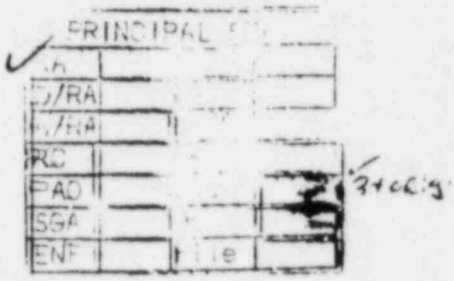
UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

April 3, 1984



MEMORANDUM FOR: Richard Vollmer, Director
Division of Engineering

FROM: Darrell G. Eisenhut, Director
Division of Licensing

SUBJECT: MIDLAND DIESEL GENERATOR BUILDING (DGB)

Harold's memo to J. Keppler of March 7, 1984, on the same subject discussed a meeting you proposed between Region III, NRR and BNL to identify the Region's comments and concerns on the BNL report on the DGB. I am advised that the meeting was held March 27, 1984. Please arrange for a staff briefing for J. Keppler and myself in the next week or so which summarizes the technical staff conclusions regarding the structural integrity of the Midland Diesel Generator Building.

Darrell G. Eisenhut, Director
Division of Licensing

cc: J. Keppler
J. Knight
H. Denton

APR 6 1984

Purpose: Very briefly cover
- To review past DGB settlement history
- To substantiate future settlement predictions
- To discuss future settlement monitoring requirements - tie Grathmo Anytime

4/13/84
Vu E.I-5
J Kane

Subject: Visual Aids for April ~~23~~ 24, 1984 Meeting w/ R Vollmer, J. Keppler and D. Eisenhut (2:00 pm in D Eisenhut's Office)

BACKGROUND

Vugraph 1 DGB Plan View - Show the following features:
- Overall dimensions, 155' x 70'
- North - Turbine Building
- 4 Bays - 30" Exterior Walls, 18" Interior Walls
- Corner of largest settlement - Settlement [illegible]
- Duct banks from Turbine Bldg area beneath DGB
- Show location of sectional view for NEXT VUGRAPH

Vugraph 2 DGB Sectional View - Show the following features:
- DGB walls, floor slabs, pedestals & continuous wall footing
- Foundation conditions - 25' to 30' of plant fill over natural soil
* - Vertical duct bank from natural soil. Hang up & release
- Surcharge Program - Placing 20' of Sand Fill - Completion of Building
- Important Elevations Plant Grade El 634, Footings @ El 628

IMPT. CONSTRUCTION EVENTS
* - Plant fill placed in 1975 thru 1977
* - DGB Walls to El. 635 by Dec. 1977
to El 654 by Mar. 1978 Start of Settlement Monitoring
* to El. 656.5 by Aug. 1978 Fill Problem Identified. Construction Temporarily Halted
Duct banks released in [illegible] walls @ 656.5
to El. 678 by Feb. 1979
* to Roof @ El. 681.5 by Mar 1979

4/13/84
2.4.5 + 5
J Kane

Vugraph 3 DG-B Settlement History - Show the following features:

- Location of 28 Settlement Markers - Surveyed since Mar. 1978 (DG-B walls in Mar. 78 @ El 654). Survey readings to 1/100 ft. and data plotted to 1/100 inch

- Vugraph summarizes DG-B settlements at 10 wall locations. The summary consists of both actually measured settlements (up to Dec 83) and estimated future settlements (to the year 2025).
- Take southeast corner (DG-3) and explain correlation between settlement increment and time period
- Indicate settlement patterns (~~~~) along South wall and East wall.
  Max. total settlement is 9.33"
  Max. Differential settlement along N-S trending wall is ≈ 2" (south) ≈ 3" (@ east wall)

* The settlement values listed on this Vugraph are the values which the Applicant and Staff ultimately agreed are appropriate for use in structural analysis of the DG-B.

Engineering significance of agreed upon settlement values:
1. Settlements have been large and much greater than anticipated, therefore the plant fill was not compacted to the specified degree of compaction. Both the Applicant & Staff agree on this.
2. The Staff and its consultants believe that the significant amount of cracking evident in the DG-B has been caused by differential settlements including the effect of being "hung-up" on

Important questions which came from recognition of the DGB settlement include:

1. What is the existing state of stress in the DGB including the level of stress induced by past settlements?
2. Is there sufficient margin of safety in the DGB's design to withstand all stresses that would be imposed by required design load combinations including the effects of future settlements?

To answer these questions the Applicant was required to reanalyze the structural capacity of the DGB using the agreed upon settlements. Unfortunately the manner in which the Applicant used the measured/predicted settlements was found not acceptable by members of the Staff and our consultants.

In looking at the structural analyses which were completed for the DGB questions have been raised:

- The Applicant himself, has questioned the accuracy of the surveyed settlements and has concluded direct input of this recorded data into the analyses is not ...

- Other problems - being able to adequately model the changing stiffness of the DGB during the various construction stages while the building was being raised and at the same time settlements were occurring.

- The effects of other factors such as cracking and the resulting redistribution of stresses and ~~the~~ non-linear stress behavior

In the face of these problems and their effects - the NRC Structural Engineering Section proposed an alternate approach to estimate settlement induced stresses - the CRACK WIDTH APPROACH - to be covered by Mr. Rinaldi.

With respect to future anticipated DGB settlements - Expect maximum total settlements on the order of 1 inch until the year 2025.

Expect differential settlements on the order of 1/2 to 3/4 inch.

The staff has concluded the future estimated settlements are reasonable based on the results of explorations and lab testing of the surcharged foundation soils

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Show VUGRAPH 4 (Settlement @ DG-3 since Sept. 1979 until late Oct. 1983 is nearly 0.6 inch)

All parties - the Applicant, the Staff, the Independent Review Group - AGREE that, monitoring of FUTURE SETTLEMENT is necessary to

VERIFY that the DGB is performing as anticipated and that settlements larger than predicted ARE NOT OCCURRING.

