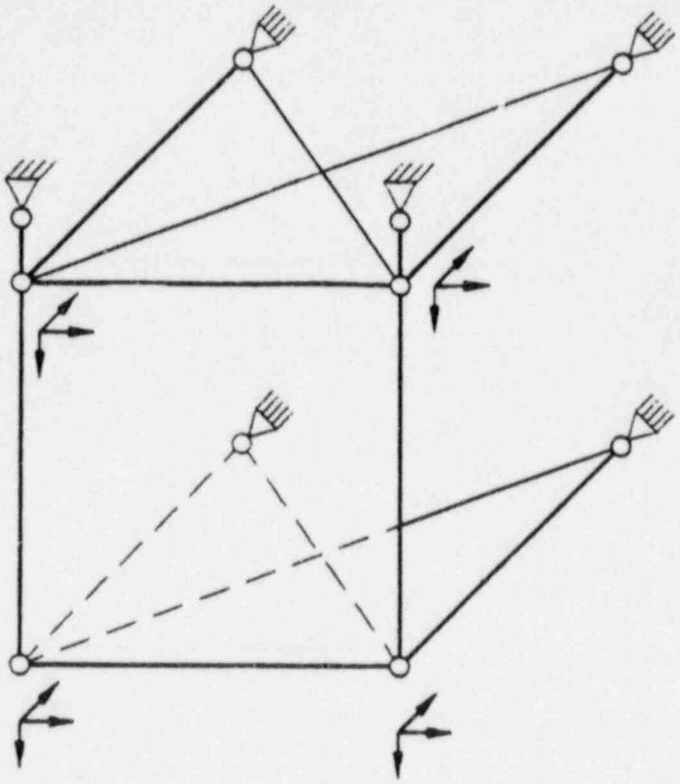
TYPICAL BRACING
INTERNAL CONNECTION



TYPICAL WALL CONNECTION
WITH BRACING



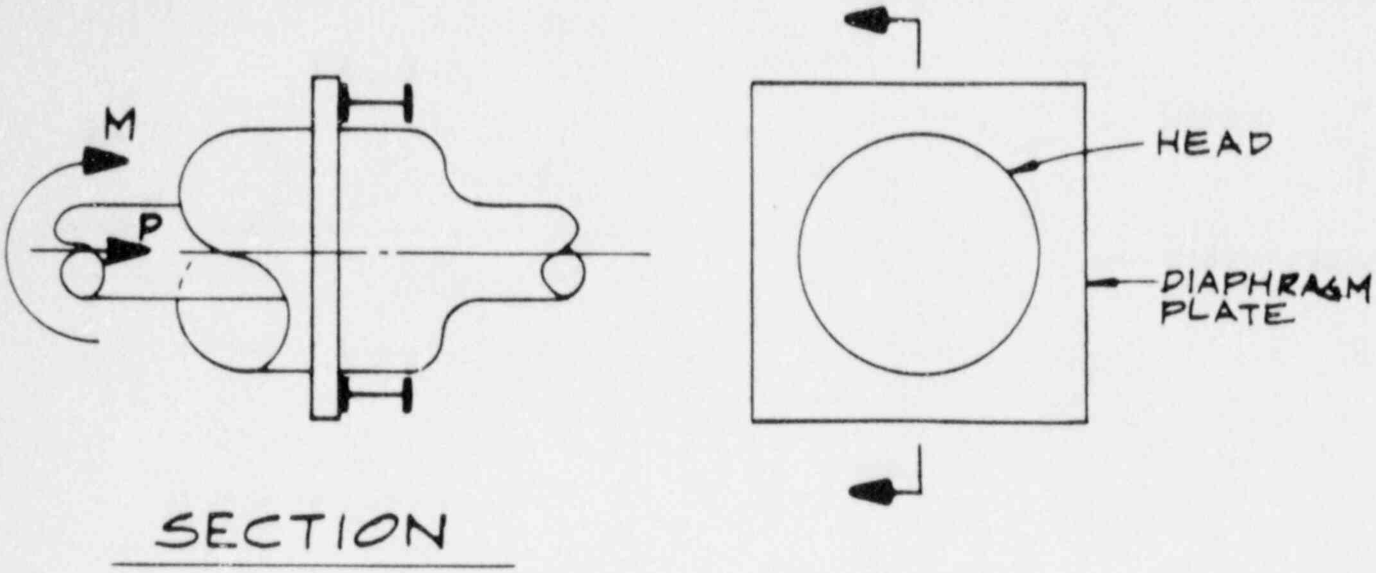
TYPICAL
FLUED HEAD ANCHOR FRAME



TYPICAL ANALYTICAL MODEL FOR ANCHOR FRAME

ASSUMPTIONS:

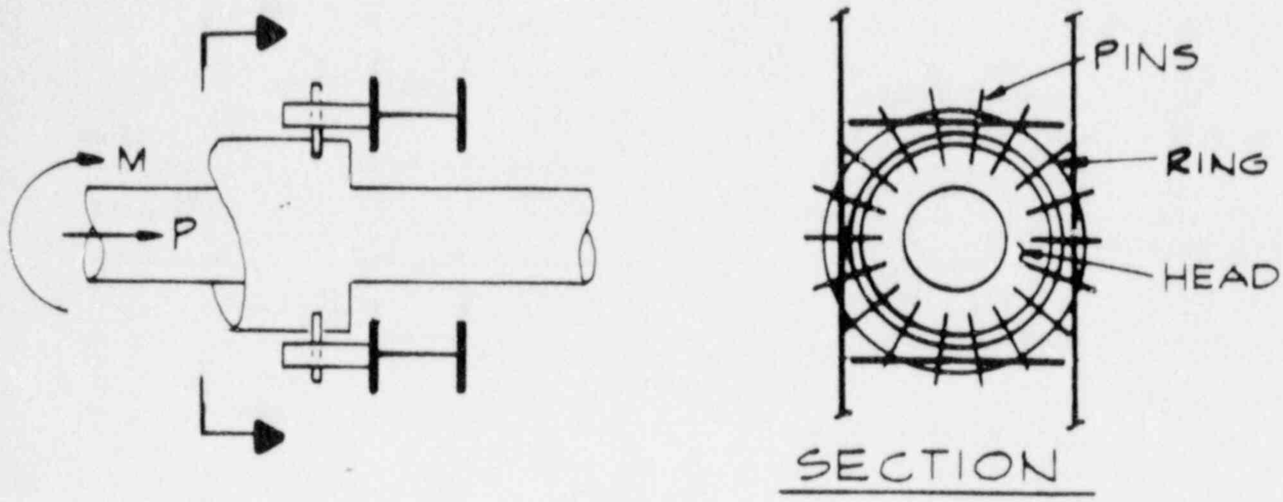
- EACH OF THE FOUR LOAD CASES APPLIED INDEPENDENTLY
- DIAPHRAGM PLATE TRANSMITS LOADS TO MEMBERS RIGIDLY
- SPACE TRUSS - STRUDL MODEL
- ELASTIC ANALYSIS METHODS USED



TYPICAL ANALYTICAL MODEL FOR DIAPHRAGM PLATE
DRESDEN ONLY

ASSUMPTIONS:

- PLATE IS ASSUMED AS RIGID FOR IN-PLANE LOADING
- ANALYSIS FOR AXIAL LOAD AND OUT-OF-PLANE BENDING INDEPENDENT
- MANUAL ANALYSIS CONSERVATIVELY ASSUMING ONE WAY ACTION
- COMBINATION OF ANALYSIS BY SUPERPOSITION
- ELASTIC PLATE METHODS USED



TYPICAL ANALYTICAL MODEL FOR ANCHOR RING AND PINS
QUAD CITIES ONLY

ASSUMPTIONS:

- PINS DESIGNED FOR SHEAR LOADING (NO TENSION)
- RING ASSUMED TO BE RIGIDLY SUPPORTED BY THE FRAME
- RING AND WELD DESIGNED FOR GLOBAL BENDING AND SHEAR
- LOAD DISTRIBUTED FROM HEAD TO PINS BASED ON ELASTIC ANALYSIS

ACCEPTANCE CRITERIA

- MEMBERS

  TENSION: $F_A = 0.9\ F_Y$

  COMPRESSION: $F_A = 0.9\ F_Y \left[1 - \frac{(KL/R)^2}{2C_C^2}\right]$

- DIAPHRAGM

  BENDING: $F_B = 0.6\ F_Y$

- RING PLATE AND PINS

  BEARING $F_P = .9\ F_Y$

  SHEAR $F_V = .75\ F_Y$

  BENDING $F_B = .9\ F_Y$

- ANCHOR BOLTS

  ROCKBOLTS: $F_T = 0.9\ F_Y$

  A36: $F_T = 0.9\ F_Y$

- WELDS

  E70 ELECTRODES: $F_W < 1.6 \times$ AISC SEVENTH EDITION

  E60 ELECTRODES: AISC SIXTH EDITION

  DIAPHRAGM PLATE TO FLUED HEAD: (E70 ELECTRODES)
  $F_W = 1.67 \times$ AISC (ADJUSTED FOR TEMPERATURE)

