Northern Indiana Public Service Company
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E. M. Shorb
Senior Vice President Operations

December 15, 1978

Mr. Roger S. Boyd, Director
Division of Project Management
Office of Nuclear Reactor Regulations
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

RE: Northern Indiana Public Service Company
Bailly Generating Station Nuclear 1
Docket No. 50-367

Dear Mr. Boyd:

Please find enclosed forty (40) copies each of Revision 1 and Report Errata for "Supplementary Information on Driven H-Pile Foundations" Report for Bailly Generating Station, Nuclear 1, Northern Indiana Public Service Company dated December 4, 1978.

The Revision, consisting of replacement pages, contains details and results of Liquifaction Analyses performed for preconstruction Areas A through D, as well as the inclusion of several portions of the test that were inadvertently omitted from the original submittal. The Report Errata corrects typographical, spelling and proofreading errors.

We would appreciate your early concurrence in our proceeding with production piles.

Very truly yours,

EMShorb

EMS:cga
Enclosure

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D008
SE
1/40

A

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December 15, 1978

REPORT ERRATA

"Supplementary Information on Driven H-Pile Foundations"

Bailly Generating Station - Nuclear 1
Northern Indiana Public Service Company
December 4, 1978

COVER LETTER

1. Revise the fifth line of this letter to show 21 additional borings having been performed in preparing this report.

TABLE OF CONTENTS

2. Page i

a. The first subsection under section 2.3.2 "Soil Improvement" should be 2.3.2.1 not 2.2.3.1.
b. Section 2.3.2.3 "Driving Resistance" does not appear in the text and should be deleted.

3. Page ii

Subsection 3.2.4.2 should be titled "Survey Precision and Accuracy."

LIST OF FIGURES

5. Page viii

Figure 3-7A gives the plots of "Pile Heave Versus Time" for piles 6, 19, 28 and 36, i.e., pile 19 not pile 9.

5. Page ix

Figure 4-7 is titled "Redrive Resistance Versus Initial Driving Resistance" not as shown.

CHAPTER 1

6. Page 1-5

"Ref. 2-5" should be "Ref. 2-4".

7. Page 1-7

Item 1 - "All piles which experience in excess" should be, "All piles which experience heave in excess".

8. Page 1-10

Rotation: "± 20 inches" should be "± 20 Degrees".

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REPORT ERRATA (cont'd)

CHAPTER 2

9. Page 2-8

Fifth line in middle paragraph, "Ref. 2-2" should be "Ref. 2-3".

10. Page 2-11

First paragraph of section 2.2.3, seven lines down, "Ref. 2-3" should be "Ref. 2-2".

11. Page 2-12

Change the elevation given in the first line of Item 4 from -100 to -110.

12. Page 2-15

First paragraph of section 2.2.4, six lines down, "Ref. 2-3" should be "Ref. 2-2".

13. Page 2-16

Revise the fifth line from the top of the page to show that the auger hole at pile location 25 was advanced to elevation -117, not -115.

14. Page 2-17

The N-values given in the ninth line from the top of the page vary from 23 (not 3) to 41.

15. Page 2-21

Eight lines down from the top of page, "Suspectible" should be "Susceptable".

16. Page 2-23

Seventh line up from the bottom of page, "Ref. 2-1" should be "Ref. 1-1".

17. Page 2-32

Five lines up from bottom of page, "80" should be "-82".

18. Page 2-33

The drill rod drop mentioned in the last line on the page was 4', not 2.5'.

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REPORT ERRATA (cont'd)

19. Page 2-34

Revise the second sentence on the page to read "This zone... of nearby Piles No. SE-70 and SE-73 which were driven to..."

20. Page 2-44

Revise the first line of Item 5 to state that 3 (not 2) verification borings will be drilled.

21. Page 2-45

a. Substitute Boring PZE-7 for PZE-5 in the fourth line from the top of the page.
b. Change elevation -133 to -138 in the fifth and seventh lines from the top of the page.

22. Table 2-2

Driving of AP-9 occurred from elevation +40 to -48 (not -54).

23. Table 2-5

Under pile "Type", there should be two asterisks, not one, adjacent to 14HP117 i.e., 14HP117**.

24. Figure 2-3

The blow count at elevation -86, given as 112, should be 142.

25. Figure 2-9

a. Delete the unneeded production pile symbols at pile locations 7, 8, 15 and 16.
b. The 22" Ø casing at location 6 was installed to elevation -12.5.
c. Label pile location 4 (the only location with no number) as such.
d. Please note under Pile 3 that no jetting was performed.
e. Add the "likely disturbance" zone and the corresponding N-value at elevation -86 for Boring PZC-2. This disturbance is referred to on page 2-15 of the text.

26. Figure 2-12

The auger hole at pile location 25 was bored to elevation -117, not -115.

27. Figure 2-14

The blow count at elevation -9 is 16, not 40 as plotted here.

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REPORT ERRATA (cont'd)

28. Figure 2-15

a. The tip elevation of Pile SE-98 is -133 (not -132).
b. Jetting was conducted to elevation -122 (not -112) on Pile SE-61.
c. In the Key, "Jetted (elevation)" should be "Jetted (Lowest Elevation)."

29. Figure 2-19

The number "1" (for note 1) should appear beside the point at elevation -115 (blow count of 28) since this sample was taken with a 2.5" I.D. split spoon.

30. Figure 2-24

The sample taken at elevation -54 in boring 70W-1 (blow count of 14) should have only 1 asterisk (*) after it since sampling was done with a 2.5" I.D. split spoon.

31. Figure 2-34

Add "weight of rod" drop from 91 to 95 feet. This W.O.R. is shown in Figure 2-19 and the boring log (Appendix 2A).

32. Figure 2-40

Add "weight of rod" drop from 91 to 95 feet. This W.O.R. is shown in Figure 2-19 and the boring log (Appendix 2A).

33. Figure 2-51A

The labels for Borings PZE-5 and PZE-7 are reversed, i.e., PZE-5 is located east of PZE-7.

34. Figure 2-51B
a. Last line of title, add "Preconstruction Area E".
b. Borings PZE-5 and PZE-7 have been interchanged.

35. Figure 2-51C

a. Last line of Note 2, "liquification" should be "liquefaction".
b. Borings PZE-5 and PZE-7 have been interchanged.

36. Figures 2-52A and 2-52C

TP-6 is still in place. Thus, it will be necessary to provide a grout hole on either side of the web instead of one hole down the middle as shown.

REPORT ERRATA (cont'd)

37. <u>Figures 2-55A and 2-55C</u>

Grouting will need to extend to elevation -122 since jetting was carried out to -117.

38. <u>Figures 2-55B and 2-55C</u>

Delete note in lower left hand corner of these figures.

<u>CHAPTER 3</u>

39. <u>Table 3-1</u>

The column heading which reads "Hammer Speed in Blows Per Inch/..." should be changed to read "...Speed in Blows Per Minute/..."

40. <u>Table 3-4</u>

Pile AB-156 received only 55 blows at full stroke not the 121 blows listed here. The additional 66 blows (121 - 55) should be noted in the "Blows with Short Stroke" column, and the redrive ratio for short stroke blows changed to 3.2.

41. <u>Figure 3-2</u>

a. Use the symbol indicated in the legend to show that Piles SA-9 and SA-11 were load test piles.
b. Use the symbol indicated in the legend to show that Pile AB-135 was instrumented with a tell-tale.

42. <u>Figure 3-5A</u>

a. The pile in row 3 with 0.22 inches of heave should be labeled as Pile 17 (not 19).
b. Heave of Pile 2 should be changed to 0.24 inches.

43. <u>Figure 3-5B</u>

a.

Pile Number	Heave as now Shown	Revised Heav.
5	0.46	0.53
6	0.59	0.58
18	0.67	0.65
27	0.59	0.53
40	-0.06	0.00

b. Delete the 0.5 inch contour line around Pile 5.

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REPORT ERRATA (cont'd)

44. Figure 3-8B

Revise the "Penetration into Bearing Stratum" for Pile 18 to 5 feet.

45. Figure 3-14B

The maximum butt deflection is 1.077 inches.

46. Figure 3-15B

The maximum butt deflection is 0.916 inches.

CHAPTER 4

47. Page 4-12

Change butt deflection given for Pile SA-11 in the fifth line from the top of the page from 0.89 to 0.92 inches.

48. Page 4-17

Last line before section 4.5, Delete "Will be provided".

49. Table 4-1

The "Cushion Thickness Before Test" for the fresh cushion is 4.9 (not 4.62) inches.

CHAPTER 5

50. Page 5-2

Insert a plus (+) sign between P_{LL} and T_o in the equation given on this page.

51. Page 5-12

Substitute "relative to" for "change in" in the first line on the page.

REFERENCES

52. Reference 1-3

Indicate the NIPSCo submittal to the NRC on July 20, 1978, in addition to July 14, 1978, as noted on Page 1-1 in the text.

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REPORT ERRATA (cont'd)

53. Reference 2-2

Report SL-3205 was dated September 15, 1975, not September 17, 1975. Include docket date of July 14, 1978.

54. Reference 2-10

Note that Dr. Seed provided the information from the Waterways Experimental Station which is used in this Report.

55. Appendix 2B

Change the word "production" to "product" in the tenth line of the second paragraph on the fourth page.

56. Appendix 2B, Figures 2B-2 and 2B-4

Add "Area E" to the title block.

57. Appendix 2C

Add the following to the title page "(Displacement Piles)."

58. Appendix 2C - Pile No. 11

Delete the "8 blows/2 inches" from this plot.

59. Appendix 2D

Add the following to the title page "(Displacement Piles)."

60. Appendix 3G

Second page. The piles listed in the second line of Item 3 should be TP-B (not TP-b) and Q-94 (not Q-96).

61. Appendix 3G - Figure 3-G-2

Change "dense silt" from 16 to 30 feet, to "very stiff clay".