4/13/84
5 of 5
J. Kane

We are currently attempting to resolve the tech. spec details of the long term settlement monitoring program and have recently prepared a request for information from the Applicant that addresses:

Item #6

BNL Rpt - 0.005" (Pg. 12)
Dr. Sozen - 0.0001" (Pg. 10980-Pg 9)

1. The required level of settlement monitoring accuracy & type of installation.
2. The required frequency of readings.
3. Establishment of allowable total and differential settlement limits during years of plant operation.

Item #7

We have also requested an update of the DGB settlement monitoring records to verify that our estimates of future settlement are reasonable and conservative. We'll do this by making a comparison at this time between actually measured settlements and settlements that we predicted would occur during this period

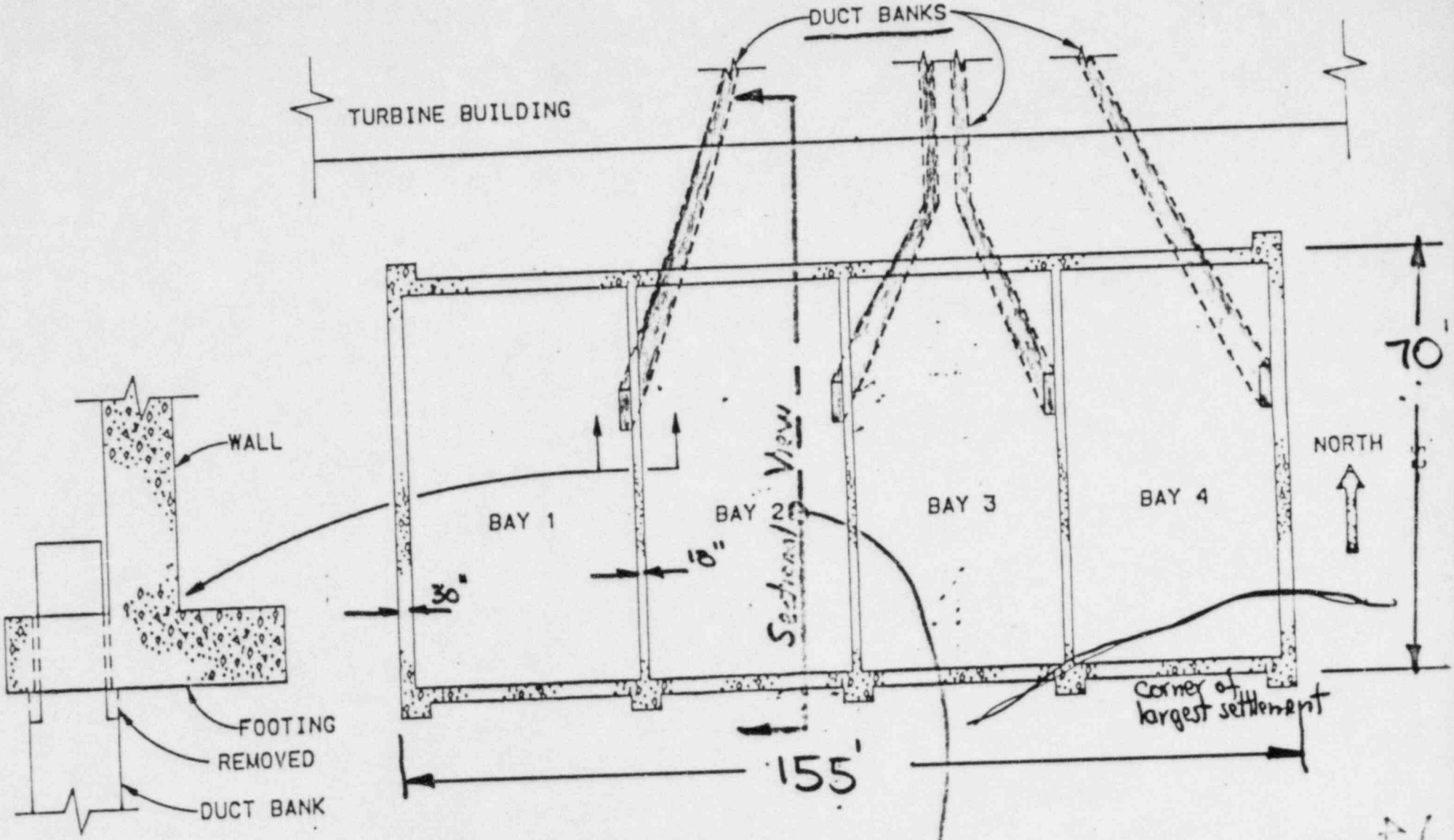


FIGURE DGB-4
DIESEL GENERATOR BUILDING
DUCT BANK LAYOUT
DGB Plan View

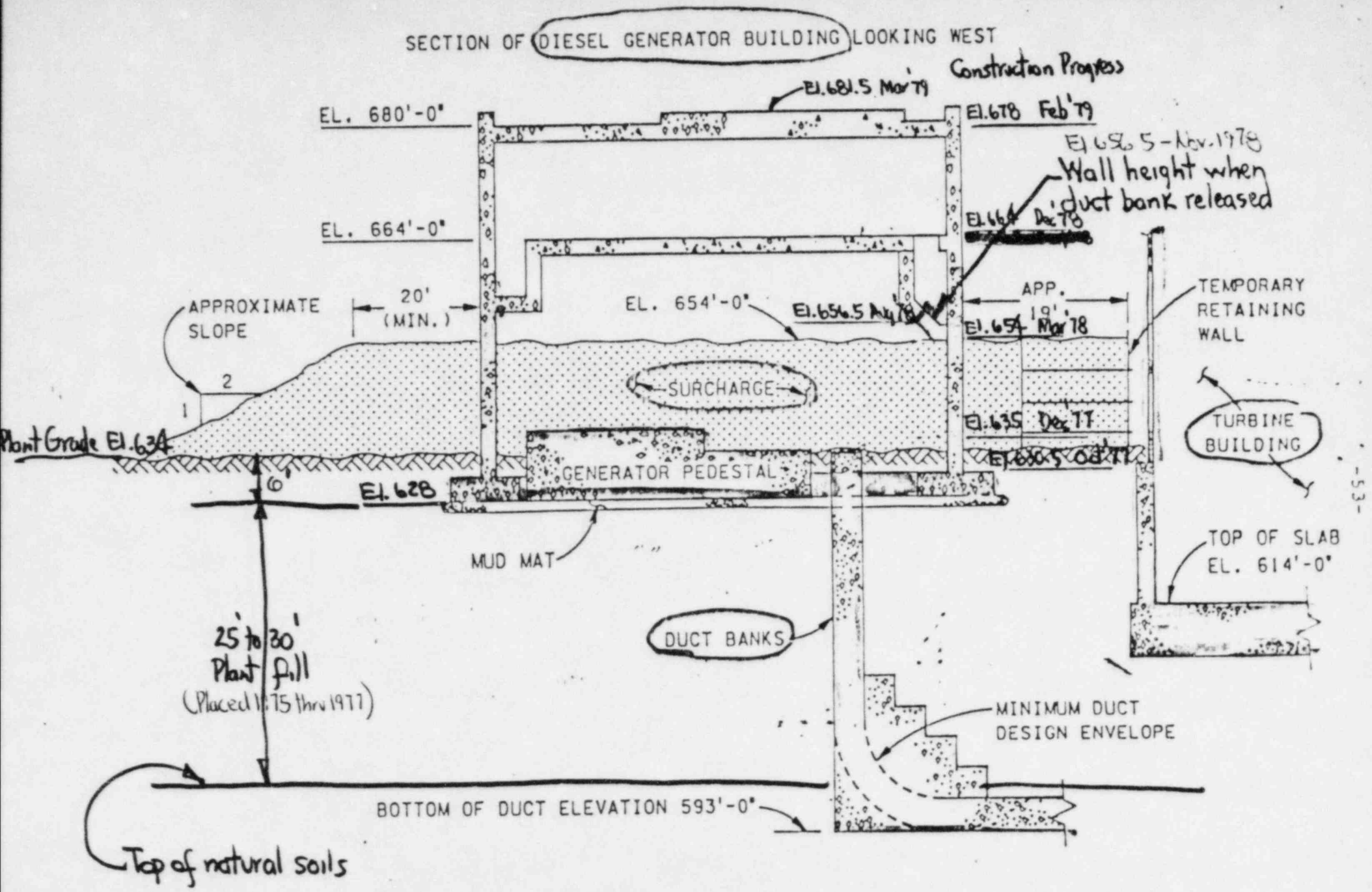
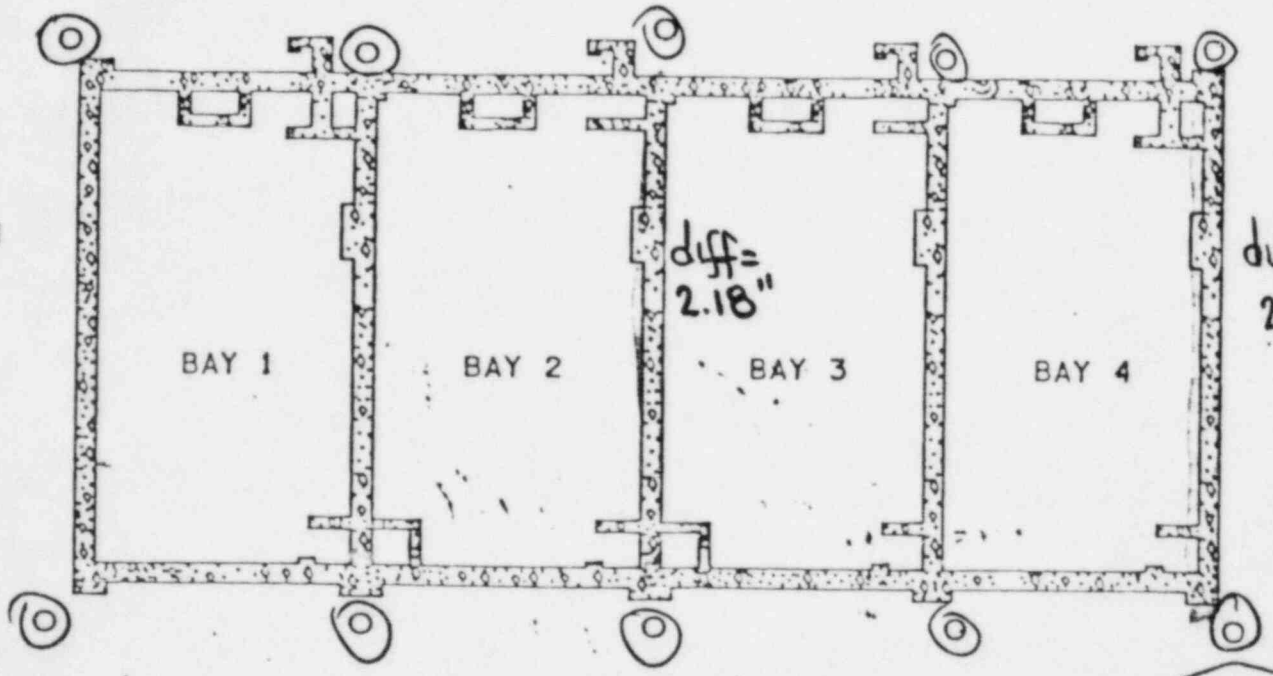


