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Christine N. Kohl  
Administrative Judge  
Chairman, Atomic Safety and  
Licensing Appeal Board  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555

W. Reed Johnson  
Administrative Judge  
Atomic Safety and  
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Washington, D.C. 20555

Howard A. Wilber  
Administrative Judge  
Atomic Safety and  
Licensing Appeal Board  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555

In the Matter of  
Louisiana Power & Light Company  
(Waterford Steam Electric Station, Unit 3)  
Docket No. 50-382

Dear Chairman Kohl and Judges Johnson and Wilber:

I enclose for the information of the Appeal Board and parties copies of two reports that were recently provided to NRC Staff by Applicant. These two reports deal with vertical surface cracking of concrete at Waterford 3.

Vertical cracking has been evaluated because of its potential relationship to basemat cracking which is the subject of NRC review and of a pending motion to reopen in this proceeding. Both reports (by Ebasco Services Incorporated and Harstead Engineering Associates) conclude that the hairline cracks observed on vertical surfaces are drying shrinkage

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Administrative Judges  
Atomic Safety and Licensing  
Appeal Board  
May 24, 1984  
Page Two

cracks and not the result of any loading mechanism, and that a structural interrelationship cannot be established between cracks on surfaces of wall and basemat.

Sincerely,

*Ernest L. Blake, Jr.*

Ernest L. Blake, Jr., P.C.  
Counsel to Applicant

Enclosures  
cc: Service List



**LOUISIANA**  
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P. O. BOX 8008 • NEW ORLEANS, LOUISIANA 70174 • (504) 366-2345

May 16, 1984

W3P84-1391  
3-A1.16.07

Director of Nuclear Reactor Regulation  
Attention: Mr. G.W. Knighton, Chief  
Licensing Branch No. 3  
Division of Licensing  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555

SUBJECT: Waterford 3 SES  
Docket No. 50-382  
Additional Information on NPIS Basemat Cracks



Dear Sir:

A technical review meeting was held on March 26, 1984 in Bethesda, Md. to discuss the Nuclear Plant Island Structure Basemat and the hairline cracks observed in the top of the basemat. This meeting was continued on March 27, 1984 at the Waterford 3 site. During the site tour a number of hairline cracks were observed on the vertical surfaces of the ring wall and cooling tower storage pool wall.

LP&L agreed at the meeting to mapping of the vertical cracks and to initiate a review by Ebasco and Harstead Engineering Associates (HEA) to develop conclusions as to the origin of the hairline cracks and their significance to, or interrelationship with, the basemat cracks.

Following the meeting, Ebasco was instructed to prepare maps showing the location of the vertical hairline cracks and to evaluate the significance. This report, Attachment I, was transmitted to HEA for their subsequent review and development of an independent position on the significance of the hairline cracks. The HEA report is included as Attachment II.

Both Ebasco and HEA have concluded that the hairline cracks on the vertical surfaces are drying shrinkage cracks and not a result of any loading mechanism. The conclusion is "...it is concluded that a structural inter-relationship cannot be established between cracks on surfaces of wall and basemat."

If you have any questions concerning the attached report, please contact me.

Yours very truly,

K. W. Cook  
Nuclear Support & Licensing Manager

cc: E.L. Blake, W.M. Stevenson, J.T. Collins, D.M. Crutchfield, J. Wilson  
G.L. Constable



ATTACHMENT I

LOUISIANA POWER AND LIGHT COMPANY  
WATERFORD STEAM ELECTRIC STATION  
UNIT NO.3  
NPIS WALL HAIRLINE CRACKS EVALUATION

PREPARED BY: P C LIU/N HASAN

REVIEWED BY: A H WERN

APPROVED BY: J L EHASZ

APRIL 1984

EBASCO SERVICES INCORPORATED  
2 WORLD TRADE CENTER  
NEW YORK, N.Y. 10048

LOUISIANA POWER AND LIGHT COMPANY  
WATERFORD STEAM ELECTRIC STATION  
UNIT NO.3  
NPIS WALL HAIRLINE CRACK EVALUATION

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LOUISIANA POWER AND LIGHT COMPANY  
WATERFORD STEAM ELECTRIC STATION  
UNIT NO. 3  
NPIS WALL HAIRLINE CRACKS EVALUATION

1.0 PURPOSE

The purpose of this report is to document the presence of hairline cracks in the walls of the Nuclear Plant Island Structure (NPIS) of Waterford SES Unit No. 3 and to provide an engineering evaluation related to basemat settlement.

The investigation and mapping of the cracks was performed during the week of April 2, 1984 at the request of NRC staff during their site visit on March 27, 1984.

2.0 SCOPE

This report covers the investigation and mapping of hairline cracks in the exposed wall surfaces in the areas between Reactor Building and Wet and Dry Cooling Towers, and between Reactor Building and Reactor Auxiliary Buildings of NPIS. The mapping covers areas from top of basemat and extending to ten (10) feet above El. - 35.0 ft.

All visible hairline cracks are located and identified, areas of wetness or leachate are documented, width and spacing pattern of cracks and possible causes to their formation are reviewed and significance of these cracks, including inter-relationship with cracks in basemat is evaluated.

3.0 CONCLUSIONS

The investigation and mapping of the cracks in the exposed walls of NPIS, from top of basemat to ten (10) feet above El-35.0 ft, leads to the following conclusions:

1. All cracks are extremely fine and identified as "hairline cracks", varying from hardly visible to less than 5 mils in width.



2. The cracks are randomly distributed and mostly oriented in a vertical direction. These cracks are superficial shrinkage cracks, formed during construction, and are considered structurally insignificant.

3. No inter-relationship between the walls and basemat hairline cracks appears to exist. In localized areas of the Reactor Building and East and West Cooling Towers some small inter-relationship between these cracks may exist, as a local phenomenon, but the proximity of these cracks could also be coincidental.

#### 4.0 BACKGROUND

The NPIS, which consists of Reactor Building, Reactor Auxiliary Building, Fuel Handling Building and the Essential Cooling System Structures are erected on a 12-ft. thick, 380 ft. by 276 ft. reinforced concrete foundation mat. The bottom of the mat is located at El.-47.0 ft. which is approximately 64 ft. below final grade. The normal ground water level is at El. 8.0 ft.

Because of the foundation soils and to minimize the differential settlement between structures a common foundation mat was selected and compensated foundation principle was utilized in the design of NPIS. According to this principle, the net soil pressure under the common mat is no greater than the existing natural soil pressure, ie, the weight of the combined structure applies an effective load to the bearing stratum equivalent to the originally-existing overburden pressure.

The entire common foundation mat was constructed following a checker board sequence consisting of 28 block placements, over a period of six (6) months. Figure 1 shows the sequence of basemat block placement with dates.

During construction, small differential settlements beneath various areas of the mat were expected due to small variations in the underlying soils and small nonuniformities in the loading due to the construction sequence.

Foundation mat settlement was carefully monitored to assume that settlement during construction of the plant was relatively uniform across the entire mat and that no significant relative movement occurred.

## 5.0 DISCUSSION

### 5.1 CURVATURE OF BASEMAT

The mat curvature resulted from a complex series of events involving the placement of the concrete mat and the scheduling of concrete placement for the superstructure as well as control of dewatering system and monitoring of sub-soil conditions.

The construction of the mat was such that the blocks located beneath the Reactor Building were placed first and then the blocks away from the Reactor Building were placed subsequently. The subsoils beneath the mat in the area which was placed first had started their consolidation process slightly earlier as compared to the areas which were placed later. The lag in the starting of the consolidation introduced part of the differential settlement creating the convex shape.

The convex shape was observed both in E-W and N-S direction, with the curvature being more pronounced in N-S direction. Figure 2 shows a generalized curvature of basemat in N-S direction at 3 key construction stages.

In April 1976, just prior to construction of Reactor Building shield wall the maximum curvature of the basemat in N-S direction was such that the center was 1 inch to 1 1/4 inches higher than the extreme edges of the mat. (At this time portions of the base mat, ie, block Nos. 15, 16, 17, 18 and 19 were not placed).

In June 1976, after the completion of Reactor Building shield wall and the remaining mat concrete, there was a slight reduction in the maximum curvature beneath the shield wall area, and resulted in a decrease of over-all differential settlement.

With additional loads added by NPIS concrete and recharging of water table, the settlement process continued, however, the mat maintained its general convex shape with only minor curvature readjustment. The mat settlement process stabilized with completion of NPIS concrete and ground water table restored to normal condition in mid 1979. Since then, no further significant net or differential settlement has occurred.

## 5.2 HAIRLINE CRACKS IN BASEMAT

The initial detection of hairline cracks in basemat was made in mid-1977 via Non-Conformance Report NCR W3-535, as the concrete surface under the Reactor Building was cleaned up and prepared for concrete fill placement. Then microscopic cracks were identified by weeping of water at a rate just enough to moisten the surrounding concrete. Subsequently, a crack map was prepared and the crack widths were observed to be between 2 and 5 mils.

An effort to repair these cracks with an injection of epoxy grout, using a maximum pressure of 180 psi, was unsuccessful, which indicated that these cracks were too small to be grouted.

In May 1983, additional hairline cracks in the basemat of the Reactor Auxiliary Building were also reported via NCR W3-6212. These microscopic cracks, similar to those detected earlier in 1977, were identified through presence of moisture.

In September, 1983 a detailed mat hairline crack mapping was performed (Reference 1), the results indicated the crack pattern follows generally the pattern of mat differential settlement. Since the contours of differential settlement show a pronounced greater convexity in the N-S direction than in the E-W, the general crack pattern lies E-W reflecting these convexities.

### 5.3 HAIRLINE CRACKS IN WALLS OF NPIS

#### Base Ring of Reactor Building Shield Wall

Surface hairline cracks in the base ring wall the Reactor Building were observed and reported in March 1976 (References 2&3).

The base ring wall is 10 ft thick and 17'-2 high, and was constructed in four placements. Surface hairline cracks were found to be vertically oriented and randomly distributed on both the interior and exterior surfaces of the ring wall. The crack width was extremely small and varied from hardly visible to less than 5 mils. These cracks were evaluated to be shrinkage cracks, since they existed on the surface and not beyond the reinforcing steel.

#### Walls in Other Areas

Surface hairline cracks in other walls areas had been noticed during construction. No detailed documentation was made because they were all considered to be shrinkage cracks.

A detailed mapping of the wall hairline cracks of the NPIS was performed during the week of April 2, 1984, in accordance with a prescribed mapping procedure (Appendix A). The mapping was conducted for all accessible and exposed walls at the interface with and up to 10 ft above the top of the basemat El-35.0 ft. The results of wall hairline crack maps are presented in Appendix B. A plan of the mapped walls is presented in Figure 3. For photographs of cracks, see Appendix "D".

Based on the results of the mapping, the following observations were made:

1. Crack Width - All cracks are extremely fine and vary from hardly visible to less than 5 mils. Their visibility is enhanced by, and in some cases the only witness to their presence is, the presence of moisture and/or leachate.



2. Crack Orientation - The cracks are mostly oriented in a vertical direction.
3. Crack Distribution - The cracks are randomly distributed.
4. Crack Wetness - No cracks were found to have surface wetness except cracks in Wet Cooling Tower walls.  
(Leachate deposits on Reactor Building ring wall were found to be dry)
5. Leachate Deposit - Large leachate deposits are found in two specific areas, Reactor Building ring wall below El.-18.0 ft and walls of Wet Cooling Towers. In both these areas leachate deposit extend to the basemat.  
  
The Reactor Building leachate was found to be dry signifying the source of moisture causing it causing it has been eliminated.

Leachate accumulations on the ring wall were caused by long term ponding of rain and construction water at the top of ring wall. Seepage of water was also facilitated by open pipe sleeves (El-18.0 ft) which were interconnected with the embedded structural steel system used as temporary support during construction.

Leachate accumulations on the Wet Cooling Tower walls was apparently caused by seepage of water from the cooling tower basins (water level at - 9.0 ft).

#### 5.4 INTER-RELATIONSHIP OF HAIRLINE CRACKS

Composite isometric maps (Appendix C) have been prepared to show the relative location and orientation of all identified cracks at the basemat/wall interface.

1. Hairline cracks at the interface are not generally found to be inter-connected or even closely inter-related (spacing less than two feet).
2. Only three localized areas were found with floor and wall cracks in close proximity:
  - a) Reactor Building ring wall, north-east quadrant (sheet 1, Appendix C)
  - b) East Wet Cooling Tower walls (Sh 2, Appendix C)
  - c) West Wet Cooling Tower walls (Sh 4&5, Appendix C)

Many leachate deposits on the walls extend further down the wall than the crack due to the originating moisture migrating down the wall. In assessing the inter-relationship, a conservative assumption has been made that hairline cracks are present in all leachate areas.

Based on the above, it is concluded that a structural inter-relationship cannot be established between cracks on surfaces of walls and basemat.

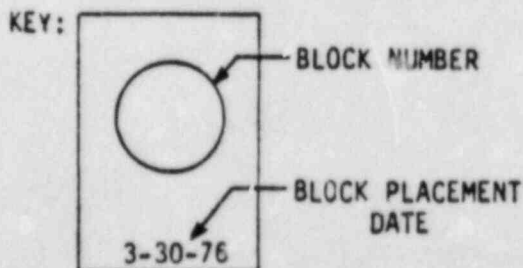
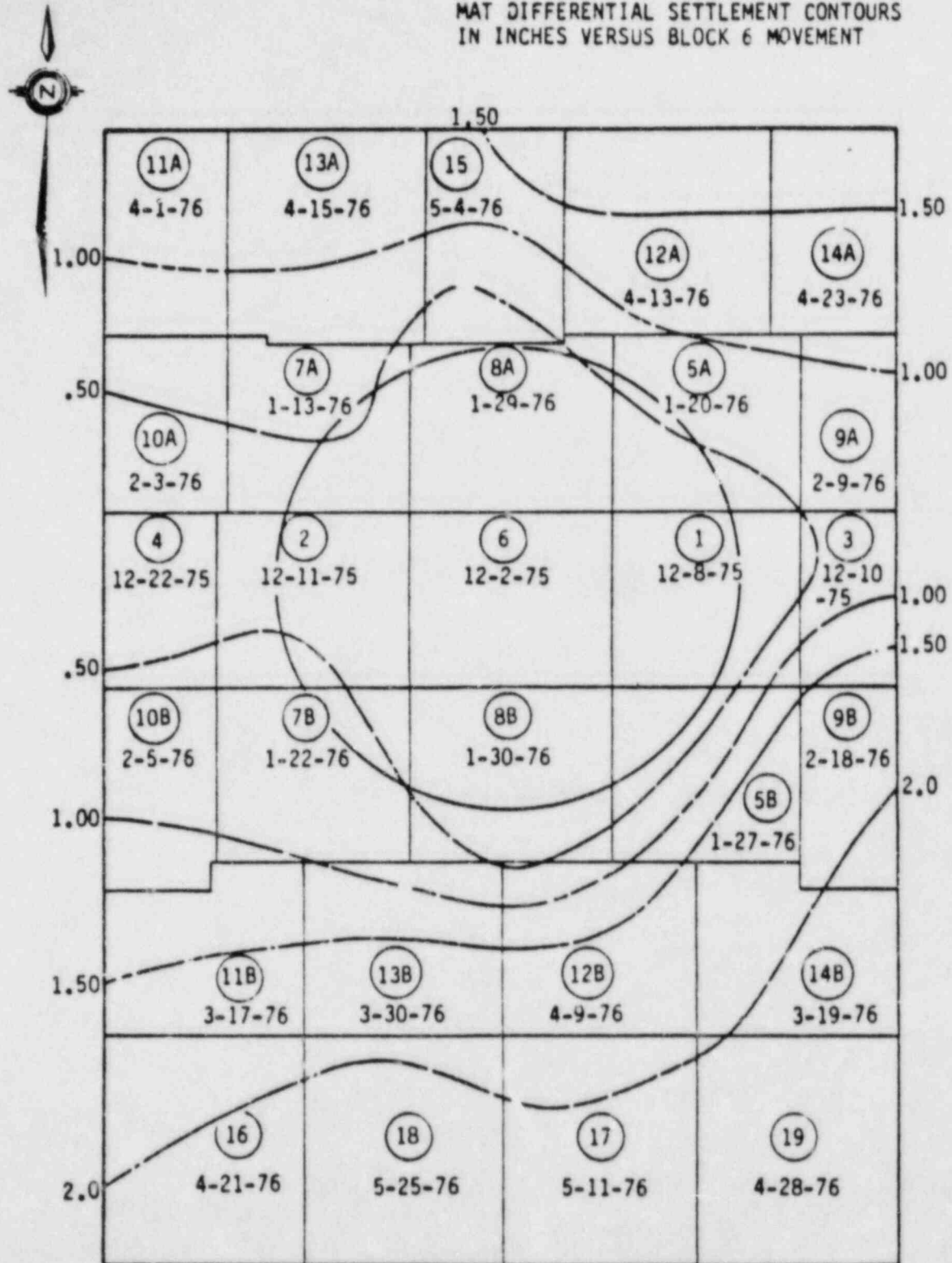
The mat top surface cracks were caused mainly by flexure and they are closely related to the general convex shape of the basemat. This convex curvature would tend to introduce cracks at the top of combined structural elements (basemat plus walls), and not at the base of walls, which would be a compression zone.

Since the wall cracks have been identified close to the base and in most areas do not extend to a great height above the top of the mat, they are most likely caused by other than basemat flexure. A likely source is shrinkage, with the mat providing great local restraint to shrinkage movement in the walls. Therefore, some inter-relationship of cracks in the walls and basemat could exist but would be a local phenomenon, contributed by minor local basemat curvature readjustment.

## References

1. Analysis of Cracks and Water Seepage in Foundation Mat, Waterford SES Unit 3, Report No. 8304-1 dated September 19, 1983, by Harstead Engineering Associates Inc.
2. Field Trip Report, Waterford SES Unit 3 March 22, 1976 by P C Liu.
3. Memo on 'Ring Wall', WSES Unit 3, March 23, 1976 by E L Boyd.

# MAT DIFFERENTIAL SETTLEMENT CONTOURS IN INCHES VERSUS BLOCK 6 MOVEMENT



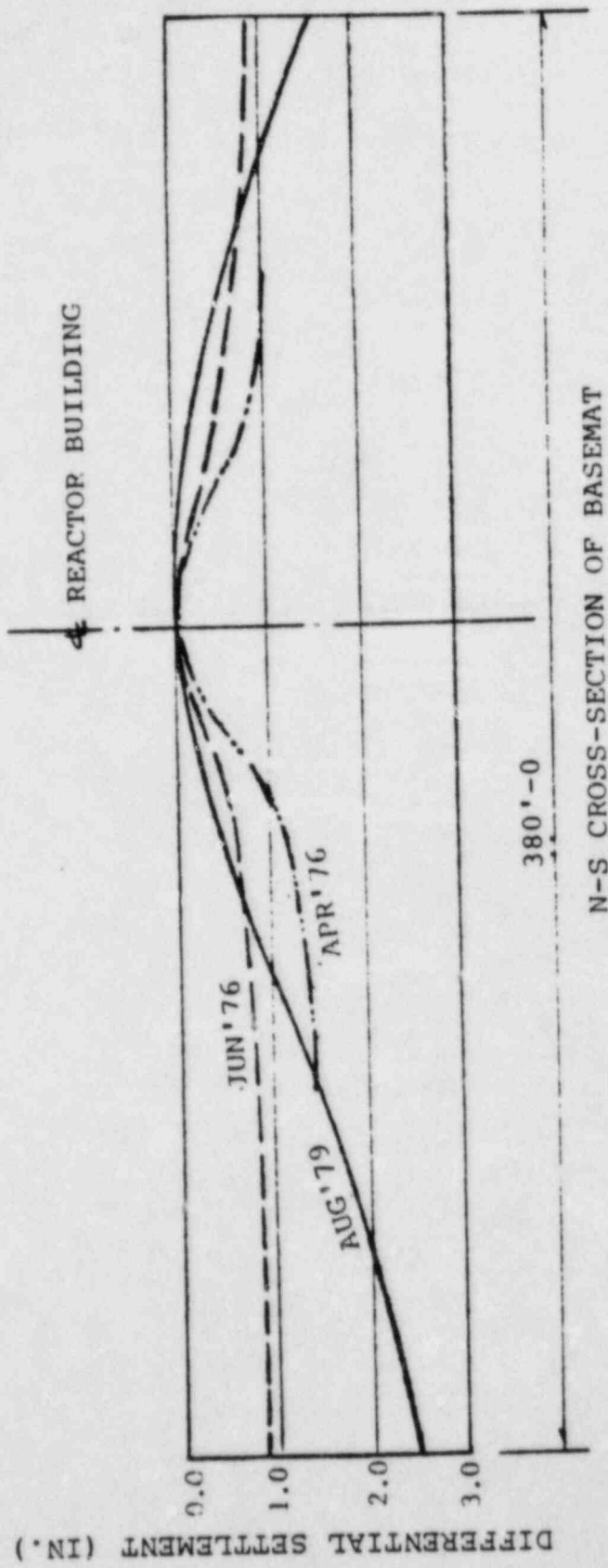
DATE 4/11/84

WATERFORD SES UNIT NO. 3  
BASEMAT PLACEMENT SEQUENCE AND  
DIFFERENTIAL SETTLEMENT CONTOURS

ERASCO SERVICES INCORPORATED

Figure 1





NOTE: VERTICAL EXAGGERATION = 300

DATE 11/1/84

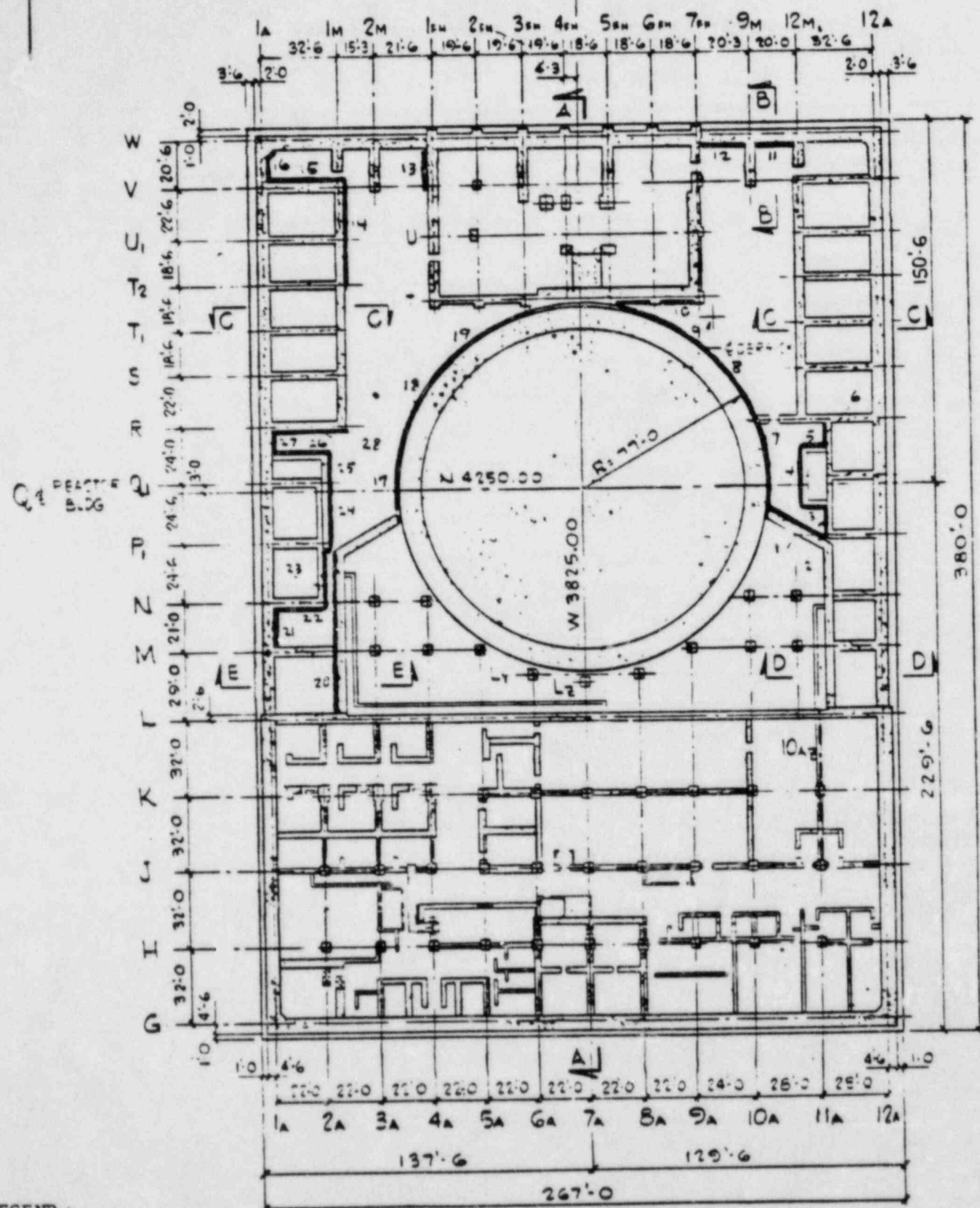
WATERFORD SES UNIT NO. 3  
BASEMAT CURVATURE

Figure 2

EBASCO SERVICES INCORPORATED

N  
↑

7A  
REACTOR BLDG



**LEGEND :**

8 see sheet 8, Appendix B

PLAN AT EL - 35.00'

DATE 4/1/84

WATERFORD SES UNIT NO. 3  
PLAN OF NPIS MAPPED WALLS  
EBASCO SERVICES INCORPORATED

Figure 3

APPENDIX "A"

WALL HAIRLINE CRACK MAPPING PROCEDURE

**EBASCO**

Interoffice Correspondence

DATE 3/30/84

FILE REF. 6Q-F-8

TO B Grant

OFFICE LOCATION Waterford Site

FROM E. S. Kowalski/P.C. Liu

OFFICE LOCATION

SUBJECT WATERFORD SES UNIT NO. 3  
NUCLEAR PLANT ISLAND STRUCTURE  
WALL HAIRLINE CRACK MAPPING PROCECURE

This subject procedure is attached for your use in mapping the wall hairline cracks of NPIS.