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12/15/78

REVISION 1

"Supplementary Information on Driven H-Pile Foundations"

Bailly Generating Station-Nuclear 1
Northern Indiana Public Service Company
December 4, 1978

Original Page	Replacement Page (s)
1-4	1-4
None	2-22A
2-37	2-37
2-40	2-40
2-48	2-48
2-49	2-49 and 2-49A
2-50	2-50
2-51	2-51 and 2-51A
2-52	2-52
2-53	2-53 and 2-53A
2-54	2-54
2-55	2-55 and 2-55A
Fig. 2-49	Fig. 2-49
None	Fig. 2-52D
None	Fig. 2-53D
None	Fig. 2-54D
None	Fig. 2-55D
None	3-18a
3-34	3-34
App. 2B, p.1	App. 2B, p.1
None	App. 2B, Fig. 2B-5
None	App. 2B, Fig. 2B-6
None	App. 2B, Fig. 2B-7
None	App. 2B, Fig. 2B-8
None	App. 2B, Fig. 2B-9
None	App. 2B, Fig. 2B-10
None	App. 2B, Fig. 2B-11
None	App. 2B, Fig. 2B-12
None	App. 2B, Fig. 2B-13
None	App. 2B, Fig. 2B-14
None	App. 2B, Fig. 2B-15
None	App. 2B, Fig. 2B-16

tration Test (SPT) N-values were used as a basis to evaluate the in-situ soil conditions and the effects of the preconsturction activities. A comparison of SPT N-values obtained within the areas of preconstruction activities to SPT N-values obtained within the same strata in areas where no such activities took place indicated that the sandy soils have been disturbed/loosened.

Liquefaction analyses were performed using state-of-the-art techniques to establish liquefaction potential criteria. Based on consultation with Dr. H. B. Seed, it was concluded that a factor of safety of 1.5, based on the SPT N-values, should be maintained to prevent liquefaction. The SPT N-values, required to prevent liquefaction are being developed for each preconstruction area. R1

The liquefaction studies in Area E (southwest corner of Service Building) indicated that soils immediately in between jetted piles were loosened sufficiently such that the factor of safety against liquefaction was less than 1.5. As a result, closely-spaced H-piles were driven, completely enclosing portions of the jetted piles in Area E, to determine the feasibility of using driven H-piles as

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disturbed soil are given the strain dependent shear moduli and damping ratios of the original undisturbed soil layers as reported in Report SL-3629 (Ref. 1-1). For the disturbed zone, shear moduli and damping ratios were taken as equivalent R1 might also have filled disturbed zones similar to that encountered in Boring PZE-5 below the depth of previous jetting activiti s. Based on the results of the Birdwell 3-arm Caliper survey, the average borehole diameter for Borings PZE-6 and PZE-7 was about 5 inches. It would require approximately 40 cubic feet of the colored drilling fluid to fill these two borings. Therefore, approximately 40 cubic feet out of the 80 cubic feet of the colored drilling fluid were lost due to communication and/or filling adjacent disturbed zones. R1

The communication is believed to occur mostly in the upper portion of the boring, especially immediately below the upper glacial lacustrine clay where the top portion of the sand layer was eroded or loosened due to the jetting and drilling activities. This mode of communication is demonstrated by the Birdwell 3- arm caliper measurements in Borings PZE-6 and PZE-7, as shown on Figures 2-49 and 2-50, respectively. Limited zones having a larger diameter were recorded in both borings at the same elevation (elevation -22) immediately below the upper glacial lacustrine clays.

sand/clay bearing stratum is reached. Thereafter, the SPT N-values will be obtained at 2½-foot intervals. These borings will be drilled approximately 10 feet beyond the maximum expected depth of disturbance in each area. Where the preconstruction activities extend to bedrock, the borings will be terminated at the bedrock surface.

Liquefaction analyses have been performed in each preconstruction area (Sections 2.3.1 and 2.4.3), using procedures similar to those described in Section 2.3.1 for Area E, to establish the minimum required N_1-values to prevent liquefaction, with a factor of safety of 1.5. A plot of SPT N-values versus depth has been prepared for each area (Sections 2.4.2.4 and 2.4.3), corresponding to the effective overburden pressure for various ground water conditions, in accordance with the procedure presented in Step 4 of Section 2.3.1.1. If the SPT N-values from the borings exceed the analytical values, i.e., factor of safety greater than 1.5, densification piles within the proximity of the supplemental borings are not required. If the factor of safety is less than 1.5, Step 3 (driving densification piles) will be carried out at predetermined locations. Also, additional supplementary borings will be subsequently drilled R1

The curves on Figure 2-51D are established based on the very conservative model of analysis (Approach 1, Section 2.3.1) and for various field groundwater conditions. The field personnel can use the groundwater level and SPT N-values for sandy soils encountered in each boring and compare the data with the appropriate curve to assess whether the sandy soils possess a factor of safety against liquefaction of 1.5 or greater.

2.4.3 Program for Other Preconstruction Areas

Based on the nature and extent of the preconstruction activities and the soil conditions revealed by borings and indicator piles (as presented in Section 2.2), remedial programs for Preconstruction Areas A, B, C, and D have also been developed utilizing the principles and concepts described in Section 2.4.1. Applicable steps in the program will be implemented in any anomalous areas identified by the driving of production piling. The programs were designed on the basis of the methods and procedures used in Area E which have proven successful in densifying the sand strata which were disturbed by the preconstruction activities. The results obtained give confidence that successful results will be obtained in other preconstruction areas as well. R1

The following subsections present the remedial programs for Areas A through D; however, for simplicity, some of the details, such as those presented in the general remedial disussion (Section 2.4.1) and the discussion of Area E (Section 2.4.2), have not been elaborated.

2.4.3.1 Area A

The background information for Area A has been summarized in Figure 2-2. Figures 2-52A through 2-52C present the plans for different phases of the remedial program. Liquefaction analyses have been performed utilizing analytical techniques similar to those presented for Area E (Section 2.3.1). The disturbed zone was modeled assuming disturbance from the top of the interbedded bearing stratum to a depth several feet beyond the maximum depth of jetting. Appendix 2-B presents the two different approaches used to model the soil in the disturbed zone (Figures 2B-5 and 2B-6) and the corresponding N_1-values required for each approach so that the factor of safety against liquefaction is 1.5 (Figure 2B-7). Based on the N_1-values obtained for the very conservative model analysis (Approach I, as discussed in Section 2.3.1), the liquefaction potential criteria for Area A are presented on Figure 2-52D (in the format of SPT N-values versus depth, similar to that presented for Area E in Section 2.4.2.4 and on Figure 2-51D). The program is outlined as follows: R1 R1 R1

1. Drill 4-inch diameter grout holes and grout at the locations shown in Figure 2-52A. At the locations where the piles have been extracted, a primary grout hole will be installed. Four secondary grout holes will be installed approximately 1.5 feet from each

of the primary grout holes. At the location of TP-6, where the jetted pile is still in place, primary grout holes will be drilled in between the pile flanges, one on each side of the web. Four secondary grout holes will be installed about1.5 feet from the center of TP-6. The depth of grouting at each location is shown on Figure 2-52A.

2. Drill six supplementary borings to the elevation of the nearest grout hole, as shown on Figure 2-52B. Liquefaction potential will be evaluated based on the liquefaction potential criteria developed for this area. (Figure 2-52D).

3. Drive densification piles at the locations and to the depths shown on Figure 2-52B. Contingency densification piles may be installed at the locations as shown, on the basis of results obtained from the supplementary borings.

4. Drill three verification borings at the locations shown on Figure 2-52B to confirm that SPT N-values meet the minimum required, according to the liquefaction analysis performed for this area (Figure 2-52D). Figure 2-52C presents a composite drawing showing the total remedial program for Area A. R1

2.4.3.2 Area B

The background information for Area B has been summarized in Figure 2-6. Figures 2-53A through 2-53C present the plans for different phases of the remedial program. Liquefaction analyses have been performed utilizing analytical techniques similar to those presented for Area E (Section 2.3.1). The disturbed zone was modeled assuming disturbance from the top of the interbedded bearing stratum to a depth several feet beyond the maximum depth of jetting. Appendix 2-B presents the two different approaches used to model the soil in the disturbed zone (Figure 2B-8 and 2B-9) and the corresponding N_1-values required for each approach so that the factor of safety against liquefaction is 1.5 (Figure 2B-10). Based on the N_1-values obtained for the very conservative model analysis (Approach I, as discussed in Section 2.3.1), the liquefaction potential criteria for Area B are presented on Figure 2-53D (in the format of SPT N-values versus depth, similar to that presented for Area E in Section 2.4.2.4 and on Figure 2-51D). The program is outlined as follows: R1 R1 R1

1. Drill 4-inch diameter grout holes and grout at the locations shown in Figure 2-53A. At all the locations where the piles have been extracted, a primary grout hole will be installed. Four secondary grout holes will be installed

approximately 1.5 feet from each of the primary grout holes. The depth of grouting at each location is shown on Figure 2-53A.

2. Drill seven supplementary borings to the elevation of the nearest grouting depth, as shown on Figure 2-53B. Liquefaction potential will be evaluated

based on the liquefaction potential criteria developed for this area (Figure 2-53D).

3. Drive densification piles at the locations and depths shown on Figure 2-53B. Contingency densification piles may be installed at the locations as shown, on the basis of results obtained from the supplementary borings.

4. Drill two verification borings at the locations shown on Figure 2-53B to confirm that SPT N-values meet the minimum required, according to the liquefaction analysis performed for this area (Figure 2-53D). Figure 2-53C presents a composite drawing showing the total remedial program for Area B. | R1

2.4.3.3 Area C

The background information for Area C has been summarized in Figure 2.9. Figures 2-54A through 2-54C present the plans for different phases of the remedial program. Liquefaction analyses have been performed utilizing analytical techniques similar to those presented for Area E (Section 2.3.1). The disturbed zone was modeled assuming disturbance from the top of the interbedded bearing stratum to the bedrock surface. Appendix 2-B presents the two different approaches used to model the soil in the disturbed zone (Figure 2B-11 and | R1

2B-12) and the corresponding N_1-values required for each approach so that the factor of safety against liquefaction is 1.5(Figure 2B-13). Based on the N_1-values obtained for the very conservative model analysis (Approach I, as discussed in Section 2.3.1), the liquefaction potential criteria for Area C are presented on Figure 2-54D (in the format of SPT N-values versus depth, similar to that presented for Area E in Section 2.4.2.4 and on Figure 2-51D). The program is outlined as follows: R1

1. Drill 4-inch diameter grout holes and grout at the locations and to the depths shown on Figure 2-54A. At locations where preaugering without jetting took place and where piles have been installed, only two primary grout holes will be drilled; one on each side of the pile web. At locations of augered holes where no pile was installed (locations 4 and 15), 4 secondary grout holes will be used around the primary grout hole to grout the predrilled hole, as shown in Figure 2-54A. At locations where piles were installed by jetting (locations 5 and 9), two primary grout holes will be used in between the flanges, on each side of the pile web, and 4 secondary grout holes around the pile. The secondary grout holes will be located about 1.5 feet from the center of the pile or the center of the primary grout holes.