FIGURE DGB-5
DIESEL GENERATOR BUILDING DUCT BANK ELEVATION
(Surcharge Also Shown)

DGB Sectional View

LINE A	1.19"	1.02"	0.90"	0.85"	0.76"
LINE B	0.77"	1.09"	1.54"	1.98"	2.41"
X LINE C	1.50"	1.51"	1.78"	1.86"	1.91"
LINE D	1.33"	1.15"	1.19"	1.18"	1.29"
TOTAL	4.79"	4.77"	5.41"	5.87"	6.37"



LINE A	1.67"	1.42"	1.28"	1.44"	1.99"
LINE B	1.14"	1.12"	1.46"	1.92"	2.21"
X LINE C	3.00"	2.92"	3.16"	3.37"	3.24"
LINE D	1.62"	1.67"	1.69"	1.98"	1.89"
TOTAL	7.43"	7.13"	7.59"	8.71"	9.33"

LEGEND

O —— DIESEL GENERATOR BUILDING SETTLEMENT MARKER

SETTLEMENT IN INCHES FOR

Relate time periods & construction status to previous sectional view

Measured Settlements - PRE-SURCHARGE PERIOD (3/78-8/78) Walls EL 654 k LS ..... LINE A

Measured Settlements - PRE-SURCHARGE PERIOD (8/78-1/79) Walls EL 664 n ..... LINE B

Measured Settlements - SURCHARGE PERIOD (1/79-8/79) DGB fully completed ..... LINE C X

Measured/Predicted Settlements - POST SURCHARGE PERIOD (9/79-12/2025) DGB fully ..... LINE D
ASSUMING SURCHARGE REMAINS IN PLACE completed

FIGURE DGB-7

SUMMARY OF ACTUAL AND ESTIMATED SETTLEMENTS

DGB Settlement History

following surcharge removal

SETTLEMENT (INCHES)

0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8

No of Days	Date
200	Aug. 14, 1979 (Start of surcharge removal)
±cc	Apr. 5, 1981
1845	Apr. 5, 1984

late 1983

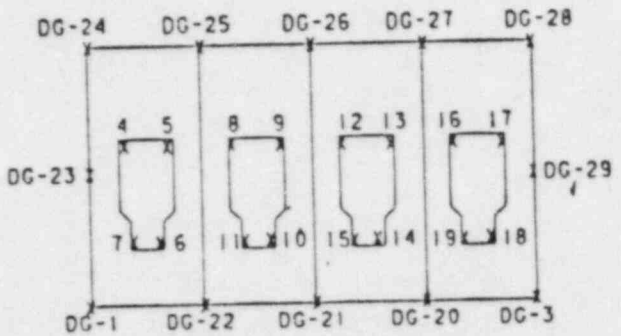
mid-Sept 1979

APPROXIMATE GROUNDWATER ELEVATION (FEET)

630.0
620.0
610.0
600.0
590.0
580.0
570.0

100 2cc 3cc 4cc 5cc 6cc 7cc 8cc 9cc 1,000 2cc+

CUMULATIVE TIME (DAYS)



SETTLEMENT MARKER LOCATION PLAN
DIESEL GENERATOR BUILDING (NOT TO SCALE)

NOTES:

1. MINUS (-) SIGN INDICATES HEAVE.
2. CUMULATIVE TIME STARTING FROM THE BEGINNING OF SURCHARGE ON JANUARY 26, 1979.

DG-3

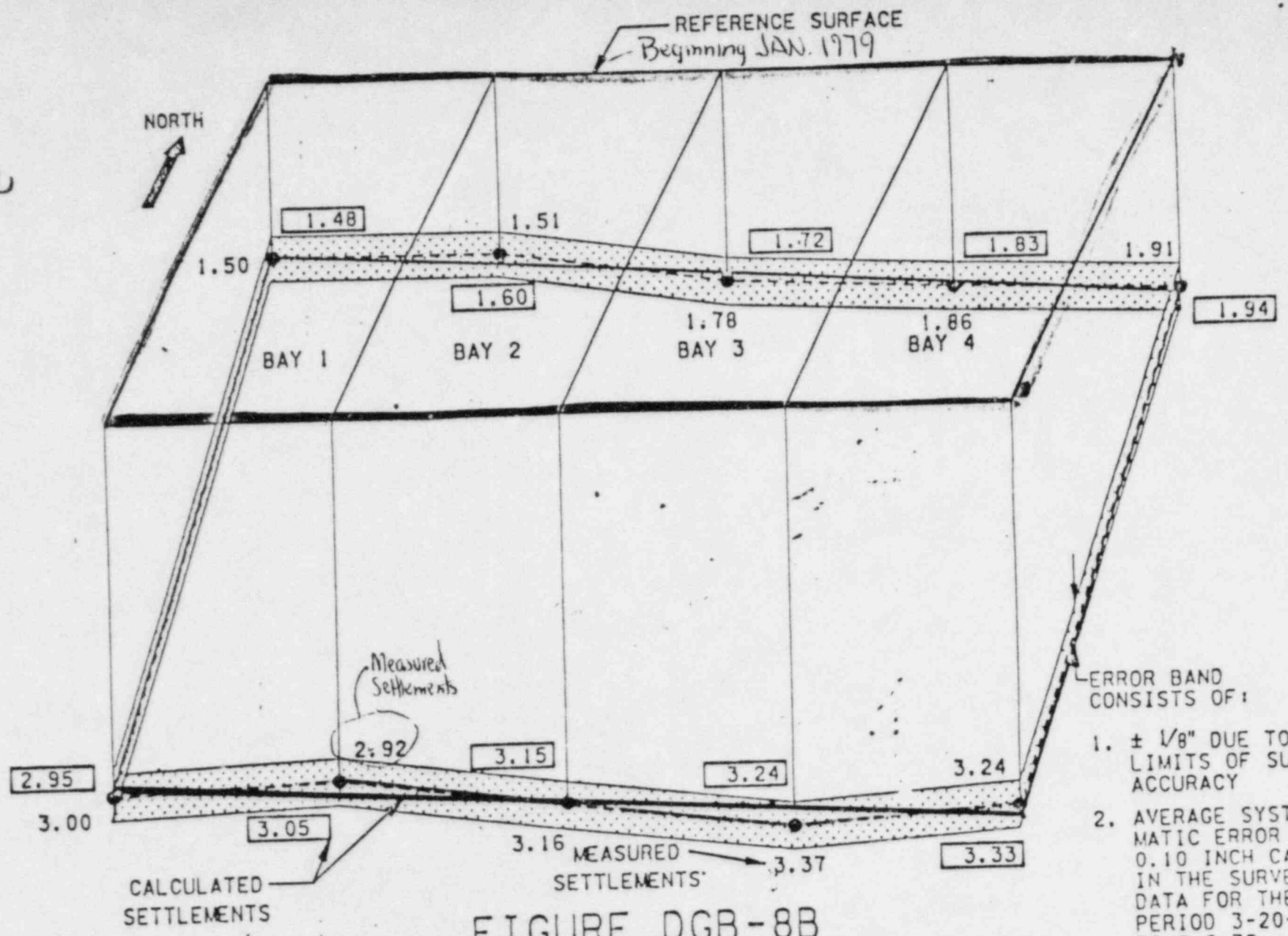


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FIGURE DGB-8B

COMPARISON OF MEASURED SETTLEMENT VALUES WITH SETTLEMENT VALUES RESULTING FROM A FINITE ELEMENT ANALYSIS OF THE DIESEL GENERATOR BUILDING

SURCHARGE PERIOD

JANUARY 1979 - AUGUST 1979

(VERTICAL SCALE IS MAGNIFIED 300 TIMES)