- CONCRETE

  PUNCHING SHEAR ALLOWABLE = $.9 \times 2 \sqrt{F'_C}$

  BEARING ALLOWABLE = $.85\ F'_C$

TYPICAL MARGINS IN ORIGINAL ANCHOR STRUCTURE DESIGN

MEMBERS	10 TO 25%
BASE PLATES	0 TO 10%
CONNECTIONS	10 TO 25%
ANCHOR BOLTS	5 TO 10%

FSAR COMMITMENTS

- PIPE RUPTURE LOAD CASES

  (1) AXIAL LOAD

  (2) MOMENT DUE TO PIPE SPLIT

  (3) MOMENT AND AXIAL DUE TO PIPE SPLIT PAST 90 DEGREE ELBOW

  (4) MOMENT, AXIAL AND TORSION DUE TO A SPLIT PAST TWO 90 DEGREE ELBOWS

SUMMARY

- LOADS USED DURING ORIGINAL DESIGN ARE POSTULATED PIPE BREAK LOADS

- ACCEPTANCE CRITERIA USED FOR ORIGINAL DESIGN ARE CONSERVATIVE ELASTIC ALLOWABLE STRESSES

- RESULTING CONFIGURATIONS ARE STRUCTURES WITH MULTIPLE LOAD PATHS (SPACE TRUSSES) AND HEAVY MEMBERS

THEREFORE, THERE IS A VERY HIGH DEGREE OF CONFIDENCE THAT THE CONTAINMENT PENETRATION ANCHOR STRUCTURES, IN THE AS DESIGNED CONFIGURATION, WILL MEET FSAR ALLOWABLES WHEN SUBJECTED TO I.E. BULLETIN 79-14 LOADINGS.

III. JUSTIFICATION FOR TREATMENT OF CONTAINMENT PENETRATIONS

- ORIGINAL VS. CURRENT DESIGN BASIS
- 79-14 AND MARK I EVALUATIONS
- MAXIMUM LOAD COMPARISONS
- SAMPLE EVALUATION RESULTS
- DRESDEN 2 LPCI EVALUATION
- SUMMARY

ORIGINAL VS. CURRENT DESIGN BASIS

ORIGINAL DESIGN

- CONTROLLED BY PIPE RUPTURE LOAD CASES (R)
- ELASTIC STRESSES

CURRENT DESIGN LOAD CASES

(1) R

(2) G + T + P + E + MKI

WHERE,

R = PIPE RUPTURE

T = THERMAL (HOT OR COLD)

P = PRESSURE DUE TO A PIPE BREAK INSIDE CONTAINMENT

E = OBE OR DBE

MKI = MARK I

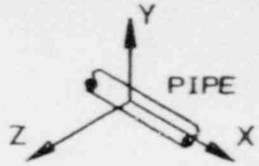
IEB 79-14 AND MARK I EVALUATIONS

IEB 79-14

- CHARTER
- MODIFICATIONS TEND TO REDUCE ANCHOR LOADS
- POSTULATED PIPE RUPTURE LOADS CONTROL ORIGINAL DESIGN
- CONTAINMENT PENETRATIONS WERE NOT RE-EVALUATED