2. Drill six supplementary borings at the locations shown in Figure 2-54B. The borings will extend to a depth of 140 feet (elevation -132). Liquefaction

potential will be evaluated based on the liquefaction potential criteria developed for this area. (Figure 2-54D)

3. Drive densification piles to improve soil conditions. The densification piles are planned at the locations shown in Figure 2-54B. Supplementary densification piles will be driven, if required, at the locations shown. The need for densification piles at these locations will be determined on the basis of the results of the supplementary borings.

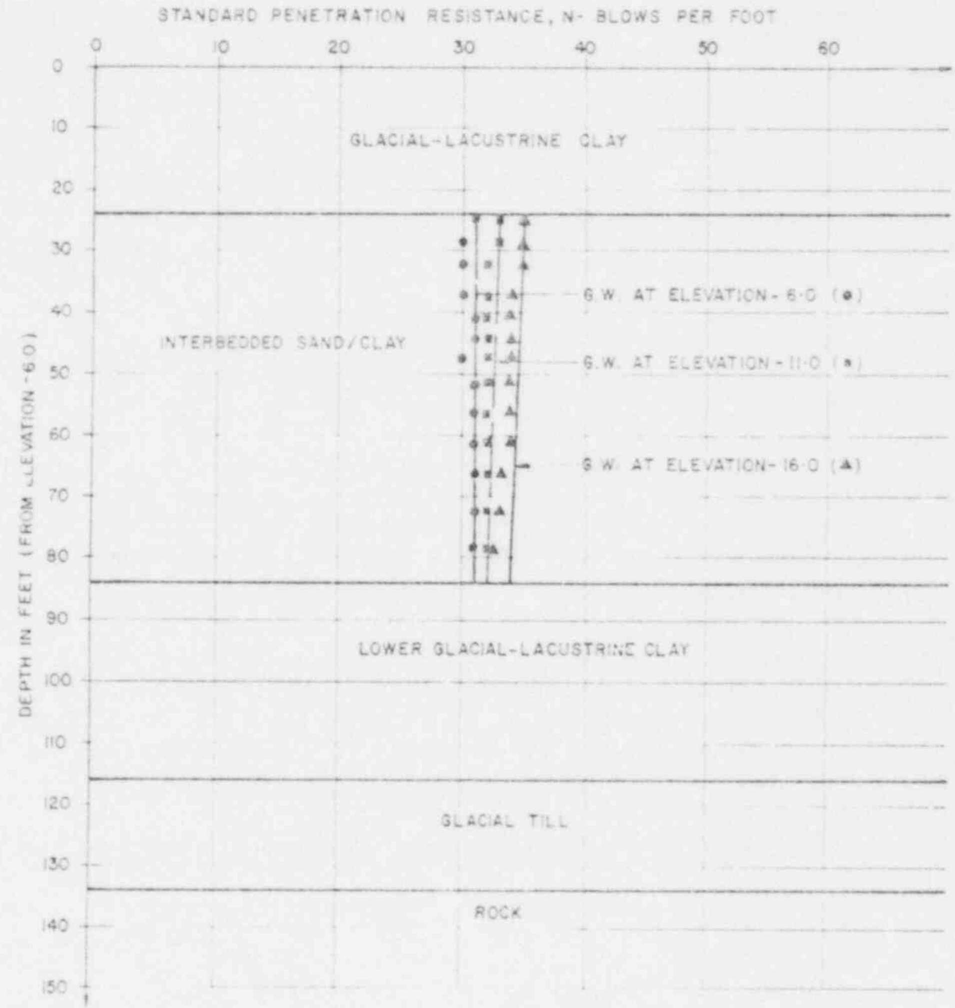
4. Drill four verification borings at the locations shown in Figure 2-54B to confirm that SPT N-values meet the minimum required according to the liquefaction analyses performed for this area. Figure 2-54C is a composite drawing showing the total remedial program for Area C. R1

2.4.3.4 Area D

The background information for Area D has been summarized in Figure 2-12. Figures 2-55A through 2-55C present the plans for different phases of the remedial program. Liquefaction analyses have been performed utilizing R1 analytical techniques similar to those presented for Area E (Section 2.3.1). The disturbed zone was modeled R1 assuming disturbance from the top of the interbedded bearing stratum to bedrock. Appendix 2-B presents the two different approaches used to model the soil in the disturbed zone (Figure 2B-14 and 2B-15) and the corresponding N_1-values required for each approach so that the factor of safety against liquefaction is 1.5 (Figure 2B-16). Based on the N_1-values obtained for the very conservative model analysis (Approach I, as discussed in Section 2.3.1), the liquefaction potential criteria for Area D are presented on Figure 2-55D (in the format of SPT N-values versus depth, similar to that presented for Area E in Section 2.4.2.4 and on Figure 2-51D). The program is outlined as follows: R1

1. Drill 4-inch diameter grout holes and grout at the locations and to the depths shown in Figure 2-55A. Primary grout holes will be drilled in between the pile flanges, on each side of the pile web. Four secondary grout holes will be drilled around each pile location, approximately 1.5 feet from the center of the pile.

2. On the basis of the very high penetration resistances recorded in Borings PZD-1 and PZD-2, it appears that soil densification is not required in this area; however, to eliminate any concerns relative to the density of the sand lenses within the interbedded deposit, two supplementary borings will be drilled at the locations shown in Figure 2-55B. If the



NOTES:

1. ALL CRITERIA ESTABLISHED FOR F.S.=1.5 DETERMINED USING APPROACH I.
2. IF N-VALUE IS LESS THAN N REQUIRED, THEN LIQUEFACTION ANALYSES WILL BE PERFORMED BASED ON CONDITIONS THAT EXIST IN EACH BORING.
3. REQUIRED N-VALUES ARE COMPUTED ASSUMING FOUNDATION GRADE (ELEVATION - 6.0) HAS BEEN ACHIEVED PRIOR TO DRILLING THE BORING.

FIGURE 2-52D
CRITERIA FOR LIQUEFACTION POTENTIAL-PRECONSTRUCTION AREA A

BAILLY N-1
NORTHERN INDIANA PUBLIC SERVICE COMPANY

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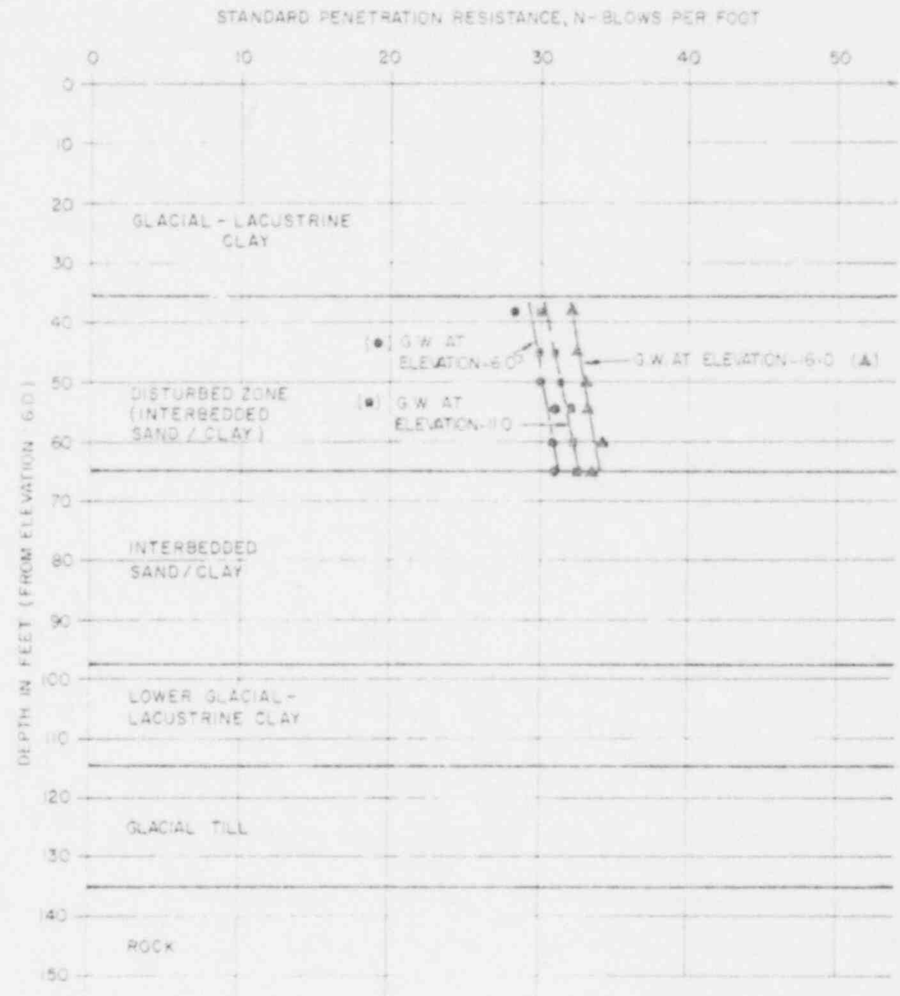
Revision 1 12/15/78