ESK/PCL:lh

Attach.

cc: J L Ehasz  
G A Kanakaris  
A H Wern  
J J Costello  
Project File



LOUISIANA POWER AND LIGHT COMPANY  
WATERFORD SES UNIT NO. 3

WALL HAIRLINE CRACK MAPPING PROCEDURE

1. The exposed wall surfaces in the areas between Reactor Building and wet and dry cooling towers, and between Fuel Handling and Reactor Auxiliary Buildings shall be visually inspected for the presence of cracks.
2. The visual inspection shall cover the areas of wall surfaces up to ten (10) ft. from the top of basemat El. -35.0 ft.
3. Location maps shall be prepared to record the results of the inspection. These maps shall be elevation views of the wall with cracks drawn on them to scale location.
4. Each location map shall include items as follows:
  - a. Date
  - b. Inspector's name
  - c. Checker's name
  - d. Crack locations - end points and approximate paths
  - e. Repair evidence
  - f. Seepage indication
  - g. Dimensions of areas covered by leachate
  - h. If the crack is extended down to mat level, the distance to the near-by mat cracks (not more than two (2) ft.).
5. A scale composite crack map shall be developed to show the general pattern of cracks on walls and the basemat.
6. The basemat crack maps which had been developed by Harstead Engineering Associates shall be utilized to develop the composite crack map.
7. Those basemat crack maps utilized shall be up-dated to include newly observed cracks, if any.

8. 35mm photos shall be taken for all mapped areas.
9. Laitance shall not be removed.

APPENDIX "B"

WALL CRACK MAPS

EBASCO SERVICES INCORPORATED

BY NACCARELLA DATE 4/2/84  
 CHKD. BY G.WU DATE 4/13/84

SHEET 1 OF 28  
 OFS NO. LDU 5234.016 DEPT. NO. 653

CLIENT L P & L  
 PROJECT WATERFORD #3  
 SUBJECT WALL CRACK MAP

LEGEND:

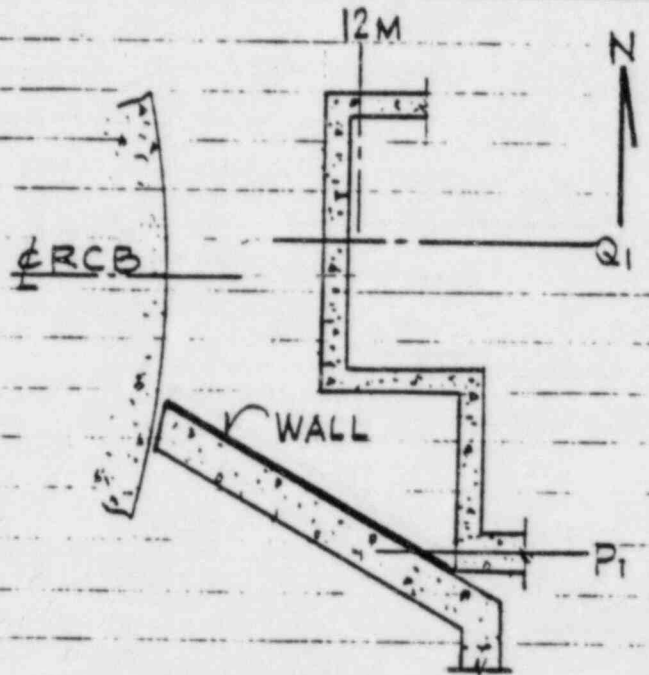


- DENOTES LEACHATE

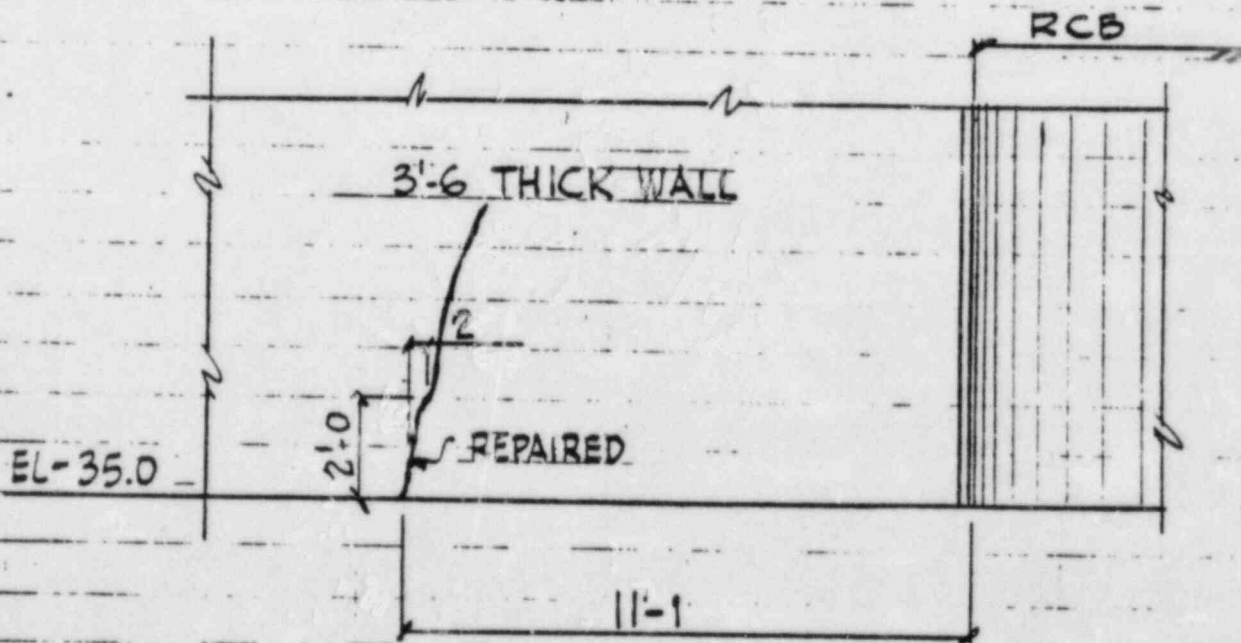


- VISIBLE HAIRLINE CRACK

NVC - NO VISIBLE CRACK



KEY PLAN



ELEV LOOKING SOUTH



# EBASCO SERVICES INCORPORATED

BY NACCARELLA DATE 4/2/84

CHKD. BY G. WV DATE 4/13/84

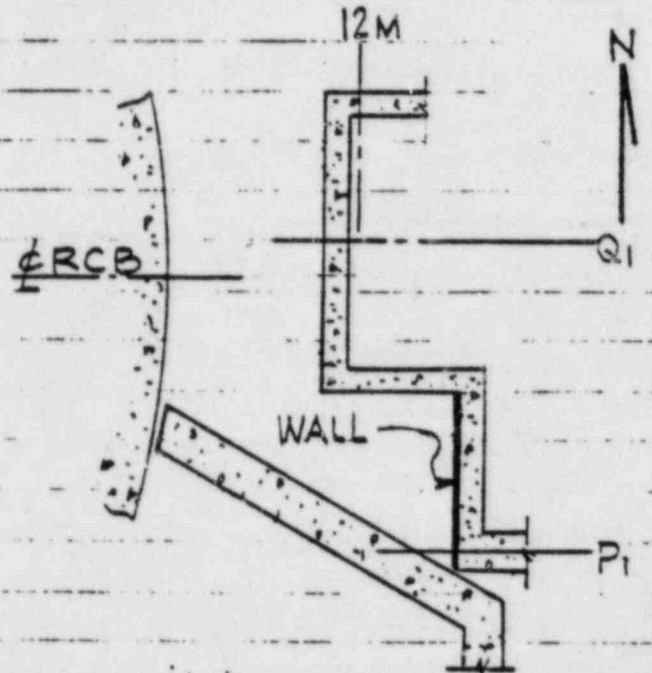
SHEET 2 OF 28

OFS NO. LOU 5234.016 DEPT. NO. 653

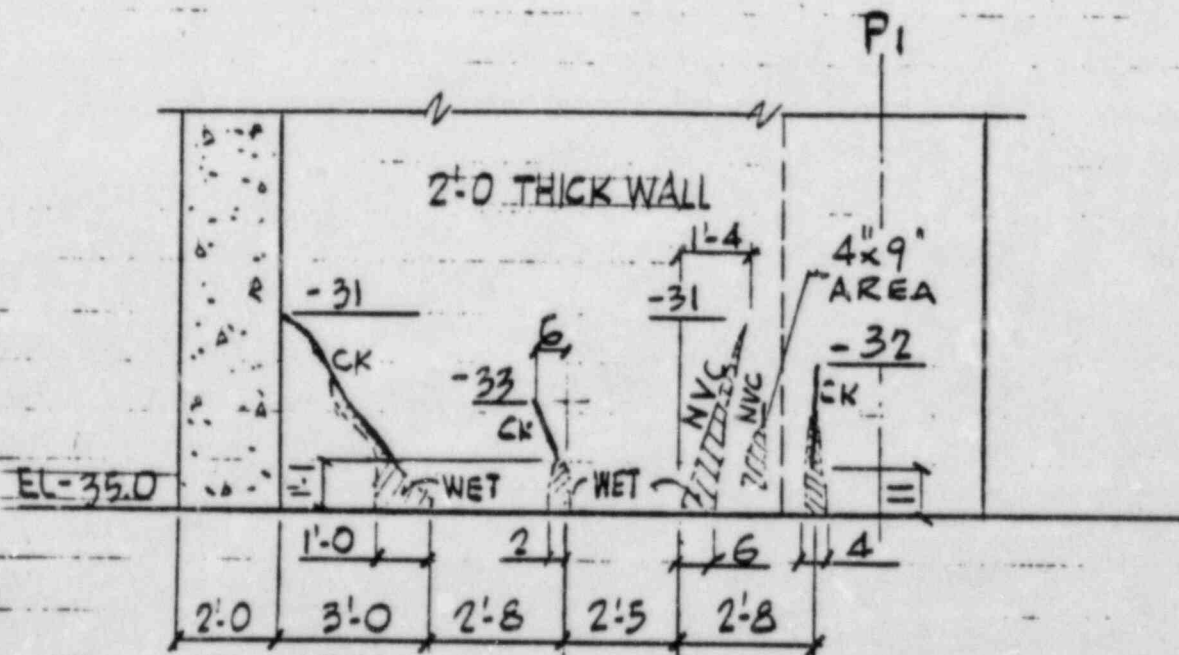
CLIENT LP&L

PROJECT WATERFORD #3

SUBJECT WALL CRACK MAP



KEY PLAN



ELEV. LOOKING EAST

EBASER SERVICES INCORPORATED

BY NACCARELLA DATE 4/2/83

CHKD. BY G. WU DATE 4/13, 2006

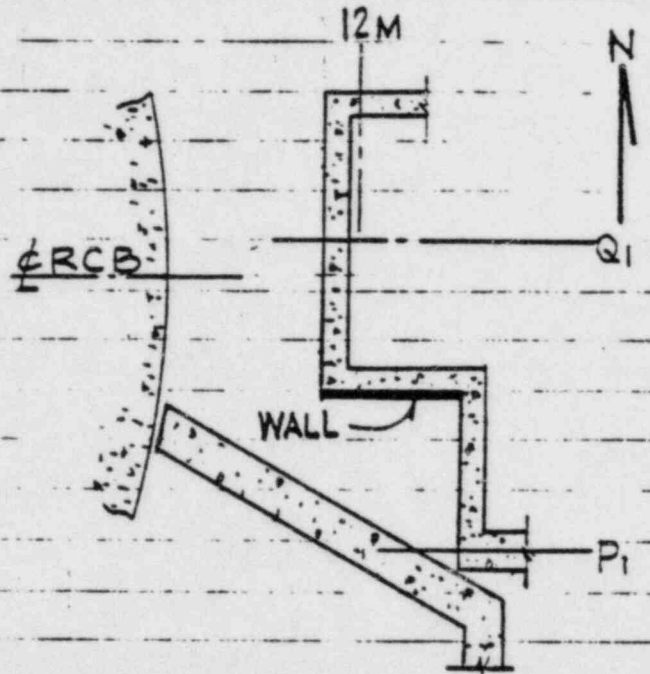
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PROJECT WATERFORD 'S

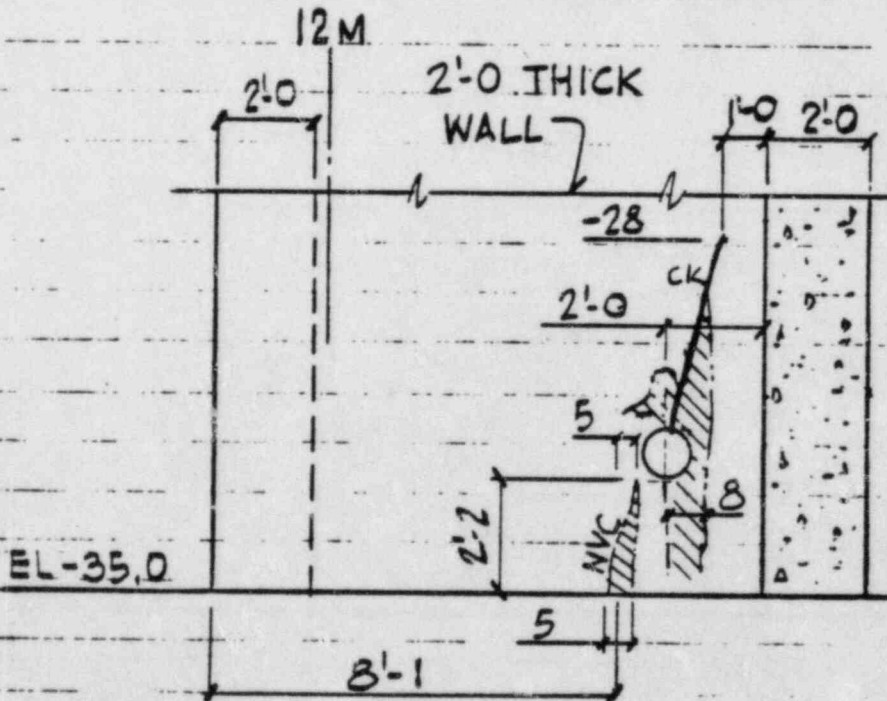
SUBJECT WALL CRACK MAP

SHEET 3 OF 28

OFS NO. LOU 5234.016 DEPT. NO. 653



## KEY PLAN



ELEV LOOKING NORTH

# EBASCO SERVICES INCORPORATED

BY NACCARELLA DATE 4/2/84

SHEET 4 OF 28

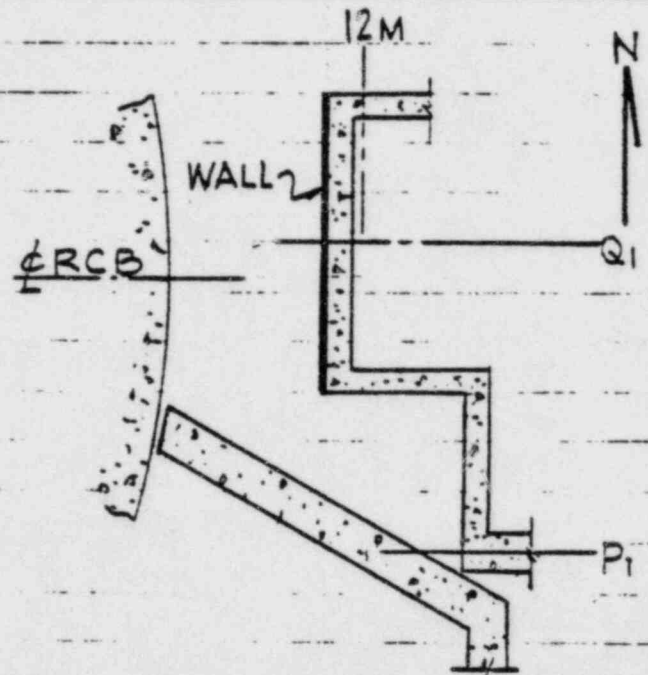
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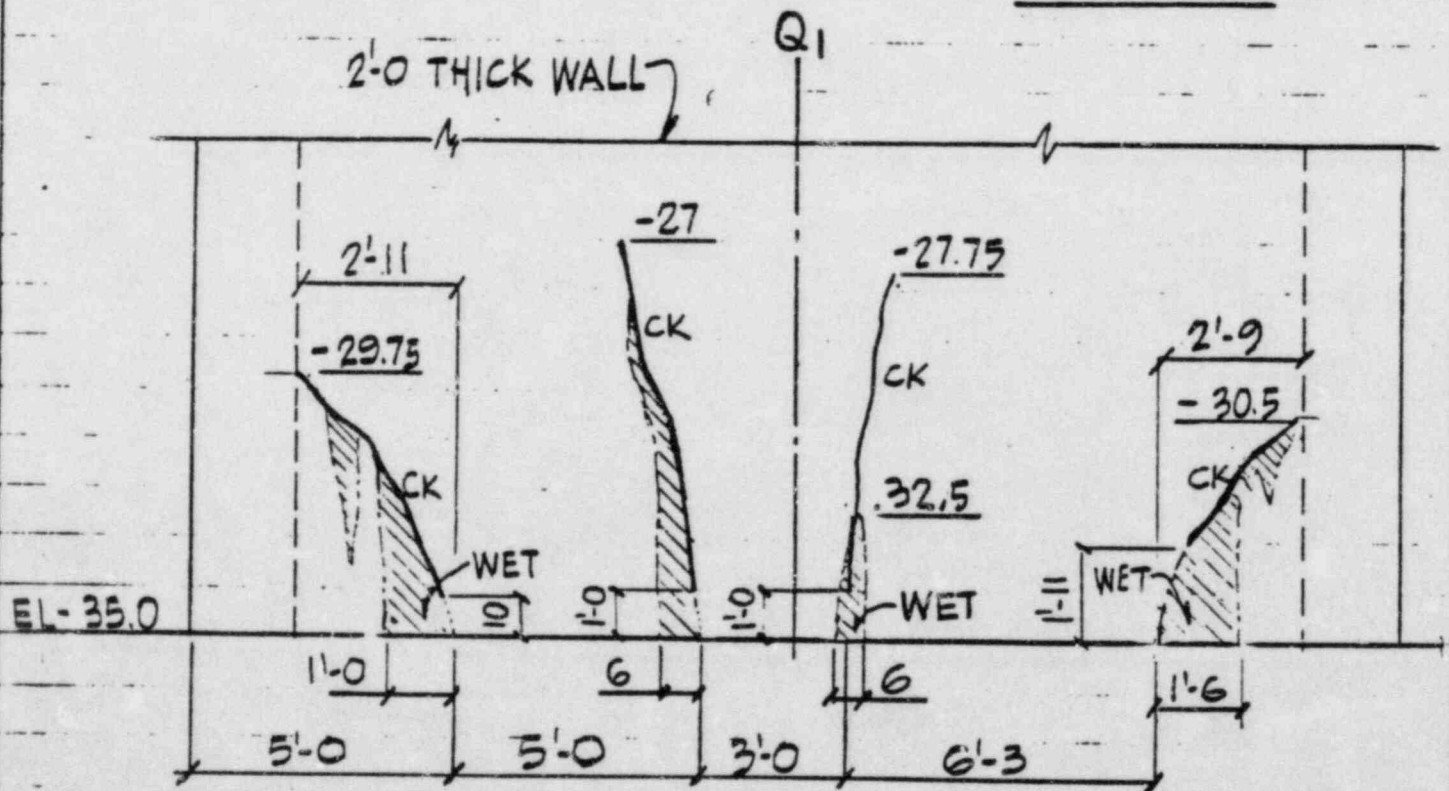
CLIENT L P & L