MARK I LOADS ARE NEGLIGIBLE

MAXIMUM LOAD COMPARISONS



	D3 SDC X-111A		D3 SDC X-111B		D3 COSP X-149A		D3 COSP X-149B		D2 HPCI X-115A		D2 LPCI X-116A	
	ORIGINAL DESIGN	RPR DBE (A)	ORIGINAL DESIGN	RPR DBE (A)	ORIGINAL DESIGN	RPR DBE (A)	ORIGINAL DESIGN	RPR DBE (A)	ORIGINAL DESIGN	79-14 DBE (B)	ORIGINAL DESIGN	79-14 DBE (B)
FX	169.0	85.73	169.0	91.53	75.4	48.78	75.4	44.72	75.4	39.95	174.7	58.6
FY	35.0	25.68	35.0	15.46	14.9	7.42	14.9	7.65	62.5	13.49	26.2	29.3
FZ	22.2	41.61	22.2	42.05	7.06	15.05	7.06	15.06	8.09	10.75	26.2	23.0
MX	160.0	90.01	160.0	86.67	81.2	21.89	81.2	17.05	141.58	31.47	156.55	89.3
MY	518.0	346.89	518.0	381.41	122.0	119.93	122.0	98.78	150.96	80.45	388.0	272.1
MZ	560.0	168.36	560.0	174.61	178.1	64.97	178.1	42.68	931.4	84.55	388.0	182.0

UNITS IN KIPS AND FT-KIPS

NOTES:

A) LOAD COMPONENTS ARE MAX. ABS. VALUES

B) LOADS ARE MAX. ABS. VALUE ENVELOPED FROM HOT AND COLD CONDITIONS

SAMPLE EVALUATION RESULTS

STATION	ANCHOR	REDESIGNED DUE TO CONSTRUCTION	ACCEPTABLE WITHOUT MODIFICATION
DRESDEN 3	LPCI X-116A	X	
DRESDEN 3	LPCI X-116B	X	
DRESDEN 3	RWCU X-113	X	
DRESDEN 3	ISCO X-109A	X	
DRESDEN 3	SDC X-111A		X
DRESDEN 3	SDC X-111B		X
DRESDEN 3	COSP X-149A		X
DRESDEN 3	COSP X-149B		X
DRESDEN 2	HPCI X-115A		X (1)
DRESDEN 2	LPCI X-116A		X (1)
QUAD CITIES 2	COSP X-16A		X

NOTES:

(1) ONLY EVALUATED WELD, BASEPLATE AND BOLTS ATTACHED TO EMBEDMENT PLATE.

DRESDEN 2 LPCI EVALUATION

PURPOSE

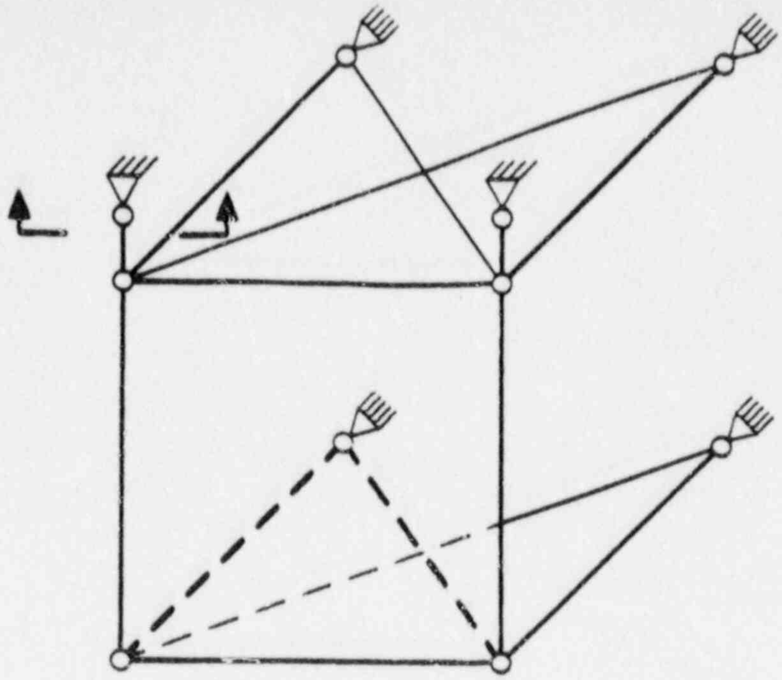
- PROVIDE LOADS ON THE EMBEDMENT PLATE
- ONE SUPPORT POINT ONLY