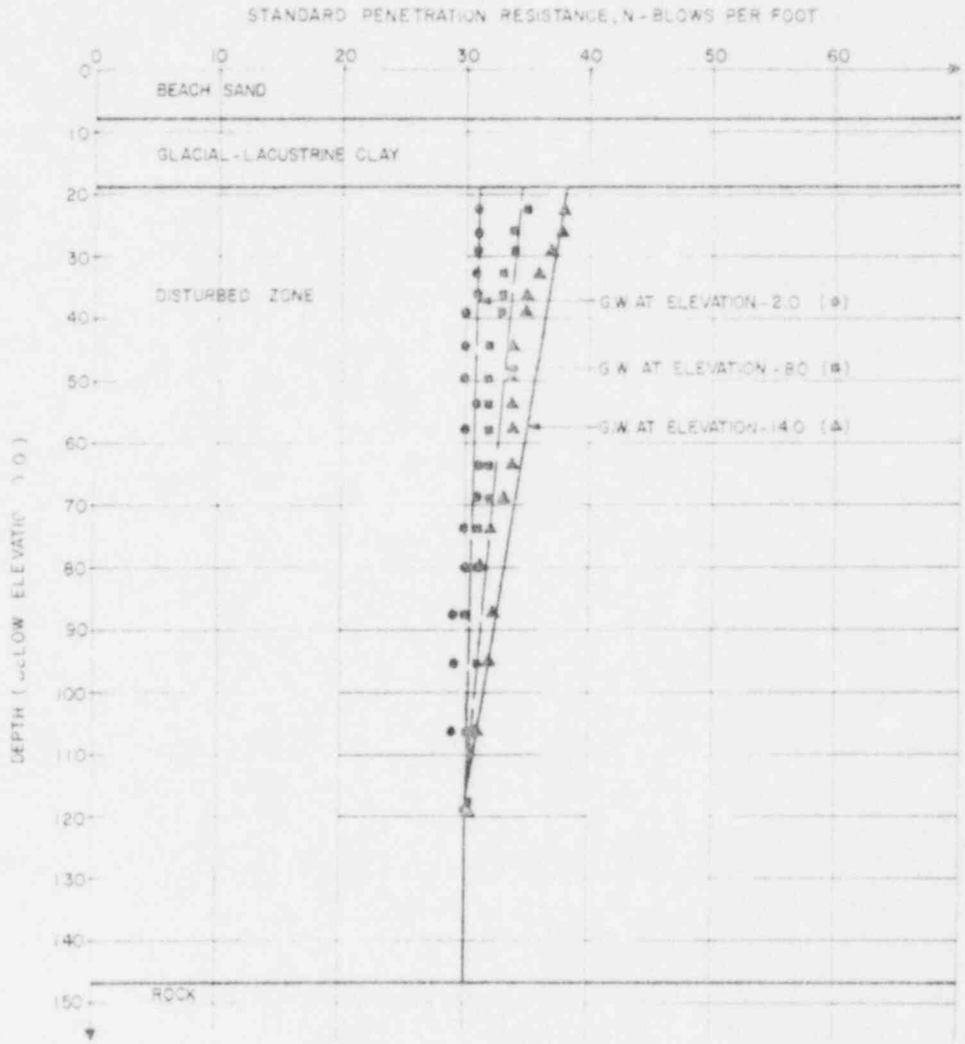
NOTES

1. ALL CRITERIA ARE ESTABLISHED FOR F.S. = 1.5 DETERMINED USING APPROACH I.
2. IF N-VALUE IS LESS THAN N REQUIRED THEN LIQUEFACTION ANALYSES WILL BE PERFORMED BASED ON CONDITIONS THAT EXIST IN EACH BORING.
3. REQUIRED N VALUES ARE COMPUTED ASSUMING FOUNDATION GRADE (ELEVATION - 6.0) HAS BEEN ACHIEVED PRIOR TO DRILLING THE BORING.

FIGURE 2-53D
CRITERIA FOR LIQUEFACTION POTENTIAL-PRECONSTRUCTION AREA B
BAILLY N-1
NORTHERN INDIANA PUBLIC SERVICE COMPANY

SARGENT & LUNDY ENGINEERS

Revision 1, 12/15/78



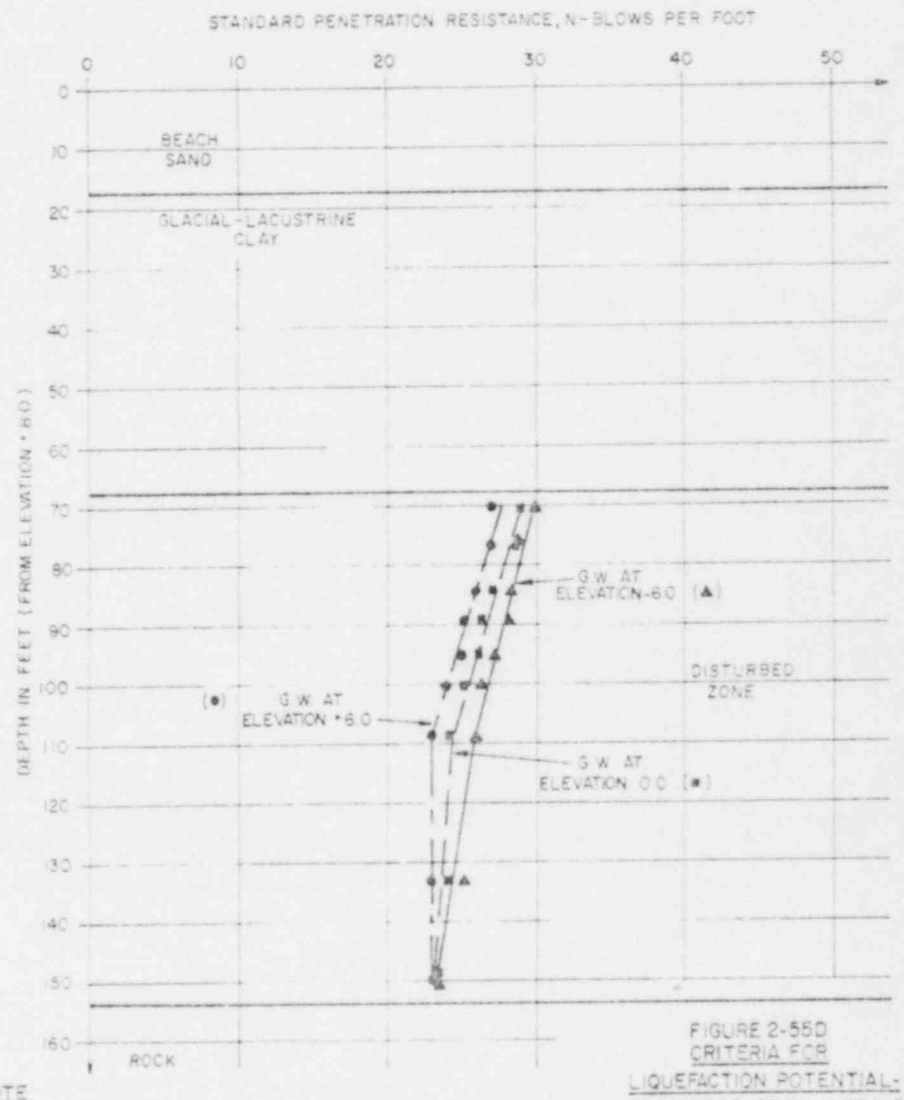
NOTES:

1. ALL CRITERIA ESTABLISHED FOR F.S.=1.5 DETERMINED USING APPROACH I.
2. IF N-VALUE IS LESS THAN N REQUIRED, THEN LIQUEFACTION ANALYSES WILL BE PERFORMED BASED ON CONDITIONS THAT EXIST IN EACH BORING.
3. REQUIRED N-VALUES ARE COMPUTED ASSUMING FOUNDATION GRADE (ELEVATION 0.0) HAS BEEN ACHIEVED PRIOR TO DRILLING THE BORING.

Revision 1 12/13/79

FIGURE 2-540
CRITERA FOR LIQUEFACTION POTENTIAL-PRECONSTRUCTION AREA C
BAILLY N-1
NORTHERN INDIANA PUBLIC SERVICE COMPANY

SARGENT & LUNDY ENGINEERS



NOTE

1. CRITERIA ARE ESTABLISHED FOR FS = 1.5 DETERMINED USING APPROACH I
2. IF N-VALUE IS LESS THAN N REQUIRED, THEN LIQUEFACTION ANALYSES WILL BE PERFORMED BASED ON CONDITIONS THAT EXIST IN EACH BORING
3. REQUIRED N-VALUES ARE COMPUTED ASSUMING FOUNDATION GRADE (ELEVATION -8.0) HAS BEEN ACHIEVED PRIOR TO DRILLING THE BORING

FIGURE 2-55D
CRITERIA FOR LIQUEFACTION POTENTIAL-PRECONSTRUCTION AREA D

BAILLY N-1
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strated on Figures 3-8A and 3-8B, which show plots of heave increment due to driving of two category B and two category A piles, respectively, versus center-to-center distance from the driven piles. The heave increment is highest at one pile spacing and decreases with increasing distance away from the driven pile. The two figures are considered representative of the range of observed variations in heave increments within the heave test cluster. Plots of incremental heave versus distance away from other piles are presented in Appendix 3-F.

Pile Tip Heave - Six piles (Nos. 10, 15, 19, 24, 28 and 33) were instrumented with tell-tales installed at the pile tip. The tops of the tell-tale rods were surveyed, thereby providing a record of pile tip movement. The heave data from the tell-tale readings are included in Table 3-2. R1

In general, the pile tips heaved slightly less than the pile butts. This is demonstrated on Figures 3-9A and 3-9B, which present heave versus time for the six piles which were instrumented with tell-tales. Pile tip heave is also shown for the six piles. Figure 3-10 plots pile tip heave versus pile butt heave. Pile tip heave is seen to be 80 to 95 percent of the pile butt heave. This small difference in heave shows that the piles elongated because of heave. The elongation indicated by these data is reasonable for the length of piles in this cluster.

the bearing stratum (and met the specified driving criteria). Such detailed heave records were obtained during driving of 9 piles in the heave test cluster. The results of the pile load tests and the heave measurements from the 9 piles described above are evaluated below.

3.5.2.2.1 Evaluations of Pile Load Test Results

Figure 3-20 summarizes the load-deflection behavior of the three piles tested as part of the heave program. The load-deflection behavior of Pile Q-94, which was load tested in October 1977 (Ref. 1-1) is also included for comparison. It can be seen from Figure 3-20, the load-deflection diagrams are practically identical for all four piles up to the maximum applied load. Variations in pile heave of 0.5 to 1.04 inches apparently have no noticeable effect on the load-deflection behavior of these piles.