PROJECT WATERFORD #3

SUBJECT WALL CRACK MAP



KEY PLAN



ELEV LOOKING EAST

# EBASCO SERVICES INCORPORATED

BY T. KITZ DATE 4.2.84

CHKD. BY G. WU DATE 4/13/84

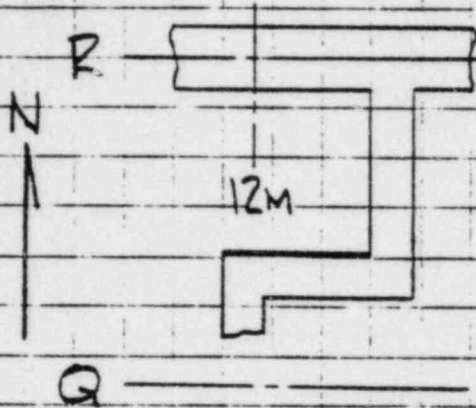
CLIENT LP & L

PROJECT WATERFORD S.E.S. NO 3

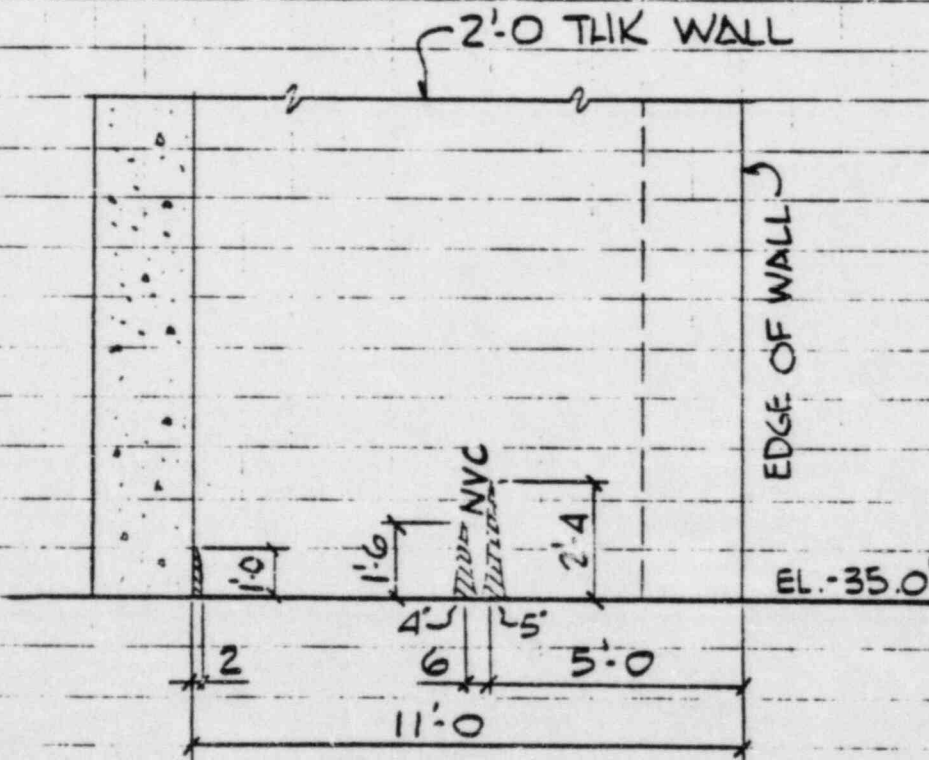
SUBJECT WALL CRACK MAP

SHEET 5 OF 28

OFS NO. LOU 5234.016 DEPT. NO. 653



KEY PLAN



ELEV. LKG SOUTH



EBASCO SERVICES INCORPORATED

BY T. KITZ DATE 4-2-84

CHKD. BY G. WU DATE 4/13/84

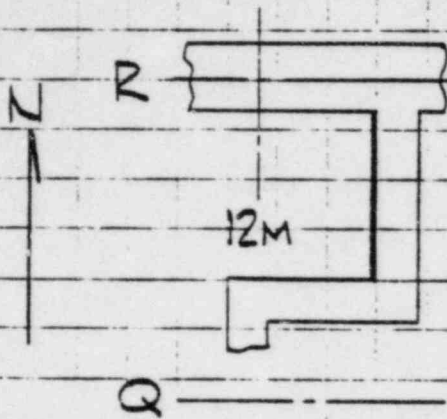
CLIENT LP & L

PROJECT WATER FORD S.E.S. NO 3

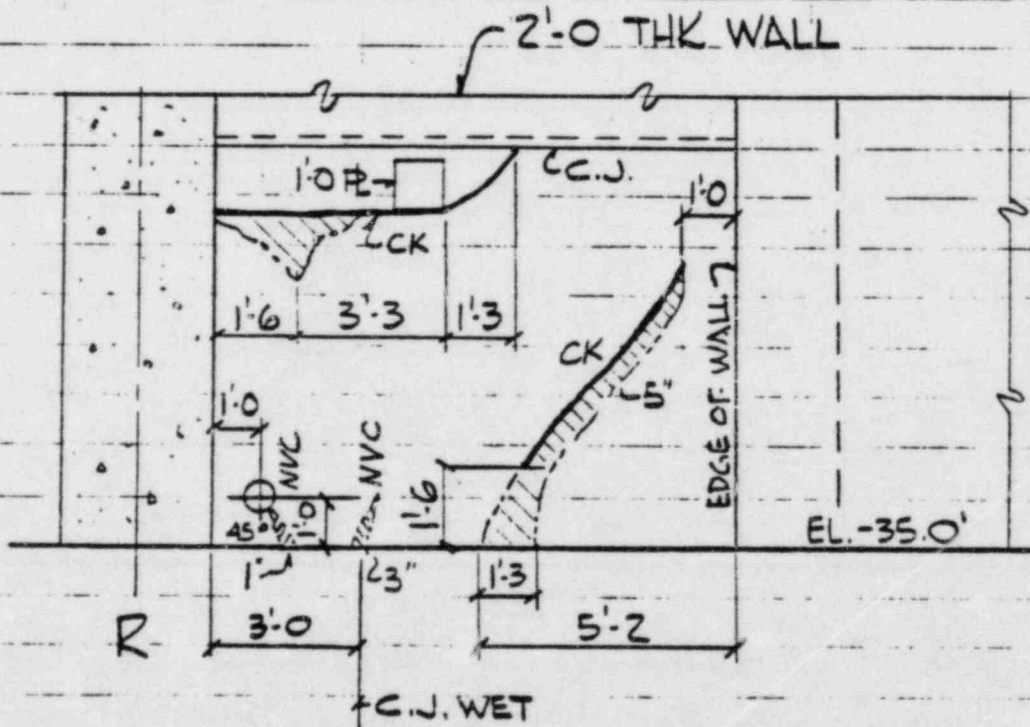
SUBJECT WALL CRACK MAP

SHEET 6 OF 28

OFS NO. LOU 5234.016 DEPT. NO. 653



KEY PLAN



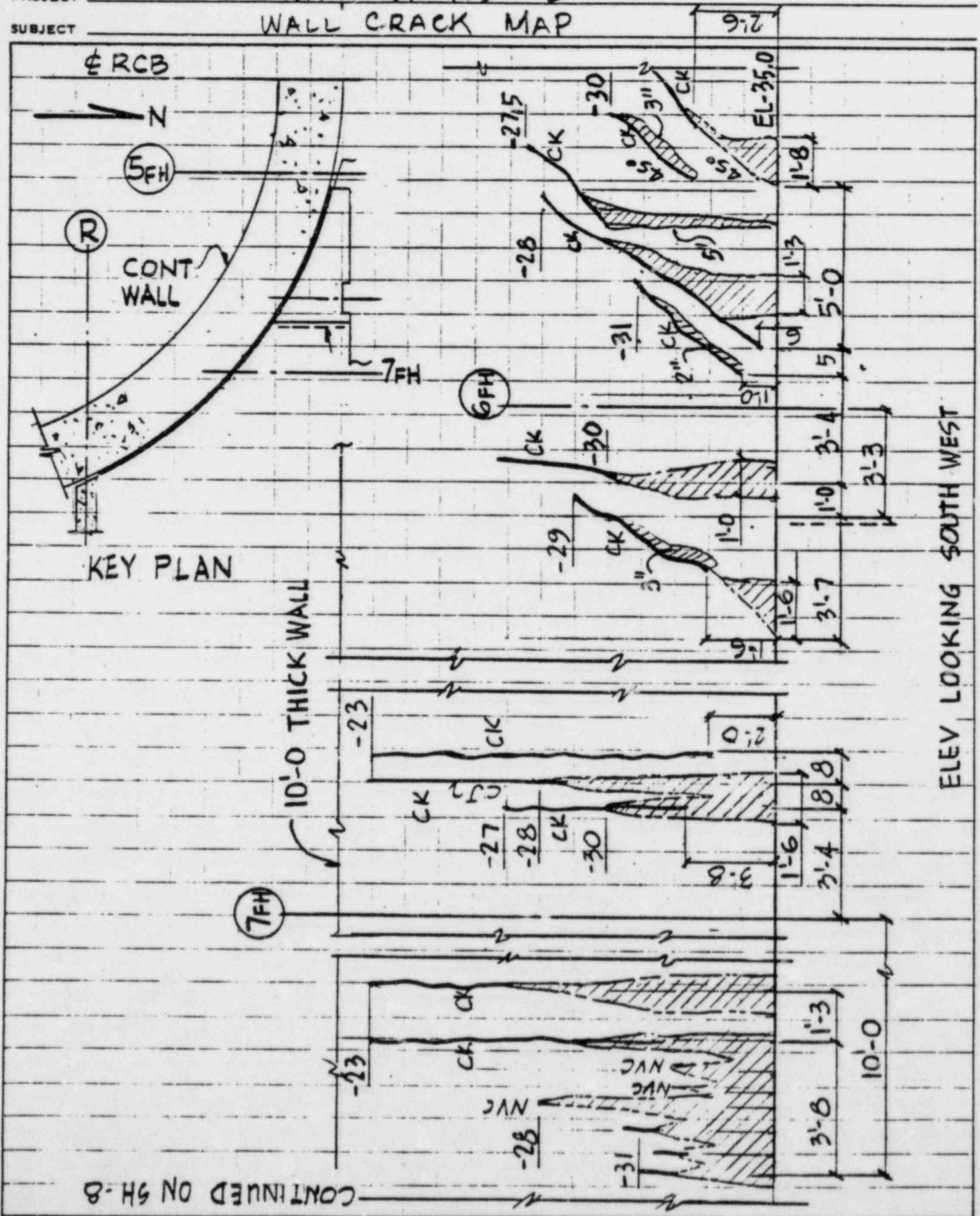
WALL-ELEV. LKG EAST

# EBASCO SERVICES INCORPORATED

BY NACCARELLA DATE 4/1/84  
 CHKD. BY G.WU DATE 9/5/84

SHEET 7 OF 28  
 OFS NO. LOU5234.016 DEPT. NO. 653

CLIENT L P & L  
 PROJECT WATERFORD #3  
 SUBJECT WALL CRACK MAP







# EBASCO SERVICES INCORPORATED

BY NACCARELLA DATE 4/1/84

CHKD. BY G.W.H. DATE 4/15/84

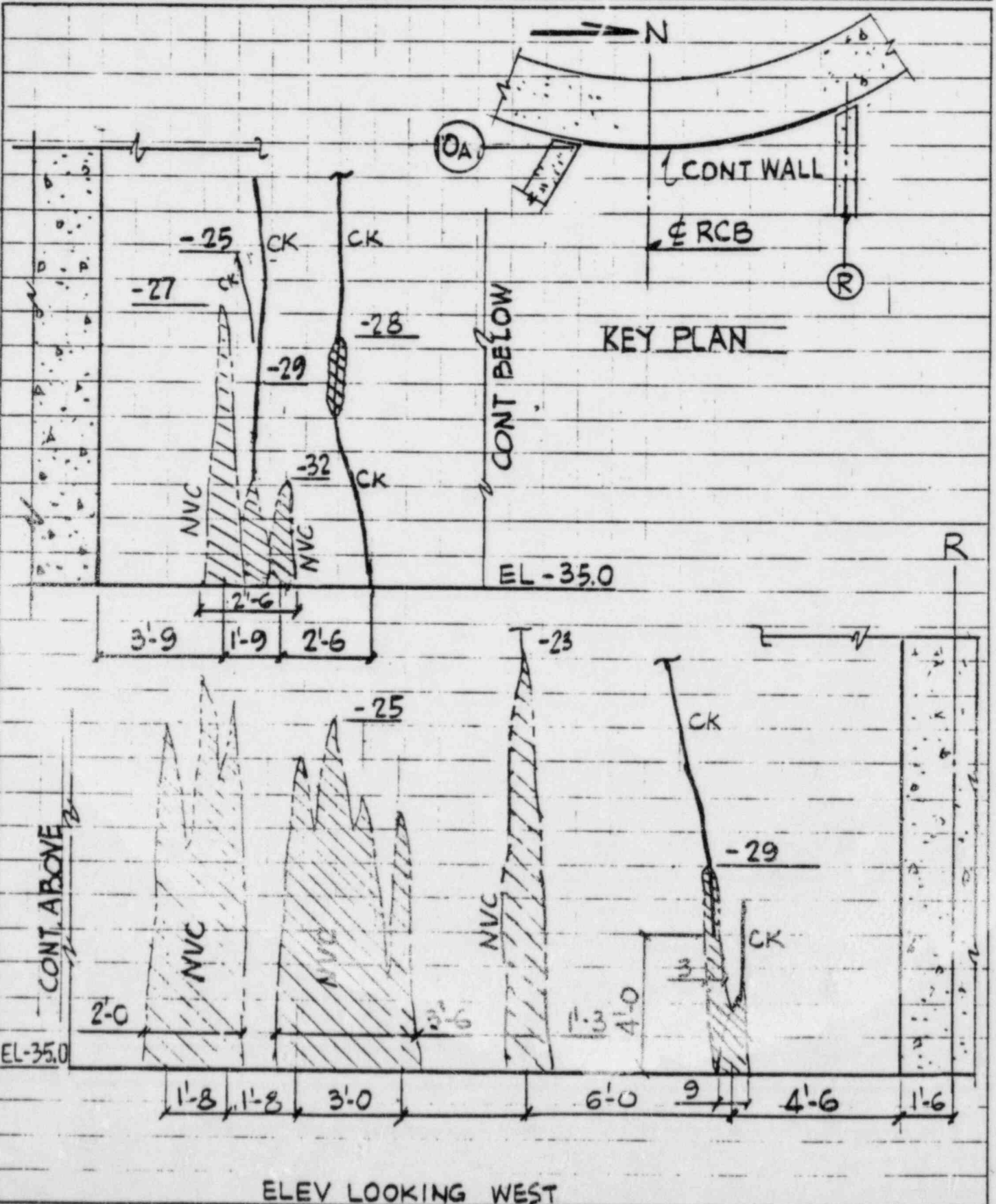
SHEET 9 OF 28

OFS NO. 105234.016 DEPT. NO. 653

CLIENT L P & L

PROJECT WATERFORD #3

SUBJECT WALL CRACK MAP





EBASCO SERVICES INCORPORATED

BY L. SAFRO DATE 4-2-88

CHKD. BY G.W.V. DATE 9/13/88

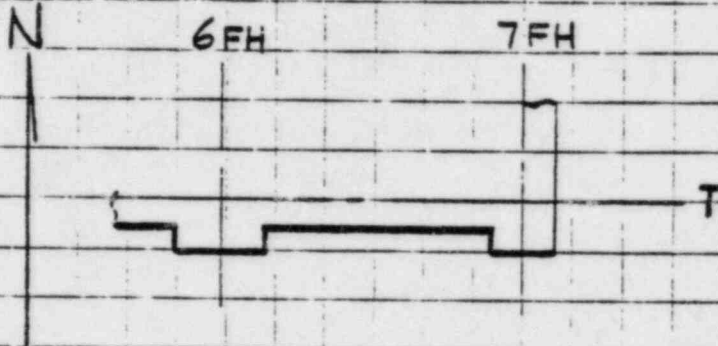
CLIENT LP & L

PROJECT WATERFORD S.E.S. UNIT N#3

SUBJECT WALL CRACK MAP

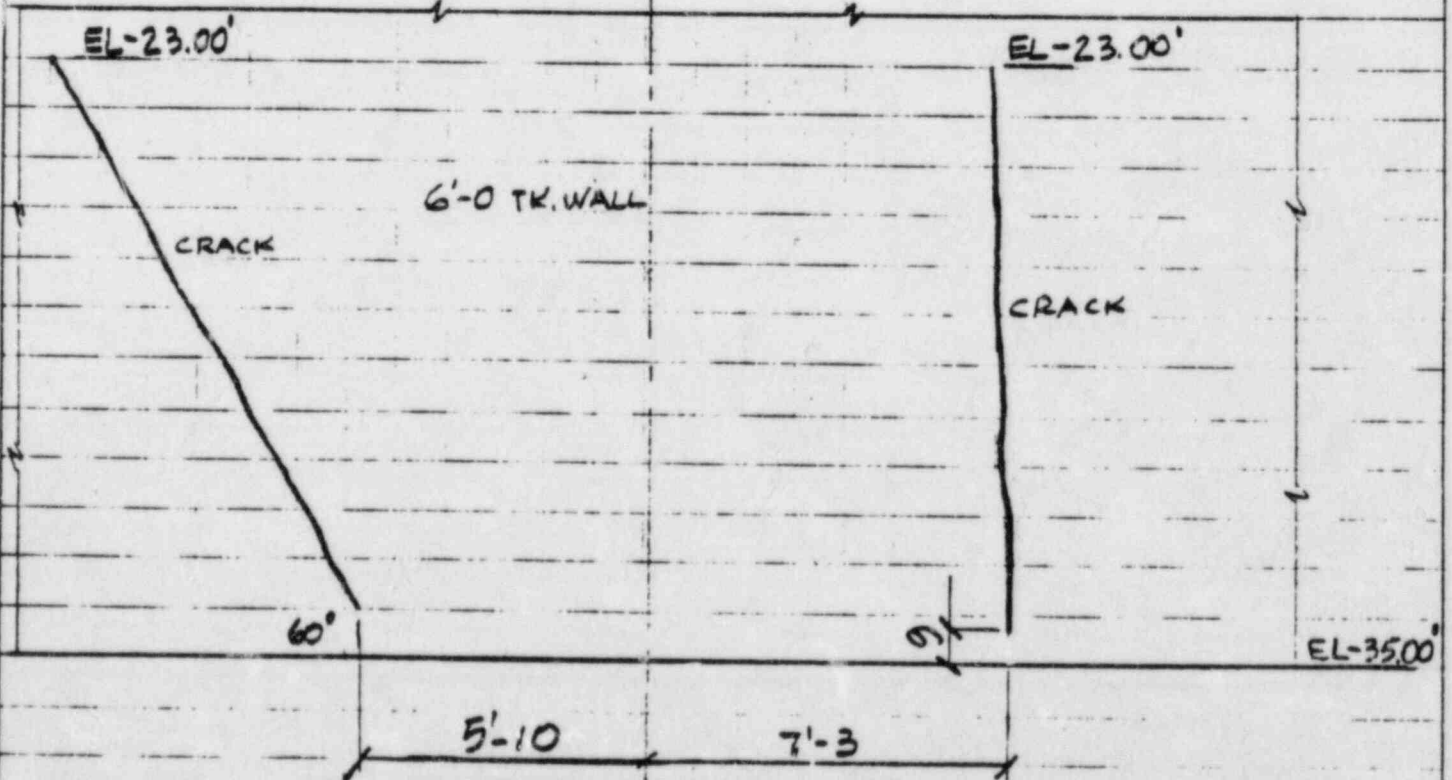
SHEET 10 OF 28

OFS NO. LOW5234.016 DEPT. NO. 016



KEY PLAN

6FH



WALL - ELEV LKG. NORTH

# EBASCO SERVICES INCORPORATED

BY I. S. AFRO DATE 4-2-84

SHEET 11 OF 28

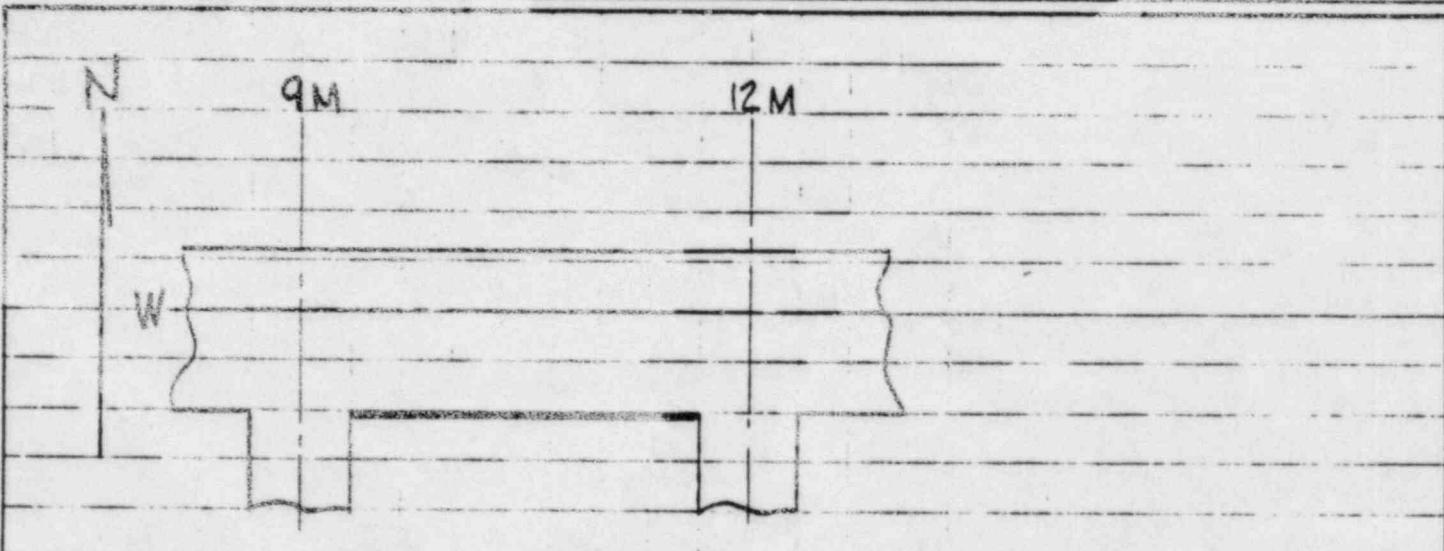
CHKD. BY EWY DATE 4/13/84

OFS NO. LOW 5234.016 DEPT. NO. 653

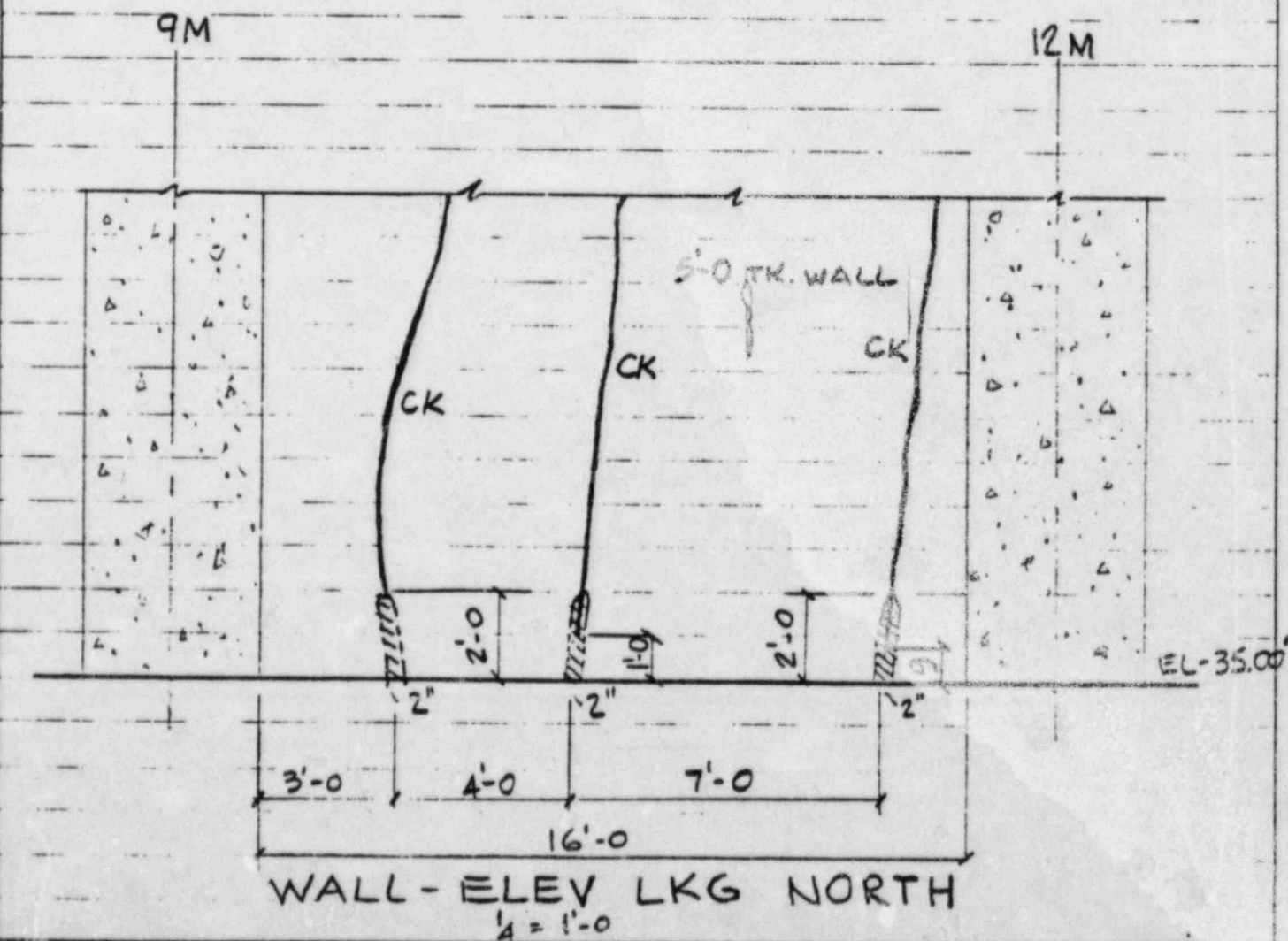