Line C on previous vugraph

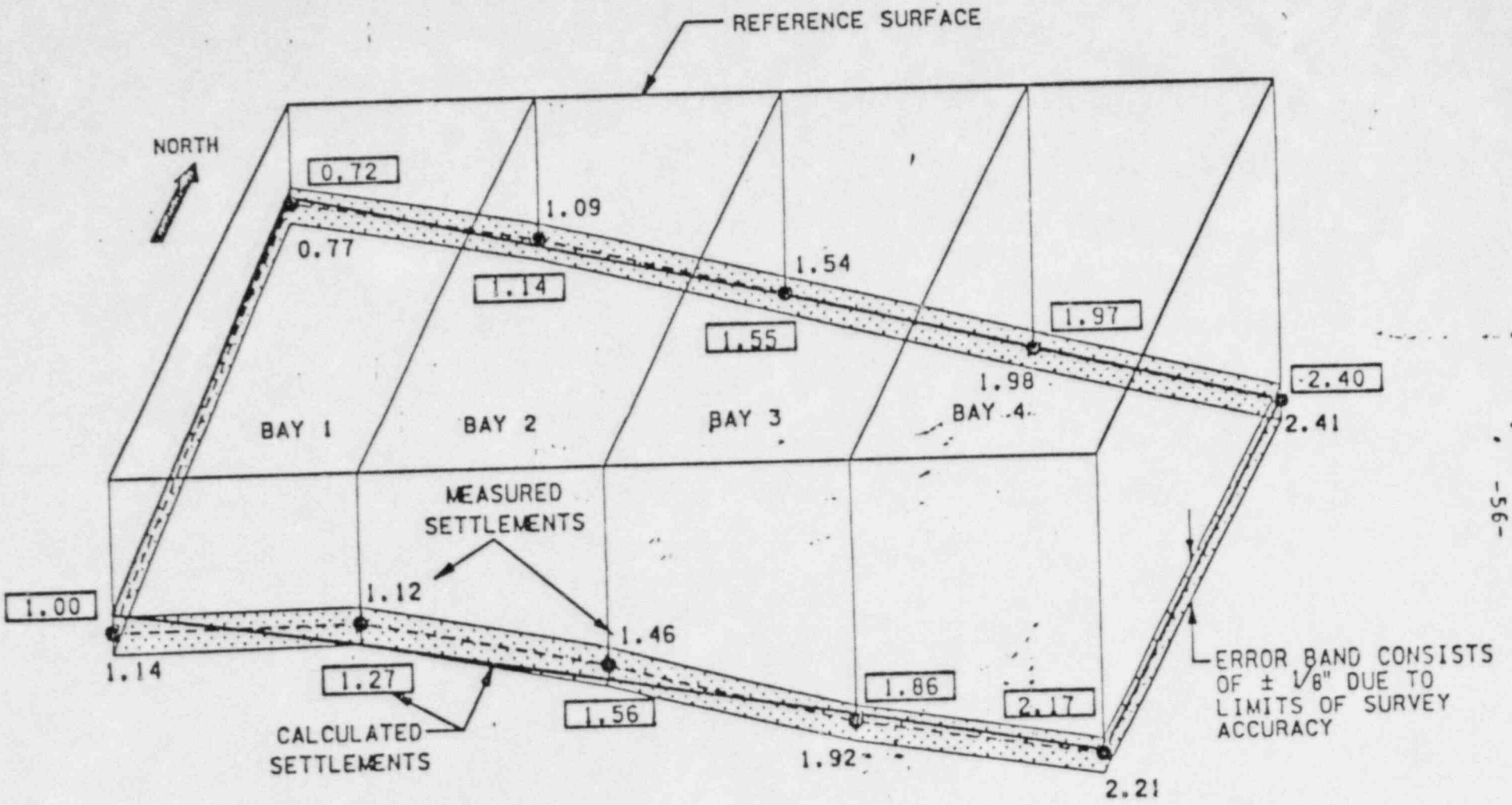
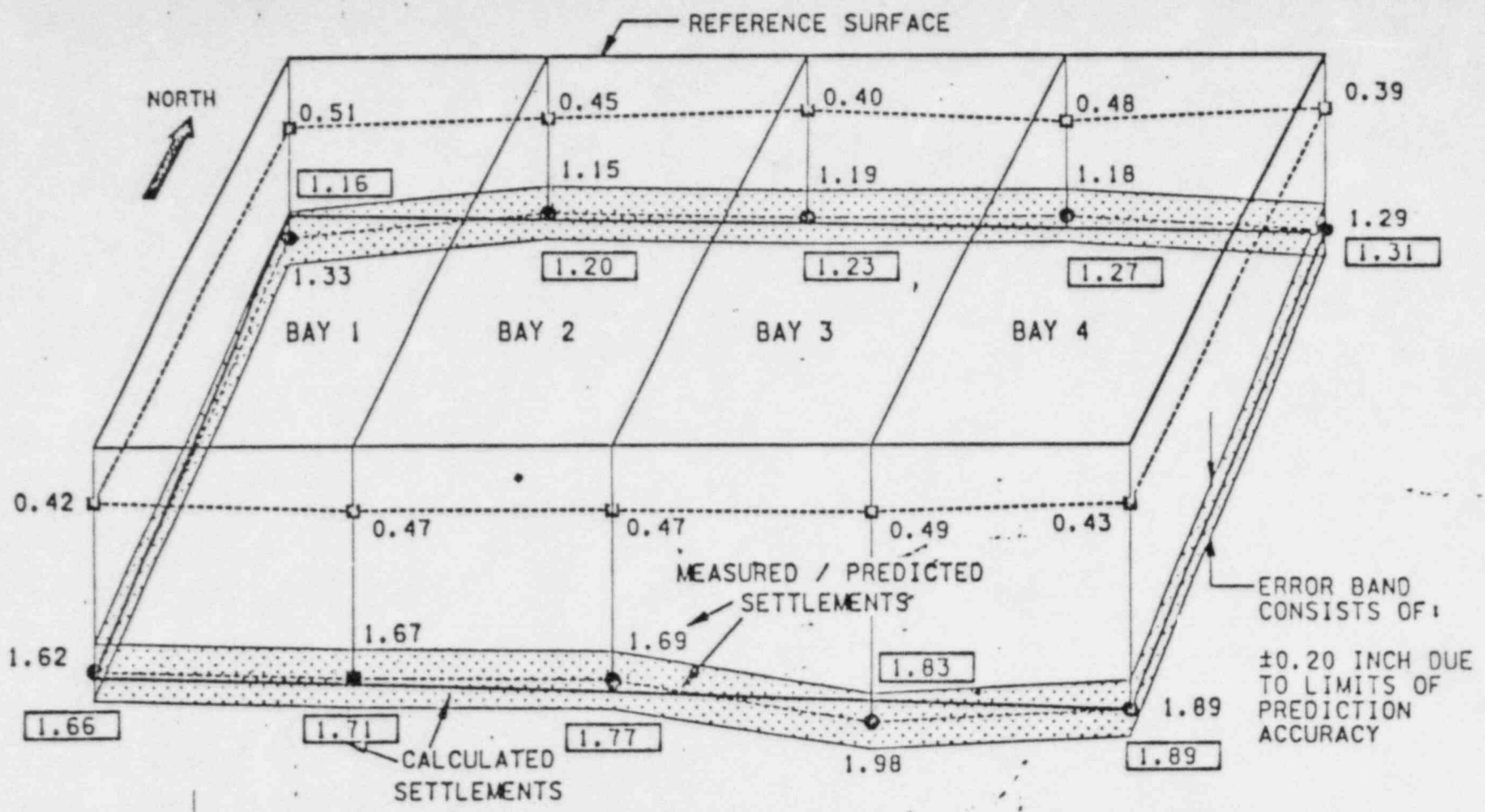


FIGURE DGB-8A

COMPARISON OF MEASURED SETTLEMENT VALUES WITH SETTLEMENT VALUES RESULTING FROM A FINITE ELEMENT ANALYSIS OF THE DIESEL GENERATOR BUILDING

PRE-SURCHARGE PERIOD

AUGUST 1978 - JANUARY 1979
(VERTICAL SCALE IS MAGNIFIED 300 TIMES)



ACTUAL MEASURED SETTLEMENT FROM SEPT. 14, 1979 TO DEC. 31, 1981. THESE INCLUDE EFFECT OF DEWATERING TO APPROXIMATELY EL. 595', AND REPRESENT MOVEMENT OF THE STRUCTURE DUE TO SETTLEMENT OF THE FILL AND NATURAL SOIL BELOW.

ACTUAL MEASURED SETTLEMENTS FROM SEPT. 14, 1979 TO DEC. 31, 1981 PLUS ESTIMATED SECONDARY COMPRESSION SETTLEMENT FROM DEC. 31, 1981 TO DEC. 31, 2025 ASSUMING SURCHARGE REMAINS IN PLACE.

FIGURE DGB-8C

COMPARISON OF ACTUAL MEASURED SETTLEMENTS PLUS ESTIMATED SECONDARY COMPRESSION SETTLEMENT WITH SETTLEMENT VALUES RESULTING FROM A FINITE ELEMENT ANALYSIS OF THE DIESEL GENERATOR BUILDING

POST-SURCHARGE PERIOD

SEPTEMBER 1979 - DECEMBER 2025

DRAFT

Ross Landsman
J. Kane
4/19/84

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

Ross -
Q on your review and comment. any changes or additions needed?
thanks
Paul Hood
492-8474
4-25-84

MEMORANDUM FOR: ~~James P. Knight, Assistant Director~~ Darrell G. Eisenhut, Director
for Components and Structures Engineering
Division of Engineering

FROM: ~~George Lear, Chief~~ Richard H. Vollmer, Director
Structural and Geotechnical Engineering Branch
Division of Engineering

SUBJECT: MIDLAND NPP - ADDITIONAL REQUIREMENTS FOR DGB EVALUATION

Reference: Memorandum dated October 21, 1983, from P. T. Kuo to J. P. Knight, subject, "Report on the Review of the Diesel Generator Building at Midland."