The load deflection behavior of Pile AB-155 was analyzed using the procedures developed by Reese (Ref. 3-4). Dr. Reese was retained as consultant to the project to provide an independent review of the work presented herein. His letter documenting the review is included immediately following Chapter 6 of this report. Dr. Reese conducted similar analyses for Pile AB-155 and Pile SA-11 as part of his evaluation. The general procedure for computing load deflection behavior of axially loaded piles using the procedure developed by Reese as well as R1

APPENDIX 2B

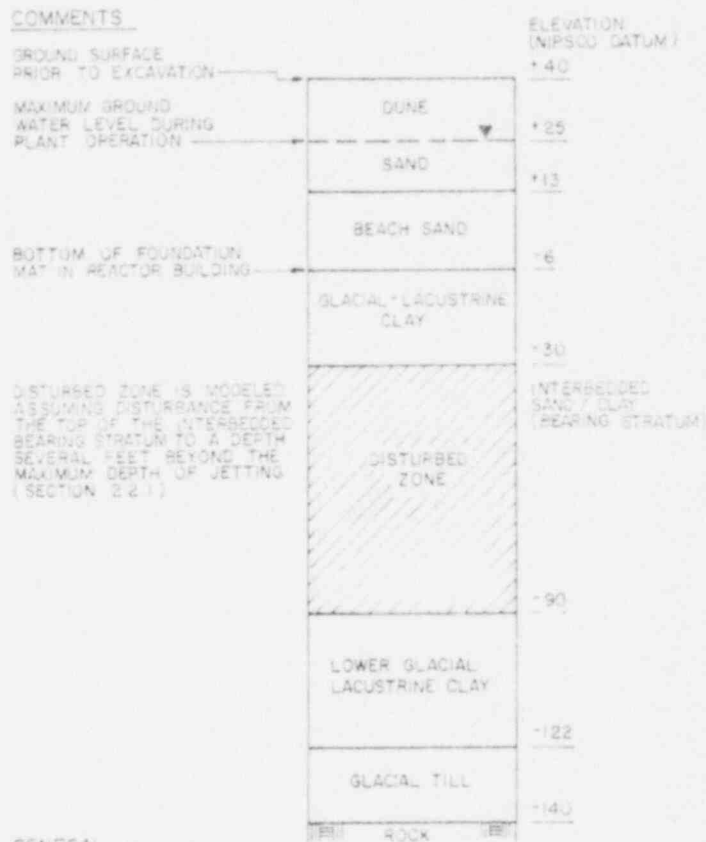
This Appendix describes the seismic input to the SHAKE analysis and the two approaches used to compute induced cyclic shear stresses throughout the disturbed zone, using Area E as the example (Figures 2B-1 through 2B-4). Corresponding figures for Areas A through D are presented on Figures 2B-5 through 2B-16. R1

I. SEISMIC INPUT TO SHAKE ANALYSES

As discussed in the Bailly PSAR (Ref. 2-5), the design Safe Shutdown Earthquake (SSE) magnitude is 6 and the maximum SSE ground acceleration is 0.2g at the site.

For the liquefaction potential evaluation of the disturbed soils at Area E, the SSE input is defined in terms of a number of suitable acceleration time histories of recorded earthquake motions and is applied at the ground surface (+40 elevation). The time histories are scaled to have a peak acceleration of 0.2g.

To select appropriate time histories to be used for the analysis, a number of earthquake time histories were reviewed. In selecting natural records, the following criteria ideally should be satisfied:



GENERAL

1. INDUCED CYCLIC SHEAR STRESSES ARE COMPUTED USING "SHAKE" WITH THE SCALED MAXIMUM GROUND ACCELERATION (0.2g) INPUT AT ELEVATION +40
2. SHEAR MODULI AND DAMPING RATIOS FOR UNDISTURBED SOILS ARE REPORTED IN REPORT SL-3629
3. SHEAR MODULI AND DAMPING RATIOS FOR DISTURBED ZONE ARE ASSUMED TO BE THE SAME AS THOSE USED IN AREA "E" ANALYSES (SECTION 2.3.1.1)

FIGURE 2B-5
SOIL PROFILE FOR APPROACH 2
PRECONSTRUCTION AREA A
BAILLY N-1
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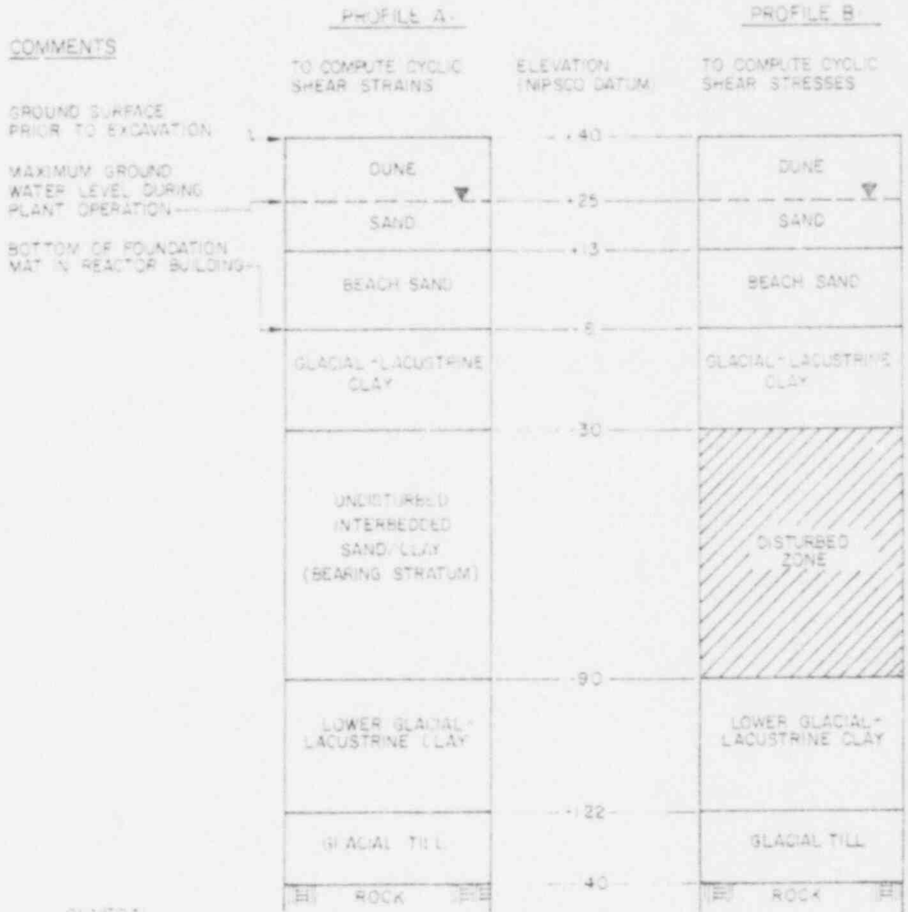

GENERAL

1. PROFILE A BASED ON GENERALIZED STRATIGRAPHIC COLUMN IN REACTOR BUILDING AREA AND PRECONSTRUCTION AREA BORINGS
2. PROFILE B IS THE SAME AS FIGURE 2B-5
3. INDUCED EFFECTIVE CYCLIC SHEAR STRAINS ARE COMPUTED FOR PROFILE A USING "SHAKE" WITH THE SCALED MAXIMUM GROUND ACCELERATION (0.2 g) INPUT AT ELEVATION +40
4. INDUCED EFFECTIVE CYCLIC SHEAR STRESSES ARE COMPUTED THROUGHOUT THE DISTURBED ZONE AS SHOWN IN PROFILE B BY MULTIPLYING THE INDUCED EFFECTIVE CYCLIC SHEAR STRAINS DETERMINED IN (3) BY THE SHEAR MODULI FOR THE DISTURBED ZONE

FIGURE 2B-6
SOIL PROFILES FOR APPROACH II
PRECONSTRUCTION AREA A
BAILLY N-1
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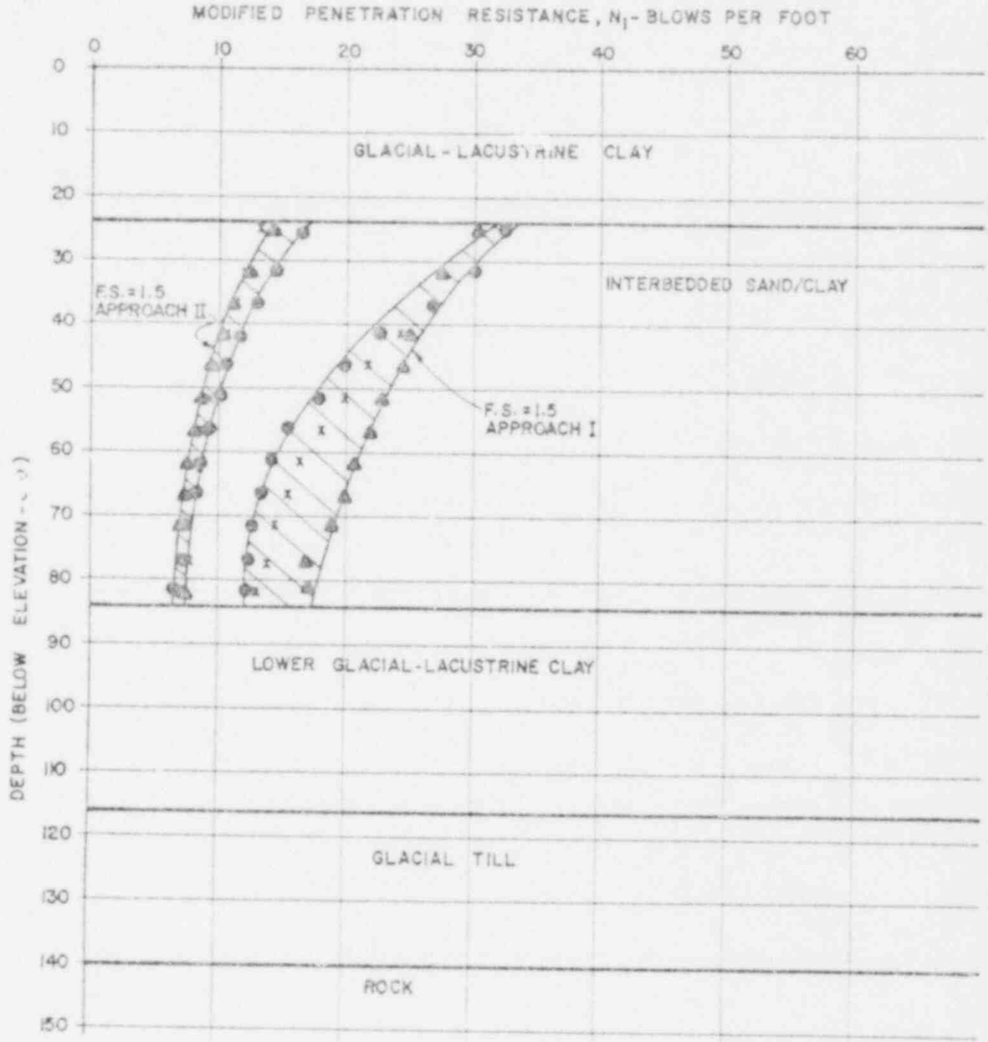