CLIENT L P E L

PROJECT WATERFORD S.E.S. UNIT NO 3

SUBJECT WALL CRACK MAP



KEY PLAN



## EBASCO SERVICES INCORPORATED

BY L. SA FRO DATE 4-2-84

CHKD. BY EWU DATE 9/13/84

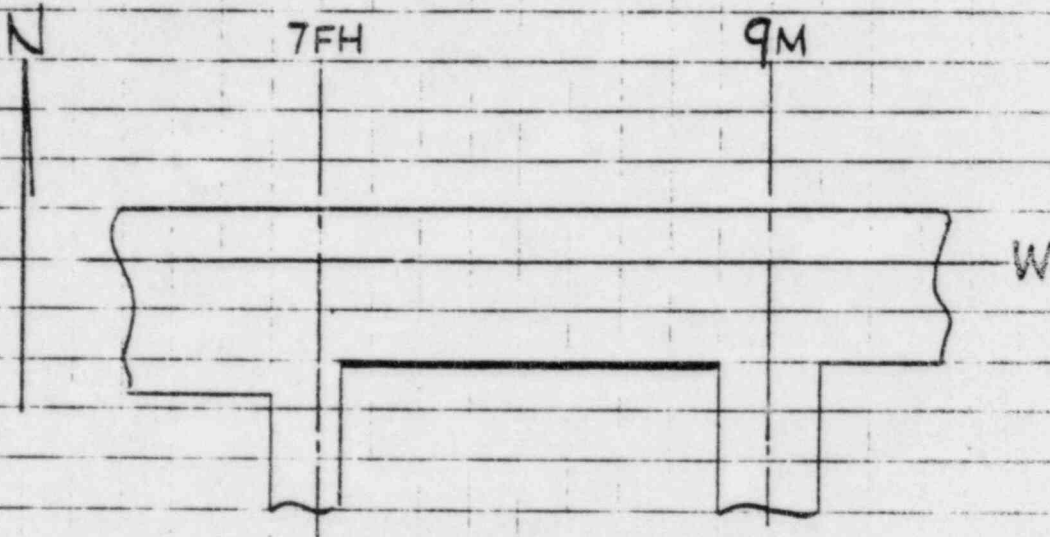
CLIENT LP E L

PROJECT WATERFORD S.E.S. UNIT 1:3

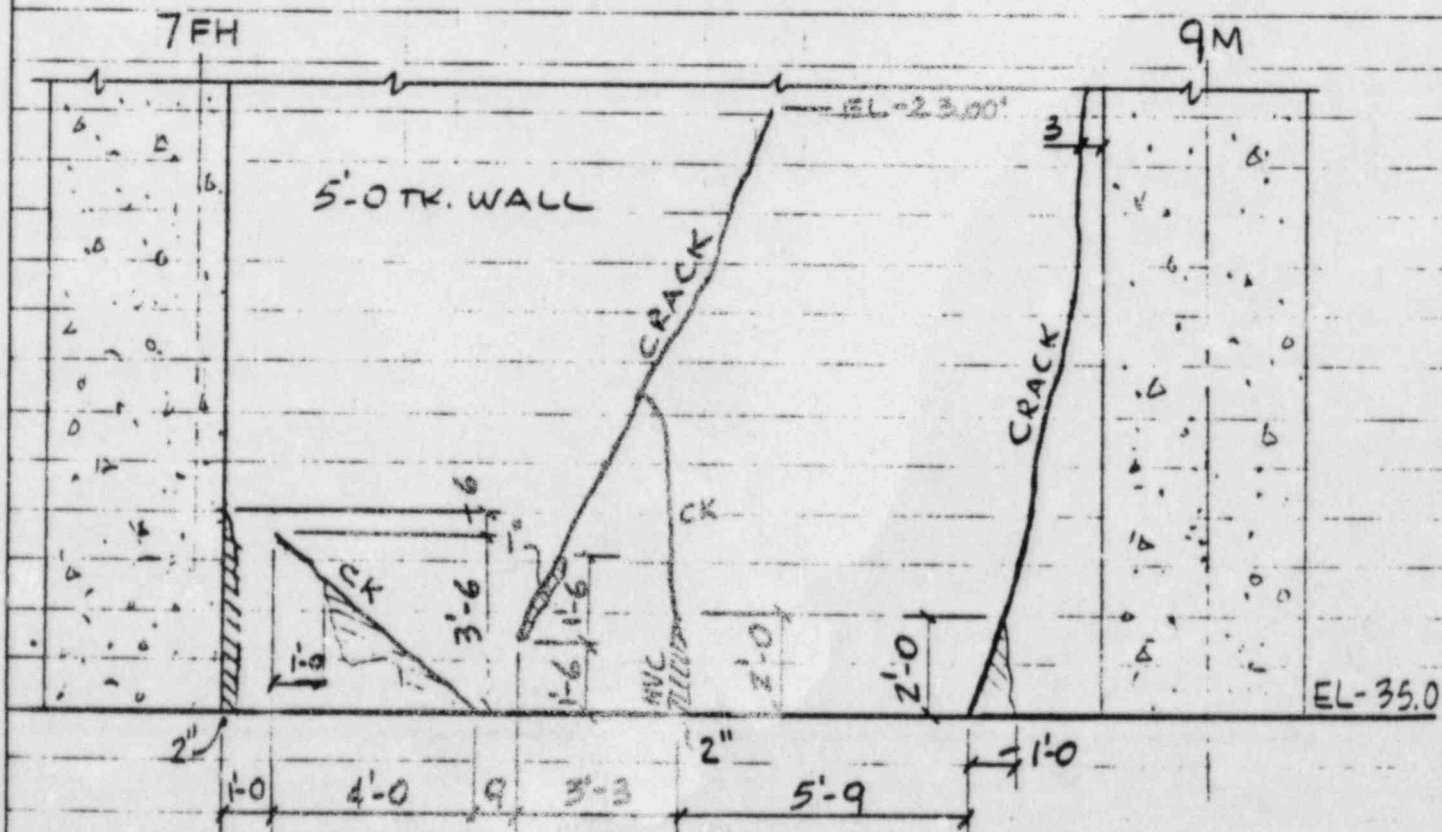
SUBJECT WALL CRACK MAP

SHEET 12 OF 28

OFFS NO. LOU 5234.016 DEPT. NO. 653



## KEY PLAN



WALL - ELEV LKG NORTH

$$0-1=1$$

# EBASCO SERVICES INCORPORATED

BY FSchrimpe DATE 4-2-84

CHKD. BY SWH DATE 2/13/84

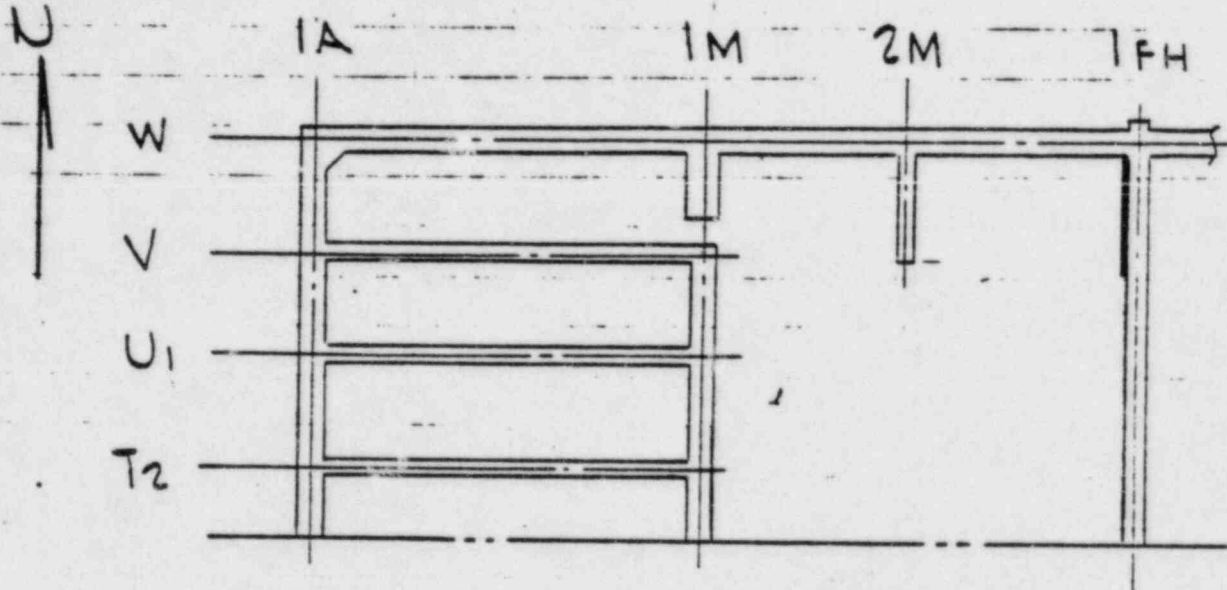
SHEET 13 OF 28

OFS NO. LOU 5234.016 DEPT. NO. 653

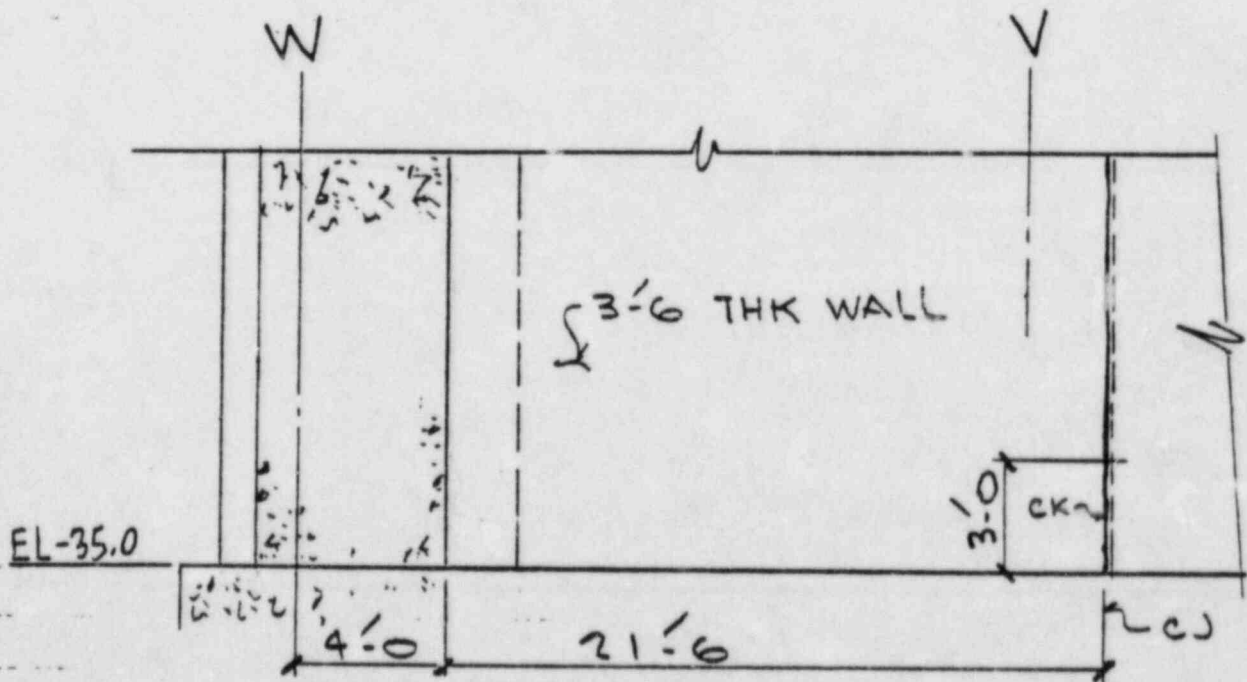
CLIENT LP&L

PROJECT WATERFORD #3

SUBJECT WALL CRACK MAP



KEY PLAN  
STS



ELEV (LKG EAST)

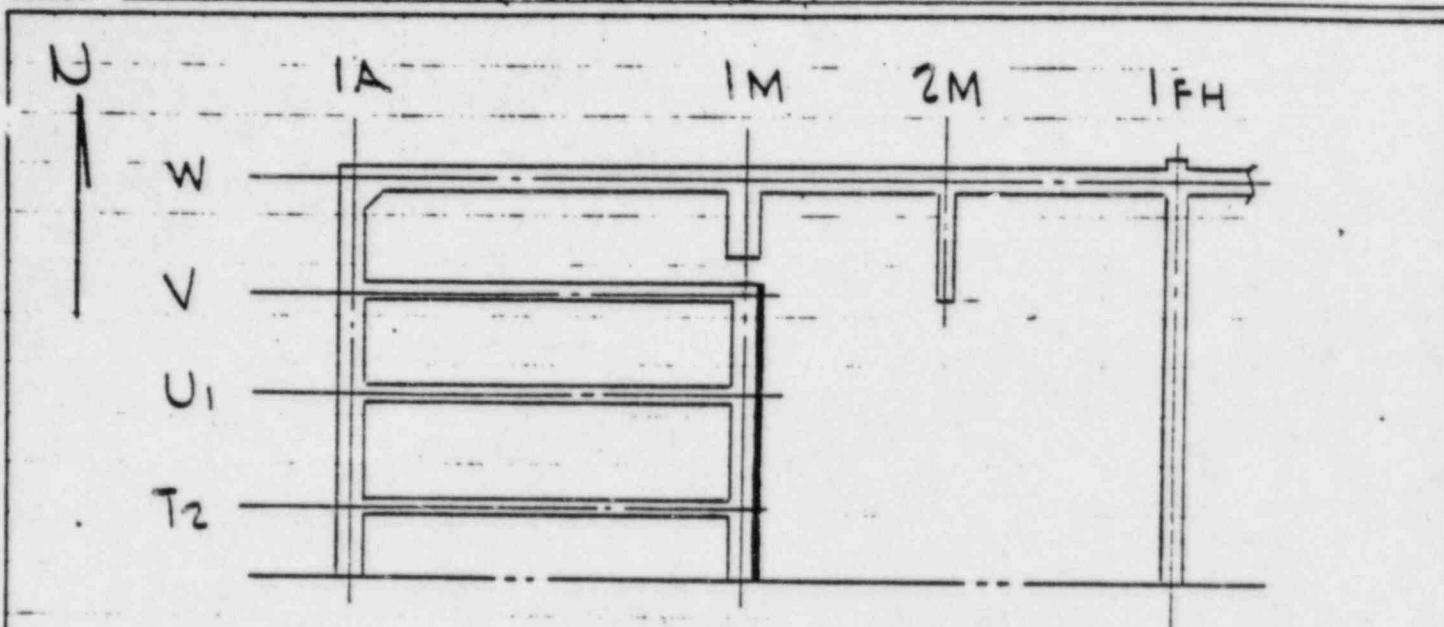


EBASCO SERVICES INCORPORATED

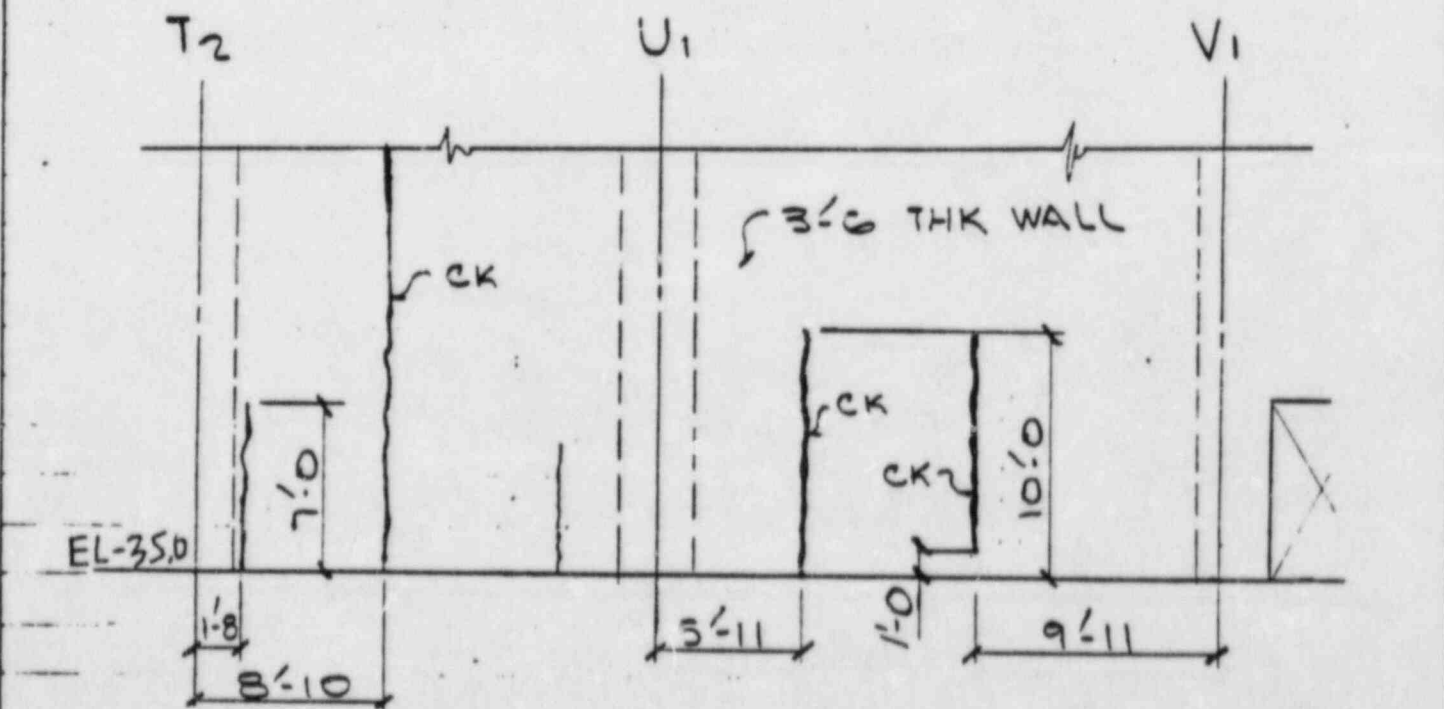
BY F Schrimpe DATE 4-2-80  
 CHKD. BY G Wu DATE 4/13/84

SHEET 14 OF 28  
 OFS NO. LOU 5234.016 DEPT. NO. 653

CLIENT LP&L  
 PROJECT WATERFORD #3  
 SUBJECT WALL CRACK MAP



KEY PLAN  
 215



ELEV (LKG WEST)

# EBASCO SERVICES INCORPORATED

BY FSchrimpe DATE 4-2-84

CHKD. BY G.W. DATE 4/13/84

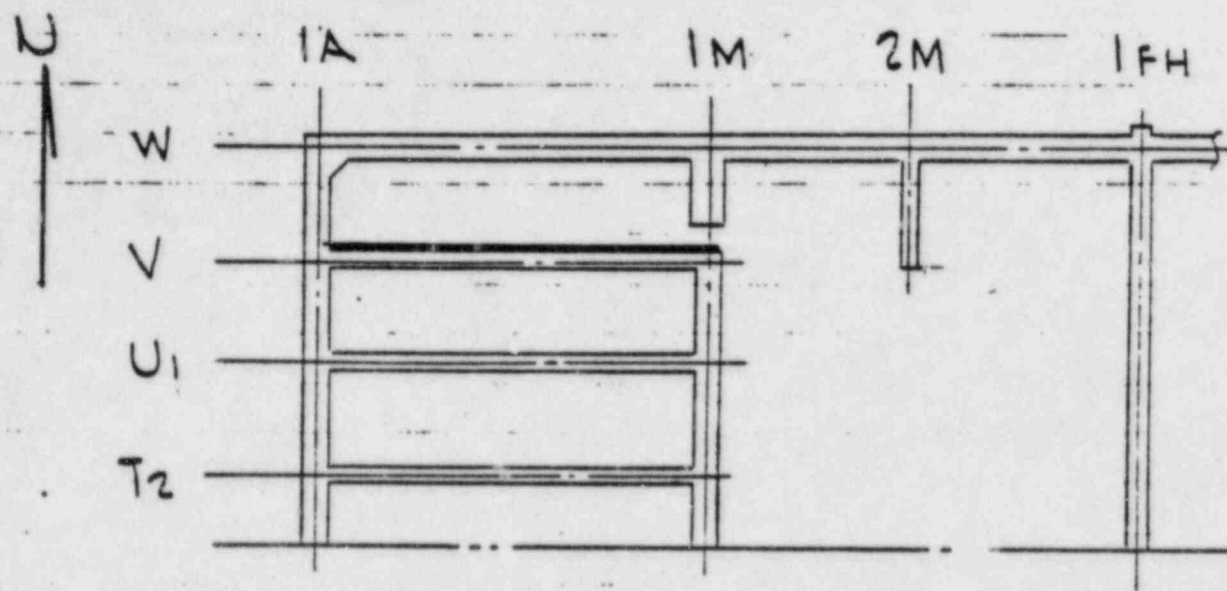
SHEET 15 OF 28

OFFS NO. LOW 5234.016 DEPT. NO. 016

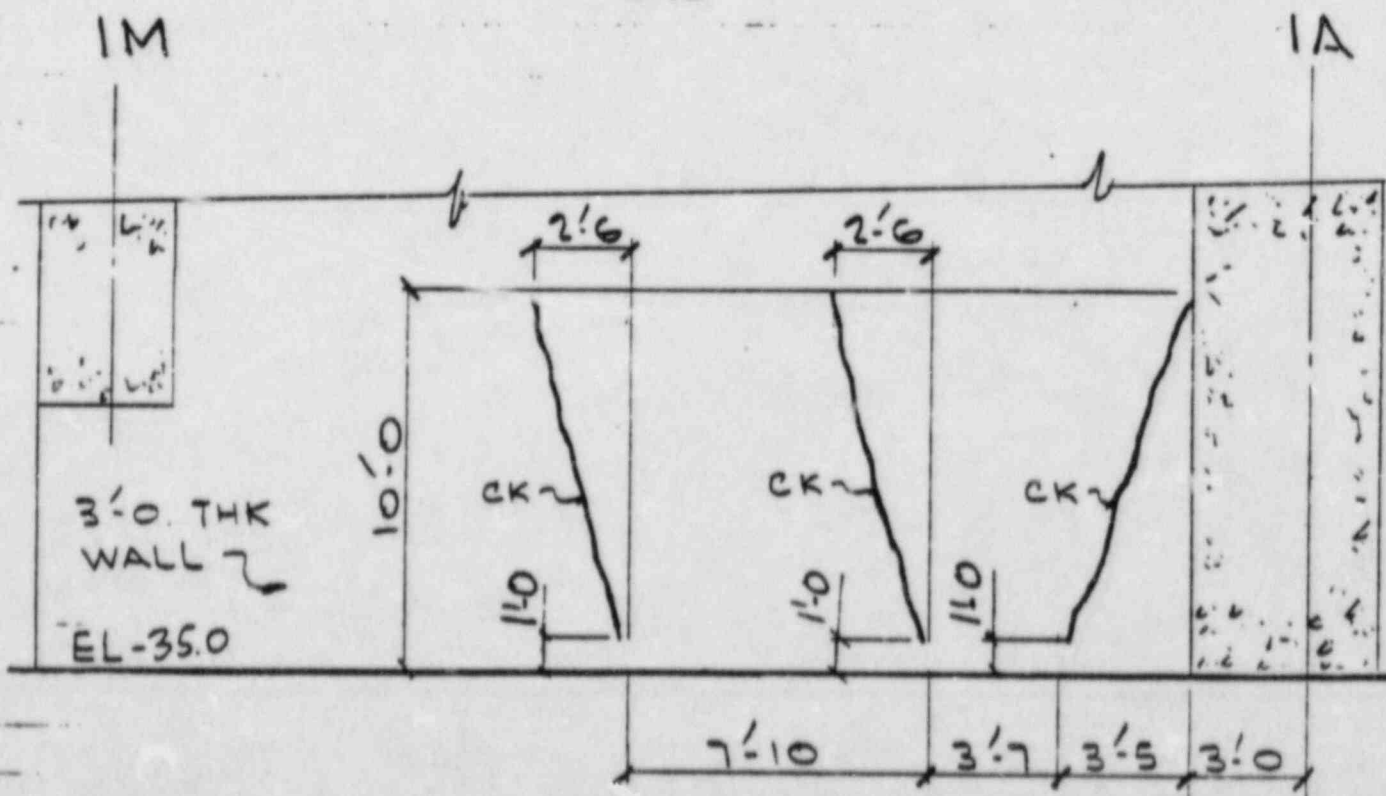
CLIENT LP&L

PROJECT WATERFORD #3

SUBJECT WALL CRACK MAP



KEY PLAN  
DTS



ELEV (LKG SOUTH)

# EBASCO SERVICES INCORPORATED

BY F Schrimpe DATE 4-2-84

CHKD. BY G.W. DATE 4/13/84

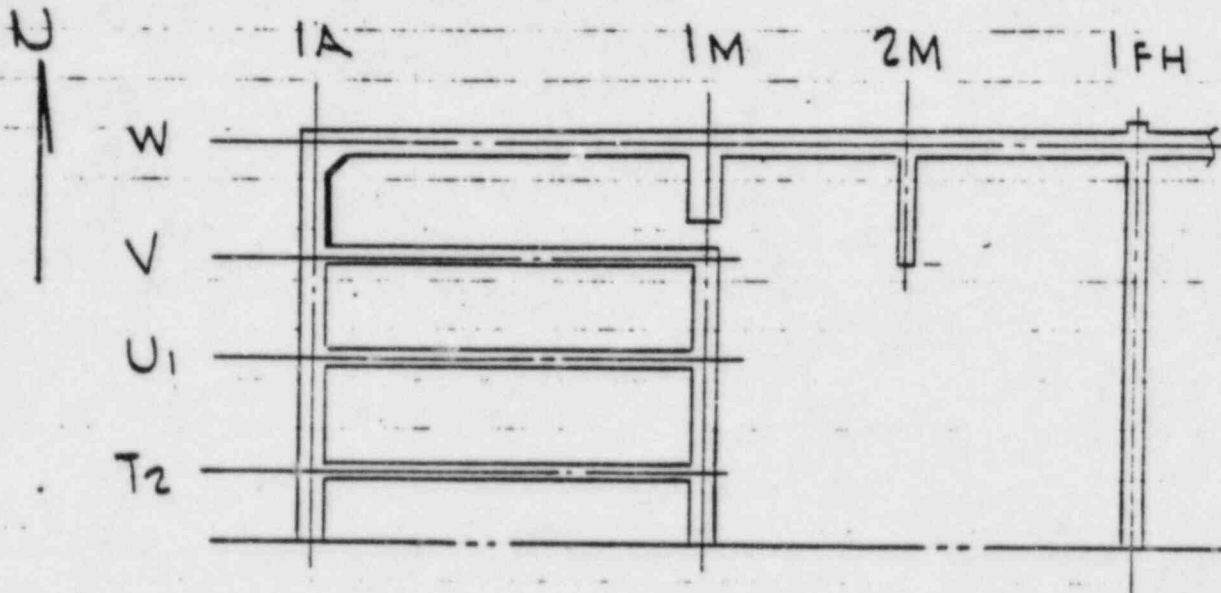
SHEET 16 OF 28

OFS NO. LOU 5234.016 DEPT. NO. 653

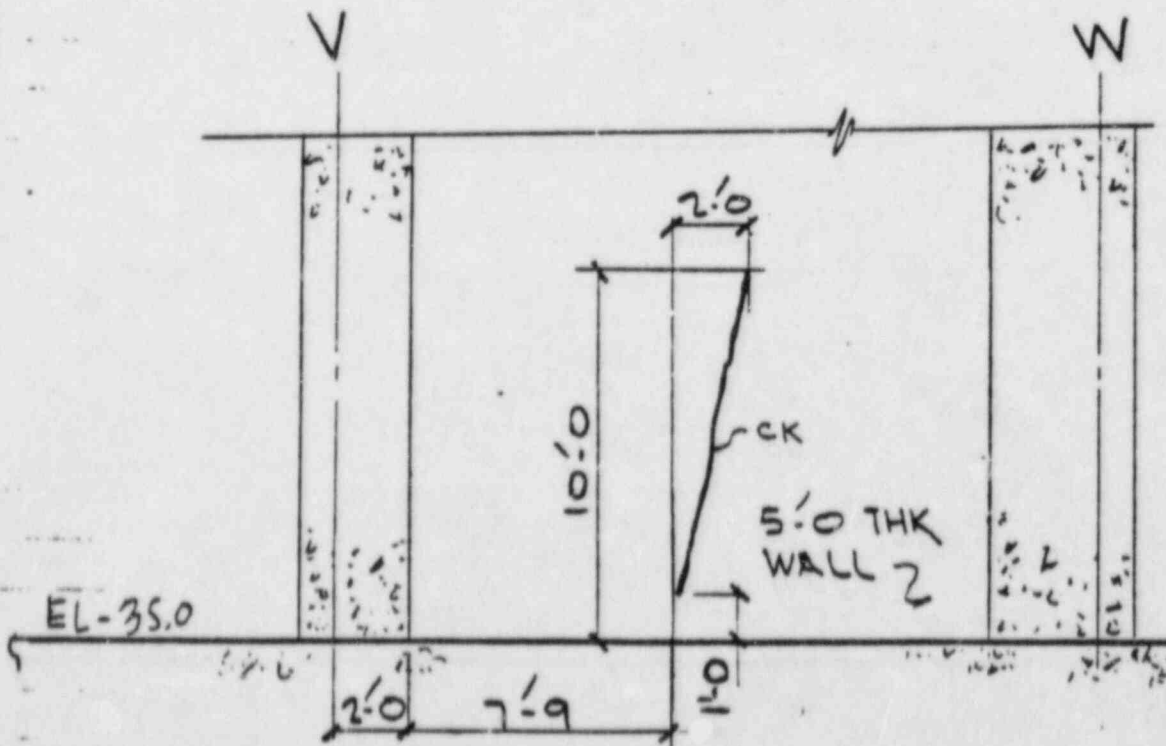
CLIENT LP&L

PROJECT WATERFORD #3

SUBJECT WALL CRACK MAP



KEY PLAN  
STS



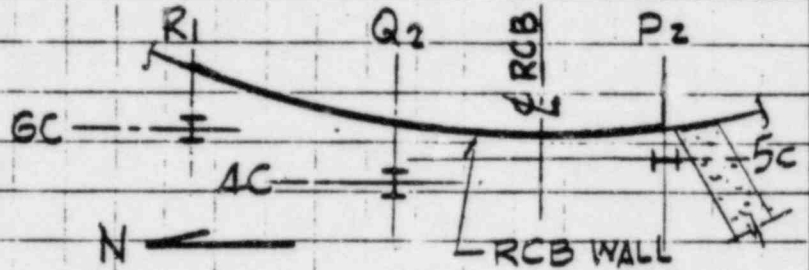
ELEV (LKG WEST)