Based on the recommendations provided in the reference report, we have identified in the enclosure additional requirements that we recommend be transmitted to Consumer Power Company. Responses providing the additional information and applicant's committments will be reviewed by SGEB staff reviewers and consultants to their satisfaction prior to potential ASLB hearings, and to the issuance of final staff safety evaluation of the DGB at the Midland site.

The enclosure has been prepared by F. Rinaldi and J. Kane of the Structural and Geotechnical Engineering Branch.

Richard H. Vollmer

~~George Lear, Chief~~
~~Structural and Geotechnical~~
~~Engineering Branch~~
~~Division of Engineering~~

Enclosure: As stated

cc: R. Vollmer
T. Sullivan
D. Eisenhut
T. Novak
E. Adensam
D. Hood
W. Paton
M. Wilcove
G. Lear
P. Kuo
L. Heller
J. Kane
F. Rinaldi

MIDLAND NPP UNITS 1 & 2
Docket Nos.: 50-329/330

ADDITIONAL REQUIREMENTS FOR DGB EVALUATION

1. Provide an updated crack mapping for all cracks on both sides of walls, floor and roof slabs, and pedestals of the DGB. The crack mapping should accurately identify the location, size and distribution of all cracks with crack width of 5 mils or greater. Cracks, or portion of cracks, with a crack width less than 5 mils need not be fully mapped. However, they should be addressed with respect to their location, size and frequency of occurrence. The location where a crack shows a significant change in crack width should be marked in the updated crack maps. The crack maps should identify areas not accessible for crack mapping and supporting documentation should be provided to identify efforts made to crack-map these areas, reasons for declaring them as un-mappable area, and a general discussion of what cracks can be expected in these areas, with supporting discussion. This updated crack mapping will establish the current condition of the DGB in terms of crack widths and related stresses and will be used as baseline data for comparison and evaluation of structural changes for the operational life of the plant.

2. Using the pertinent information from the requested crack mapping determine the maximum tensile stress in the reinforcing steel for each wall, floor and roof slab, and pedestals. It is recognized that engineering judgement is required in the selection of the parameters (i.e. total crack width, length, etc.) utilized in determining the reinforcing steel stress. Therefore, the bases for the selection of these pertinent parameters and the general formulation need to be clearly documented. Also, significant locations of maximum stress in each structural component (i.e. wall or slab) need to be documented. These locations for each DGB structural component should be determined considering long and short lengths over which bar tension is determined. Provide tables identifying the maximum stresses due to crack evaluation and all other stresses resulting from the design load combinations (ACI 318 and 349 as modified by SRP).

3. Re-evaluate the current proposed crack monitoring program identified at the ASLB December 1982 hearings. Consideration should be given to additional monitoring of cracked surfaces that will be epoxed and sealed during the proposed structural repairs of the DGB. A detailed discussion of the proposed additional monitoring identified in the reference report or other alternative approaches should be provided for staff review.

4. Re-evaluate the Alert and Action Limits to assure that sufficient stress margins are available to resist the critical load combinations. Also, the monitoring program should mandate specific actions for the Alert and Action Limits. Provide detailed discussions on all criteria.

5. In the reference report (Appendix III, page 5, last paragraph) three instances of inconsistencies in settlement data are identified. Provide a response that addresses each of the inconsistencies and which identifies the correct data. This should include the providing of pertinent settlement marker locations and settlement histories as necessary to fully

understand the explanation.

6. The level of survey accuracy proposed in Chapter 16 of the FSAR for settlement monitoring of seismic Category 1 structures and tanks is inadequate should future settlements be significant and a reanalysis of structures be required because of the occurrence of larger than anticipated settlements. This Staff conclusion on survey accuracy is based on the applicant's own testimony given in the December 1982 ASLB hearing session on the DGB and on statements provided in the reference report, Appendix III, page 12. The applicant is requested to provide a revised settlement monitoring program for the DGB and other seismic Category 1 structures and tanks which will establish the required level of accuracy for the settlement measurements. The proposed monitoring plan also needs to address the number and specific monitoring locations, the installation type and details, frequency of readings and allowable total and differential settlement limits. The allowable settlement limits are to be based on the structure's capacity to safely withstand the actual movements and should not be based on predicted future settlements. These limits, therefore, need to consider the present state of stress in the DGB and other stresses estimated to result from required design load combinations.

7. Provide updated settlement-time history plots for all the surveyed DGB settlement markers and a summary table which compares actually measured settlements to date with estimated settlements for the same time period. Provide a written evaluation of this comparison that includes a discussion on the conservatism and adequacy of total and differential settlements which are predicted during years of plant operation.

UNITED STATES
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WASHINGTON, D. C. 20555

MAY 10 1984

MEMORANDUM FOR: Darrell G. Eisenhut, Director
Division of Licensing

FROM: Richard H. Vollmer, Director
Division of Engineering

SUBJECT: MIDLAND NUCLEAR POWER PLANT

Reference: Memorandum dated October 21, 1983, from P. T. Kuo to J. P. Knight, subject, "Report on the Review of the Diesel Generator Building at Midland".