LEGEND

- ● EL CENTRO, 1940 / EL CENTRO
- x SAN FERNANDO, 1971 / HOLLYWOOD
- ▲ LOWER CALIFORNIA, 1934 / EL CENTRO

WHERE: EARTHQUAKE / RECORDING STATION

FIGURE 2B-7

DEPTH VS. REQUIRED N, VALUES
PRECONSTRUCTION AREA C
BAILLY N-1
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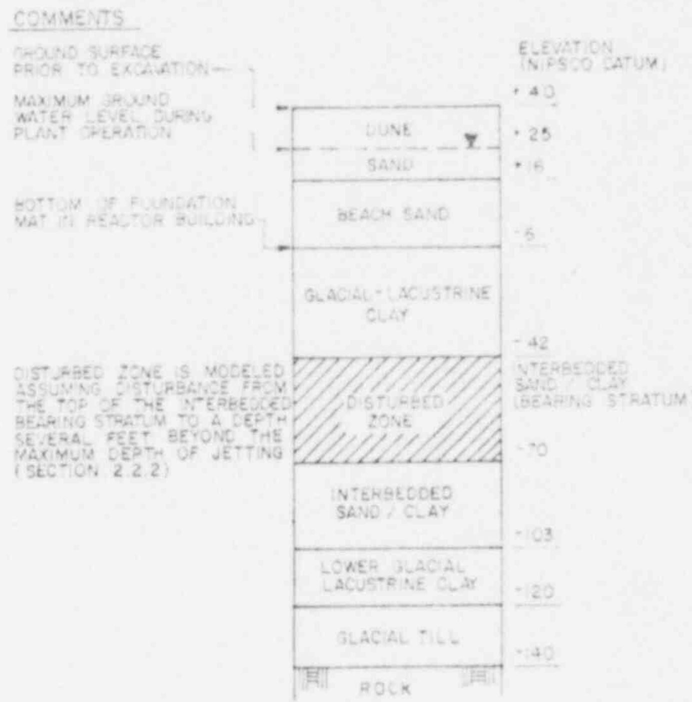

GENERAL:

1. INDUCED CYCLIC SHEAR STRESSES ARE COMPUTED USING "SHAKE" WITH THE SCALED MAXIMUM GROUND ACCELERATION (0.2 g) INPUT AT ELEVATION + 40.
2. SHEAR MODULI AND DAMPING RATIOS FOR UNDISTURBED SOILS ARE REPORTED IN REPORT SL- 3629
3. SHEAR MODULI AND DAMPING RATIOS FOR DISTURBED ZONE ARE ASSUMED TO BE THE SAME AS THOSE USED IN AREA E ANALYSES (SECTION 2.3.1.1).

FIGURE 2B-8
SOIL PROFILE FOR APPROACH PRECONSTRUCTION AREA B
BAILLY N-1
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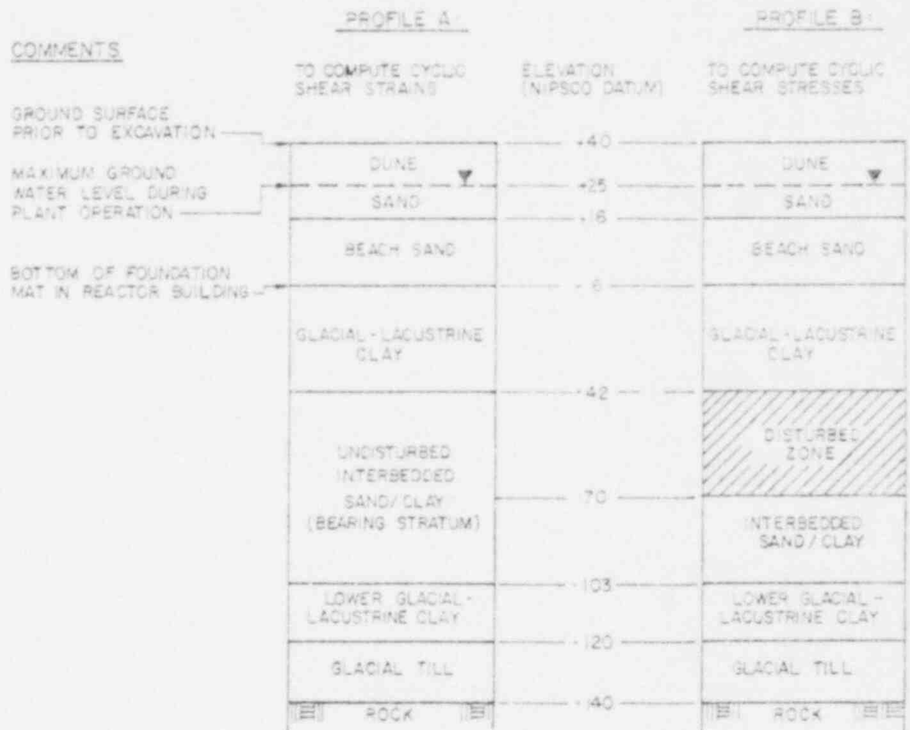

GENERAL

1. PROFILE A BASED ON GENERALIZED STRATIGRAPHIC COLUMN IN REACTOR BUILDING AREA AND PRECONSTRUCTION AREA BORINGS.
2. PROFILE B IS THE SAME AS FIGURE 2B-8
3. INDUCED EFFECTIVE CYCLIC SHEAR STRAINS ARE COMPUTED FOR PROFILE A USING "SHAKE" WITH THE SCALED MAXIMUM GROUND ACCELERATION (0.2g) INPUT AT ELEVATION +40
4. INDUCED EFFECTIVE CYCLIC SHEAR STRESSES ARE COMPUTED THROUGHOUT THE DISTURBED ZONE AS SHOWN IN PROFILE B BY MULTIPLYING THE INDUCED EFFECTIVE CYCLIC SHEAR STRAINS DETERMINED IN (3) BY THE SHEAR MODULI FOR THE DISTURBED ZONE

FIGURE 2B-9
SOIL PROFILES FOR APPROACH II
PRECONSTRUCTION AREA B
BAILLY N-1
NORTHERN INDIANA PUBLIC SERVICE COMPANY

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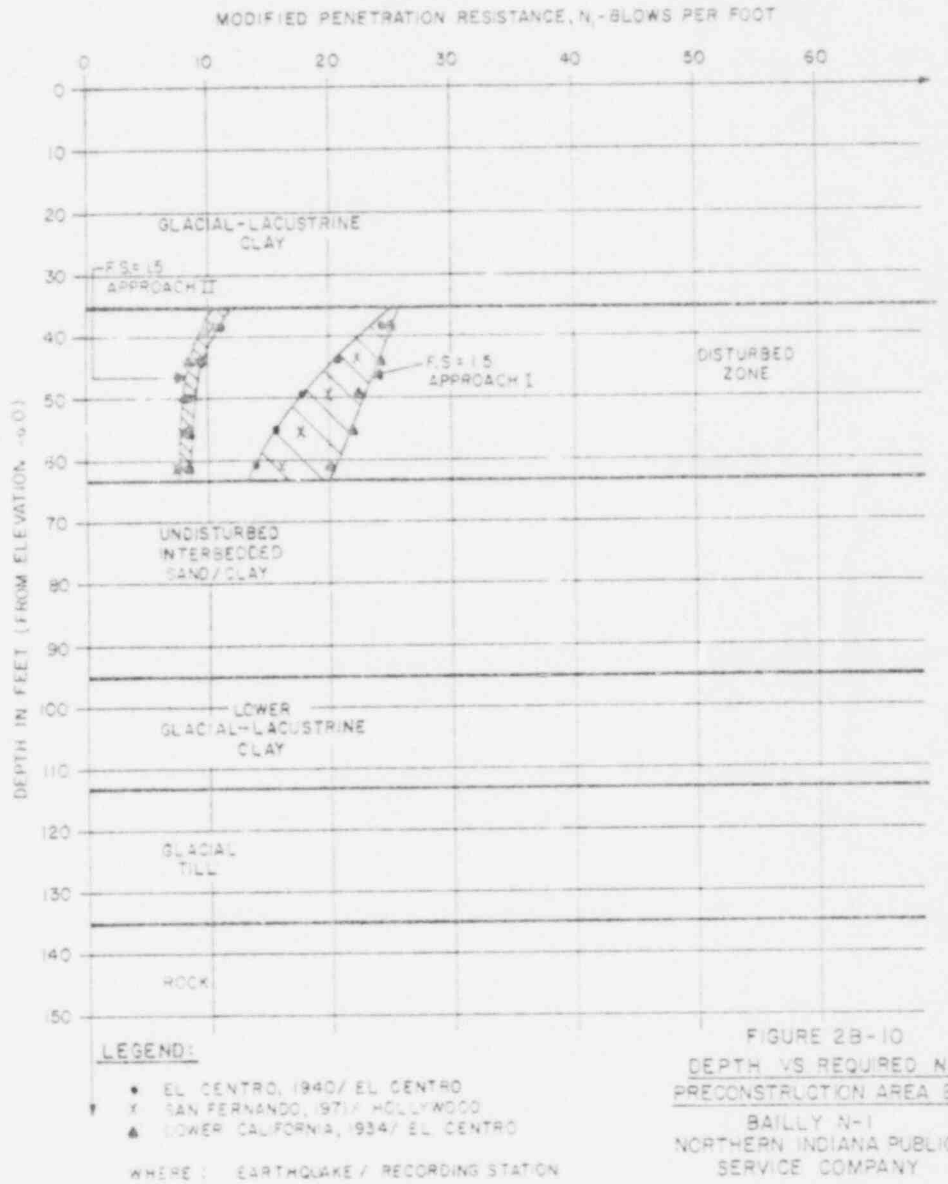