# EBASCO SERVICES INCORPORATED

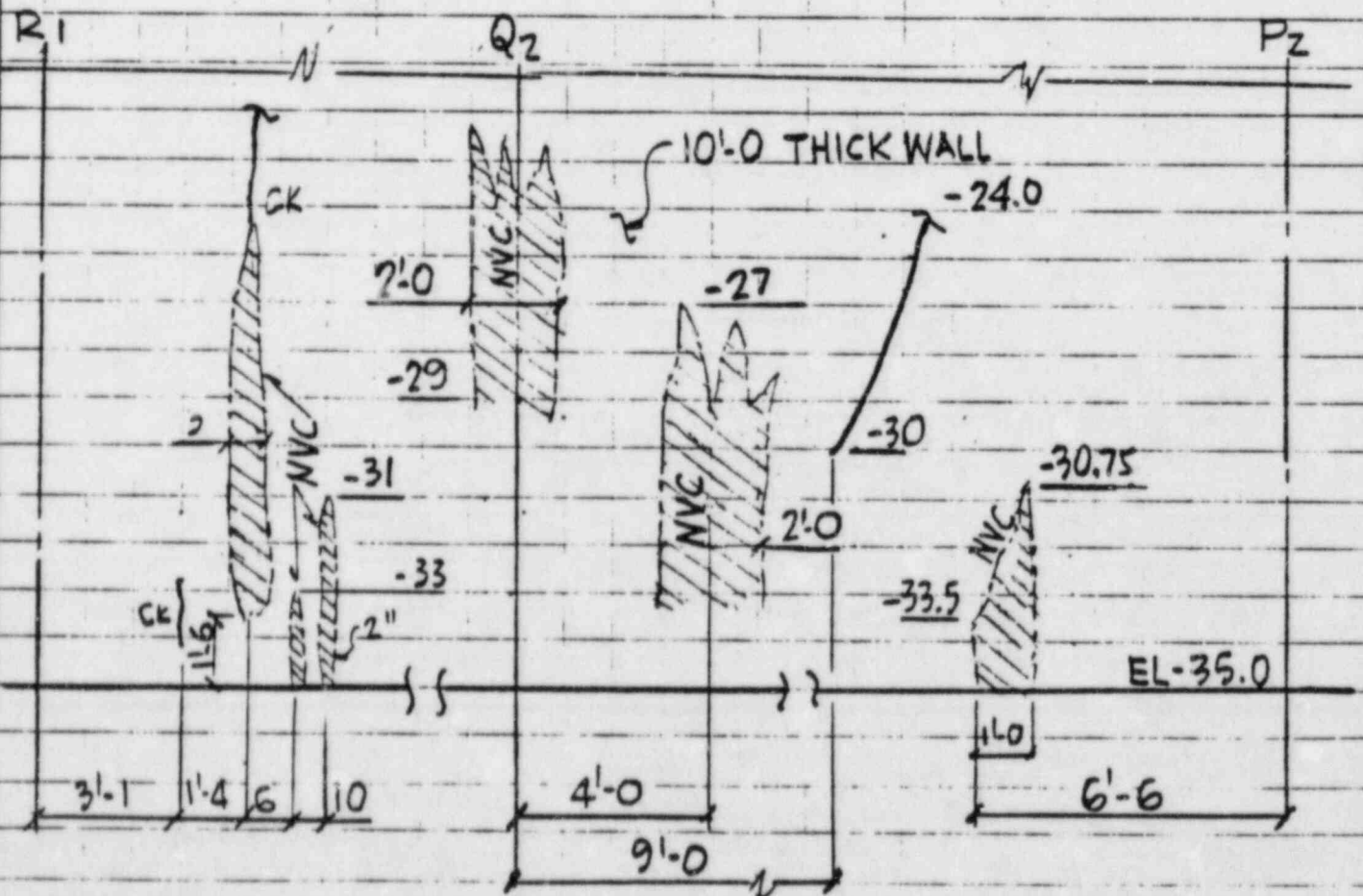
BY NACCARELLA DATE 4/2/84  
 CHKD. BY S.W.U. DATE 4/15/84

SHEET 17 OF 28  
 OFS NO. LOW 5234.D16 DEPT. NO. 653

CLIENT L P & L  
 PROJECT WATERFORD #3  
 SUBJECT WALL CRACK MAP



KEY PLAN



ELEV LOOKING EAST



**EBASCO SERVICES INCORPORATED**

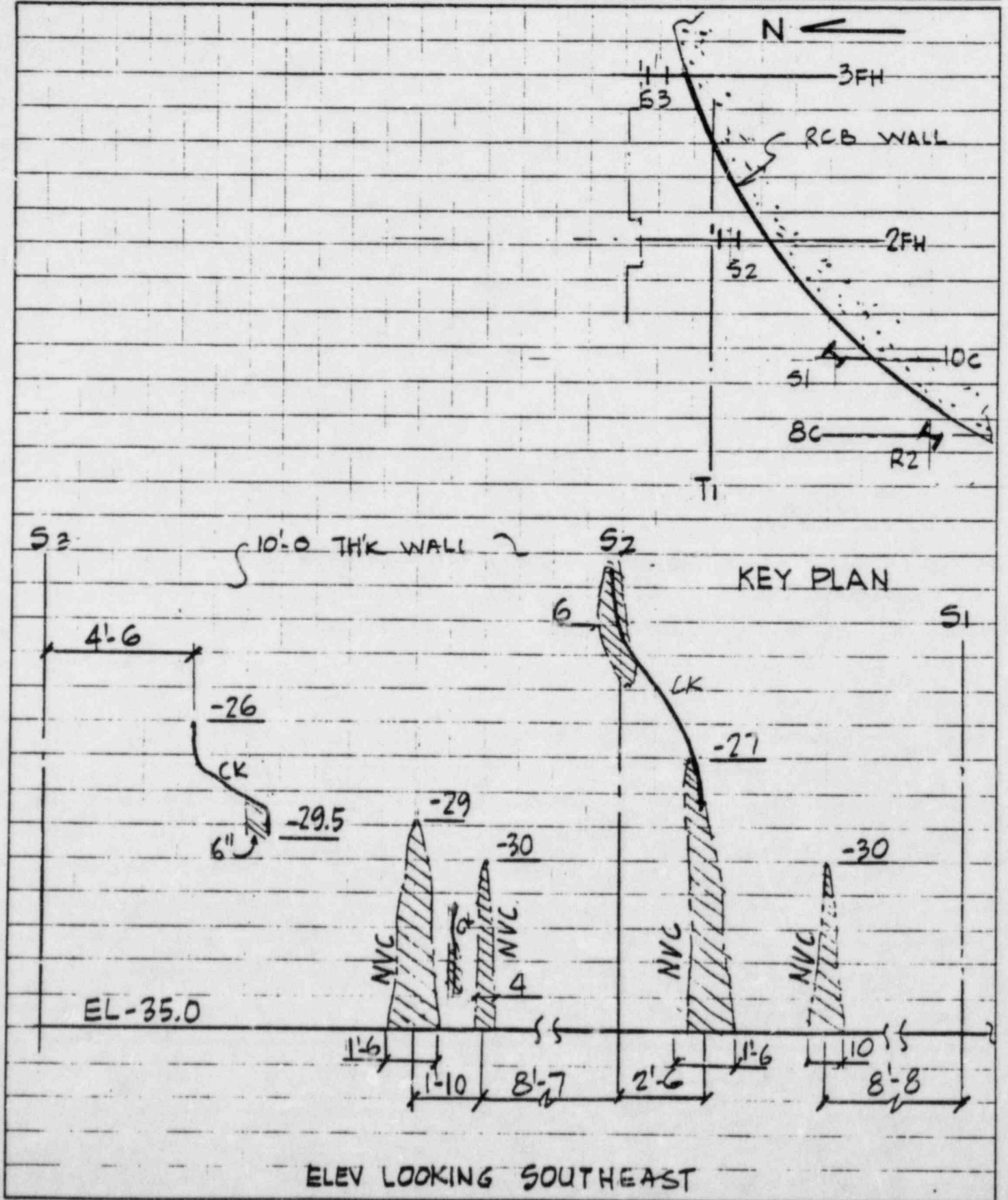
BY NACCARELLA DATE 4/2/84  
CHKD. BY G. WU DATE 4/13/84

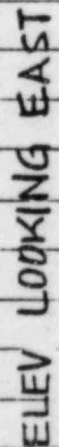
SHEET 18 OF 28  
OFS NO. 1245234.016 DEPT. NO. 653

CLIENT L P & L

PROJECT WATERFORD III

SUBJECT WALL CRACK MAP





**EBASCO SERVICES INCORPORATED**

BY I. SAFRO DATE 4-2-84

CHKD. BY G. WU DATE 4/13/84

CLIENT L P E L Co

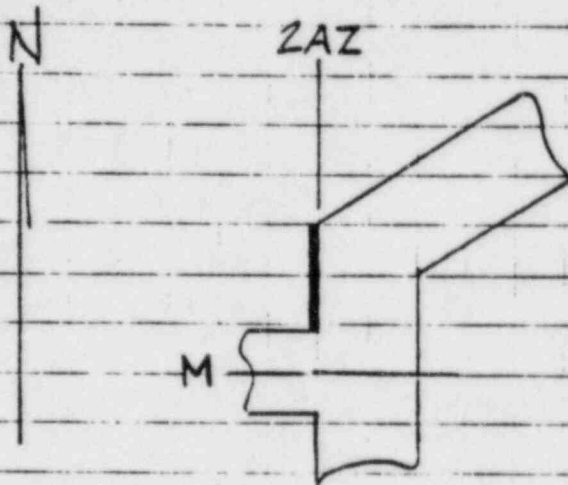
PROJECT WATERFORD S.E.S. UNIT N°3

SUBJECT WALL CRACK MAP

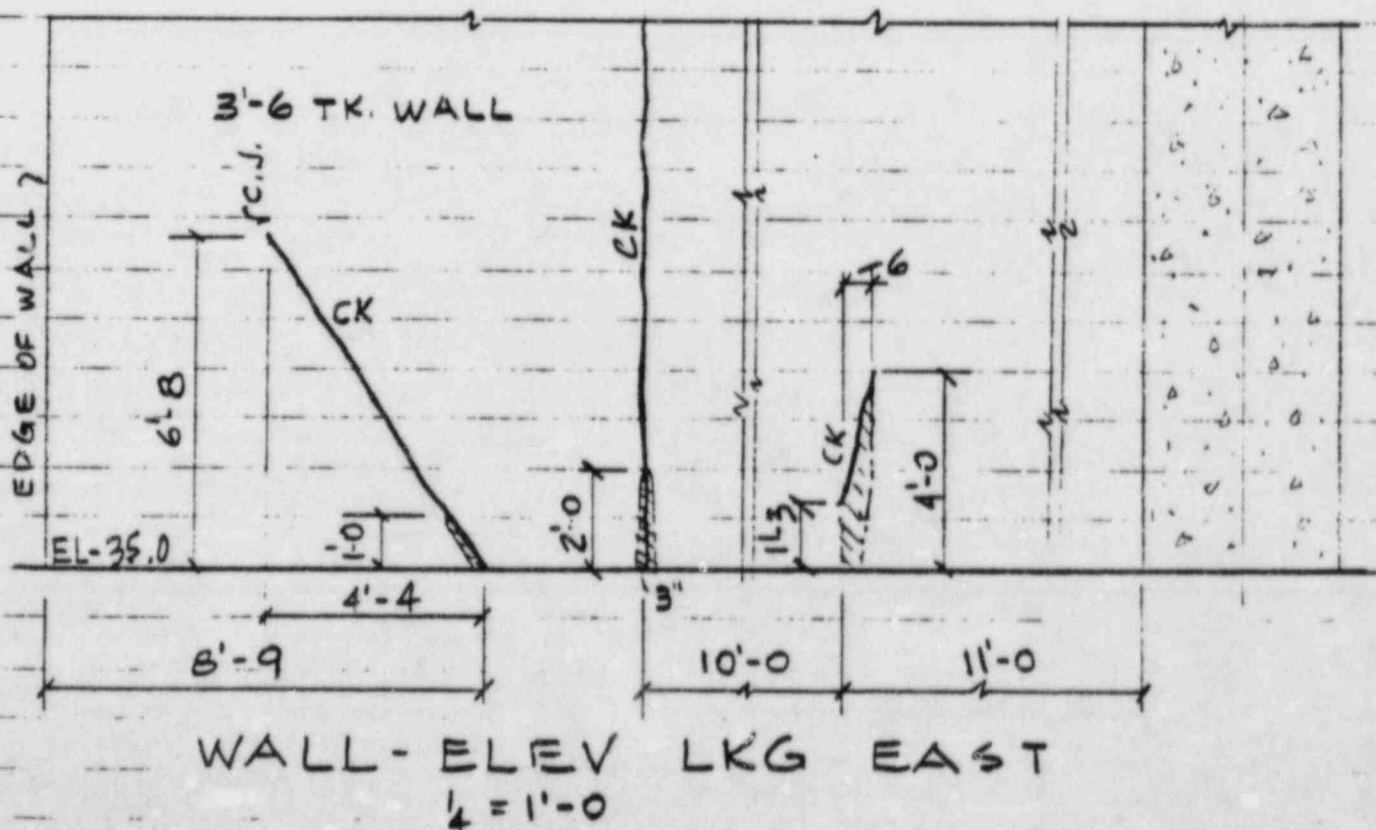
SHEET 20 OF 28

OFFS NO. LOW 5234.010 DEPT. NO. 653

DEPT. NO. 653



## KEY PLAN



# EBASCO SERVICES INCORPORATED

BY F. Schrimpe DATE 4-2-84

CHKD. BY G. W. G. DATE 4/13/84

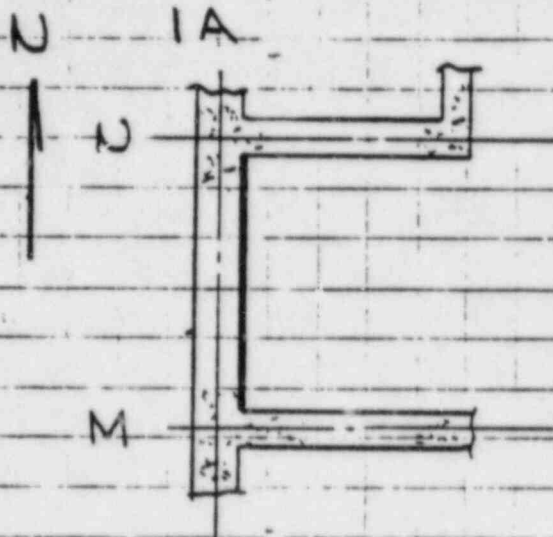
SHEET 21 OF 28

OFS NO. LOW 5234.016 DEPT. NO. 653

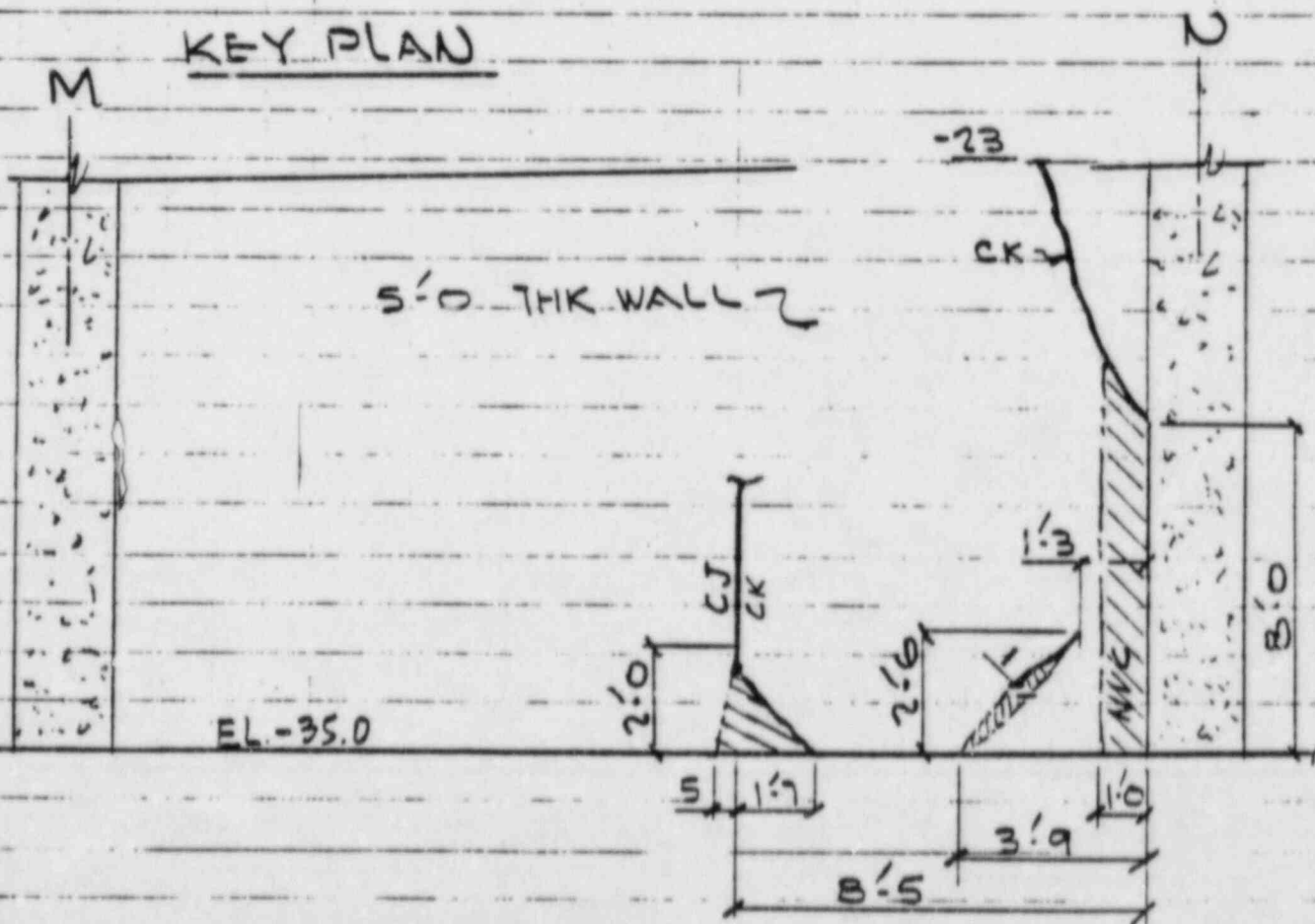
CLIENT LPEL

PROJECT WATERFORD # 3

SUBJECT WALL CRACK MAP



KEY PLAN



ELEV (LKG WEST)



**EBASCO SERVICES INCORPORATED**

BY F Schnimpe DATE 9-2-89

CHKD. BY G WU DATE 4/13/99

LPOL

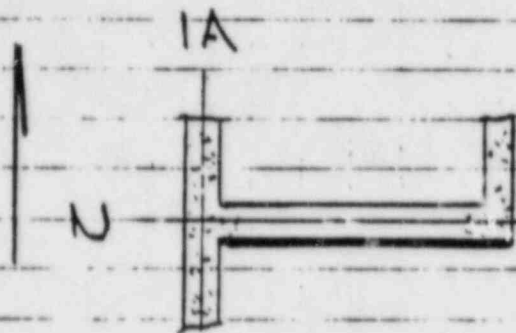
WATERFORD #3

SUBJECT WALL CRACK MAP

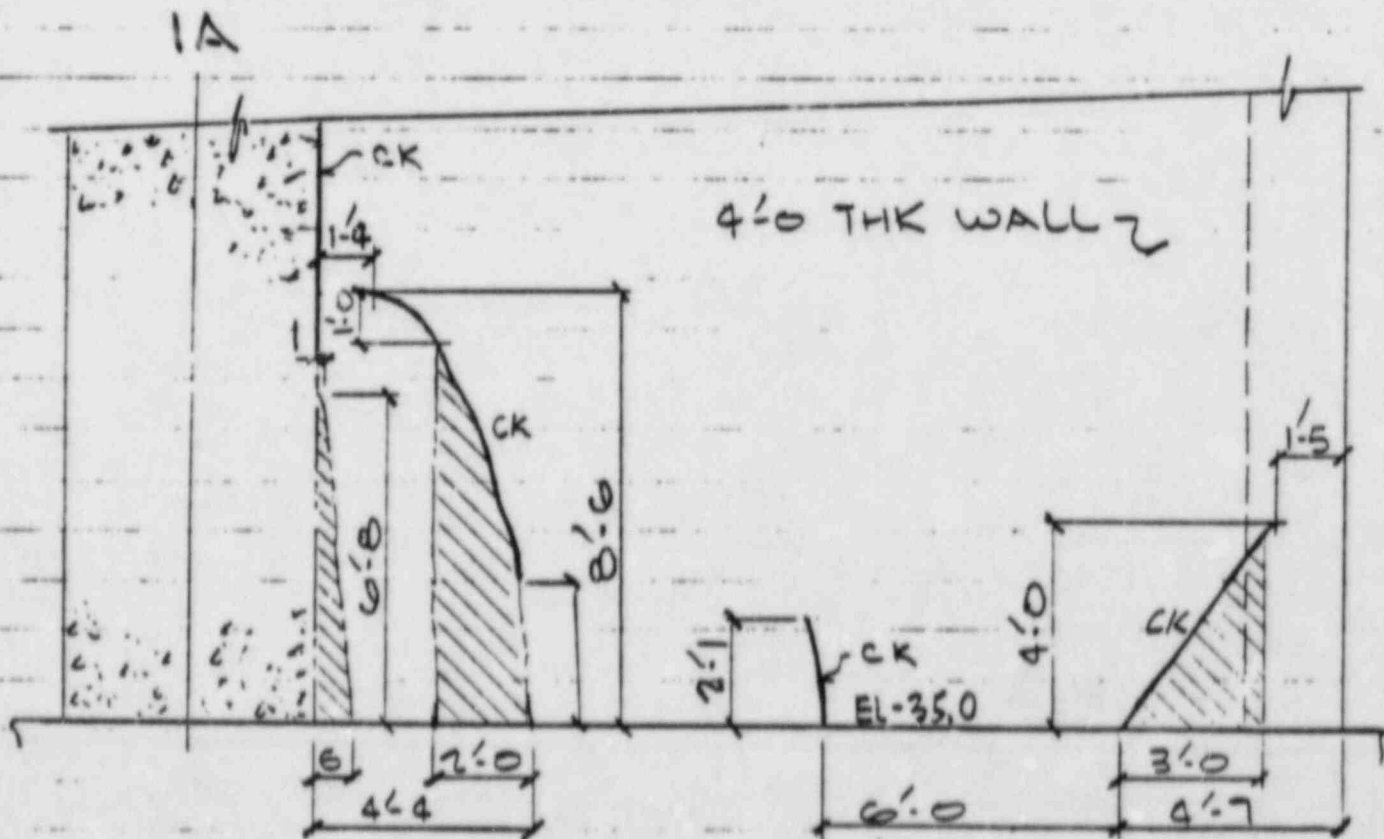
SHEET 44 OF 60

OFS NO. LOW 5234.016

DEPT. 653  
NO. \_\_\_\_\_



## KEY PLAN



ELEV (LKG NORTH)

BY RHANDCOCK DATE 4-2-84

CHKD. BY G. W. U DATE 9/13/84

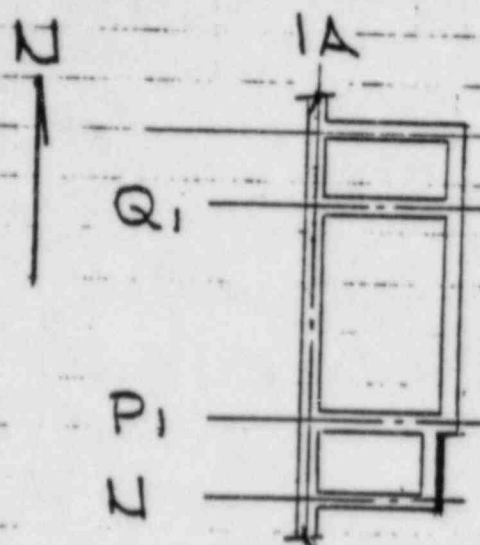
SHEET 23 OF 28  
OFS NO. LOW 5234.016 DEPT. NO. 653