The task group assigned to evaluate the staff position with regard to the adequacy of the diesel generator building (DGB) at Midland has completed their evaluation of the existing diesel generator building structure and the prior documentation of the staff review, The task group consisted of three members of the Structural and Geotechnical Engineering Branch, Dr. P. T. Kuo, who was the task group leader, Dr. C. P. Tan and Mr. N. Romney. Three consultants, Dr. A. J. Philippacopoulos, Dr. C. A. Miller and Dr. C. J. Costantino, from Brookhaven National Laboratory (BNL) collaborated with the staff in the performance of this task. Drs. Miller and Costantino prepared an evaluation report which was made an integral part of the referenced final task group report.

The task group has provided a list of recommendations that, when implemented, will provide the basis for confirming the adequacy of the Midland diesel generator building. Enclosed is a list of additional information which will be required to implement the task group's recommendations. The enclosure has been prepared by F. Rinaldi and J. Kane of the Structural and Geotechnical Engineering Branch and reviewed and concurred in by Dr. R. Landsman of Region III.

Richard H. Vollmer, Director
Division of Engineering

Enclosure:
As stated

cc w/encl:
See next page

8405210475

CF

R. Landsman

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

MAY 10 1984

MEMORANDUM FOR: Darrell G. Eisenhut, Director
Division of Licensing

FROM: Richard H. Vollmer, Director
Division of Engineering

SUBJECT: MIDLAND NUCLEAR POWER PLANT

Reference: Memorandum dated October 21, 1983, from P. T. Kuo to J. P. Knight, subject, "Report on the Review of the Diesel Generator Building at Midland".

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BUL 5117

The task group has provided a list of recommendations that, when implemented, will provide the basis for confirming the adequacy of the Midland diesel generator building. Enclosed is a list of additional information which will be required to implement the task group's recommendations. The enclosure has been prepared by F. Rinaldi and J. Kane of the Structural and Geotechnical Engineering Branch and reviewed and concurred in by Dr. R. Landsman of Region III.

Richard H. Vollmer, Director
Division of Engineering

Enclosure:
As stated

cc w/encl:
See next page

MAY 14 1984

cc: T. Novak
J. Knight
E. Sullivan
E. Adensam
D. Hood
W. Paton
M. Wilcove
G. Lear
P. Kuo
L. Heller
R. Landsman
J. Kane
F. Rinaldi

ENCLOSURE

Request for Additional Information
Regarding Structural Adequacy of
Midland Diesel Generator Building

Provide the following information with respect to the "Report on the Review of the Diesel Generator Building at Midland" (hereafter called the task group's report) provided by Board Notification 83-165 dated October 26, 1983:

1. The staff requires an updated crack mapping to establish the current condition of the DGB in terms of crack widths and related stresses and to establish a baseline for comparison and evaluation of structural changes for the service life of the plant. The updated crack mapping should identify all cracks in accessible areas on both sides of DGB walls, floor and roof slabs, and pedestals. The crack mapping should accurately identify the location, size and distribution of all cracks with crack width of 5 mils or greater. Although cracks, or portion of cracks, with a width less than 5 mils need not be fully mapped, they should be addressed with respect to their location, size and frequency of occurrence. The points at which a crack shows a significant change in width should be marked in the updated crack maps.

   The crack maps should identify areas not accessible for mapping and supporting documentation should be provided to identify efforts made to crack-map these areas, reasons for declaring them as areas incapable of being mapped, and a general discussion of the cracks expected in these areas, with supporting bases for judgements.

2. Using the above crack maps determine the maximum tensile stress in the reinforcing steel for each DGB wall, floor and roof slab, and pedestal. Because engineering judgement is required in the selection of the parameters (i.e. total crack width, length, etc.) utilized in determining the reinforcing steel stress, the bases for the selection of these pertinent parameters and the general formulation should be clearly documented. Also, significant locations of maximum stress in each structural component (i.e. wall or slab) should be documented. These locations for each DGB structural component should be determined considering long and short lengths over which bar tension is determined. Provide tables identifying the maximum stresses due to crack evaluation and all other stresses resulting from the design load combinations (ACI 318 and 349 as modified by SRP).

3. Re-evaluate your proposed crack monitoring program as identified at the December 1982 hearing session. Consideration should be given to additional monitoring of cracked surface that will be epoxed and sealed during the proposed structural repairs of the DGB. Provide a detailed discussion of the additional monitoring identified in the task group's report or of other alternative approaches you would propose.

4. Re-evaluate the Alert and Action Limits to assure that sufficient stress margins are available to resist the critical load combinatins. Also, the monitoring program should mandate specific actions for the Alert and Action Limits. Provide detailed discussions on all criteria.

5. In the reference report (Appendix III, page 5, last paragraph) three instances of inconsistencies in settlement data are identified. Address each of the inconsistencies and identify the correct data. Your response should identify pertinent settlement marker locations and discuss settlement histories as necessary to fully explain the inconsistencies.

6. The staff finds that the level of survey accuracy currently proposed in the Technical Specifications (Chapter 16 of the FSAR) for settlement monitoring of seismic Category I structures and tanks would be inadequate should future settlements be significant and a reanalysis of structures be required because of the occurrence of larger than anticipated settlements. This staff conclusion on survey accuracy is based upon Applicant's testimony during the December 1982 hearing session regaring the DGB and upon the task group's report, Appendix III, page 12. Provide a revised settlement monitoring program for the DGB and other seismic Category I structures and tanks which will establish the required level of accuracy for the settlement measurements. The proposed monitoring plan also should address the number and specific monitoring locations, the installation type and details, frequency of readings and allowable total and differential settlement limits.

   The allowable settlement limits are to be based upon the structure's capacity to safely withstand the actual movements rather than upon predicted future settlements. These limits, therefore, should consider the present state of stress in the DGB and other stresses estimated to result from required design load combinations.

7. Provide updated settlement-time history plots for all the surveyed DGB settlement markers and a summary table which compares measured settlements to date with estimated settlements for the same time period. Provide a written evaluation of this comparison that includes a discussion on the conservatism and adequacy of total and differential settlements predicted for plant service life.