FIGURE 2B-10
DEPTH VS REQUIRED N1
PRECONSTRUCTION AREA B

BAILLY N-1
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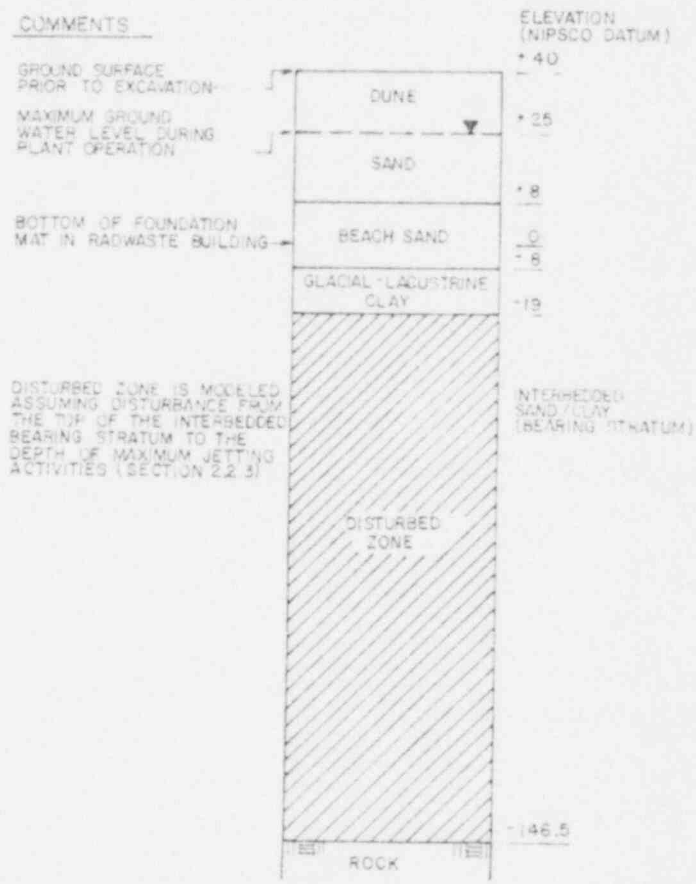

GENERAL

1. INDUCED CYCLIC SHEAR STRESSES ARE COMPUTED USING "SHAKE" WITH THE SCALED MAXIMUM GROUND ACCELERATION (0.2g) INPUT AT ELEVATION +40
2. SHEAR MODULI AND DAMPING RATIOS FOR DISTURBED SOILS ARE REPORTED IN REPORT SL-3629
3. SHEAR MODULI AND DAMPING RATIOS FOR UNDISTURBED ZONE ARE ASSUMED TO BE THE SAME AS THOSE USED IN AREA E ANALYSES (SECTION 2.3.11)

FIGURE 2B-11
SOIL PROFILE FOR APPROACH 2
PRECONSTRUCTION AREA C

BAILLY N-1
NORTHERN INDIANA PUBLIC SERVICE COMPANY

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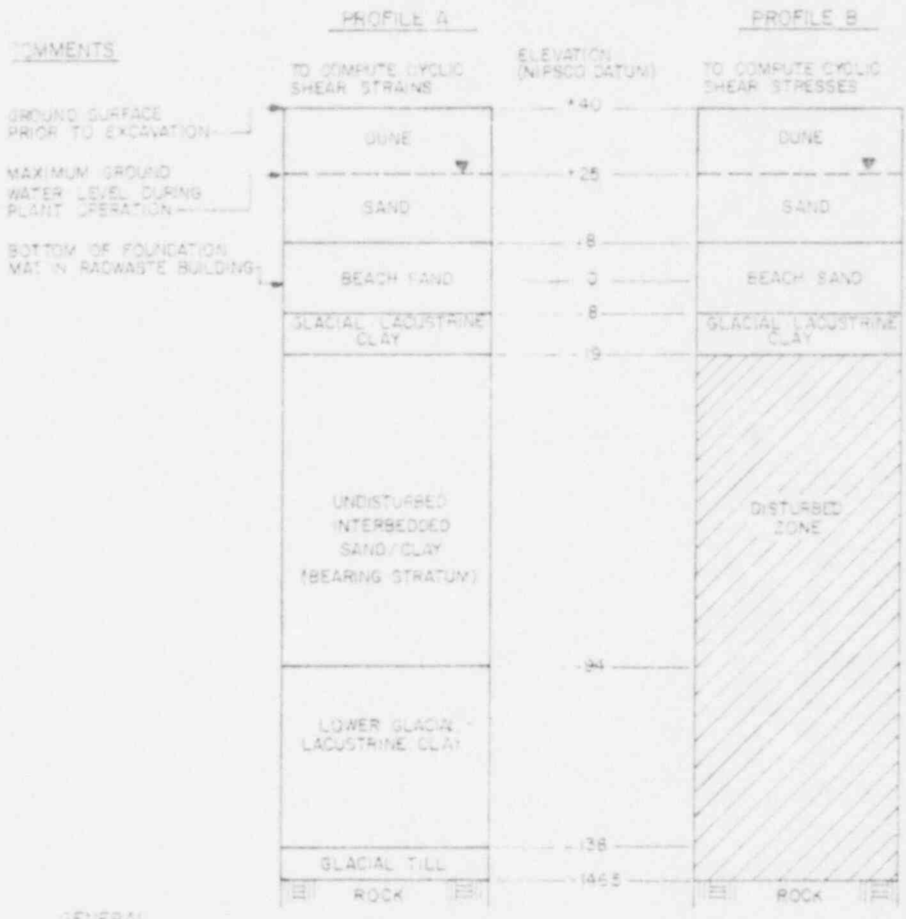

GENERAL

1. PROFILE A BASED ON GENERALIZED STRATIGRAPHIC COLUMN IN RADWASTE BUILDING AREA AND PRECONSTRUCTION AREA BORINGS.
2. PROFILE B IS THE SAME AS FIGURE 2B-11.
3. INDUCED EFFECTIVE CYCLIC SHEAR STRAINS ARE COMPUTED FOR PROFILE A USING "SHAKE" WITH THE SCALED MAXIMUM GROUND ACCELERATION (0.2 g) INPUT AT ELEVATION +40.
4. INDUCED EFFECTIVE CYCLIC SHEAR STRESSES ARE COMPUTED THROUGHOUT THE DISTURBED ZONE AS SHOWN IN PROFILE B BY MULTIPLYING THE INDUCED EFFECTIVE CYCLIC SHEAR STRAINS DETERMINED IN (3) BY THE SHEAR MODULI FOR THE DISTURBED ZONE.

FIGURE 2B-12
SOIL PROFILES FOR APPROACH II
PRECONSTRUCTION AREA C
BAILLY NH
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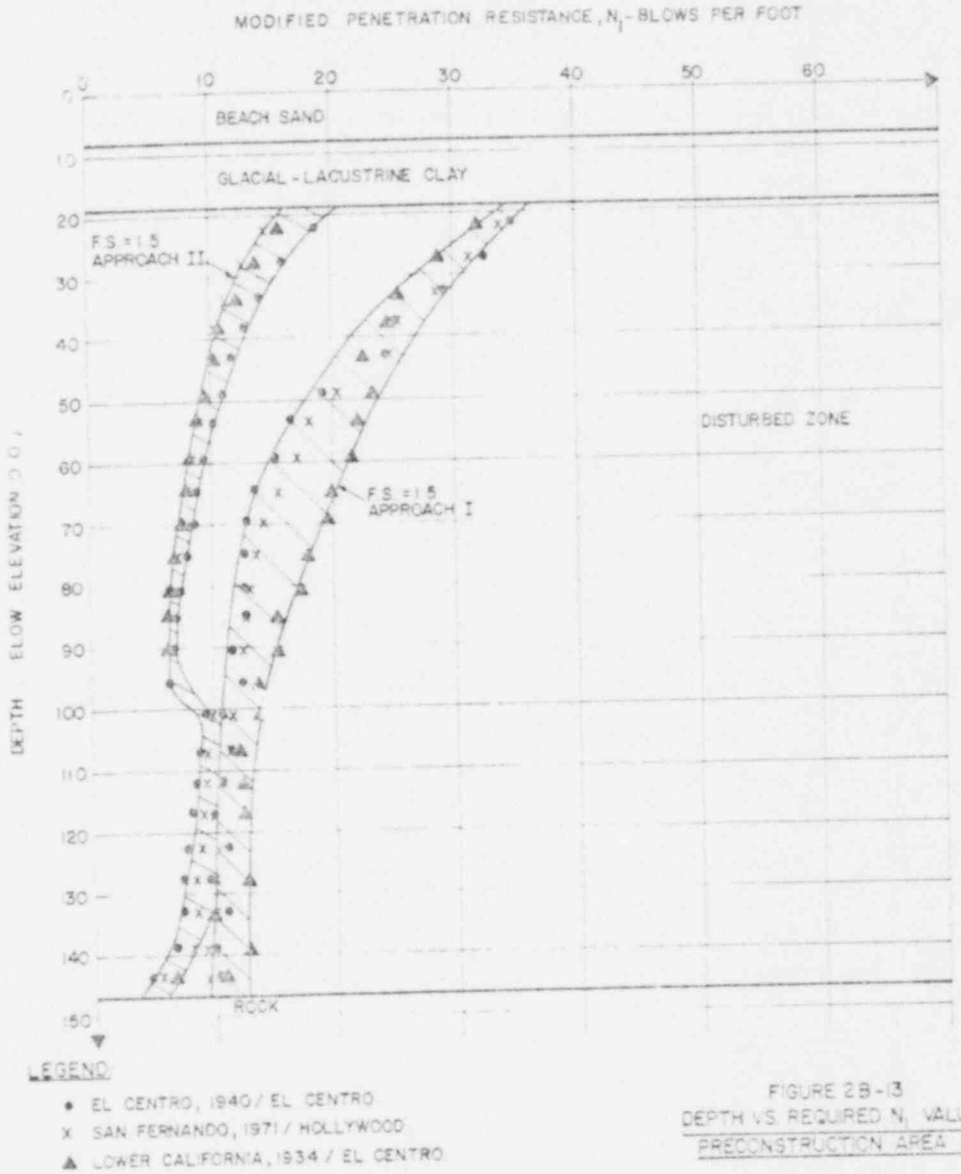