OFS NO. LOW 5234.016 DEPT. NO. 653

CLIENT LP EL

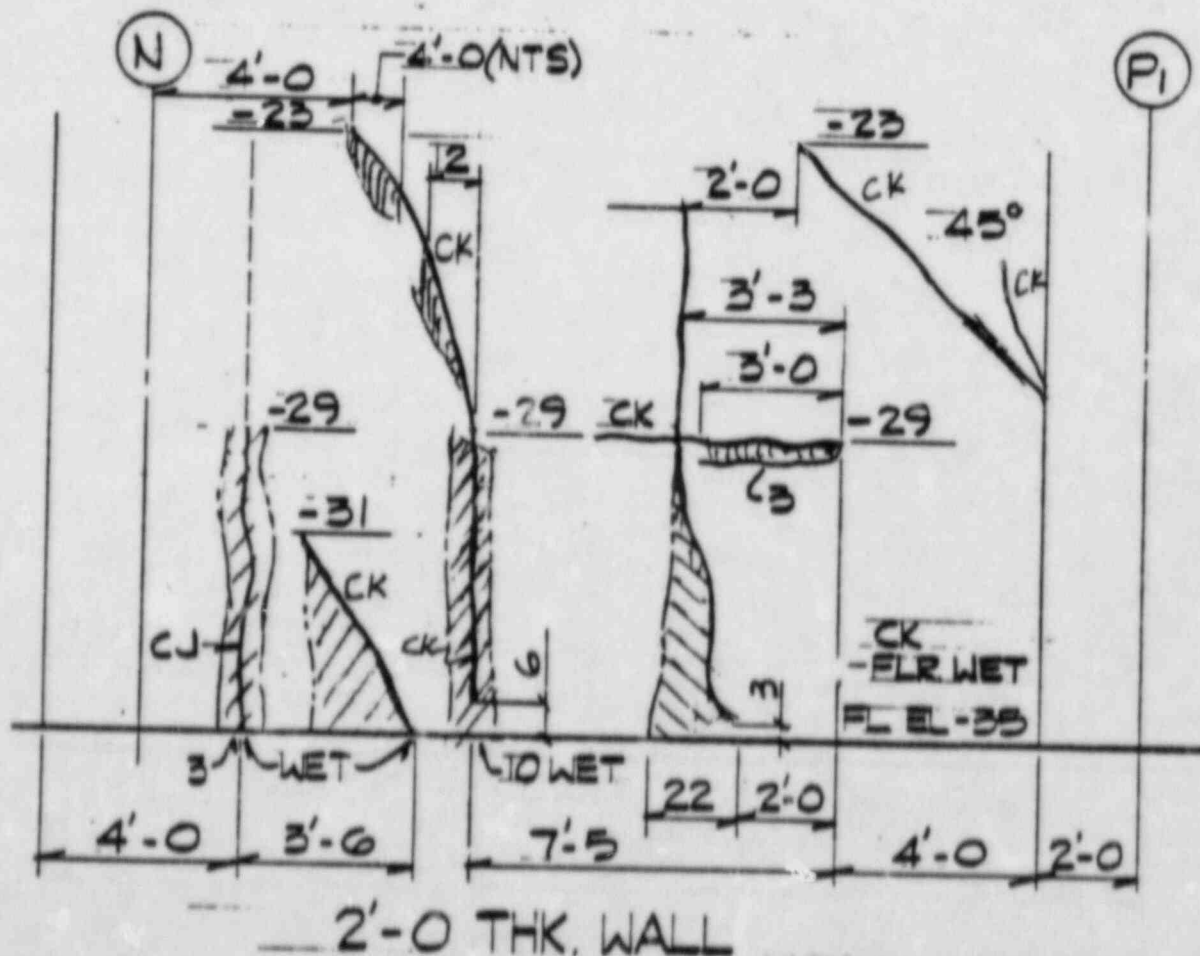
PROJECT WATERFORD #3

SUBJECT WALL CRACK MAP



## KEY PLAN

275



**EBASCO SERVICES INCORPORATED**

BY F. Schirmer DATE 4-2-54

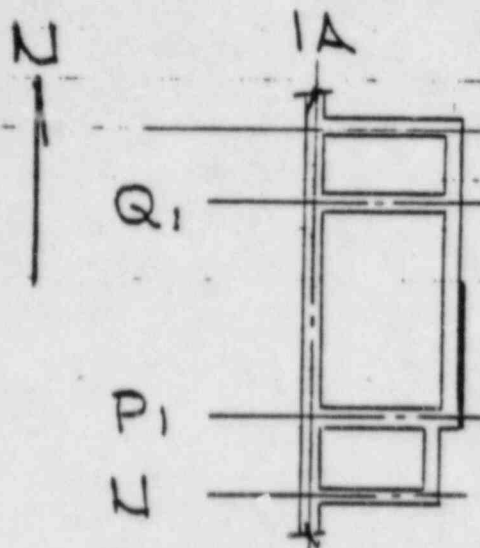
CHKD. BY G W U DATE 4/13/84

CLIENT LP EL

PROJECT WATERFORD #3

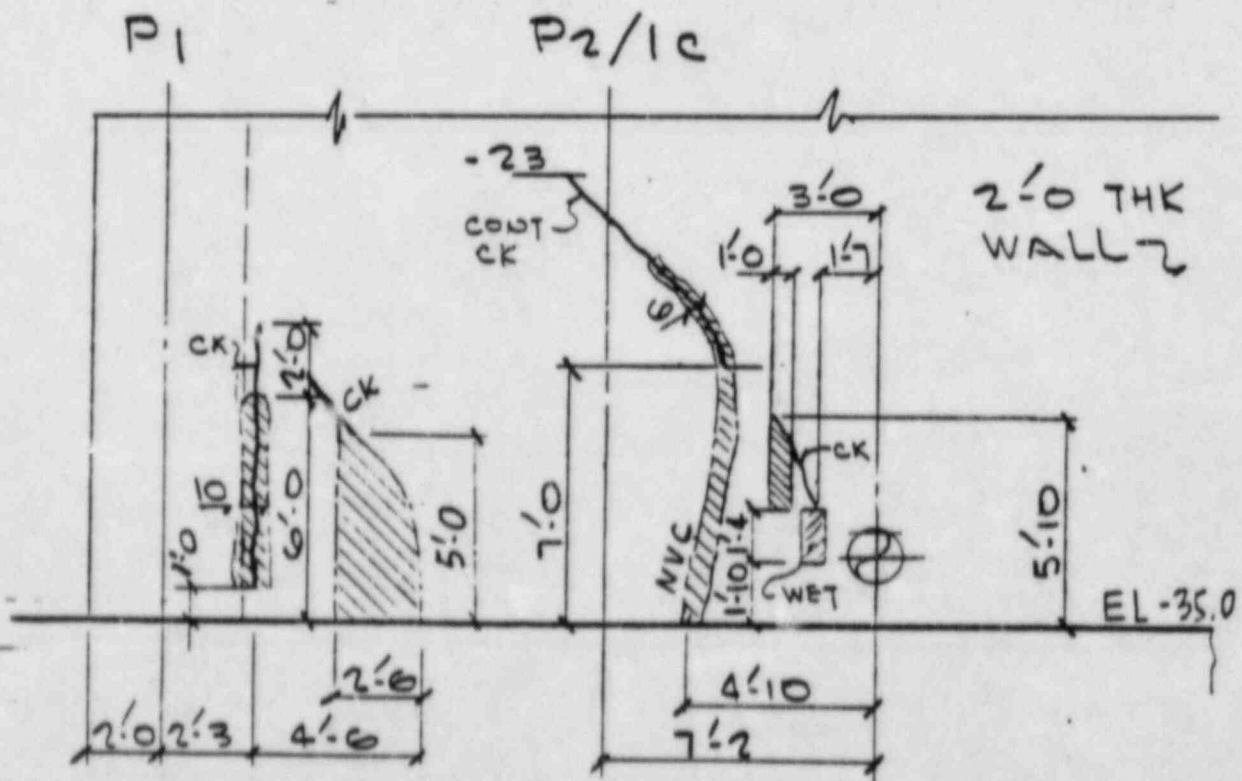
SUBJECT WALL CRACK MAP

SHEET 24 OF 28  
OFS NO. LOU 5234.016 DEPT. NO. 653



## KEY PLAN

275



ELEV (LKG WEST)





# EBASCO SERVICES INCORPORATED

BY I. SAFRO DATE 4-2-84

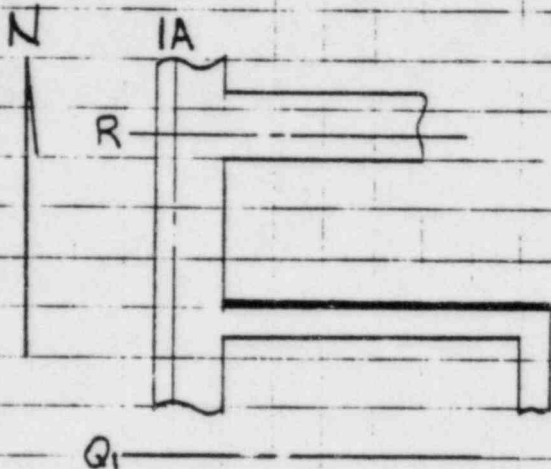
CHKD. BY S.WU DATE 4/13/84

CLIENT LPE L

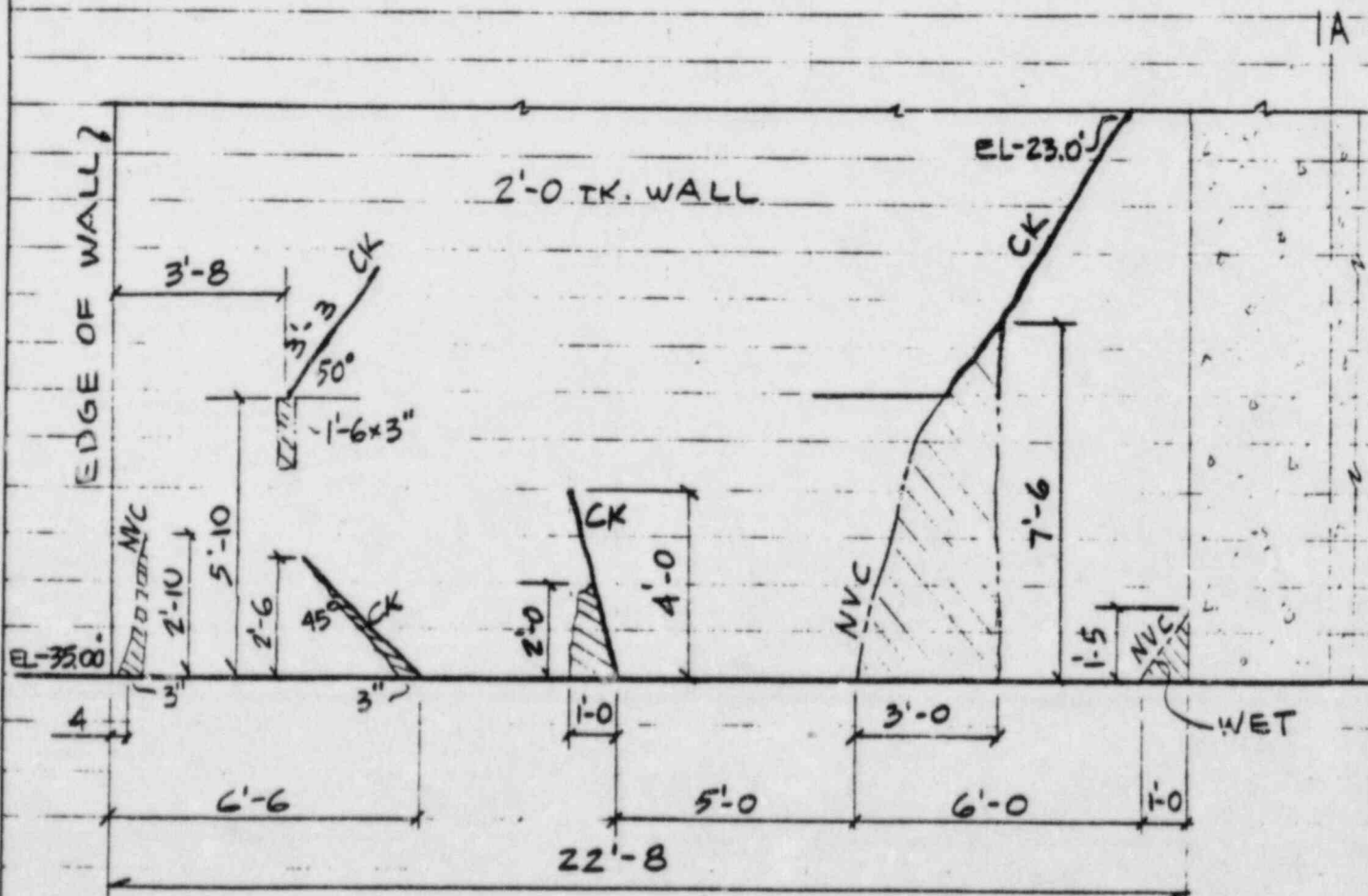
SHEET 26 OF 28  
OFS NO. Lou 6234.016 DEPT. NO. 653

PROJECT WATERFORD S.E.S. UNIT N° 3

SUBJECT WALL CRACK MAP



KEY PLAN



WALL-ELEV LKG SOUTH

# EBASCO SERVICES INCORPORATED

BY I. SAFRO DATE 4-2-84

SHEET 27 OF 28

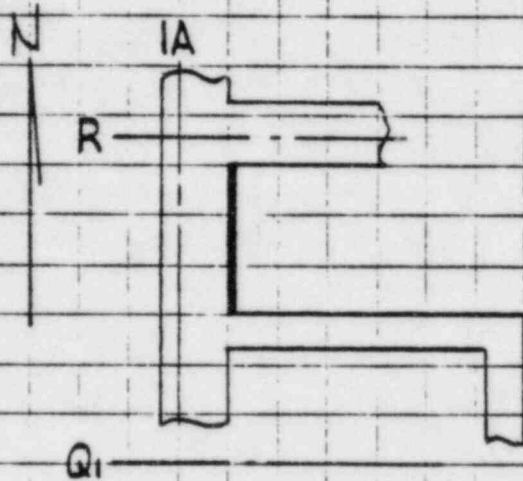
CHKD. BY G.W.U. DATE 4/13/84

OFS NO. LOW 5234.016 DEPT. NO. 653

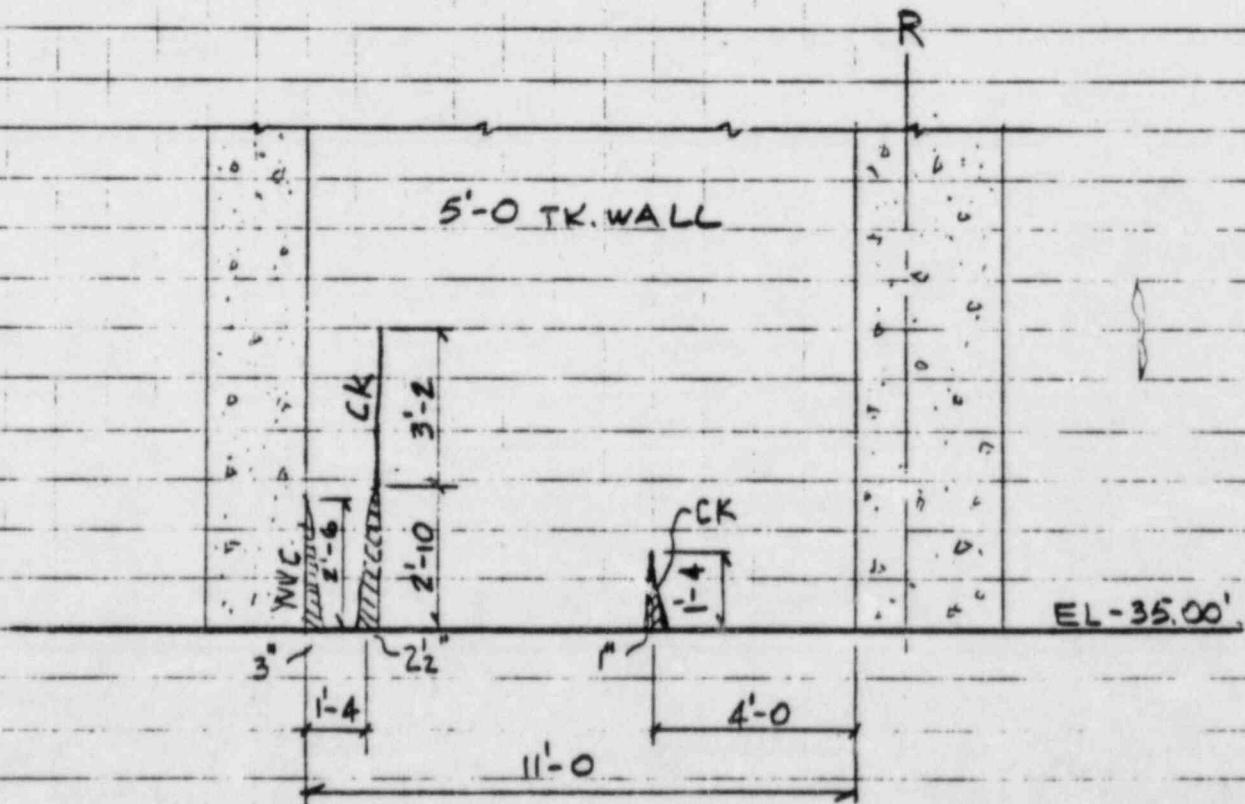
CLIENT LP & L

PROJECT WATERFORD S.E.S. UNIT N° 3

SUBJECT WALL CRACK MAP



KEY PLAN



WALL - ELEV LKG WEST

**EBASCO SERVICES INCORPORATED**

BY T. KITZ DATE 4.2.84

CHKD. BY G.WU DATE 9/13/84

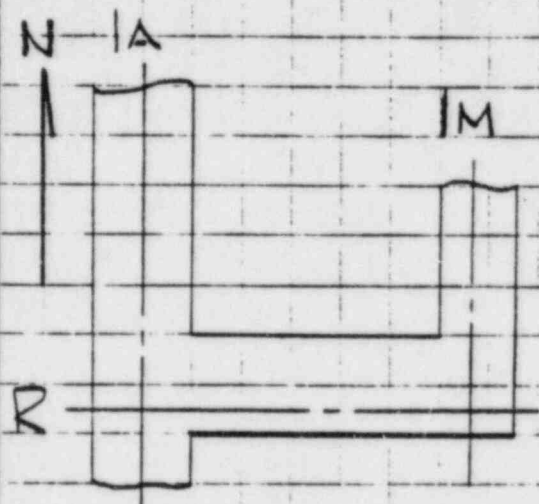
CLIENT LP&L

PROJECT WATERFORD S.E.S. UNIT NO 3

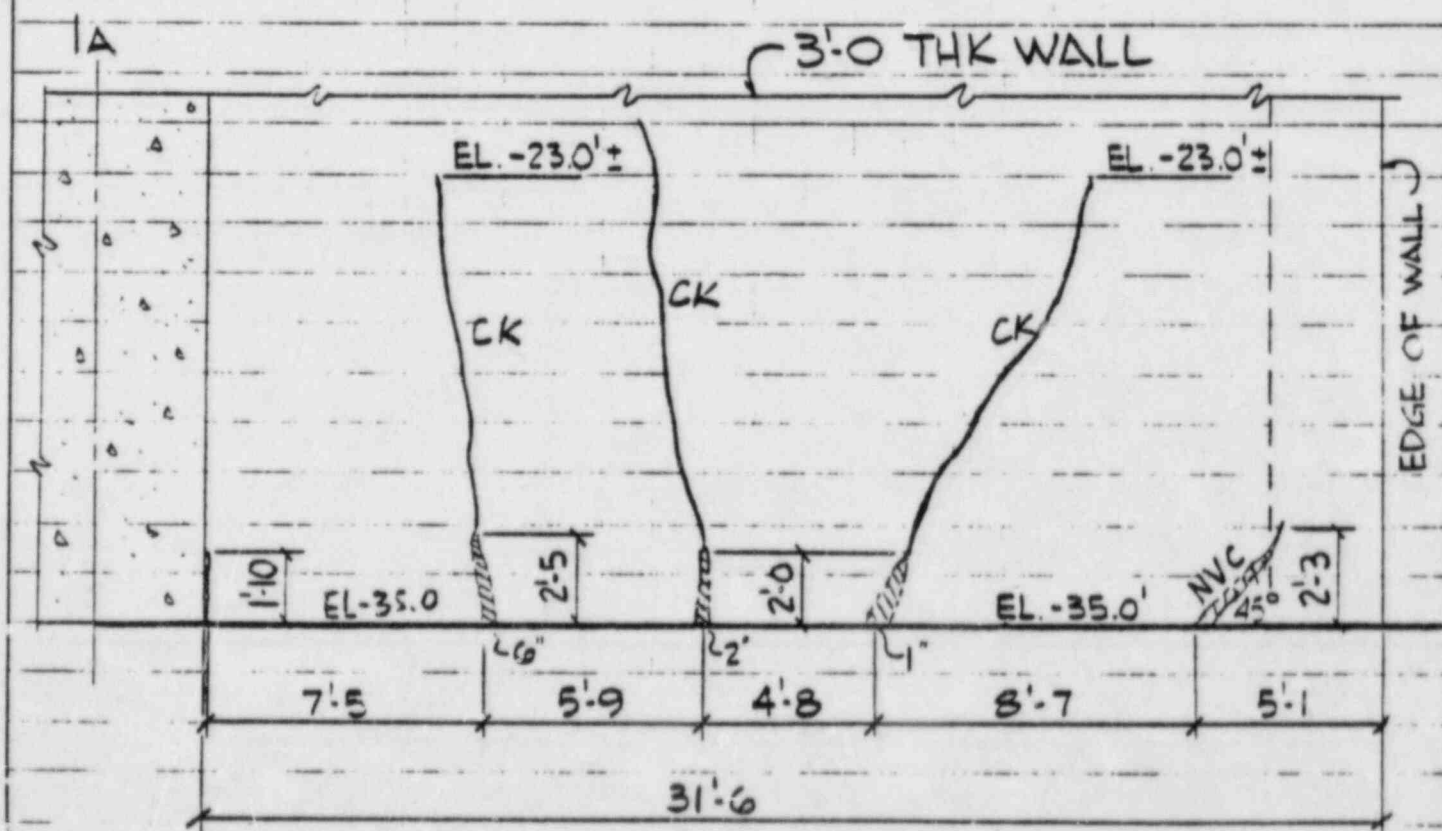
SUBJECT WALL CRACK MAP

SHEET 28 OF 28

OFFS NO. LOW 5234.016 DEPT. NO. 653



## KEY PLAN



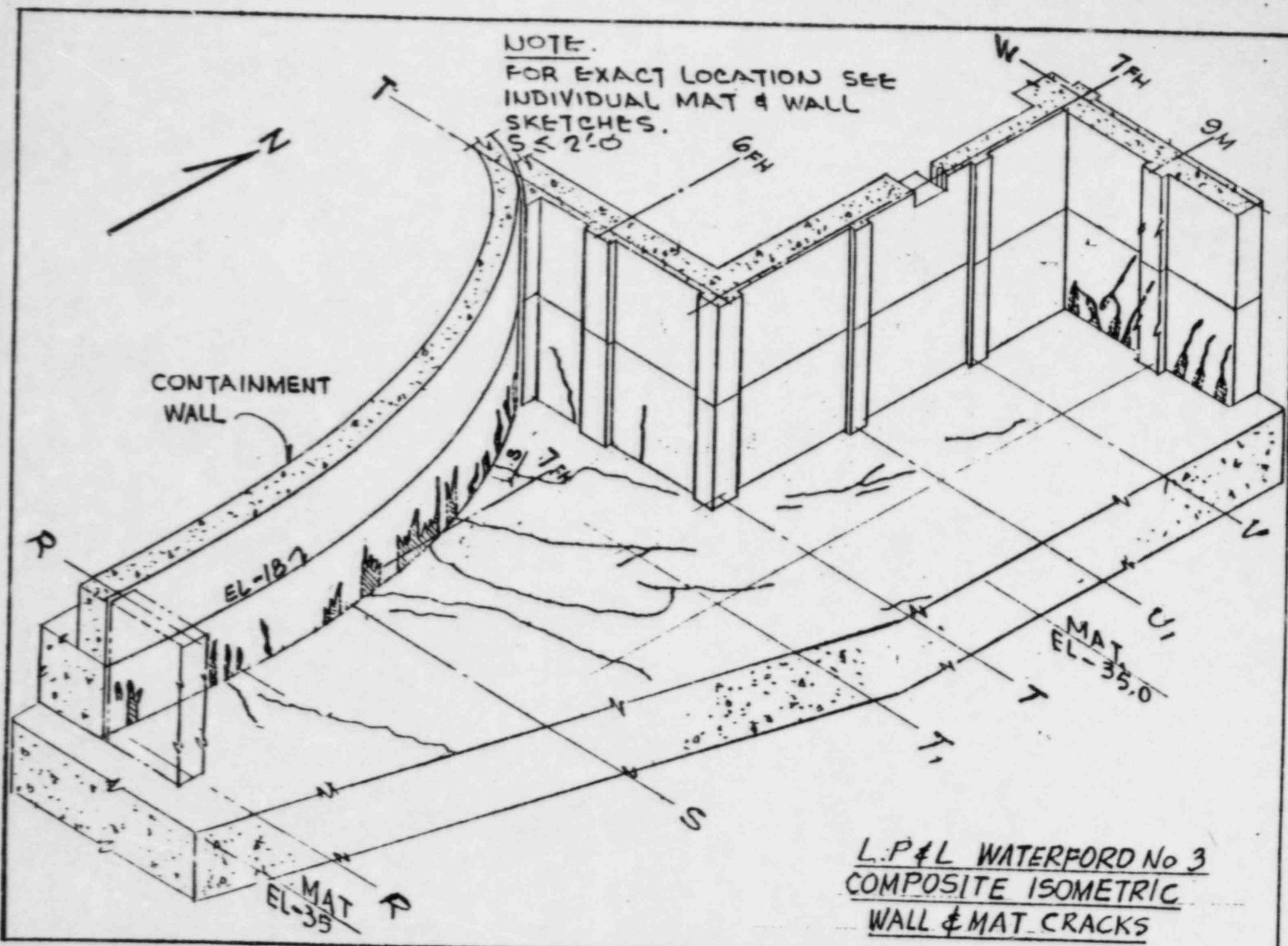
WALL - ELEV. LKG NORTH

APPENDIX "C"

COMPOSITE ISOMETRIC WALL AND MAT CRACK MAPS



NOTE.  
FOR EXACT LOCATION SEE  
INDIVIDUAL MAT & WALL  
SKETCHES.  
S ≤ 2' 0"



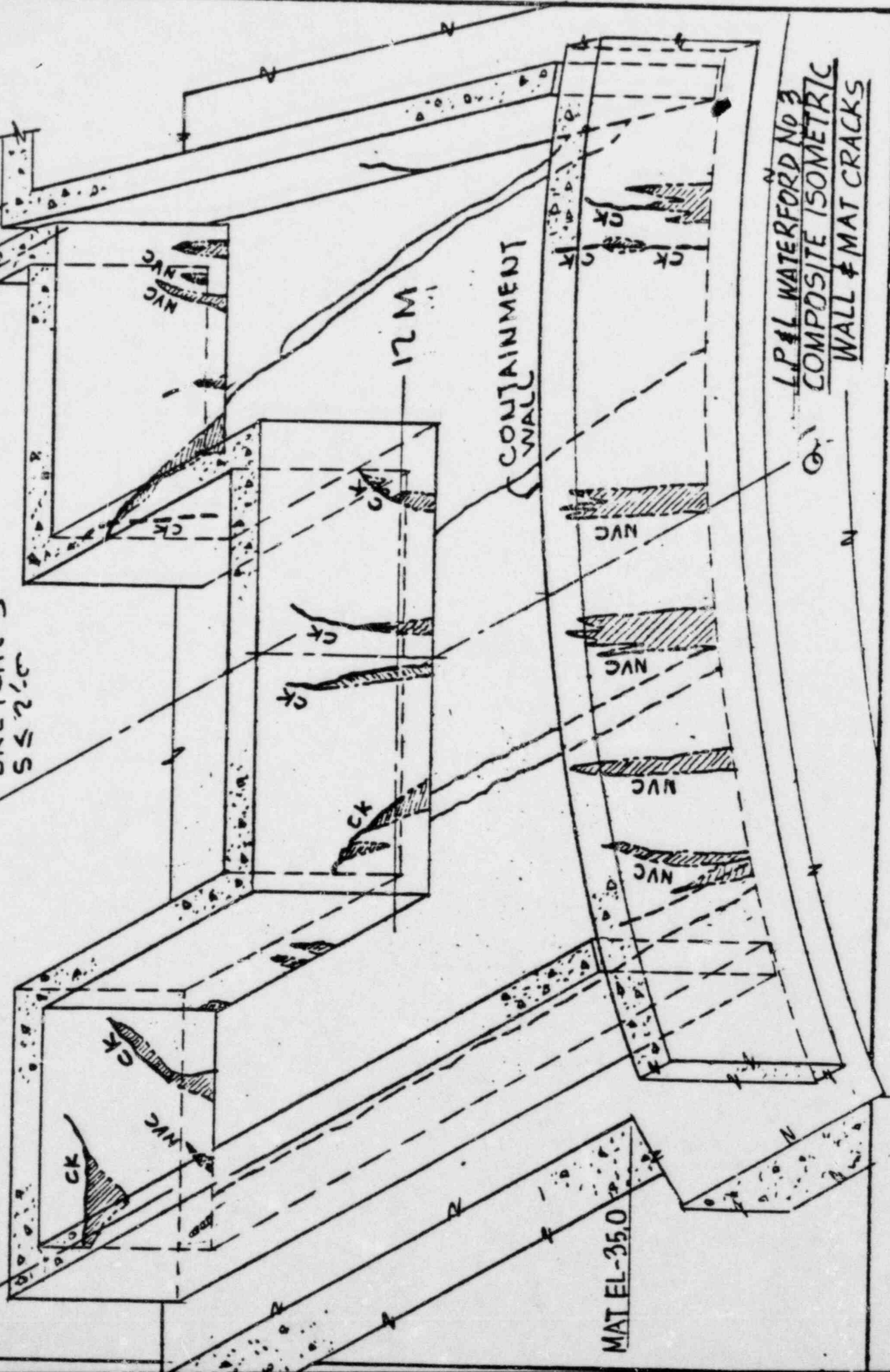
L.P & L WATERFORD No 3  
COMPOSITE ISOMETRIC  
WALL & MAT CRACKS