PIPE LOAD SUMMARY

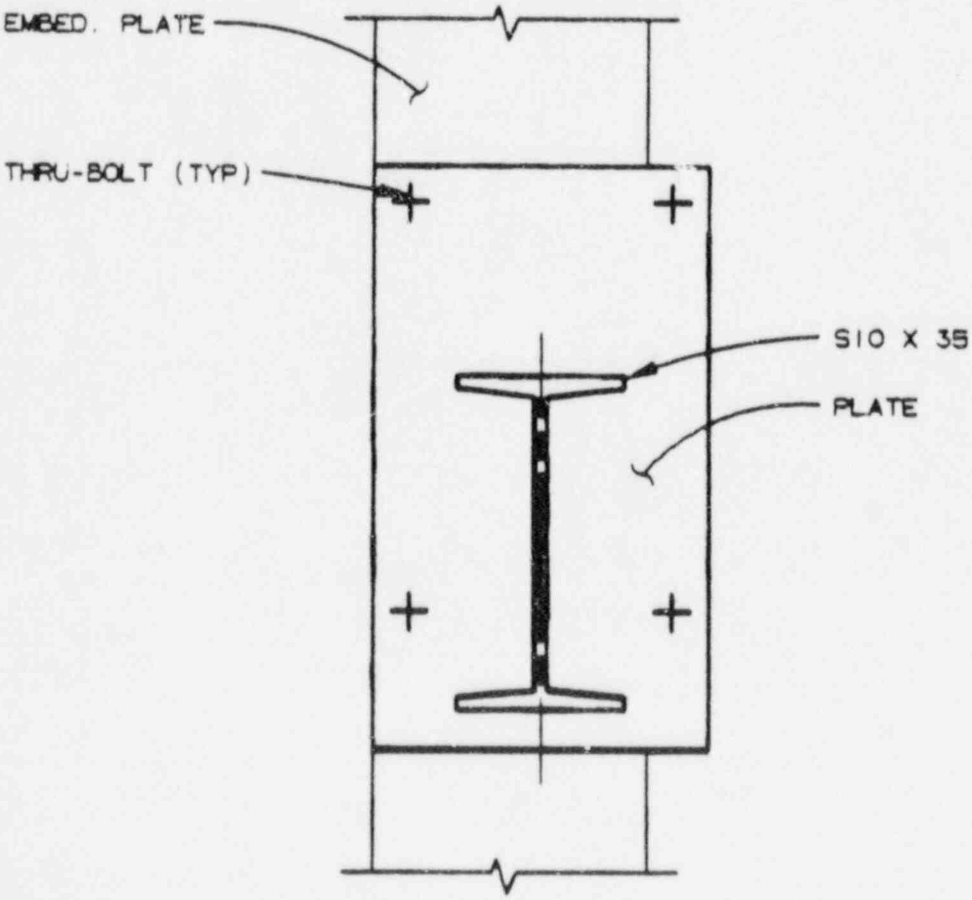
ANALYTICAL MODELING

- ORIGINAL: SPACE TRUSS
- PRELIMINARY RE-EVALUATION: SPACE FRAME
- FINAL RE-EVALUATION: SPACE TRUSS
- OVERALL DESIGN MARGIN

NO MODIFICATIONS ARE REQUIRED



SPACE TRUSS



SECTION

DRESDEN 2 LPCI X-116A

CONTAINMENT PENETRATION ANCHOR LOAD COMPARISON

	FX	FY	FZ	MX	MY	MZ
ORIGINAL DESIGN (R) (1)	174.7	26.2	26.2	156.6	388.0	388.0
G+T+E+F+MKI MAXIMUMS (2)	58.6	29.3	23.0	89.3	272.1	182.0

UNITS IN KIPS AND FT-KIPS

NOTES:

(1) PER UPDATED FSAR LOAD CASES:

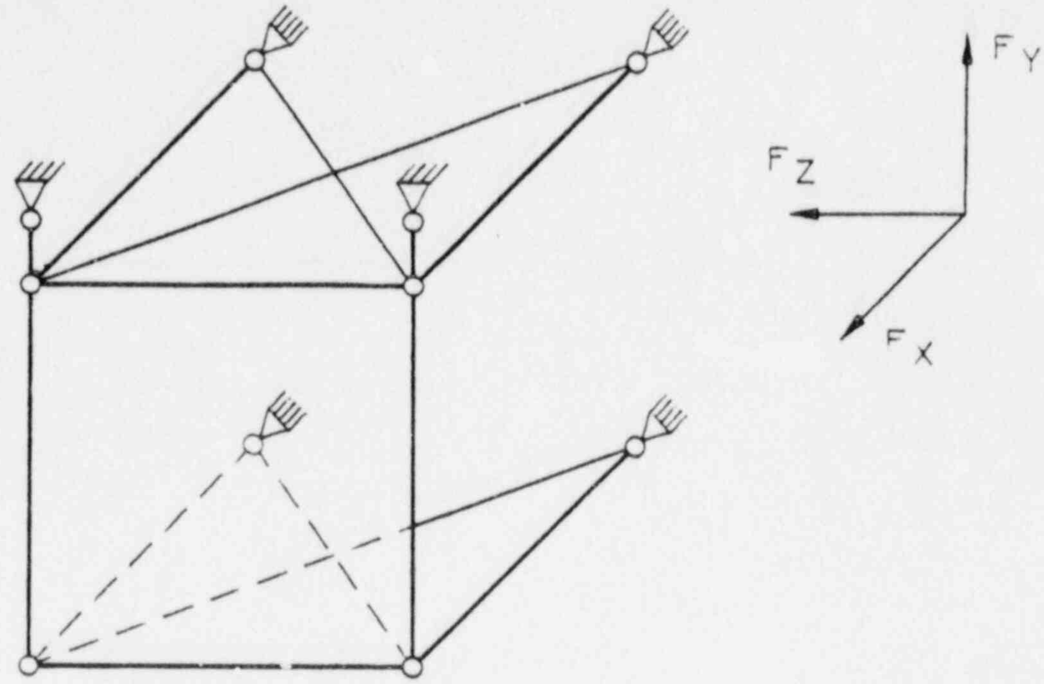
1) AXIAL LOAD

2) MOMENT DUE TO PIPE SPLIT

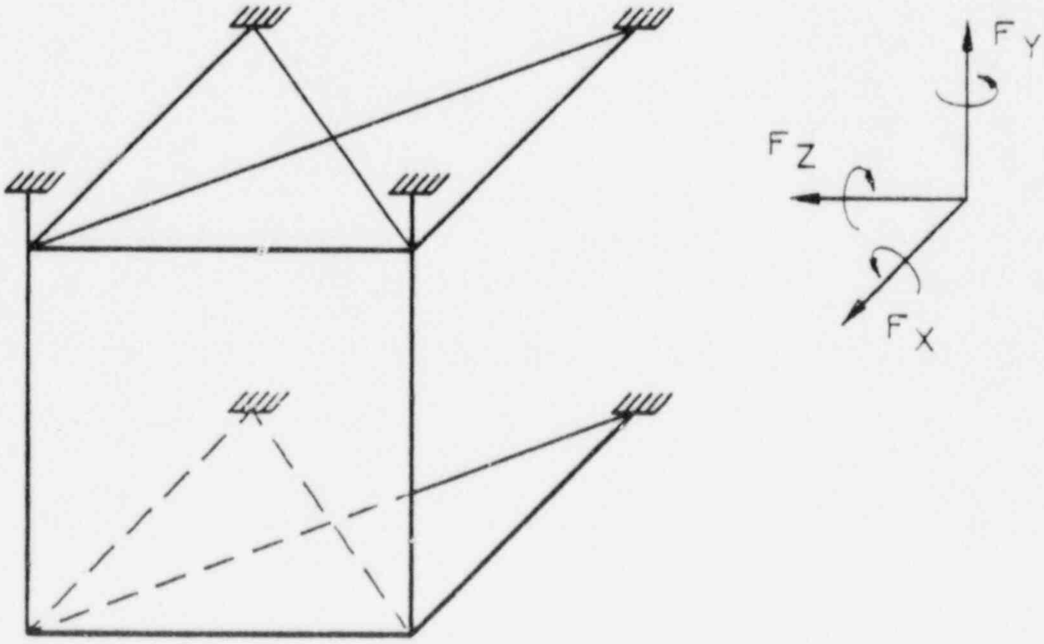
3) MOMENT AND AXIAL LOAD DUE TO PIPE SPLIT PAST A 90° ELBOW

4) MOMENT, AXIAL AND TORSION DUE TO A PIPE SPLIT PAST TWO 90° ELBOWS

(2) THE MAXIMUM ABSOLUTE VALUE FOR EACH LOAD COMPONENT IS SHOWN.