FIGURE 2B-13
DEPTH VS. REQUIRED N_1 VALUES
PRECONSTRUCTION AREA C

BAILLY N-1
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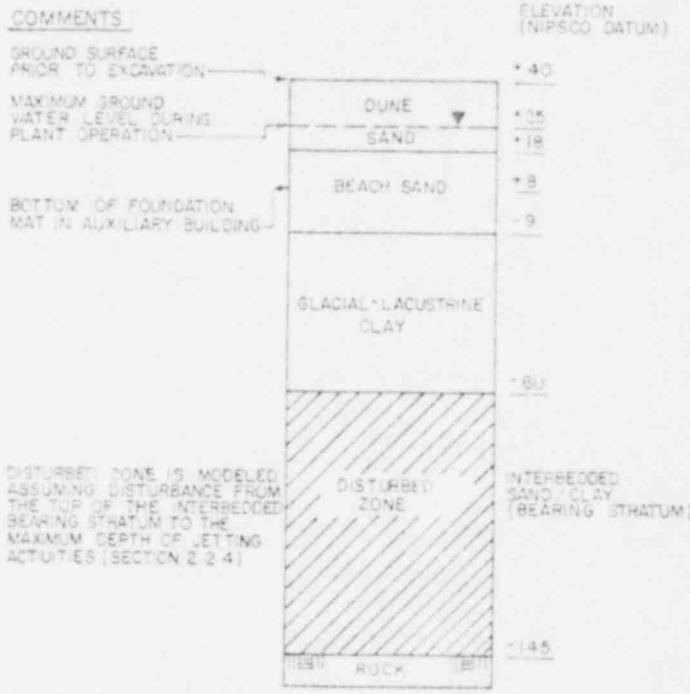

GENERAL

1. INDUCED CYCLIC SHEAR STRESSES ARE COMPUTED USING "SHAKE" WITH THE SCALED MAXIMUM GROUND ACCELERATION (0.2 g) INPUT AT ELEVATION +40
2. SHEAR MODULI AND DAMPING RATIOS FOR UNDISTURBED SOILS ARE REPORTED IN REPORT SL-3629
3. SHEAR MODULI AND DAMPING RATIOS FOR DISTURBED ZONE ARE ASSUMED TO BE THE SAME AS THOSE USED IN AREA E ANALYSES (SECTION 2.3.1.1)

FIGURE 2B-14
SOIL PROFILE FOR APPROACH I
PRECONSTRUCTION AREA D
BAILLY N-1
NORTHERN INDIANA PUBLIC SERVICE COMPANY

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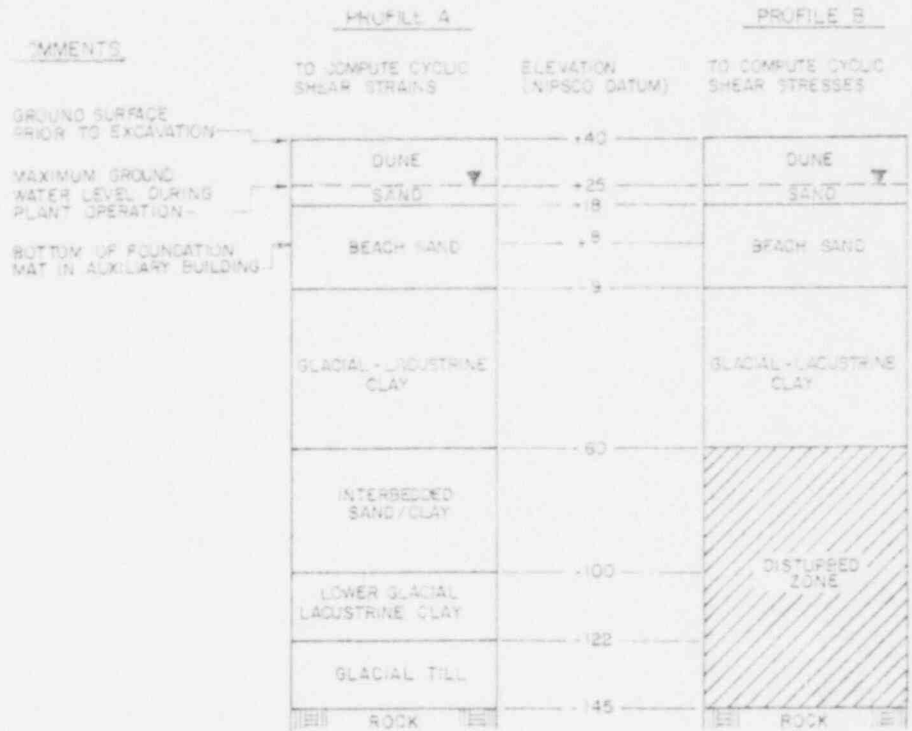

GENERAL

1. PROFILE A BASED ON GENERALIZED STRATIGRAPHIC COLUMN IN AUXILIARY BUILDING AREA AND PRECONSTRUCTION AREA BORINGS.
2. PROFILE B IS THE SAME AS FIGURE 2B-14
3. INDUCED EFFECTIVE CYCLIC SHEAR STRAINS ARE COMPUTED FOR PROFILE A USING "SHAKE" WITH THE SCALED MAXIMUM GROUND ACCELERATION (0.2g) INPUT AT ELEVATION +40.
4. INDUCED EFFECTIVE CYCLIC SHEAR STRESSES ARE COMPUTED THROUGHOUT THE DISTURBED ZONE AS SHOWN IN PROFILE B BY MULTIPLYING THE INDUCED EFFECTIVE CYCLIC SHEAR STRAINS DETERMINED IN (3) BY THE SHEAR MODULI FOR THE DISTURBED ZONE.

FIGURE 2B-15
SOIL PROFILES FOR APPROACH II
PRECONSTRUCTION AREA D
BAILLY N-1
NORTHERN INDIANA PUBLIC SERVICE COMPANY

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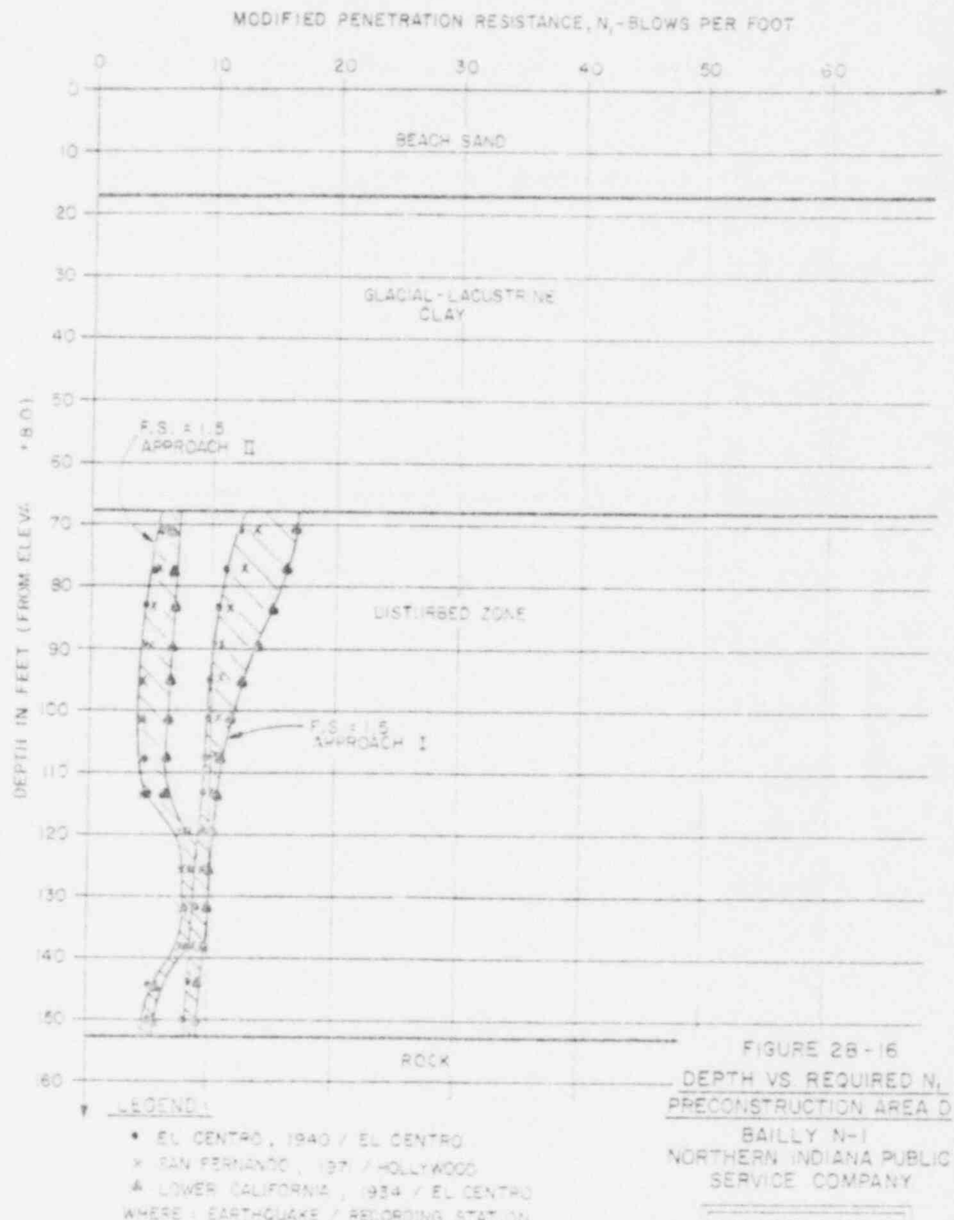

FIGURE 2B-16

DEPTH VS REQUIRED N,

PRECONSTRUCTION AREA D

BAILLY N-1

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