NOTE:

FOR EXACT LOCATION SEE P. 12  
INDIVIDUAL MAT & WALL  
SKETCHES  
S.S. 2' C

N

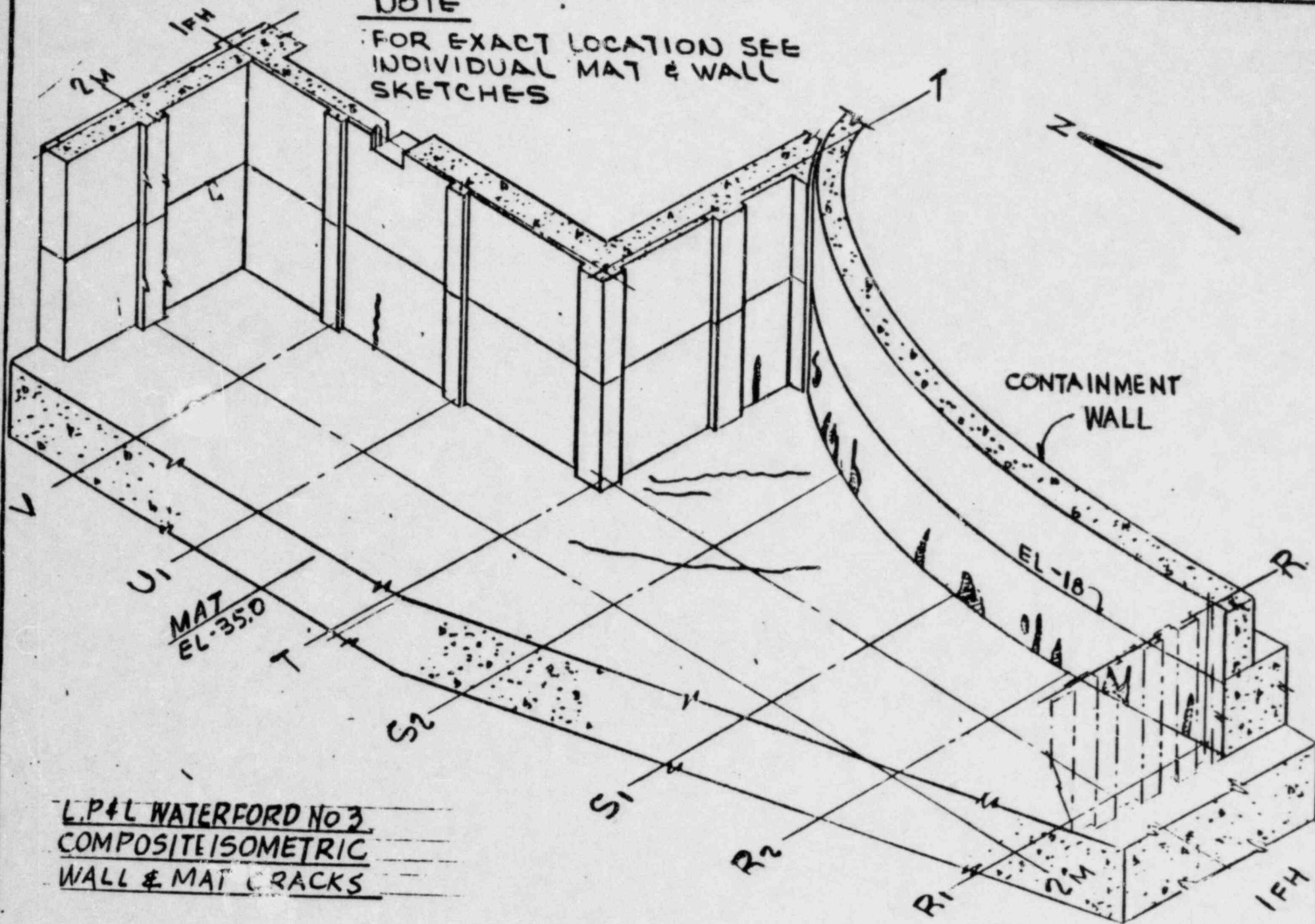
Q1



LP 16 WATERFORD No 3  
COMPOSITE ISOMETRIC  
WALL & MAT CRACKS

NOTE

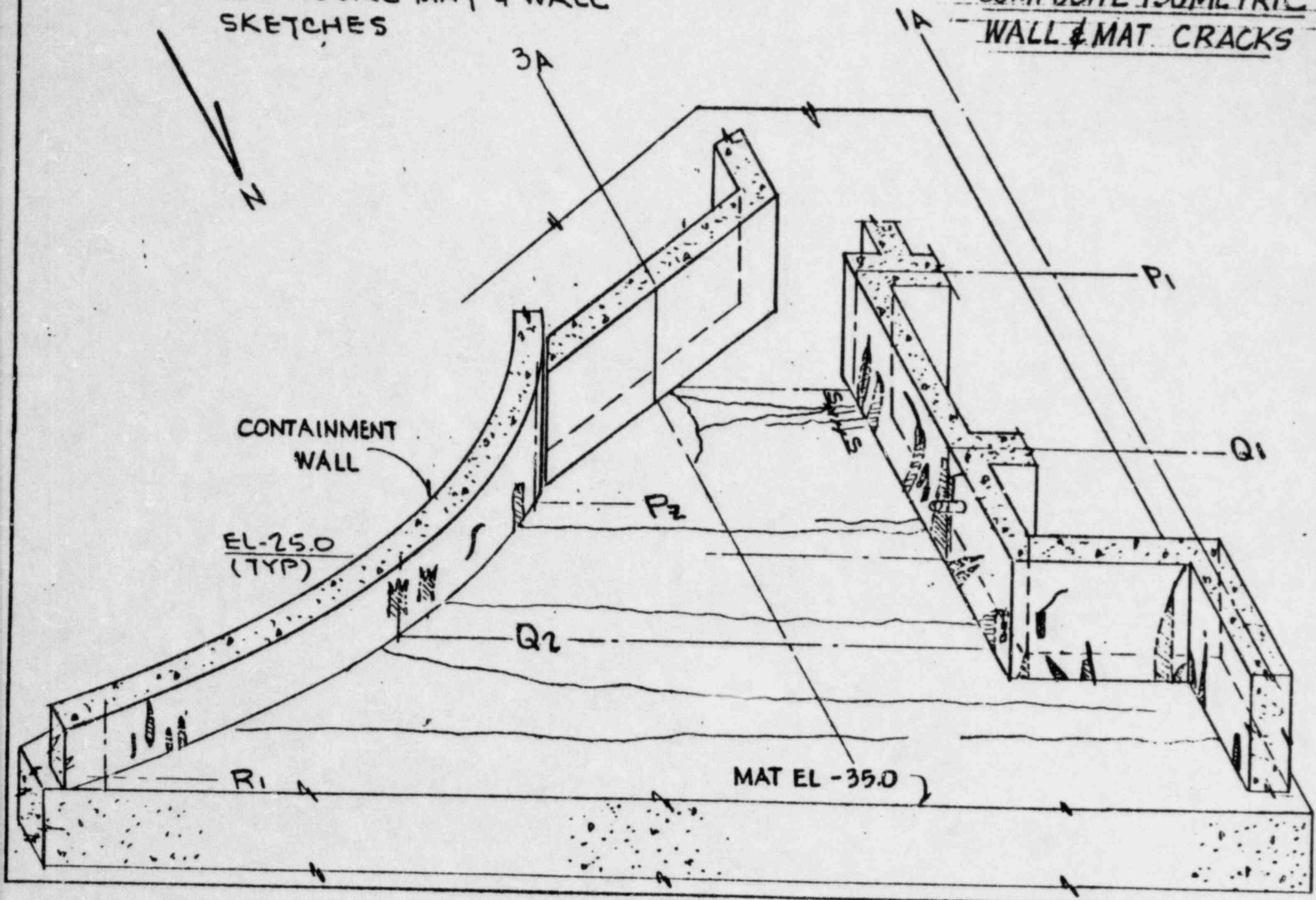
FOR EXACT LOCATION SEE  
INDIVIDUAL MAT & WALL  
SKETCHES



L.P.4L WATERFORD No 3  
COMPOSITE ISOMETRIC  
WALL & MAT CRACKS

NOTE  
FOR EXACT LOCATION SEE  
INDIVIDUAL MAT & WALL  
SKETCHES

LP & L WATERFORD No 3  
COMPOSITE ISOMETRIC  
WALL & MAT CRACKS



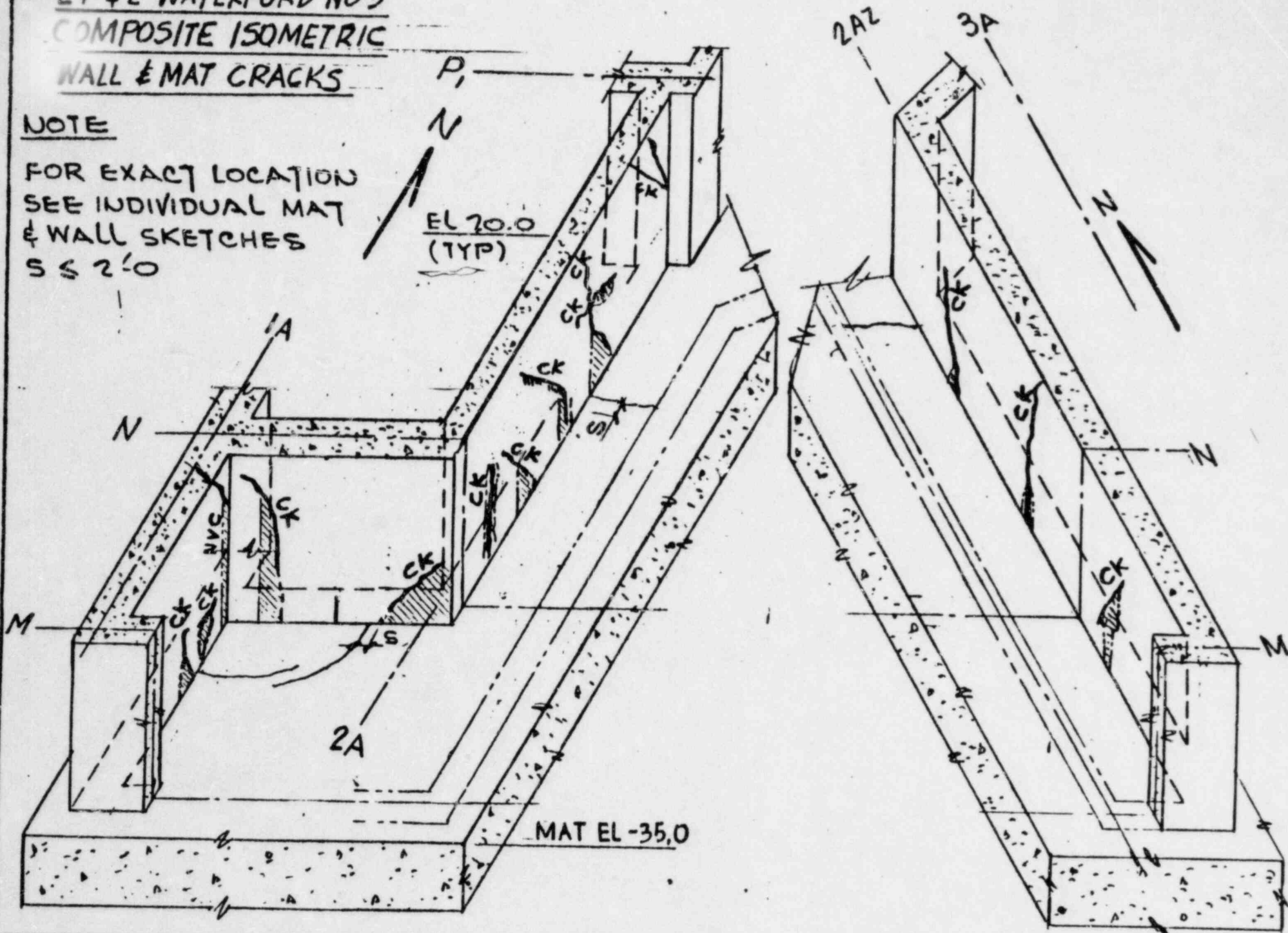
BY: A. NACCARELLA SHEET 4 OF 5  
CHKD BY: G WU DATE: 4/13/84



LP & L WATERFORD NO 3  
COMPOSITE ISOMETRIC  
WALL & MAT CRACKS

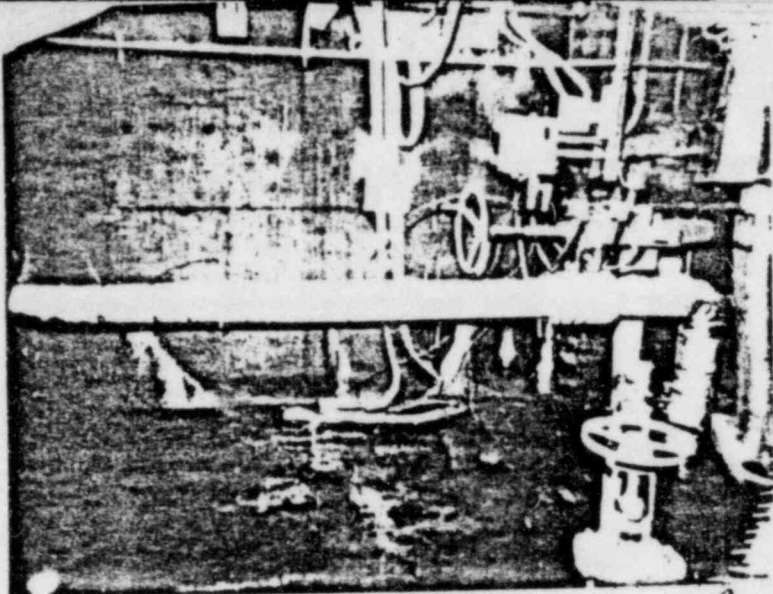
NOTE

FOR EXACT LOCATION  
 SEE INDIVIDUAL MAT  
 & WALL SKETCHES  
 S S 2'0



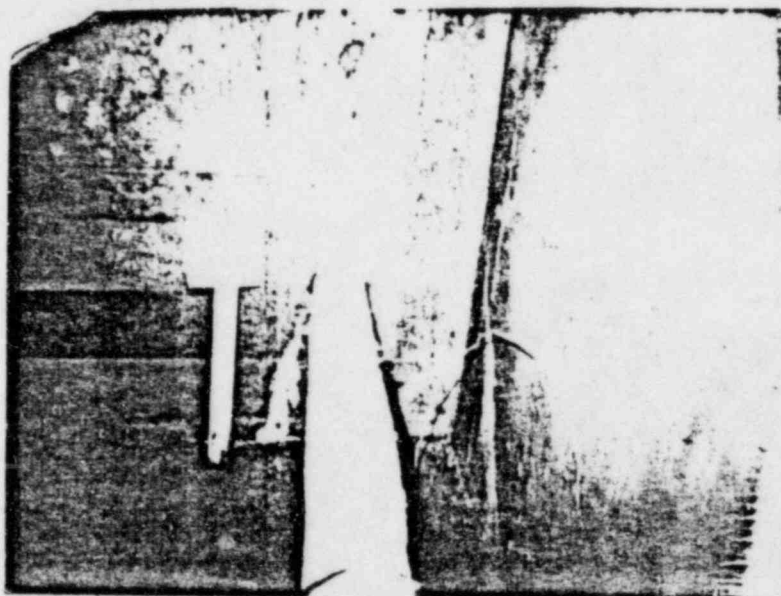
APPENDIX "D"

PROTOGRAPHS

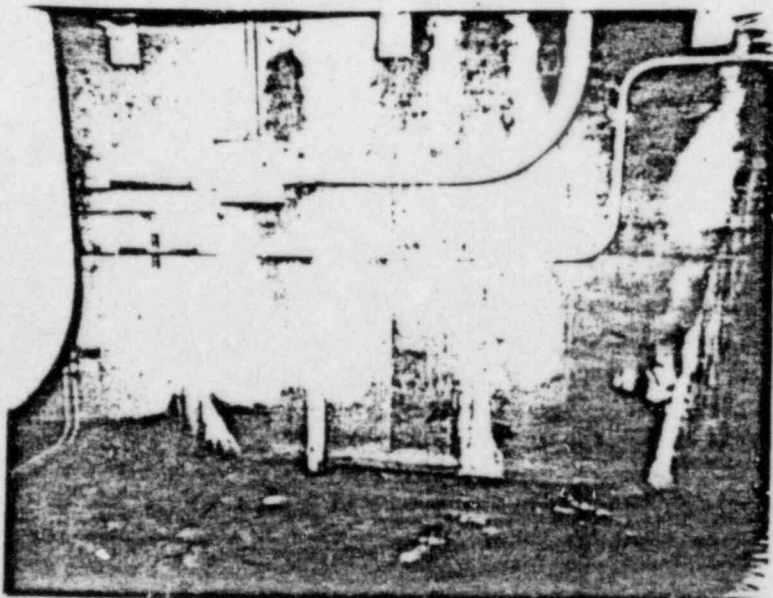


2

Number on each Photograph  
Corresponds to Wall Map  
Sheet, Appendix B

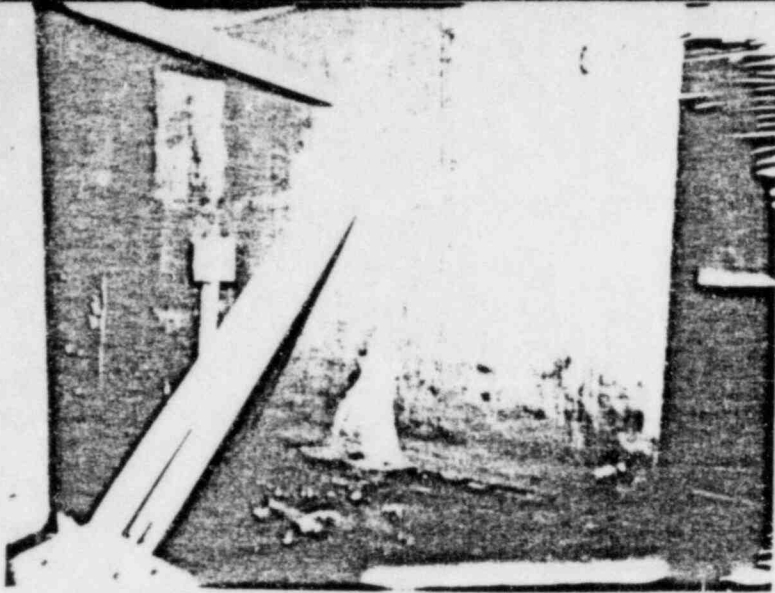


3

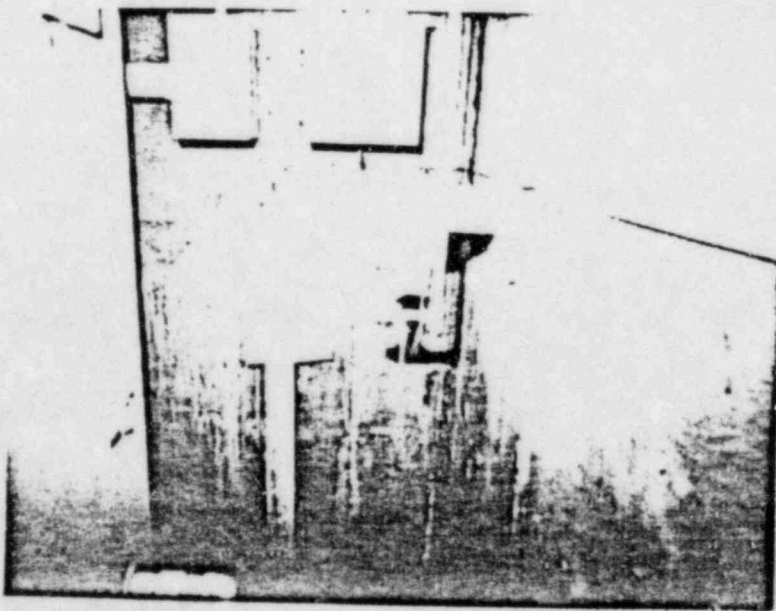
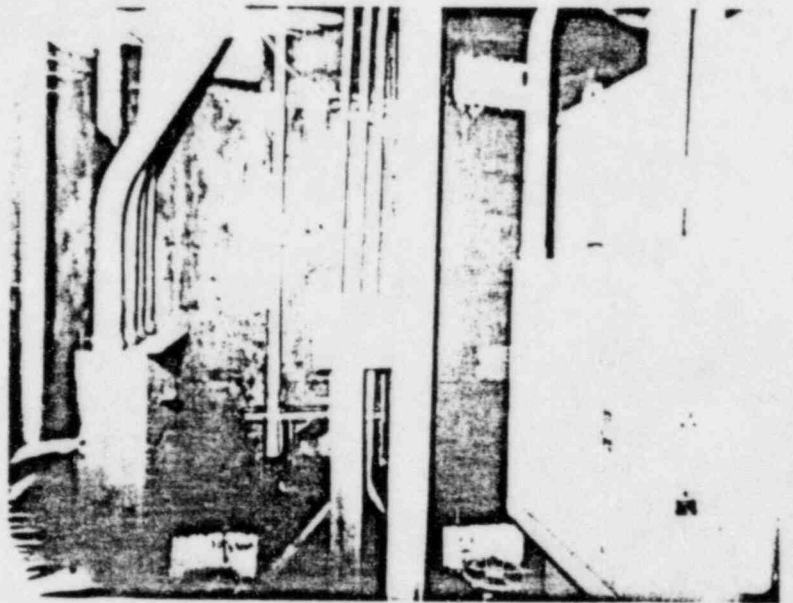


4

EAST WET COOLING TOWER WALLS



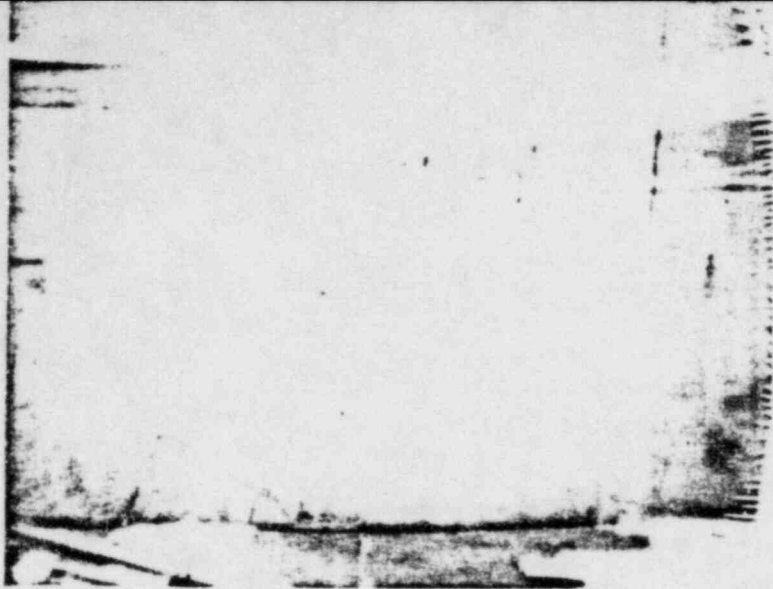
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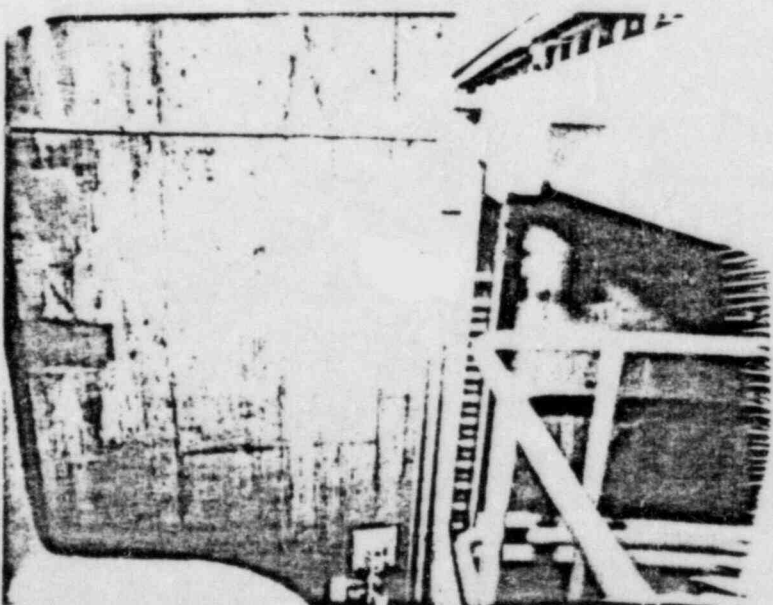
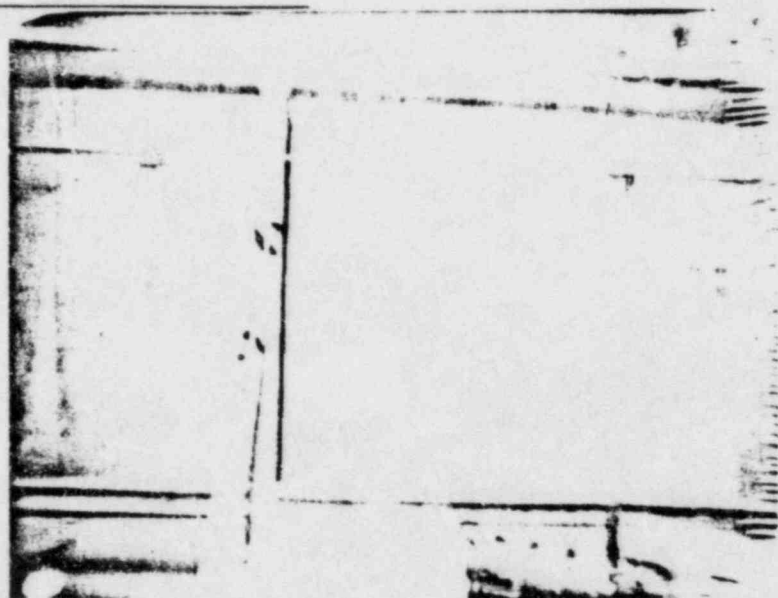
6