SPACE TRUSS



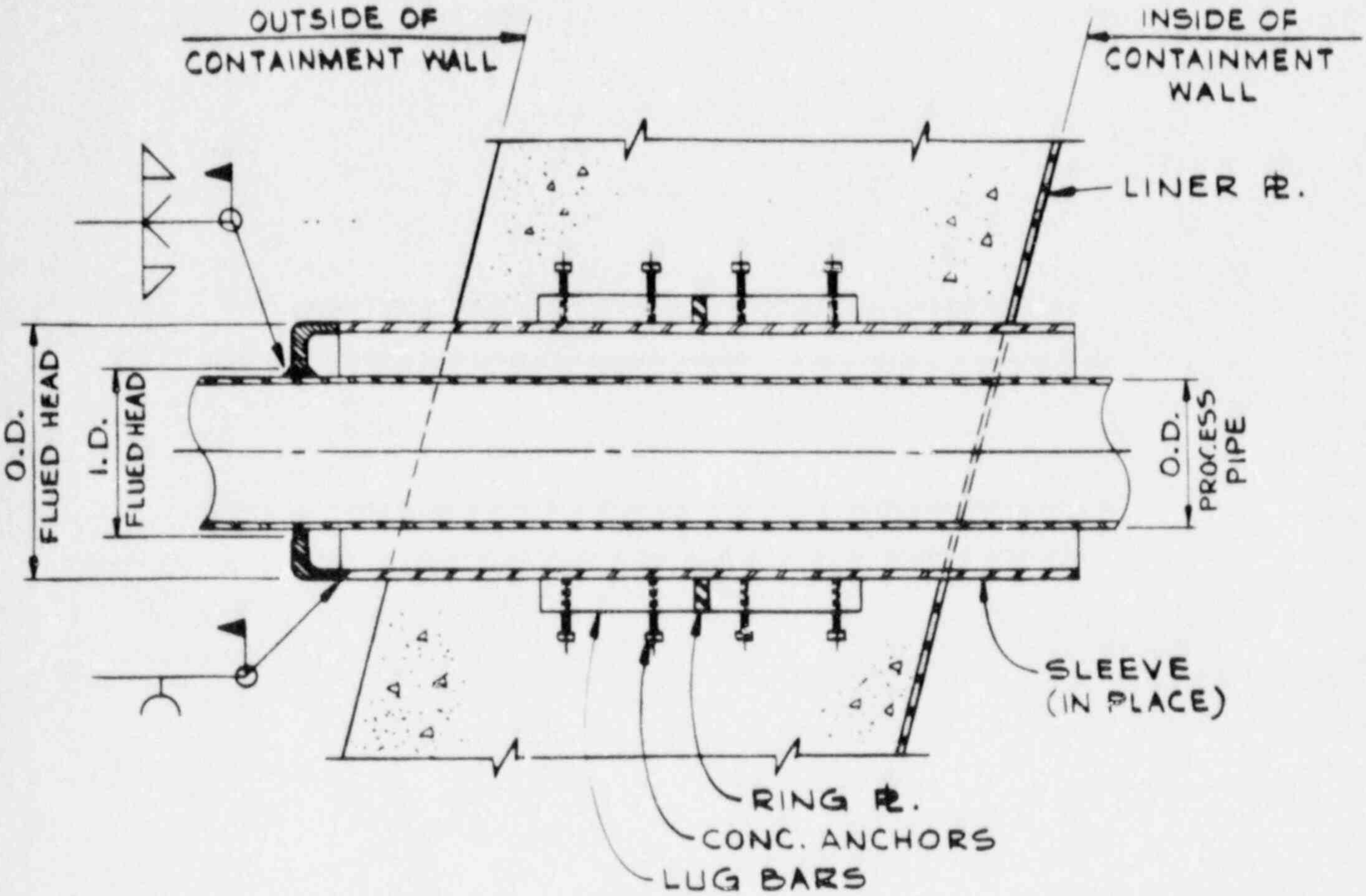
SPACE FRAME

SUMMARY

DESIGN BASIS HISTORY

RESULTS AND CONCLUSIONS

- ORIGINAL DESIGN BASIS IS CONSERVATIVE
- CONFIRMED BY SAMPLE EVALUATIONS USING CURRENT LOADS
- NO MODIFICATIONS ARE REQUIRED FOR DRESDEN 2 LPCI



TYPICAL CONTAINMENT
PENETRATION DETAIL
LASALLE COUNTY STATION
UNITS 1&2

LASALLE, BYRON AND BRAIDWOOD PENETRATIONS

LOADS USED FOR CONTAINMENT PENETRATION ANALYSIS WERE AS FOLLOWS:

- PIPE BREAK LOADS

- AS-BUILT PIPING ANALYSIS LOADS