EAST WET COOLING TOWER WALLS



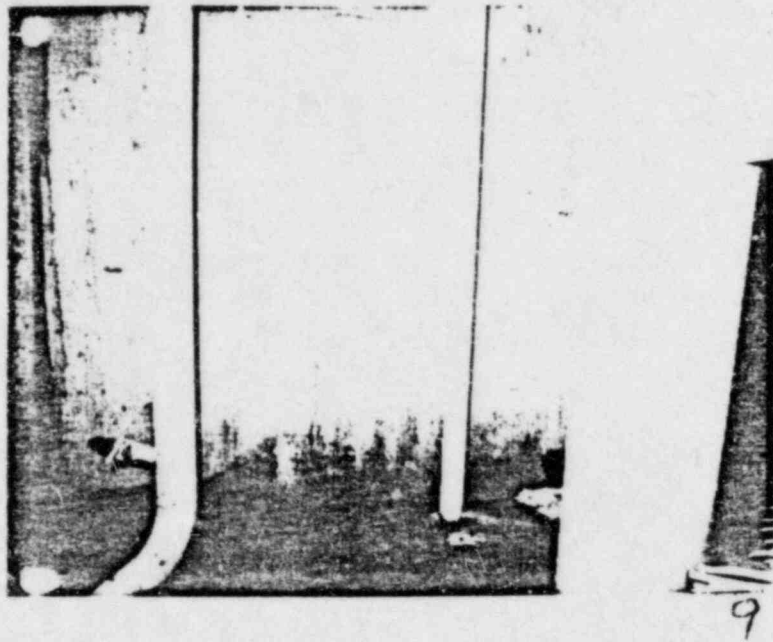


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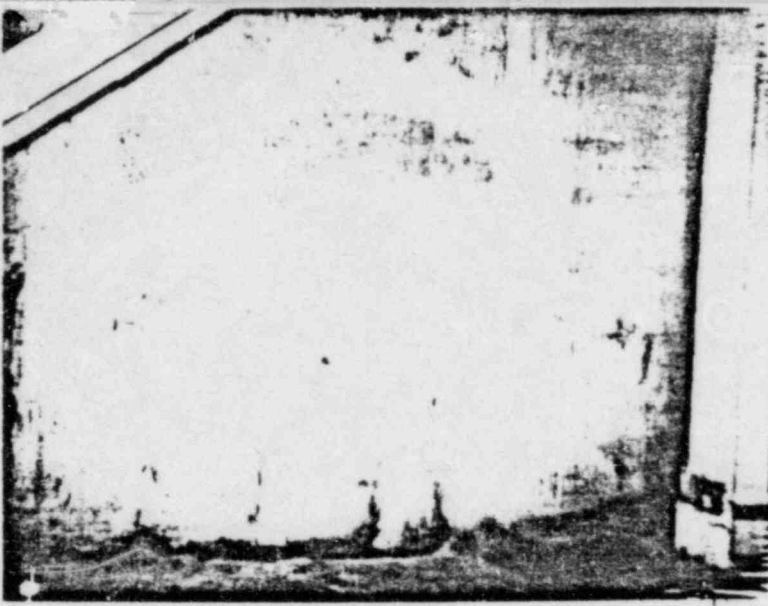


9

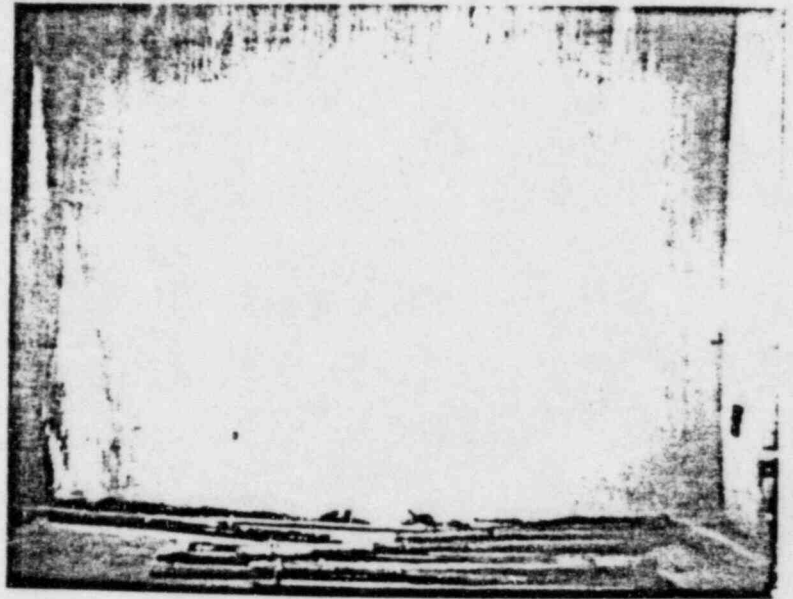
REACTOR BUILDING RING WALL.  
(NORTH EAST QUADRANT)



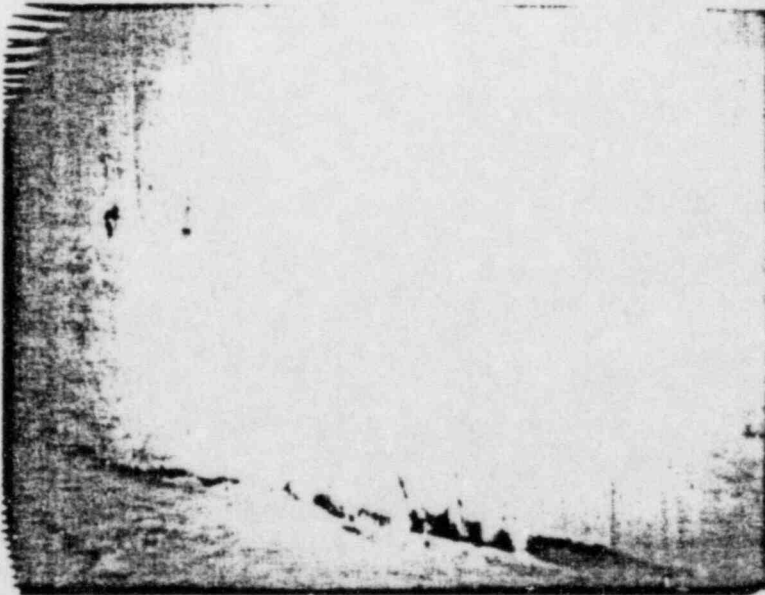
REACTOR BUILDING RING WALL  
(NORTH EAST QUADRANT)



17

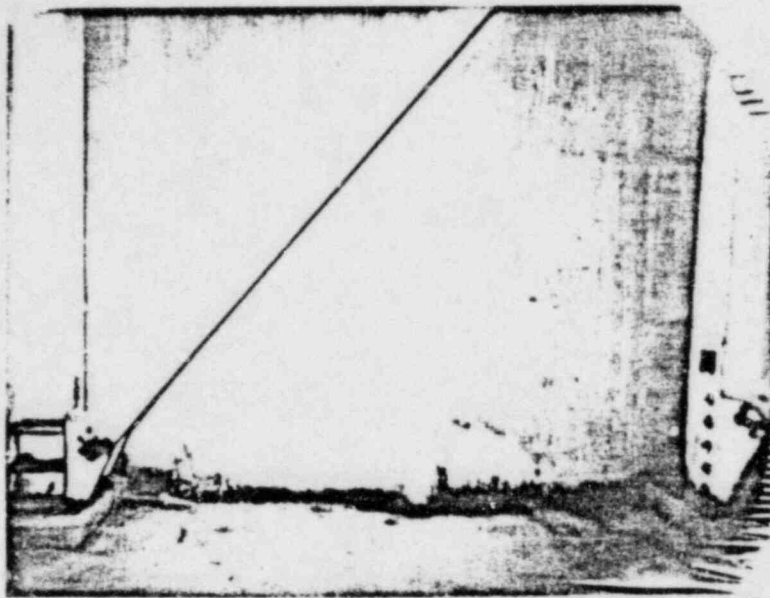


18

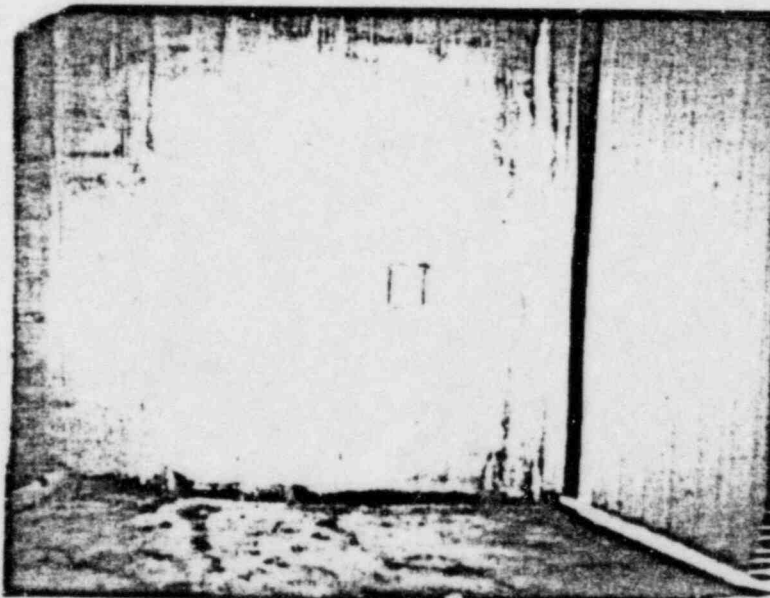


18

REACTOR BUILDING RING WALL.  
(NORTH WEST QUADRANT)



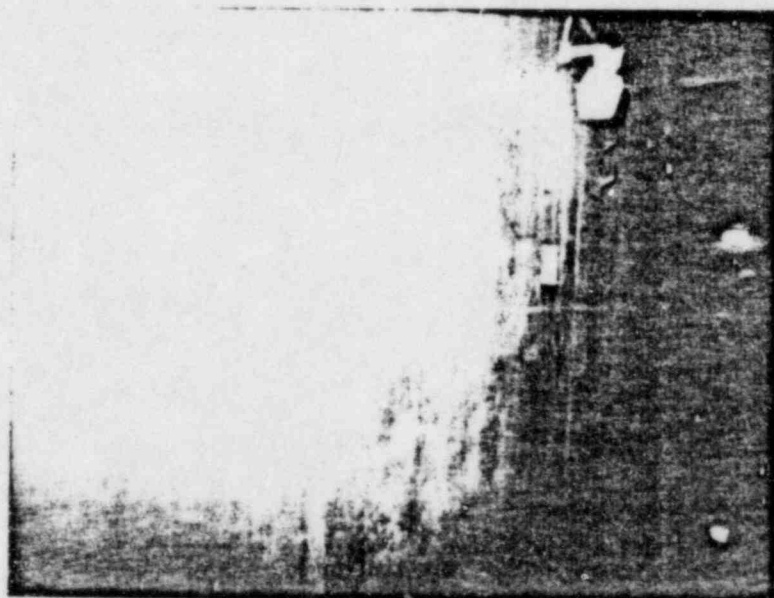
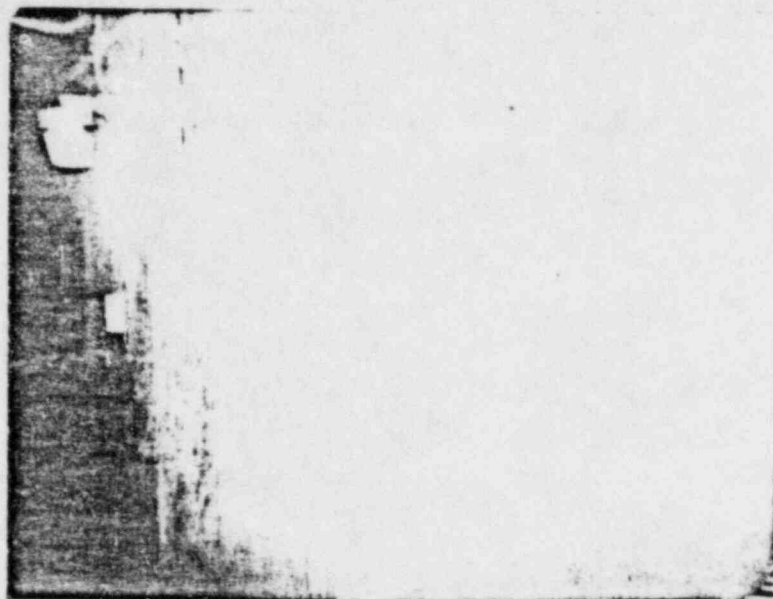
19



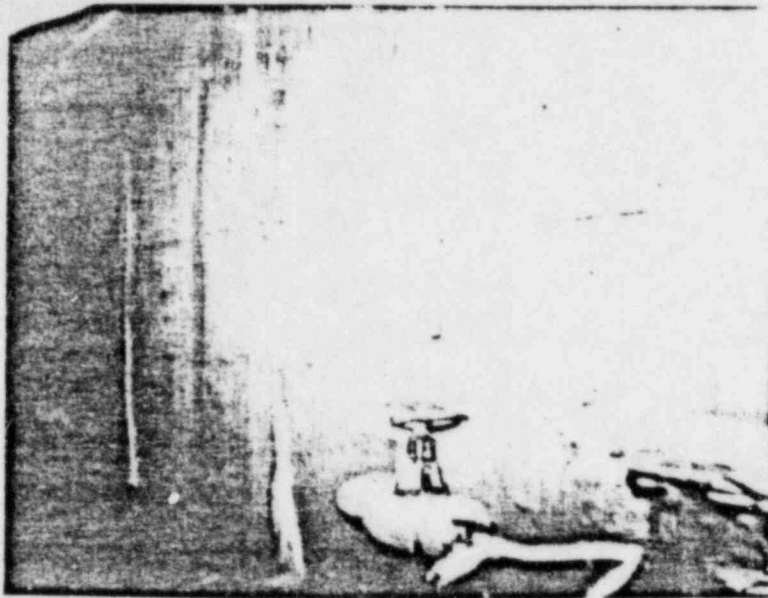
19

REACTOR BUILDING RING WALL.  
(NORTH WEST QUADRANT)

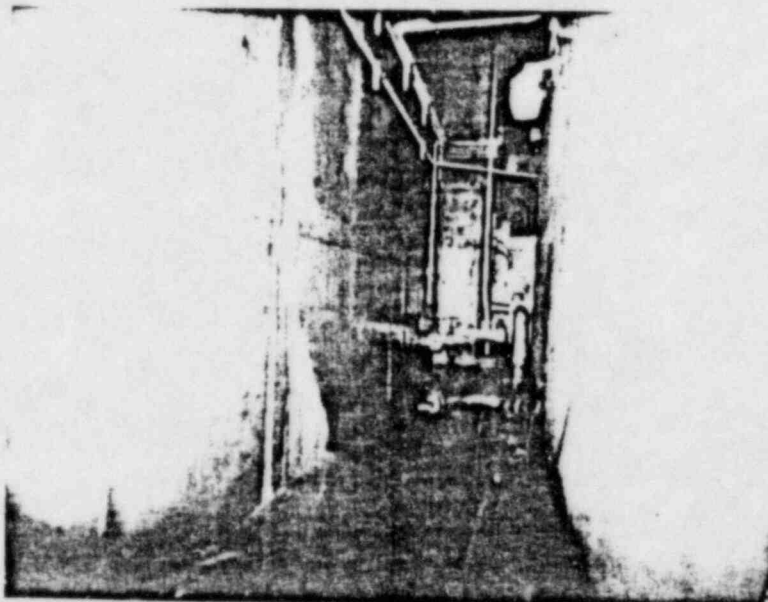




REACTOR AUXILIARY BUILDING  
WEST WING WALL

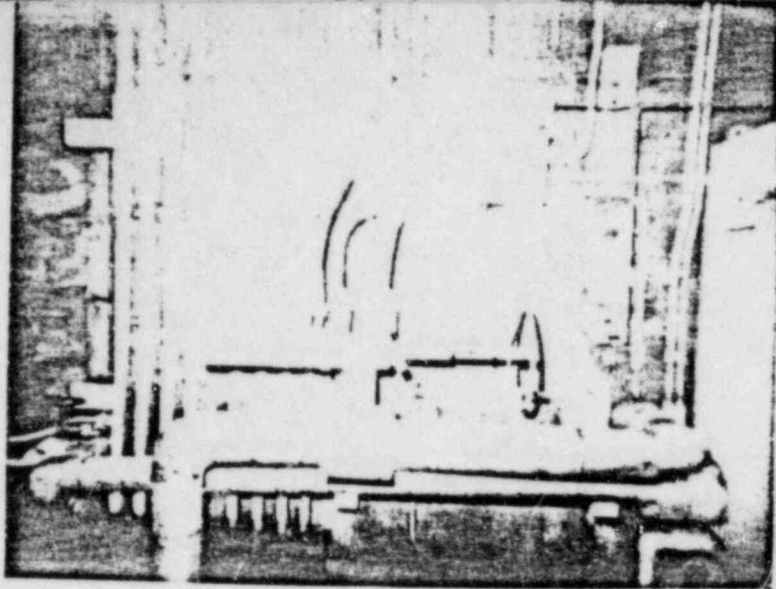


25

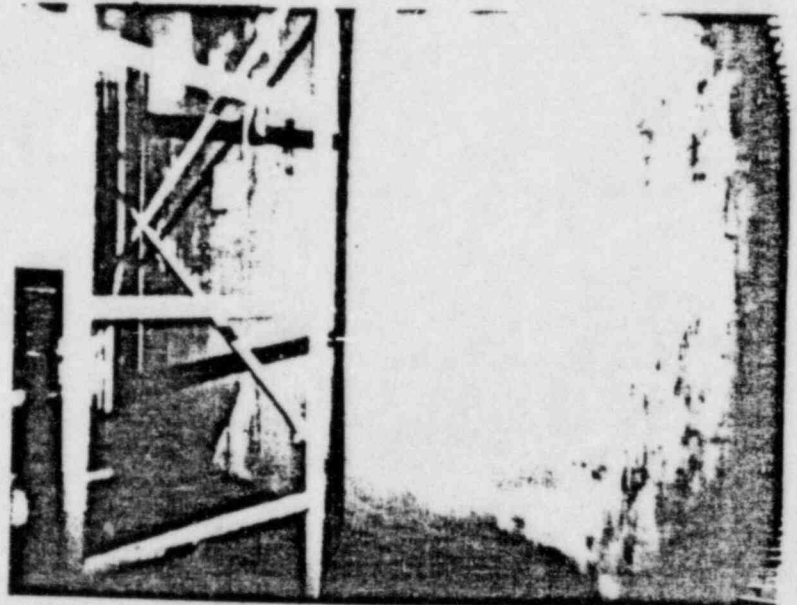


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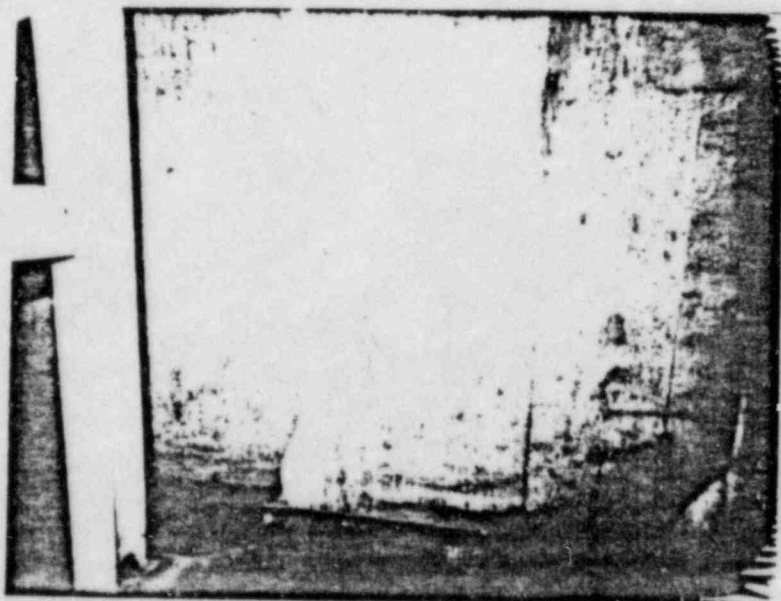
WEST WET COOLING TOWER WALL



211



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213

WEST WET COOLING TOWER WALL.

ATTACHMENT II



17  
HARSTEAD ENGINEERING ASSOCIATES • INC.

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Project No. 8304  
April 26, 1984  
W3-HE-LP-015

Louisiana Power & Light Co.  
Waterford III Nuclear Plant  
P.O. Box B  
Killona, LA 70066

Attn: Mr. T. Gerrets

Subject: Waterford III SES  
Analysis of Cracks and Water Seepage in Foundation  
Review of Wall Cracking

References: (1) HEA Report No. 8304-1 dated 9-13-83  
(2) Ebasco Report NPIS Wall  
Hairline Cracks Evaluation, dated April 1984.

Gentlemen:

1.0 Introduction

On Tuesday April 17, we received a copy of an Ebasco Report, Reference 2 A memo from J. Costello attached to the subject Report requested HEA review with subsequent notification to Louisiana Power and Light Company. Dr. A.V. du Bouchet of our office has reviewed the Ebasco Report in conjunction with a site visit (conducted with the assistance of I. Safro of Ebasco) on April 21, 1984.

2.0 Purpose

The purpose of the site visit was to confirm the validity of the wall crack maps generated by Ebasco (see Appendix B of the Ebasco Report). There are a total of 28 pages of crack maps contained in Appendix B. The location key to each of these pages is provided in Figure 3 of the Report, which details the locations of the concrete walls mapped by Ebasco with respect to the top of the NPIS basemat at Elev. -35.00 ft.

### 3.0 Site Review

The following items were specifically reviewed at the site:

1. Each crack map contained in Appendix B was reviewed qualitatively for accuracy and completeness.
2. A notation was made for any wall crack spaced closer than 2 ft. to a basemat crack at the juncture of the wall and basemat.
3. Additional walls not specifically mapped by Ebasco were also reviewed to confirm the validity of the Ebasco scope of work.

With respect to Item 3, a continuous circuit was established in both the NE and NW quadrants of the basemat to verify the absence of any substantial cracking in walls not mapped by Ebasco.

### 4.0 Evaluation

The following quantitative observations with reference to HEA Report 8304-1, Reference 1 can be made in order to confirm the validity of the Items extracted from Sections 5.3 and 5.4 of the Ebasco Report:

1. there are a total of 146 cracks mapped by Ebasco, of which 87 are directly observable; the remaining cracks can only be inferred from the presence of leachate;
2. there are a total of only 19 instances in which wall and mat cracks fall within a 2.0 ft. dimension at the base of the mat and wall;
3. Ebasco mapped a total of approximately 700 linear feet of wall (these dimensions were scaled directly from Ebasco Drawings LOU-1564-G-499 SO1, 2 and 3);
4. the average spacing of observable cracks is therefore (700 ft./87 cracks) or about 8 ft. on center;
5. the average spacing of all cracks counted is therefore (700 ft./146 cracks) or about 4.8 ft. on center;
6. the percentage of wall cracks interacting with basemat cracks as a function of the total number of wall cracks is therefore  $(19 \times 100 / 146)$ ; about 13 percent, or about 1 in 8 cracks.

If we restrict ourselves to an evaluation of the Reactor Bldg walls alone, we then note that:

1. there are a total of 70 cracks mapped by Ebasco, of which 29 are directly observable; the remaining cracks can only be inferred from the presence of leachate;
2. there are a total of only 5 instances in which wall and mat cracks fall within a 2.0 ft. dimension at the base of the mat and wall;
3. Ebasco mapped a total of approximately 210 linear ft. of wall;
4. the average spacing of observable cracks is therefore (210 ft./29 cracks) or about 7.2 ft. on center;
5. the average spacing of all cracks counted is therefore (210 ft./70 cracks) or about 3.0 ft. on center;
6. the percentage of wall cracks interacting with basemat cracks as a function of the total number of wall cracks is therefore  $(5 \times 100 / 70)$ ; about 7 percent, or about 1 in 14 cracks.

## 5.0 Conclusions

The cracks observed in the top of the foundation mat were discussed in detail in HEA Report 8304-1, Reference 1. We concur with the observation that the wall cracks are drying shrinkage cracks which form when the wall dries but is restrained from shrinking at the intersection of walls with the foundation mat. In some cases there may have been a predisposition of these wall shrinkage cracks to emanate from a pre-existing crack in the mat. However, the cracking as observed is not consistent with any possible loading mechanism.

The incidence of wall and mat crack interaction as detailed in Items 6 above is not considered significant enough to substantiate a wall-basemat crack interaction hypothesis. We therefore concur with the key Ebasco conclusion contained in Section 5.4 of their Report which notes that: "-it is concluded that a structural inter-relationship cannot be established between cracks on surfaces of walls and basemat."

In summary we concur with the observations and conclusions described of the Ebasco Report, Reference 2.

If we can provide any additional information or clarification with respect to our review of the subject Ebasco Report, please call us.

Very truly yours,  
HARSTEAD ENGINEERING ASSOC., INC.

Gunnar A. Harstead  
President

cc. J. Costello



UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Appeal Board

In the Matter of	)	
	)	
LOUISIANA POWER & LIGHT COMPANY	)	Docket No. 50-382
	)	
(Waterford Steam Electric	)	
Station, Unit 3)	)	

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